REPORT

OF

The Committee on Educational Survey

TO THE FACULTY OF

The Massachusetts Institute of Technology

PUBLISHED BY

THE TECHNOLOGY PRESS
of the Massachusetts Institute of Technology
Cambridge, Massachusetts
December, 1949

This report
to the Faculty of the Massachusetts Institute of Technology
by its Committee on Educational Survey
was first issued in an edition of only 497 copies.
A reprinting, in its original form and without change or revision,
has been authorized by the Faculty
for wider distribution.

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LETTER OF TRANSMITTAL

To the Faculty of the Massachusetts Institute of Technology:

Final reports are the traditional monuments to the labors of committees, and too often serve only as a burying ground for ideas. On the following pages are recorded the conclusions and recommendations of the Committee on Educational Survey. Our hope that they will exercise a beneficial and lasting influence on the future of this institution springs less from confidence in the power of the written word than in the belief that our inquiries have stimulated thought and discussion among our colleagues on issues of basic educational importance. If indeed the studies of the committee have materially contributed to this awakened interest, we shall feel amply rewarded for our efforts.

We herewith transmit to the faculty our report, together with the reports of our two auxiliary committees, the Committee on General Education and the Committee on Staff Environment.

Respectfully submitted,

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November 15, 1949

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ACKNOWLEDGMENTS

WE WISH TO ACKNOWLEDGE our indebtedness to all those who met with us for discussion, who responded to questionnaires, commented upon drafts of various sections of this report, and who in a multitude of ways aided and encouraged us. In accordance with our directive, broad faculty participation, through informal discussions and otherwise, has contributed to every aspect of our study.

We desire also to express here our thanks to the members of the two auxiliary committees who for nearly two years worked unremittingly on special aspects of our broad assignment. We are confident that the recommendations of the Committee on General Education and the Committee on Staff Environment will have a profound influence on the ultimate character of this institution.

On the behalf of the members of all three committees we wish to express our appreciation to officers of the administration for their constant and friendly interest throughout the course of this study, and for patient and generous assistance in making available at all times any and all information.

Professor Elting E. Morison, apart from his service with the Committee on Staff Environment, provided invaluable criticism and advice on the drafting of this report, for which we extend our sincere thanks.

We wish to acknowledge with the warmest gratitude and thanks the part taken by Professor Lynwood Bryant in the conduct of this study. As aide to our committee he has given unsparingly of his energy and time, and has contributed to all our discussions understanding, mature judgment, and a wide knowledge of educational problems.

We wish to express our special indebtedness to Miss Persis Joan Ladd, who served conscientiously as staff assistant for more than two years, and to her capable successor, Miss Ann Orlov, for their invaluable aid in the organization and execution of our work.

REPORT

OF

The Committee on Educational Survey

Foreword

IN JANUARY OF 1947, the Faculty of the Massachusetts Institute of Technology appointed the Committee on Educational Survey to review the state of education at the Institute. The committee was instructed to reëxamine the principles of education that had served as a guide to academic policy at M.I.T. for almost ninety years, and to determine whether they are applicable to the conditions of a new era emerging from social upheaval and the disasters of war.

Our study has consumed more than two years, and we have at times been appalled both by the magnitude of our task and the slowness of progress. We have given little attention to the details of curricula, for we have believed that major revision should be undertaken only after a basic reëvaluation of our educational philosophy. We have, however, examined the concept of professional education upon which this Institute was founded and reassessed our way of teaching. Our task, as we have seen it, has been to determine whether the Institute must alter the direction of its effort, or broaden its base, or apply its methods in new ways and to new areas.

A long tradition of leadership in professional education at M.I.T. has culminated in a magnificent record of national service. At no time has the Institute stood so high in the public esteem. One senses a feeling of confidence and power. The frontiers of knowledge are being attacked with boldness and enterprise. We take pride in our fine body of students; our relations with industry have never been more cordial; and we have been called upon to participate in national planning and defense on an unprecedented scale.

Why, then, was there felt a need of critical appraisal at a time when the Institute was conspicuously healthy and vigorous? In formulating questions to guide the deliberations of this committee, the faculty has indicated concern about the educational implications of changes that have taken place

both in the Institute and in the society that it serves. Our studies have revealed apprehensiveness among our staff and alumni that in an exciting inflationary atmosphere, when money was easy and physical expansion tempting, we may have yielded uncritically to temporary pressures and lost sight of long-range educational goals. These misgivings as to the wisdom of some of our current enterprises are clearly tempered by a reluctance to abandon them. We find also a fear that we are complacently adhering to a kind of education that proved successful a generation ago, without taking into account significant changes that may have made this kind of education obsolete.

Forces are at work that appear to be bringing about subtle and profound alterations in the very character of the Institute. There has been an enormous expansion of physical plant, and a corresponding growth of staff. We continue to proclaim that our primary mission is to teach, but other activities have assumed an unprecedented role at M.I.T. Service to the community and to the national government has always been recognized as a primary obligation, but now the dollar volume of government-sponsored research amounts to far more than the academic budget. Postwar government funds have been used to maintain a very large technical staff without privilege of tenure, and a major part of the Institute's personnel is now dependent upon the continuation of short-term financial support. Government money has made available to us magnificent facilities that have become a permanent part of the Institute, and that involve continued responsibility for their maintenance.

This committee has no desire to recommend change for the sake of change, but it also believes that there is no road back. The world of 1950 is not the world of 1940, nor can this institution ever again be the same sort of place it was before the war. We are faced with certain accomplished facts that cannot be ignored. All of our future planning must take these changes into account.

Many of the changes that have taken place in the Institute reflect new conditions in the world about us. The release of nuclear energy is having a profound effect upon the course of human events, but other forces are also at work on society. They were beginning to modify our way of life long before the atomic bomb.

We are awake now, at last, to the knowledge that our rich and prosperous nation cannot withdraw into isolation. We have discovered that the social institutions of the United States are subject to forces similar to those that are molding the destinies of Europe and Asia. The very concepts of democracy, of equality of opportunity, and of leadership are shifting and developing in the American mind. The utter waste of two world wars confronts us with the necessity of considering the finite limits of our national resources. Even more significant, and perhaps more threatening to our present form of democracy, is a persistent tendency to growth and centralization of control in all organizations and institutions, industrial, financial, educational, and labor. There is a concerted effort to increase the efficiency of management and to eliminate fluctuations in economic and social status. One must at times wonder whether the price of some of these changes may be an ever-diminishing premium placed on the man who is different, on the function and qualities of imaginative and creative leadership.

Democracy as we have known it for more than two hundred years is the fruit of leadership that rises from the initiative and individuality of the people. If this nation is to hold to a high goal, it must continue to cultivate a superiority of spirit and intellect. Since the war, there has appeared a new national consciousness of the responsibility for providing education to all of our young men and women commensurate with their ability. But in broadening the educational base, let us not stifle individuality by seeking uniformity; let us not fail to discern the gifted mind, to foster special talents, and to provide an environment in which these may flourish.

We believe that the mission of the Institute should be to encourage initiative, to promote the spirit of free and objective inquiry, to recognize and provide opportunities for unusual interests and aptitudes; in short, to develop men as individuals who will contribute creatively to our society, in this day when strong forces oppose all deviations from set patterns. We believe that the Institute should boldly undertake new experiments in education and new explorations into the unknown, withdrawing at the same time from ventures in which its leadership is no longer required. Our task, as we see it, has been to consider how the Institute may accomplish these purposes most effectively.

Chapter I

Development of an Educational Philosophy

What is the concept of professional education upon which the Institute was founded? Has it been followed consistently through the years? If not, have the deviations been desirable or undesirable, and what can we learn from them of use in our future planning? Is the basic philosophy of education that has characterized the Institute in the past still relevant in our time? If so, are we applying it to best advantage?

These and other pertinent questions can be answered with greater clarity if we examine the highlights of educational philosophy developed at M.I.T. In doing so we shall arrive at certain conclusions, but even more important, we shall be able to introduce, in appropriate context, numerous issues that are to be considered in succeeding portions of this report. This chapter therefore serves both as means of establishing the general frame of reference of our discussion and of forecasting the pattern of what is to come.

THE ESTABLISHMENT OF M.I.T. IN 1865 was no accident of philanthropy or local interest. It was the culmination of a mature plan centered on a new philosophy of education in response to new conditions of society. The Institute was a direct product of an awakening industrial era. Within a few short decades the capacity of man to construct, to produce, to express himself in terms of tangible physical materials, had been multiplied a thousandfold. The volume and variety of material with which the human mind had to deal had increased enormously. New patterns of thought were molding social institutions, and new concepts of social responsibility, no less than the material innovations of technology, were imposing new demands on the education of youth. There was a need in America for a new approach to higher learning, a need that William Barton Rogers undertook to fulfill through his plan of professional education.

The Institute survived the financial vicissitudes of its early years and the competition of universities based upon other principles of education because Rogers had not only conceived a philosophy of professional education but had formulated a plan of action and provided an inspiring leadership in administrative skill. But

above all, the Institute survived and grew to greatness because this new plan satisfied a basic need in a fresh and youthful industrial society. Our academic policy to this day is shaped in many respects by the basic concepts of the founder.

Rogers was motivated by a deep-rooted conviction that the classic modes of higher education failed to meet fully the needs of the new era. He was by no means alone in this belief. His ideas were in the spirit of his time and reflected the influence of many of the most eminent writers of the day. In Boston Jacob Bigelow and later Charles W. Eliot, one an officer, the other a professor in the new institute of technology, wrote eloquently on the inadequacies of contemporary university education, borrowed from abroad, and expressed the hope that there might soon emerge a new form of university, indigenous to American soil and American culture. Elsewhere other educational leaders expressed similar views. But among them, Rogers was distinguished by having formulated his concepts with unusual thoroughness into a practicable working plan and we shall do no violence to truth in referring to it as the Rogers Plan.

The Rogers Plan

Rogers had three main principles in mind when he founded the Massachusetts Institute of Technology.

First, he believed in the educational value of useful knowledge. He felt that in an industrial society science and technology were legitimate foundations of higher education and that a place must be made for the young man who wished to apply the fruits of scientific discovery to the satisfaction of human wants.

Second, he believed in learning by doing, that is, education through first-hand experience with real situations.

Third, he believed in introducing professional education at the undergraduate level, and in combining with it the basic elements of a liberal education. The development of technical proficiency was not enough; higher education ought to enable a man to participate effectively in what Rogers called "the humane culture of the community."

In order that the full significance of Rogers's innovations may be understood, it is essential to consider the above points in greater detail.

Rogers's conviction of the dignity and importance of useful knowledge must be interpreted broadly lest it be misconstrued as placing high value on specialized training in vocational skills. He recognized that in the ultimate all knowledge is first derived from experience, and that the relevance of fundamental knowledge to genuine situations ought therefore to be understood clearly and put to practical use. This point of view is not incompatible with training at the most advanced and highest possible levels. Indeed, as Richard Cockburn Maclaurin later pointed out,

the world's oldest universities all began with the clear purpose of preparing men for definite callings; ". . . it was not a merit, but a defect of these schools, that most of them had failed to keep pace with the changes in the character of human occupations that time had brought forth." [1]

In the new era, society needed men trained in science and technology and these areas of knowledge could therefore provide a sound basis for a higher education in which one might benefit by the motivation of striving toward a useful goal. This purpose to develop higher education upon a basis of science and technology, therefore, did not imply a desire to provide mere vocational training. Rogers always made a sharp distinction between professional education and vocational training: ". . . the most truly practical education, even in an industrial point of view, is one founded on a thorough knowledge of scientific laws and principles, and one which unites with habits of close observation and exact reasoning, a large general cultivation."[2] He urged that the principles of science rather than the details of their application be cultivated in our undergraduate curricula, and he believed strongly that the accumulation of facts about science and technology is secondary to the mastery of a scientific method of thinking.

Rogers believed that, from the very outset of his studies as an undergraduate, a student should acquire appreciation for concrete conclusions founded on factual data, and M.I.T. very early took the lead in the educational use of laboratories, shops, and drafting rooms. But "learning by doing," as he intended it, must not be confused with mere acquisition of manual dexterity; rather it is any means by which the student learns to seek out and come to grips with facts. Learning by doing means active rather than passive learning, and underlying it is the desire to be effective. Whatever the field, the student must be led to seek out for himself the sources of knowledge, and by his own efforts convert facts into the body of his personal experience.

Rogers's advocacy of a broad liberal education, including English, history, economics, and the living languages, in addition to technical training, as a preparation for life was not of course novel, but his conviction that professional training should be combined with these other studies in an *undergraduate* curriculum was at variance with the thinking of the majority of his contemporaries. Indeed, this integration of professional and cultural education as contrasted with the stratified plan in which professional training is deferred to postgraduate years is limited even today to a few professional fields. Of these, largely as the result of the influence of Rogers and his successors, engineering education in the U. S. A. is the outstanding example.

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[1] From an address by President Maclaurin, as quoted in "An Impressive Anniversary," *The Technology Review*, XIII, No. 5, May, 1911, p. 308.

[2] *Ibid.*

Rogers considered that the attainment of professional stature in science and engineering calls for an orientation of mind and habit that are best achieved by appropriate conditioning in the undergraduate years. The integration of general and professional studies into an undergraduate curriculum should insure breadth of view. By drawing illustrations of scientific principles from a professional field for which the student has a predisposed interest, the whole effort is enriched with a sense of purpose and usefulness.

These three aspects of Rogers's philosophy have had important influence throughout the development of the Institute. Suitably interpreted in the light of changed conditions, they seem to us excellent guiding principles in our educational planning today, and they will be recognized as recurrent themes in much of what follows.

An Institution with Limited Objectives and Unity of Faculty

As early as 1846 Rogers had formulated his theories of professional education and in the years that followed he pondered various means of putting them into effect. He took a particular interest in the founding of the Lawrence Scientific School at Harvard in 1847 but ultimately concluded that the principle of his proposed institute of technology could not be brought to full fruition within the framework of a large university. Actually, discussions between Harvard and M.I.T. continued until 1917 with a view to a coördinated program in the fields of applied science or even to a merger of the two institutions, and these negotiations constitute in many respects a most illuminating study of two different philosophies of engineering education.

Rogers became convinced that his objectives could best be achieved by an independent institution devoted to science and technology, with a unity of purpose and method, rather than through a professional school attached to the larger and more diversified organization of a university.

Both academic and administrative policies at M.I.T. have from the very outset been governed by these principles of limited objectives and unity of the faculty, and we believe that they have been of great importance in contributing to the success of the Institute. In Chapter III we shall recommend that increased emphasis be given to promising areas in which we foresee opportunities for unique contributions. We should also wish to see the wise curtailment of activities that have served their useful purpose. The facilities of the Institute should, in our view, be employed where they can be most effective, and we prefer changes of direction to indiscriminate expansion. We fear that the unity of the faculty is already endangered by expansion, especially that which has resulted from wartime and postwar trends. But we are confident that this situation can be remedied by reorganizing some of our methods of operation, and we shall discuss this matter in detail in Chapter V.

An Institution with an Urban Character

The establishment of the Institute at the center of a large urban area was a well-considered point in the Rogers Plan. As Charles W. Eliot put the matter in an *Atlantic Monthly* article in 1869: ". . . A technological school is best placed in a large city, in a great industrial center. A college needs quiet and seclusion; a technical school, on the contrary, should be within easy reach of works, mills, forges, machine shops and mines. The professors of a scientific school have need to be brought into daily contact with practical affairs, to watch the progress of new inventions as they develop from day to day, and to know the men who are improving special industries. The students of a scientific school have a like need."[1]

The location of M.I.T. has long since ceased to be a matter over which anyone may exercise control. It is a fact, however, and a vital one, that we are an urban institution and that this urban quality has been closely related to the intimate association always maintained by our faculty with the non-academic world. Our situation in a metropolitan area and our traditional relation to industry are environmental factors that have played a dominant role in the development of the Institute, and that must always be taken into account in planning for the future.

Our urban setting makes it essential to plan the development of the physical aspects of the Institute in such a manner that the best possible environment for creative work and effective teaching can be provided for our staff. This problem has been given careful consideration by the Committee on Staff Environment, and is discussed in detail in their report.

Trends Toward Vocational Training

The Institute as we know it today expresses with remarkable fidelity the ideals of its founders, but it also bears the scars of a period of conflicting theories and practice.

The first phase of our academic development was characterized by a centralization of interest on engineering with a strong practical bent. Even before Rogers retired, a shift in emphasis towards the more practical, and even the frankly vocational objectives, became apparent. In the succeeding years this evolution continued, often through changes of policy of which the implications may have been unperceived at the time. After fifty years it is difficult to evaluate the academic atmosphere that prevailed at the Institute near the turn of the century and we incur the risk of doing an injustice to the many true scholars who were members of

[1] Charles W. Eliot, "The New Education, Its Organization, Part II," *The Atlantic Monthly*, XXIII, March, 1869, p. 364.

our faculty during this mid-period. There appears, nevertheless, to be little doubt that our instruction had assumed a vocational cast far beyond that contemplated by Rogers.

Early catalogs reveal that within a few years after the founding of the Institute a marked decrease took place in the time devoted to general studies. The first curricula were in fact notably rich in material that we now ascribe to the Division of Humanities, and the subsequent disappearance of these subjects from the annual catalogs is evidence of a shift in academic policy. Simultaneously there began a steady growth in the number of subjects devoted to the practical details of engineering; more hours were devoted to boilers, stokers, and mining practice, without any compensating increase in time spent on such theoretical matters as thermodynamics. Likewise, there occurred a notable increase in the facilities for practical work, such as drafting rooms, shops, and foundries. "Learning by doing" began to be interpreted in its narrowest and most utilitarian sense. The records also show a proliferation of curricula, options, and subjects; evidence of an increasing departure from first principles and growing attention to technical detail.

Not only had a sound preparation in mathematics, physics, and chemistry been considered by Rogers to be the indispensable foundation for professional engineering, but he had also considered the pursuit of knowledge in the natural sciences to be a desirable end in itself. The education of future teachers and scholars in these fields was, to his mind, an objective of the Institute equal in importance to that of training engineers. Nevertheless, the science departments failed to thrive. They appear to have been reduced at an early date to fulfilling little more than a service function. A few men of exceptional scientific attainments graced our faculty during that period, and a few alumni pursued distinguished careers in pure science; the performance, however, was spotty and the average poor. English, history, and economics (the last introduced by Walker) hovered unhappily in a peripheral region, while architecture largely pursued its independent way. Thus, increasingly, "Boston Tech" became synonymous with a school of practical engineering.

Meanwhile the pattern of education at M.I.T. became more rigid. Whether by intent or by an accident of growth, the Institute tended more and more to turn out a standard product; a man was a Tech man or he wasn't, he passed or he failed. Special distinctions, even honorary fraternities, were frowned upon. There was little disposition to recognize work done at other institutions by transfer students, and little encouragement was offered to the student of unusual aptitude who wished to advance more rapidly through independent study.

These trends toward the vocational have since been reversed, but they illustrate certain dangers inherent in professional education: the danger of overspecialization in professional curricula, especially in the undergraduate years, and the danger that

too exclusive an emphasis on the practical aspects of engineering may retard the development of natural science and the humanities. To guard against these dangers we have tried in Chapter II to define the goals of undergraduate education and to recommend specific means of achieving them.

Return to Earlier Ideals

Following the intermediate period of emphasis upon vocational as contrasted with professional education, the influence of two presidents, Richard C. Maclaurin and Karl T. Compton, markedly altered the intellectual direction of the Institute. President Maclaurin did not live long enough to accomplish his full program, but he provided the Institute with new and adequate physical facilities and with the inspiration and resources to advance into a new period of development.

During the 'thirties, the Compton administration undertook to enlarge the purpose and meaning of an M.I.T. education. The balance between science and technology was restored by an increasing support for work in the pure sciences. The curricula were revised to reduce the amount of required practical work in shops and drafting rooms. Subject matter was simplified and the significance of fundamentals as opposed to details was emphasized. The Graduate School was expanded in all departments, and the importance of research in all fields was increasingly emphasized.

These changes lifted the morale of the M.I.T. community and resulted in renewed confidence in the ability of the Institute to develop leadership in science as well as in engineering. The Institute was no longer dominated by the engineering point of view, and the engineering departments themselves became less narrowly vocational. Differences in professional attitudes and objectives between engineering and non-engineering fields were recognized, insuring independent development of each major activity.

The appointment of Deans of Science, Engineering, and Humanities reflects this altered intellectual emphasis and marks the beginning of a recognition that the Institute has an important mission in fields other than engineering and architecture.

We believe that the time has come to give new emphasis to this broader mission, and we shall recommend methods of doing so in Chapter III.

Recent Changes as a Result of World War II

In November, 1940, the Radiation Laboratory was established at M.I.T., and this date marks the active entry of the Institute into a wartime regime, well over a year before Pearl Harbor. Although the Radiation Laboratory was by far the largest of all our projects, every department ultimately became engaged in war work, and the volume of research and development contracts had exceeded one hundred million dollars before the end of 1945.

The contractual responsibility for the effective administration of these many projects was an Institute affair, but technical direction was by no means confined to our own staff. Particularly in the case of the Radiation Laboratory, whose personnel by the close of the war approached four thousand, M.I.T. acted as host to an extraordinarily distinguished group of physicists and engineers drawn from throughout the land.

Thus, for nearly six years, the Institute served as the vortex of intense activity in the development of new weapons and techniques in a great variety of fields, drawing experts from many institutions and sending away members of its own staff as consultants to industry and the armed forces. These six years comprise a most important chapter in the history of M.I.T. and they have left indelible marks on the character and outlook of the institution. The experience of receiving into our midst such an imposing gathering of scholars from other universities was invaluable. There was a period during the early years when the multitude of our visitors conveyed the impression of an invasion from abroad. In time, however, the conciliatory changes characteristic of most extended foreign occupations began to occur, and it was notable in 1945 that many of the sharp distinctions between the several groups about our campus had begun to disappear.

We trust that those who now have returned to their own colleges and universities will look back upon the war years at M.I.T. as a profitable and intensely interesting period. For our part these war-time experiences and associations have, without question, exercised a very great influence on educational matters and research. Furthermore, the administrative experience of managing a very large enterprise was an invaluable one. We acquired much first-hand knowledge of the problems of a big institution and the conduct of research under government sponsorship on an extended scale.

The New Problems

The war-time changes have led to several problems of paramount importance to M.I.T. Among these, the four that follow seem to us to deserve particular consideration.

First, there is the matter of size. The spectacular war-time activities of the Institute left us with a greatly expanded plant, gave our staff new interests and opportunities, and vastly stimulated the demand for our type of education. Size has an important bearing on the character of every institution. Those who have been at the Institute for the past ten years are well aware that this period has been accompanied both by progressive diversification of activities and by decrease in unity of the M.I.T. community — staff, student body, and administration.

As the Institute grows, the problem of carrying on its daily business becomes

more complicated; satisfactory coördination requires the substitution of formal rules and procedures for actions that were once accomplished more informally and flexibly. Such is the price that must be paid for the added power and prestige that come with growth, and the question that confronts us is that of deciding at what point the gains achieved by growth become so costly as to make further expansion inadvisable. Insofar as the teaching program is concerned, size should at the very least be limited by the ability of the Institute to attract high-caliber students, and although this has not been a controlling factor in the immediate past, it may very well be one in the future. In the absence of this factor, what constitutes an expansion of activities sufficient to endanger the unity of the staff and the unity of the objectives that have contributed to M.I.T.'s past greatness? This question cannot be answered by means of an explicit formula; many intangible factors, interpretations, and opinions must be taken into account, and we can merely state that in our judgment there is some evidence that the optimum size may already have been exceeded.

Second, there is the apparent shift of interest from undergraduate affairs to the Graduate School and to research. The accumulation of scientific data and the increasing complexity of engineering problems have led to constant pressure in the direction of longer or more specialized professional education. At the same time, increasing awareness of the need to provide future leaders of industrial and civic affairs with broader social and cultural backgrounds has led to advocacy of the devotion of more time to non-technical subjects.

Because of this dilemma, many persons have begun to doubt the merits of professional work in the undergraduate years and to recommend, instead, a conventional liberal arts undergraduate program followed by concentration of all professional work in a graduate school. This has long since been the course adopted by law and medicine, but the very real possibility that M.I.T. is now moving in the direction of becoming exclusively a graduate school is a disconcerting one to many of our staff and alumni. We must ask whether our success in the graduate field is to be achieved at the expense of our undergraduate professional program; for we have seen that the entire educational philosophy of the Institute is based on the premise that an approach to professional training through the undergraduate years is desirable.

At this juncture we ought either to reaffirm our faith in our kind of undergraduate education and fortify it to meet the needs and competition of our day, or prepare to abandon it in favor of a different kind of institution devoted to other objectives. We have concluded, for reasons discussed in detail in Chapter II, that the former alternative is clearly the better one for M.I.T.

Third, new problems have been engendered by the phenomenal growth of

sponsored research. The questions involved are all the more perplexing in that the advantages of a large program of subsidized research are manifest. The practical application of knowledge and skills to immediate problems fits in well with our philosophy of education, emphasizing as it does the combination of theoretical and practical work and the intimate association of teaching with creative activity. Sponsored projects have provided research facilities to our staff and educational opportunities for students that would not otherwise have been available.

The sheer size of the program is alarming, but there are other problems of equal importance. Is all this work genuinely creative? Can it indeed be justified on the ground that it strengthens our educational program? Have our staff members not on occasion been lured by the prestige that accompanies an enlargement of activities without considering the loss in their professional competence that the undertaking of added administrative burdens may entail? Is there not, in fact, danger that the energy and interests of some of our most talented colleagues are being diverted from education to income-producing work? And is it safe to rely on this source of income, to become accustomed to a standard of living that we should find impossible to maintain in the event of a sudden cut-back of government support?

In Chapter IV we have considered both the advantages and the inherent dangers of our sponsored research program, and we have concluded that we must, in the future, give greater emphasis to periodic and realistic evaluations of all aspects of this effort if we are to derive the greatest educational benefit from it.

Finally, we are confronted with a fourth set of problems that are by no means peculiar to M.I.T.; they relate to the place of all privately controlled institutions in a critical period of social change, in a society committed to universal education and to tax policies that threaten future income and endowment. There was a time when the private colleges of this country possessed a virtual monopoly in the field of higher education. Today they carry a steadily diminishing share of the total burden.

To survive as a private institution M.I.T. must make a unique contribution, must provide a service and a kind of education that are both needed and not easily to be had elsewhere. Can we now lay claim to meeting such a need? Can we justify to our prospective students and the families of those students the high cost of four, five, or even seven years at M.I.T.? What value are we to place on institutional independence, and to what extent is that independence endangered by the growth of government subsidy of education and government contracts for research?

We believe that the mission of the private institution in this era is to provide a kind of education that cannot be obtained elsewhere, sufficiently superior to attract exceptional students. We believe that the Institute can provide such an education. But, as developed further throughout this report, we feel that this cannot be accomplished by complacently continuing as we are; it can only be accomplished if

we take advantage of the many opportunities that lie ahead both to improve the education that we now offer and to extend it into new and promising areas hitherto undeveloped.

Conclusions and Recommendations

Our review of the origins and development of the Institute's educational program throughout the past ninety years has led us to a number of conclusions that are mentioned briefly in the foregoing discussion. We summarize these conclusions below, together with the recommendations to which they have led; however, it should be noted that the reasons for most of these conclusions and the more detailed recommendations relating to them are developed in later chapters.

1. We conclude that William Barton Rogers's original concepts of higher education with a scientific and technical basis, of learning by doing, and of the value of an integrated professional and liberal education are important guiding principles relevant to our educational planning today. However, his concepts must be interpreted broadly and applied with full cognizance of the many changes that have taken place since his time.

2. We conclude that the principles of limited objectives and of unity of the faculty are important elements in the Institute's strength. We recommend that the Institute progress to meet new opportunities by reevaluation and modification of its program rather than by mere expansion into new fields without accompanying withdrawal from activities that no longer serve a useful purpose. We also recommend that methods of faculty operation be reorganized as outlined in Chapter V in order that the unity of the faculty may be strengthened.

3. We conclude that the urban setting of the Institute is both an asset in that it provides close liaison with commerce and industry, and a liability in that it gives rise to certain environmental problems inimicable to teaching and research. We recommend putting into practice to the fullest extent feasible the suggestions of the Committee on Staff Environment for creating an environment aimed at permitting the staff to carry on its work most effectively.

4. We conclude that our educational program has at times veered unduly toward the vocational. We recommend that such tendencies be avoided in the future by the adoption and effective application of the policies and procedures discussed in Chapters II and V.

5. Although the Institute's long period of emphasis upon engineering education at the expense of science, the humanities and social sciences, and perhaps even architecture, was followed by an awakening to a broader mission in the 1930's, we conclude that we have not yet begun to exploit to the full our opportunities in these other fields. We recommend full acceptance of our broader mission at this time, as discussed in Chapter III.

6. We conclude that our rapid growth as a result of World War II has given rise to dangers of overexpansion. We recommend a serious effort to stabilize our over-all size within limits that will avoid purposeless dissipation of our abilities and resources. The problem lies in the jurisdiction of the administration and should receive continuing attention.

7. We conclude that many factors, including expansion of knowledge and enlarged support of research and development activities, have led to a preoccupation with graduate education at the sacrifice of attention to our undergraduate program. We reaffirm our belief in Rogers's concept of undergraduate professional education. We recommend establishment of an appropriate balance by strengthening and revitalizing undergraduate education along the lines suggested in Chapters II and III, and in the report of the Committee on General Education, rather than by curtailing the achievements of the Graduate School.

8. We conclude that the growth of sponsored research has opened to us invaluable opportunities for realizing the educational advantages of an active research and development program, but has also led to possibilities of indiscriminate participation in activities of questionable creative value, of dissipation of staff effort in administration, and of dependence upon unreliable short-range financial support. We recommend, as discussed in Chapter IV, that greater emphasis be given to periodic and realistic evaluations of all aspects of this effort in relation to our educational program.

9. We conclude that social trends toward a broader base of higher education, and financial trends toward decreased endowment income, pose problems for the Institute no less than for other private educational institutions throughout the country, and that in the future the primary goal of private institutions should be to provide limited groups with useful kinds of education not readily duplicated elsewhere. We recommend that the Institute limit its educational efforts to fields in which it can clearly excel, and that it continue to give special emphasis to the pioneering of new areas wherein its leadership can be of distinct value to the community and the nation.

Chapter II

Undergraduate Professional Education at M.I.T.

We have encountered widespread opinion that the Institute is already primarily a graduate school and that its responsibilities for undergraduate education are no longer taken seriously. Regardless of the extent to which this situation may be real or imaginary, it is a fact that strong feelings are expressed about it. Some deplore the situation, stating that we are losing sight of our primary mission, and that our alumni are tending more and more to send their sons to other institutions for undergraduate work. Others suggest that the future opportunities for the Institute lie almost exclusively at the graduate level where its exceptional facilities for research and advanced training give it special advantages.

We have considered and rejected the proposal to concentrate our energies exclusively on postgraduate training, and have concluded that we should continue, and improve, our educational program at both the undergraduate and graduate levels. In this chapter we reëxamine the objectives of professional education and reassess the various routes by which such an education can be achieved. We conclude that the most important problem of general education is to devise effective methods of developing in the student intellectual power and competence. We discuss specific means for improving the undergraduate program and recommend a variety of changes that we believe to be essential if the Institute is to maintain its leadership in the undergraduate field.

UNDERGRADUATE EDUCATION in a technological school has two objectives: the *professional* and the *general*. The professional objective is to prepare a man for a certain kind of work in society. The general objective is to develop the character traits, the intellectual habits and skills, and the understanding of nature and man that an educated person should have, regardless of the kind of work he does.

It is convenient for the discussion of educational problems to make this logical distinction between two aims of education, but it is important to remember that it is primarily a distinction in objective and not necessarily in educational materials and methods. In practice the professional and the general elements should not be isolated; they should not be assigned to separate subjects or to separate teachers. All parts of an educational program should contribute to both ends. The term *general education* may be used to refer to the components of a curriculum that are more immediately related to the general aims than to the professional, but these

components also make an essential contribution to a man's professional competence; the subjects more directly related to the professional aim help to develop a man's character, judgment, and intellectual power, and their place in an undergraduate curriculum is justified by this contribution.

The Integral Plan

The segregation of the general and the professional educational functions in separate institutions or in separate years of a curriculum leads to a kind of professional education that has been called the *stratified*[1] plan. Education in law and medicine, for example, is normally a concentrated professional training in a graduate school superimposed on a general undergraduate education. This is also the pattern of engineering education in most European countries.

From the beginning, M.I.T. has held to a different course based on Rogers's theory that in science and technology it is possible and desirable to combine a sound general education and a sound foundation for a professional career in one undergraduate program. In the United States, engineering education, partly because of M.I.T.'s consistent leadership, has commonly followed this pattern, which has been called the *integral* as distinct from the stratified plan.

Since 1865 many educators have questioned the wisdom of the integral plan, and in recent years some engineering schools, faced with the difficult problem of integrating general and professional education within narrow time limits, have experimented with the stratified plan in one form or another. The difficulty with the integral plan, it is said, is that in trying to do two things at once it fails to do either one well. The great accumulation of technical knowledge in recent years has increased the demand for specialization in the professional school, and on the other hand the mere smattering of humanities possible in a technological curriculum, it is said, is wholly inadequate for future leaders of technology and business, who will have to grapple with social problems more important than strictly technical problems.

It has been suggested that M.I.T. can best meet modern educational needs by concentrating on specialized professional education in the graduate school, in which it has been conspicuously successful, leaving the undergraduate preparation to other schools. It has also been suggested that if the undergraduate program is retained it should be lengthened to five or six years, in order to make room for the broader cultural background and for the increased amount of specialized instruction now considered necessary for undergraduate education in science and technology.

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[1] We have taken the terms *stratified* and *integral* from an article by William E. Wickenden, "Shall Higher Education be Expanded on the Technological Pattern?" *Journal of General Education*, I, April, 1947, pp. 178-186.

We have considered and rejected both these proposals. We conclude that M.I.T. should continue to offer a strong undergraduate program, and that for most courses it should be limited to four years.

We believe that the general and the professional objectives ought not to be separated and that in the fields of science and technology they can be integrated in a four-year program to produce educated men with a sound basis for a professional career.

We recognize that the recent rapid advances in science and technology and the increasing need for a broad cultural education among professional men have created serious educational problems for us, but we believe they make the integral plan more rather than less desirable. Preparation for careers in these fields ought to begin in the undergraduate years, and an undergraduate education in the atmosphere of a professional school with a curriculum based on science and technology meets the general educational needs of a large class of students.

This conclusion is not merely a complacent endorsement of the traditional aim and the curricula of the Institute. It is a commitment to a program of improvement that will revitalize undergraduate education at M.I.T. We must enlarge and strengthen the cultural elements in our curricula and make the technical subjects a better vehicle for the development of such general qualities as intellectual power and creative imagination.

To lead the way to an improved synthesis of general and professional education in a four-year undergraduate program based on science and technology is the most important service M.I.T. can render to society. We believe that M.I.T., because of its many years of experience with the integral plan, is well qualified to undertake the development of such an educational program.

The General Educational Value of the Integral Plan

One objection to the integral plan is that the general objectives of education, which in an undergraduate school must have priority over the professional objectives, cannot be reached through the typical curriculum in science and technology, which is crowded with subjects essentially practical and illiberal.

We agree that in undergraduate education the general rather than the professional aims must be dominant, and we also recognize that the study of the humanities is necessary in all education. Indeed, one of our major recommendations is for a decisive strengthening of our work in the humanities and social sciences.

However, for general education we do not rely solely on the humanities. Our faith in the concept of undergraduate professional education rests on the conviction that the subjects of study and the methods of teaching characteristic of a technological curriculum have a general as well as a professional educational value.

In 1865 science was still struggling for a respectable position in the college

curriculum. The struggle is long since over, and it is no longer necessary to argue the general educational value of the study of the natural sciences and their applications. Indeed, it is now commonly agreed that without some understanding of the meaning of science and its importance in the modern world, no man is adequately educated. It is just as important for liberal arts colleges to make science intelligible to students whose primary interest lies in other fields as it is for technological schools to develop in their students an appreciation for the humanities and an understanding of the social sciences. An awareness of the values in both these areas is essential in any education, and either one may be the primary focus in a general educational program. A large and increasing number of American young people can best be stirred to intellectual growth through their natural interest in science and technology. The technical school has a great opportunity to use these natural interests and aptitudes as the central motivation in an educational program.

The *method* of learning typical of technological education also has a general educational value. The laboratory method, in which M.I.T. pioneered in this country, has long since justified itself as the best way to an understanding of the principles of natural science, and it has been adopted as the basic method in other professional schools; it becomes the clinical method in medicine and the case method in schools of business and law. But "learning by doing" means more than the laboratory method. It means a general method of learning applicable in all fields: the method of learning by inquiry rather than learning from authority. It implies the theory that an active participation of the learner in genuine problems is necessary for full understanding. It breaks down the artificial barrier between the academic and the non-academic world; it gives the school an atmosphere of relevance to the outside world. The professional atmosphere of an institution like M.I.T., with its respect for genuine practical problems and with its intimate and responsible relations with the non-academic working world, can be an inspiring one for many students. In this atmosphere, using these methods of teaching, M.I.T. can give students the kind of understanding of the modern world that future leaders must have.

The technological school is sometimes considered unsuitable for undergraduate education because its narrowly specialized curricula tend to produce men insensitive to values outside their field, men who ignore their responsibilities as citizens, men who are content to devote themselves to techniques and leave the determination of policy and the choice of values to other men. In the past this sort of criticism has undoubtedly been justified by rather narrow interpretations of the aims of technological education, but the fault is not so much in the theory as in the practice of this type of education, and the fault is not one peculiar to technological institu-

tions. The man who dodges social responsibility and seeks refuge from the world in the comfortable isolation of narrow specialization is not unknown in the liberal arts college.

All education should prepare men for social responsibility; all education should concern itself with ends as well as means, with value as well as technique. We reject the view that there is one particular curriculum suitable to prepare men to be the leaders of society, and another distinct type suitable for specialists in techniques who are to be the servants of the policy makers. We believe that if the problems chosen for study are alive and complex, with social and ethical dimensions, the curriculum of the technological school can be an excellent medium for the development of leaders competent to handle the urgent social and political problems that now confront the world.

The Integral Plan as Preparation for a Professional Career

An undergraduate education in a technological school is a professional education in the sense that it appeals to students who wish to prepare for more or less specific roles in society, and it educates them partly through the study of genuine professional problems. It is not a vocational education in the sense that it teaches the specific skill or information necessary in a particular narrow occupation, and it does not produce a fully formed professional man ready for a responsible position. It is a foundation for a professional career.

An undergraduate education is no longer enough, as it may have been in certain fields fifty years ago, to give a man the command of a special field necessary for full professional competence. But it is enough to orient a young man in a broad field in which he has shown some interest or talent, to give him a mastery of fundamental principles, and to impart the spirit and the vocabulary of a profession. In the fields of science and technology, this sort of preparation for a career should normally begin in the undergraduate years.

A man with this kind of basic technological education has a good foundation for full professional specialization in graduate school, and if he chooses to go directly into business or industry he is prepared for a wide variety of occupations. Applied science now touches so many different aspects of modern life that there are important opportunities for men with a general understanding of science and technology, but without a high degree of technical specialization; men with a knowledge of basic principles and a capacity for learning rather than with specialized knowledge or skills. It is this thorough grounding in fundamentals and this adaptability that make a man valuable to industry despite fluctuations in the demand for specialists.

M.I.T. can speak with assurance of the value of the integral plan as a foundation

for a professional career. Most of the distinguished leaders in technology and business that M.I.T. has produced have had this kind of education, without formal specialization in a graduate school, and a surprisingly large number of our graduates have been successful in positions remote from their special fields of interest as undergraduates. We believe that a large share of the future leaders will be chosen from this group whose formal professional education ends with the bachelor's degree.

The Four-Year Plan

We have concluded that undergraduate education at M.I.T. should normally be limited to four years. To increase the standard course to five or six years would certainly ease the pressure on the curriculum and simplify many educational problems. But we believe that our first task at M.I.T. is to make undergraduate education more effective within the present time limits, and we are instinctively suspicious of any proposal to improve education simply by adding subjects to the curriculum or years to the course.

America's uncritical faith in education is not an unmixed good. It has increased the reliance upon educational institutions to provide the kind of professional training that should be acquired through experience on the job. It has overemphasized formal educational requirements for entrance into certain fields. It has encouraged, we sometimes fear, the use of the graduate school as a shelter for the timid who wish to postpone the shock of entering the competitive world. For some kinds of professional work, a prolonged formal education is indispensable. For others it is not.

We recognize that the four-year plan is not suitable for all purposes, and we believe that M.I.T. should continue to offer, as it does now, a variety of other plans to meet the needs of certain professions and certain groups of students. The Institute now offers, for special reasons, a five-year undergraduate course in architecture, and several five-year courses leading to both a bachelor's and a master's degree. The Combined Plan, which provides for a five-year undergraduate program in coöperation with certain liberal arts colleges, has already proved its value as a sound educational scheme for certain students, and we hope it will become increasingly popular. The latest example of the developments of an educational plan to meet the special needs of a profession is the two-year graduate degree in engineering, which makes possible a good six-year program for the professional engineer. All these plans seem reasonable to us.

Nevertheless, the four-year curriculum should be the standard in our undergraduate school. The education of a professional man is a lifelong process; graduation from secondary school and graduation from college are merely convenient halting places provided *en route* from which the student may survey his situation. If the professional school distinguishes carefully between the basic principles

that ought to be learned under guidance in school and the practical applications and routines that should be learned independently in later professional experience, a four-year undergraduate professional curriculum can be a good foundation for a professional career.

Improvement of Undergraduate Education

We have concluded unconditionally that undergraduate education should be continued at the Institute. We must now consider how to improve and strengthen it, for we find a widespread feeling among our staff and the public at large that in actual practice undergraduate education at M.I.T. falls considerably short of the ideals that we have been discussing.

It is said that the Institute offers in its undergraduate curriculum the kind of concentrated special education possible only in a graduate school. But there are other criticisms: the undergraduate curriculum is too rigid; the work in the humanities is elementary and discontinuous; the prevailing attitude is not professional; routine application displaces creative imagination; the classes are impersonal; the environment is graceless and illiberal; the students are so overloaded with routine work that they have no leisure for reflective thought or for the social and cultural experiences that are necessary for proper intellectual and social growth.

An honest appraisal of our undergraduate program will show that these criticisms are not without foundation. To meet them, we recommend that the faculty adopt as a basic policy the principle that the primary objectives in undergraduate years are general ones of developing intellectual power rather than knowledge of routine procedures; mastery of basic principles rather than accumulation of information; and sensitivity to a variety of values and broad understanding of nature and man rather than specific competence in a narrow field.

To implement this policy we recommend a program with six aims:

1. To center faculty responsibility for undergraduate educational policy in one group, of workable size, headed by one person.
2. To strengthen the humanities staff and the instruction in the humanities and social sciences.
3. To improve the subjects of instruction by reduction of detailed content and by increased emphasis upon fundamental principles and upon the development of powers of judgment and discrimination in the formulation and application of these principles.
4. To improve the quality of instruction by giving greater recognition to good teaching, providing means for developing teaching techniques, and insuring an environment for the staff that will be conducive to the most effective work.

5. To make greater allowance for individual differences in aptitude and interest among the students.
6. To avoid overloading students.

Undergraduate Education — Whose Responsibility?

We believe that much of the weakness that exists in the undergraduate program at the Institute arises from the diffusion of the faculty's responsibility for undergraduate education among a large number of uncoördinated committees that are necessarily preoccupied with administrative detail rather than with the consideration of educational policy.

In the days when the total instructing staff of the Institute numbered forty to fifty, it was practicable to consider all undergraduate problems, whether broad and general or specific and detailed, intelligently and effectively in meetings of the entire instructing group. With the present size of the Institute, such a procedure is impracticable. A meeting of the entire faculty provides little or no time for individual discussion, and unless much time of many individuals is to be wasted, it is essential that proposals brought for consideration to the faculty as a whole should have been considered thoroughly in advance by those in the best position to understand their advantages and disadvantages. A technique is needed for the development of details of the undergraduate program by those who are in close contact with teaching, for consideration of broader implications by representatives of different points of view in the Institute, and for final review from the broad policy viewpoint by the faculty as a whole.

We recommend as a solution that special aspects of the program be developed through the departments and the schools, with consideration of broad policy by a new committee on undergraduate policy, and with final review by the entire faculty, as discussed more fully in Chapters III and V. The ultimate responsibility for developing and improving the undergraduate program will then center in one group, the Committee on Undergraduate Policy, headed by one individual, its chairman; this will provide a means for concentrated and unified effort toward achieving the distinction in undergraduate education to which the Institute should aspire.

Strengthening the Humanities

There can be no dispute about the increasing importance of the humanities and the social sciences in the education of scientists, engineers, and architects. It is M.I.T.'s duty to prepare its students for social responsibility and for a rich and complete life. But, important though these objectives may be, technological and social problems are now so inextricably interwoven that the humanities and social sciences are also essential components of a man's professional education. Without

an adequate cultural background, a technical specialist is no longer qualified for leadership in his own field.

The contribution of the humanities and social sciences to the education of our undergraduates has never been entirely satisfactory, and our weakness in this area places us at a serious disadvantage in comparison with alternative ways to prepare for a professional career. One reason for this situation is the lack of status for our staff in the humanities comparable in importance to that of staffs in other fields. In the past, the humanities have necessarily been service fields concerned primarily with instruction at the elementary level. Now, however, there is a growing concern with human and social problems, an increased awareness of the interplay between science and technology on the one hand and the conduct of human affairs on the other, and an awakened realization of the fruitfulness of the techniques of the natural sciences in the study of human and social problems. We believe that these trends now make possible the development of the humanities and social sciences at advanced professional levels in the environment of a technological institution. The concepts and techniques of science and engineering can give important insight into certain kinds of human, social, philosophical, and historical problems, and the atmosphere of an institution like M.I.T. can be made attractive to men interested in these phases of the humanities.

This broadening of the mission of the humanities and social sciences at the Institute will be more fully discussed in Chapter III. We believe it will provide the solution to one problem that has beset technological education for half a century. It will make it possible for the Institute to attract outstanding men in the field by offering them the opportunity for creative work in a group that has a status within the Institute of full parity with other groups.

Another reason for our weakness in this area is that we still allot less time to the humanities and social sciences than the minimum recommended by the American Society for Engineering Education.[1] One result is that subjects in these fields must be taught at an elementary level. Despite improvements in recent years we still do not offer sequences of subjects in these fields that will permit students to progress to the relatively advanced levels without which effective education is not possible. The Committee on General Education has studied in detail the problem of the humanities in the common curriculum. We urge immediate adoption by the faculty of the following recommendations of this committee:

1. Extension of the time devoted to the humanities and social sciences in the common curriculum from eight term-subjects to ten.

[1] This recommendation is discussed by the Committee on General Education on pp. 99 and 105 of their report.

2. Arrangement of subject sequences that will insure better training in depth as well as breadth.

The Committee on General Education has also recommended the experimental establishment of a new curriculum in natural and social sciences. We are not prepared to recommend the immediate adoption of this experimental curriculum. However, we recommend that the proposed School of Humanities and Social Sciences attack this problem in coöperation with the proposed Committee on Undergraduate Policy. While the objectives of this curriculum are attractive to us, we feel that the question of its adoption should be deferred until the faculty has modified its procedure for action on questions of this kind.

Undergraduate Specialization

To accept the principle that the general aims must be dominant in undergraduate education does not mean that we should abandon the professional motivation of the undergraduate student. Depth as well as breadth is necessary in an undergraduate education. The concentration of interest on a specific field in the later undergraduate years at M.I.T. is an important means of awakening professional interest. It makes possible the experience of mastering one small area and the experience of facing genuine unsolved problems that are essential in any kind of education. The senior thesis, in which a man brings to bear on one problem the creative and critical powers he has developed, is a vital part of a man's professional education, and it ought to be the culmination of a general education.

We recommend a continuation of the present system of organizing undergraduate education into professional courses. In Chapter III, however, we have suggested that the distinction in broad fields of interest, represented by the schools, are the ones that should be emphasized in the future planning of undergraduate curricula rather than the narrower departmental distinctions. The ideal toward which we should work is to have four main species of undergraduate education with enough variation within each species to take advantage of the diversity of interests among students and staff. Ultimately the curricula might be enough alike so that an Institute graduate entering the Graduate School would lose not more than half a year if he changed fields within one school, and not more than a year if he changed from one school to another.

Improvement of the Subjects of Instruction

The criticism of undergraduate education at M.I.T. that causes us the most concern is that many students seem to be able to graduate from the Institute on the basis of routine learning, and that, though often fully equipped with knowledge of standard procedures and able to apply formulas to typical problems, they lack

the critical judgment, the creative imagination, the competence in handling unique situations, that leaders must have.

We believe that such qualities as sound judgment and creative imagination can be developed through the proper kind of study of professional problems in a professional atmosphere, and that the primary objective of the individual subjects of instruction is to provide the kind of educational experience that will stimulate the growth of these qualities. To improve the subjects of instruction, we need to explore vigorously every means for confronting the student with basic data in genuine problem situations. We must train him to marshal, evaluate, sift, and interpret the facts for himself, and to use the knowledge and experience acquired in the past toward the solution of the difficulties of the present.

The conspicuous success of M.I.T.'s undergraduate school fifty years ago was chiefly due to the intimate cooperation between staff and students in the study of real and significant problems of contemporary technology. Nowadays the student has a longer road to travel before he reaches the frontier where problems are real, but it need not be a routine journey. We believe that it is possible to give undergraduates the kind of stimulating educational experience that we provided fifty years ago. Science and technology are fields in which vital problems of contemporary interest can be found that are simple enough to be used in the early years and complex enough to be challenging. The Institute possesses unique facilities and resources for undergraduate professional education of which it has not yet taken full advantage.

We recognize difficulties in using professional methods and materials in the early undergraduate years when the emphasis must be on the mastery of fundamental skills and basic principles. We are aware also that the professional method seems more easily applicable to engineering than to science. But the professional spirit, the pervasive atmosphere of relevance to the outside world, the insistence on active participation by the learner rather than passive absorption, the reluctance to separate principle and practice, the belief that abstract concepts are often best taught through their applications, together provide a key to the revitalization of our instruction in all fields.

It would be presumptuous of us to attempt to say specifically what should be done to improve particular subjects of instruction. No single rule can apply generally to such a great variety of educational activity as we now have at M.I.T. In fact, we are suspicious of all fixed patterns and rules in education that impose uniformity and stifle spontaneity. What is most needed is a willingness to discard stereotypes and a readiness to experiment. To indicate the direction which experiments might take, we offer the following suggestions to the many staff groups concerned with the improvement of undergraduate education:

Reduction of Coverage. The objective in all subjects of instruction should be the development of intellectual power and judgment rather than the continuous or exhaustive coverage of a field of knowledge. All subjects need to be scrutinized periodically to make sure that they can justify their place in a crowded curriculum by contribution to this general aim.

In such rapidly expanding fields as science and technology, there is a natural tendency to increase the coverage of individual subjects until they become overcrowded with material of doubtful educational value. This tendency must be resisted firmly. In many subjects coverage should be reduced to allow time for more thorough study of fewer topics. An instructor in any subject should be able to take advantage of the various interests that appear spontaneously in a classroom, to trace an historical development, or to explore the implications of a basic concept without feeling guilty because he is departing from a syllabus or failing to prepare the students specifically for a quiz.

It is our impression that very little really first-rate, concerted intellectual effort is being spent on the attempt to find new, compact, meaningful syntheses of the fields with which we are concerned at the Institute. Such reorganizations in the various fields of knowledge are especially needed at the elementary level.

Professional Methods. We urge a fuller exploitation of the possibilities of using professional methods and problems in undergraduate technological courses, beginning as early and developing as rapidly as possible. Technological education requires a certain amount of routine exercise, but we believe that more of the problems chosen for study could be full multidimensional ones, like the real problems of professional life, which rarely respect academic departmental barriers; problems requiring evaluation and judgment as well as calculation. Technical problems have a social setting and human and even ethical dimensions that cannot be ignored in life and ought not to be ignored in school.

Integration. We should like to see an undergraduate's education regarded as an integrated whole rather than as an accumulation of credits in a series of one-term subjects. The division of a curriculum into isolated subjects each taught by a specialist may be a necessary expedient, but we need to be continually reminded that it is essentially unrealistic and that the ideal lies in the opposite direction. We believe there should be more interdepartmental coöperation in undergraduate education, and perhaps more study of large problems that cut across departmental lines; what we have in mind here is chiefly an attitude of the instructor and the student toward their work. The instructor in every classroom should be aware that he is working with integrated personalities and should have some interest in and

knowledge of the contribution of other subjects to the education of his students. As a contributing scholar his responsibility may be confined to a narrow specialty, but as a teacher his responsibility is not limited by the boundaries of a particular subject.

If a subject like descriptive geometry, history, or a foreign language is important enough to be required in a professional curriculum, it should be made relevant to and used in the more directly professional subjects. It should not be regarded as a subject to be taken once and then forgotten. The instructor in an engineering course, if he is to give his students a realistic educational experience, must insist on competence in such subjects and make the students understand that bad human relations or careless writing, for example, can be the cause of failure in an engineering problem in school just as it can be in professional life.

Examinations. Our system of quizzes and examinations needs careful study. We recommend vigorous experimentation with testing methods with a view to making the examination a better educational experience and a better instrument for evaluating a student's judgment and intellectual power rather than his memory. We also recommend experimentation with examinations set by outside examiners, and with comprehensive examinations covering the work of more than one subject or more than one year.

Development of Initiative. Much of the undergraduate work, especially in the laboratory subjects, is so explicitly defined and highly organized that it offers little chance for the development of initiative and responsibility in the student. The senior thesis is an excellent device for developing these qualities, but increased effort should be made to place greater responsibility on the student earlier in his career, and particularly in the laboratory.

Rescheduling Instruction. We recommend that the proposed Committee on Undergraduate Policy consider the desirability of rescheduling instruction so that the student studies fewer subjects at one time but devotes more hours per week to each subject. Such rescheduling presents difficulties, of course, but we believe that the possible advantages are great enough to justify a careful study of the plan and experimentation with it.

Improvement of the Quality of Instruction

One of the most common criticisms of undergraduate education at M.I.T. is that the teaching is poor, and the reason most frequently given is that research reputation rather than teaching ability is recognized and rewarded. Our best

men, it is said, are often preoccupied with research, and a large part of the teaching, especially at the elementary levels where teaching ability counts most, is left to the inexperienced members of the staff whose primary interest is naturally in obtaining advanced degrees, or in the research part of their work on which they will be judged.

There is, of course, a place in our society for the school and the small college whose only function is teaching. But M.I.T.'s primary obligation is to provide for a certain group of students, especially for the most intellectually promising, a particular type of education through intimate association with a staff engaged in professional activities and original inquiry. In a professional school like M.I.T., the teacher must be more than a mere teacher; he must be a professionally competent man. In science, this usually means activity in pure research; in other fields it may mean other kinds of creative activity, public service, or service to industry. In any event, the teacher must maintain some sort of inspiring contact with his professional field outside the classroom.

The important point is that outstanding accomplishments in both teaching and research must be recognized and rewarded if we are to have a superior educational program. The teacher must have a genuine interest in the student's welfare. His primary function is the development of the student's intellectual power, and his contribution to the educational life of the Institute should be measured by his success, however difficult the evaluation may be. Recognition of distinguished teaching is already a part of the stated policies of the Institute. That this policy needs better implementation is indicated by the fact that the reports of both our auxiliary committees have emphasized the desirability of giving greater recognition to outstanding teachers.

Special courses in teaching methods have been suggested as a way of improving undergraduate instruction. We believe that our staff should have an opportunity, on a purely voluntary basis, to learn of recent progress in the psychology of learning and methods of communication. But our main reliance must be on the informal guidance of inexperienced men by senior members of the staff. We believe that the departments should use their best men in the planning and direction of the elementary courses and should place greater emphasis on rewarding men who accomplish this task effectively.

Our opportunities for the development of unique visual and auditory aids to education are exceptional. We have many special facilities of use in such undertakings, and we believe that these possibilities should be exploited to the fullest extent practicable.

Finally, the most effective teaching requires an environment that is stimulating and conducive to creative work on the part of the staff. The performance of an

institution is determined in the ultimate by its staff, and every effort should be made to insure a spiritual and physical environment at M.I.T. that will permit our staff to be most effective in its work. In some respects, this is the most important single problem related to the improvement of our educational program, and we have considered it of sufficient moment to appoint a special group, the Committee on Staff Environment, to study it. We recommend that the faculty and administration accept their report as a guide in future planning.

Providing Flexibility in the Students' Programs

For nearly a century the freedom of choice allowed an undergraduate in selecting his subject of study has been a major educational issue. The position of M.I.T. has been notably uncompromising. It imposes a common first-year program on all students. The student has a free choice among some twenty professional curricula, but within the curriculum he has almost no choice in the second year and very little in the last two.

Although we recognize that curricula in scientific and technological education must often be more rigid than in other fields, we are concerned about the trends toward standardization and uniformity inherent in large-scale education in all types of institutions of higher learning. How to avoid standardization, that is, how to provide for the extraordinary spread of individual differences within any educational unit, even a single classroom, is a basic pedagogical problem, a problem that becomes more difficult as an institution grows. We believe that M.I.T. has often placed too high a premium on uniformity of product, that it is not now making sufficient allowance for individual variations in aptitudes and professional interest, and that the rigidity of its curricula and the inflexibility of its administrative disposition of the educational problems of individual students make it difficult to develop the best talent in the undergraduate school.

If we are to take advantage of the full range of aptitudes of our students, the best way to get the necessary flexibility is not to increase the number of fixed educational patterns, but to make the ones we already have more flexible. In the continual review of the undergraduate curriculum by the methods proposed in Chapters III and V, we hope that the faculty will devise ways of increasing the tolerance for deviation from the standard pattern in professional courses, especially in the cases of men of exceptional talent. A change in spirit is more important than a change in rules.

The present organization of undergraduate curricula with a common first year and increasing diversity thereafter seems reasonable to us. Nevertheless some differentiation among the types of education offered by the four schools might begin as early as the first year. A school should be able to experiment with ways of making

the required first-year and second-year subjects more suitable to the needs of its students. We should also like to see a freer substitution of subjects in the curricula within a school, and less emphasis on the so-called prerequisites, especially for transfer students.

Avoiding the Overloading of the Student

One of the most damaging criticisms of our undergraduate program is that the students feel so harassed by rigid routine and so overburdened by the quantity of work required in the individual subjects that they do not have time for reflective thinking or for the social experience that should be an important part of a college education. We recognize this unrelieved tension as a serious evil and we think that steps should be taken to remedy it.

The solution, we believe, is not a general reduction of the work load in terms of hours per week. The question of work load has been raised repeatedly since the founding of M.I.T., and despite many investigations and reports on the subject no major change has ever been made. Established practice in American technological education involves twenty to thirty hours of classes and laboratories per week instead of the twelve to twenty typical of liberal arts colleges, and any marked change in the number of scheduled hours would involve such drastic modifications in the present educational pattern that we question its feasibility.

Much can be done, however, to relieve the tension within the particular subject, and within the individual class-hour, by a reduction in the number of topics covered. The necessity of passing hurriedly from topic to topic within a single class-hour, and of considering a great variety of subjects within a day or a week, seems to us a more likely source of tension than the absolute hours of the work load.

In an earlier section, we have recommended the reëxamination of the individual subjects with a view to emphasizing mastery of basic principles rather than complete coverage of a field. We are convinced that new syntheses of material can be found and new methods developed that will substantially reduce the pressure within the individual subject and allow time for more thorough study of fundamental principles and for more leisurely and spontaneous discussion. We believe that this is the most effective way to encourage reflective thinking and to lessen the present sense of pressure in undergraduate work.

Attracting Able Students

The success of our undergraduate school depends ultimately on its ability to attract good students. To do so we must not only improve and strengthen our undergraduate education along the lines indicated in this chapter. We must also make the educational opportunities for undergraduates at M.I.T. more widely

known and better understood. The Institute is still thought of in many quarters as a narrow vocational school, and many promising students are lost to us partly because of our failure to make clear to the public the objectives of undergraduate education in a technological school.

The administration is fully aware of the critical importance of this problem. Its efforts to improve our public relations should have the full understanding and support of the faculty.

Conclusions and Recommendations

1. We conclude that a four-year undergraduate professional education has special advantages today either as direct preparation for a career or as a foundation for advanced work in science and technology. We see no advantage in a general lengthening of the undergraduate curriculum to five or six years.
2. We conclude that a scientific and technical environment affords special opportunities for many individuals who wish to acquire a broad cultural education and a full appreciation of modern trends in society.
3. We conclude that a fundamental problem at technological institutions is that of developing sufficient strength in the social sciences and humanities. We recommend as a solution that M.I.T. take advantage of new opportunities to give the social sciences and humanities full professional status, as discussed in Chapter III.
4. We conclude that the contribution of the humanities and social sciences to the undergraduate program must be strengthened. We recommend immediate adoption of two of the proposals of the Committee on General Education:
   (*a*) Extension of the time devoted to the humanities and social sciences from eight term-subjects to ten, and
   (*b*) Arrangement of subject sequences to insure better training in depth as well as breadth.

   We recommend further that the faculty give detailed study to the other proposals of that committee.
5. We conclude that undergraduate education at M.I.T. is everyone's responsibility and therefore no one's responsibility. We recommend that this situation be remedied by the establishment of a Committee on Undergraduate Policy, having broad authority, as discussed in Chapter V.
6. We conclude that subjects of instruction could be improved by reduction in coverage and increased emphasis upon basic principles, early introduction of professional methods, and increased emphasis upon development of the student's initiative and judgment. We recommend experimentation with such innovations as comprehensive examinations and rescheduling of instruction so that fewer subjects are studied at one time but more hours per week are devoted to each subject.

7. We conclude that the quality of undergraduate instruction should be improved and we recommend three steps toward that end:

   (*a*) Increased recognition for effective teaching,

   (*b*) Guidance of inexperienced members of the teaching staff, and

   (*c*) Consideration of the proposals of the Committee on Staff Environment for providing an atmosphere at the Institute most conducive to effective teaching.

8. We conclude that the subject requirements in undergraduate courses are too rigid. We recommend serious effort in curriculum planning toward the provision of sufficient flexibility to meet the needs of students with unusual interests and aptitudes.

9. We conclude that undergraduate students are under pressures that prevent them from devoting sufficient time to reflective thinking or to desirable social pursuits. We reject a general reduction in contact hours as a remedy. We recommend instead reduction in the number of topics covered in individual subjects of instruction, with emphasis upon mastery of basic principles rather than upon complete coverage of fields.

Chapter III

A Broader Educational Mission

In reviewing the educational program at the Institute, we have had to consider the emphasis that should be given to education at different levels on the one hand, and in different fields on the other. The first problem was discussed in Chapter II and the second is the subject of the present chapter.

A reëvaluation of the present scope of the Institute's educational activities in various fields and a consideration of new educational opportunities that have arisen as the result of the needs of present-day society have led us to conclude that there are compelling reasons for the Institute to undertake a broader educational mission in the future. We shall define this mission as we see it, and we shall consider how it can be accomplished in a manner consistent with the principle of limited objectives that has always been a source of strength to the Institute. We shall also suggest evolutionary changes in the present school structure as a means of contributing to the achievement of the broader mission.

FOR MORE THAN HALF A CENTURY, M.I.T. was renowned as a school of engineering with which was associated a distinguished, but largely autonomous, school of architecture. The majority of its graduates during this period were clearly destined for industrial pursuits, and every effort was made to give them an education that emphasized direct, practical applications to industry.

The primary purpose of instruction in mathematics and physics was to provide a substantial foundation for subsequent engineering studies. In large measure this was also true of chemistry, although the direct applications of the principles of chemistry to industrial processes were recognized. Geology provided basic material for the then extremely important course in mining engineering. Biology was distinguished for its applied aspects, such as public health and industrial microbiology. The natural sciences were valued for their educational utility as a foundation for engineering or for their contribution to the practical arts. Thus, the more the natural sciences resembled engineering in their creative activities, the more they were respected in the practical engineering school environment.

English, history, modern languages, and a scattering of general studies have always been a part of the Institute's curriculum, and economics has been taught since Walker's day. But these subjects were offered primarily to broaden the education of engineers; they were not regarded as fields in which creative development should be a primary concern.

From the beginning architecture has had a distinguished career. The School of Architecture was considered to be outstanding quite independent of its association with an engineering school. This very fact set it apart and caused it to be regarded as a curious anomaly, almost as though some accident of fate had led it to prosper simultaneously with a technological institution to which it was tied through administration but not in spirit.

The foregoing situation was natural and perhaps desirable during the period in which the Institute's primary problem was that of establishing itself in the engineering field, for it permitted the concentration of resources and energies upon the attainment of that one goal. Nevertheless, the complete subordination to engineering of all fields except architecture contributed to the narrowness of outlook and lack of professional breadth discussed in Chapter I as characteristic of one period of the Institute's history.

The Compton administration recognized that weakness in fundamental as contrasted with applied aspects not only handicapped the natural sciences, but also retarded the attainment of full stature in engineering; steps were therefore taken to strengthen fundamental scientific inquiry at the Institute, particularly in physics. Further attention was also given to improving the status of the humanities and social sciences. These trends marked the widening of our educational horizon, but they were modified or interrupted to a considerable extent by World War II. The aftermath of the war has created new problems and has brought new opportunities for educational leadership by the Institute. A reassessment of the desirable scope of the Institute's activities has therefore become essential in this postwar period.

We believe from such a reassessment that the time has come for full acceptance by the Institute of a broader educational mission; a mission that involves pioneering and leadership of a higher order not only in engineering but also in the three other fields, namely, the natural sciences, the humanities and social sciences, and architecture and planning. We believe, further, that this goal must be achieved without departing from the philosophy of limited objectives that has contributed to the strength of the Institute in the past.

Principle of Limited Objectives

Three important policies have been followed in choosing fields of educational activity at the Institute throughout the years, and we believe that a broadening of our educational program can be undertaken now in a manner consistent with the principle of limited objectives if we continue to be guided by these policies. *First,* in accordance with Rogers's belief in the dignity of useful knowledge, the educational program has been designed at all times to fit men for direct contribution to the needs of the society of their day. *Second,* effort has been limited to fields that could

contribute to or profit from an environment in which the predominant concern is with science and technology. *Third*, major activity has been confined at all times to those fields in which there appeared to be opportunity for the Institute to use its resources effectively.

The policy of designing the educational program to fit men for direct contribution to current social needs has led the Institute to be dynamic, sensitive to the shifting interests and needs of society, responsive to economic and technological changes, and ready to pioneer in new ventures or to support newly discovered talent. If we are to follow this policy consistently, we must be ready to respond to new needs in the society of today.

The policy of limiting effort to fields that could contribute to or profit from an environment in which the predominant concern is with science and technology has prevented the possibility of a progressive broadening of activities toward the all-embracing scope of a university. Thus, law, medicine, and the classical languages, to cite a few from many possible examples, are fields or subjects that would clearly be excluded from the Institute's program by the application of this criterion.

The policy of confining major activity to fields in which there appeared to be opportunities for the Institute to use its resources effectively has insured against disorderly growth or unwise expansion followed by financial difficulties. This policy has also caused old enterprises to be discontinued when they had ceased to serve a useful purpose, thus permitting new ventures to be undertaken without undue over-all expansion.

Our recommendations for the acceptance of a broader mission in the fields of engineering, science, the social sciences and humanities, and architecture involve the corollary that these changes must be brought about in a manner consistent with the foregoing policies.

Four Fields of Activity at M. I.T.

The Field of Engineering — The Institute has always been outstanding in the field of engineering and it is obviously desirable for it to maintain this leadership. But if we are to offer outstanding engineering education in the present era, revision and improvement of the whole educational program are necessary. We recognize especially a need to develop a broader type of professional training that will fit engineers to assume places of leadership in modern society, and we believe that this can be accomplished in part by improvement in the professional subjects themselves, and in part through further strengthening of the natural sciences, the social sciences, and the humanities.

The modern engineer is a servant of the public, which measures his success not by his scholarship but by strict standards of performance. He is responsible for the

safety of people, and his activity often has direct bearing on the welfare of large groups of individuals, whether in his own employ or as a part of his society. His decisions and actions must be subject, also, to the limitations imposed by economic considerations.

Like the physician, the engineer cannot always defer action until all facts in a given situation are fully known but must work within the limitations of the state of the art at any given time. Even in the absence of complete information, it is necessary for the engineer to make decisions with respect to the merits of several alternative possibilities. It is through this ability to make critical judgments that the engineer's professional competence often finds its highest expression.

The professional background that the engineer absorbs during his years of training, and adds to according to his ability during his active years, consists in part of basic science, in part of practical information related to the state of his art, in part of the technique of applying basic science to engineering problems, and in part of the development of broad interests that will lead him to be effective in his relationships with his fellow men. The competent professional man must master all of these elements within his field.

It is essential that the modern engineer be able to organize and direct men. His success depends as much upon his understanding of human relations and his skill in handling men as upon his technical competence. Full achievement in his profession requires that he be a man of broad culture with a deep sense of social responsibility.

In order to train leaders in the engineering profession today, it is not enough, therefore, that they be taught by competent professional men who offer instruction of the highest quality. It is essential, also, that they be given a broad appreciation and understanding of the natural sciences and of the social sciences and humanities. We believe that this objective can be fully achieved only in an environment in which active, creative work, of professional stature, is being pursued in these other fields as well as in engineering.

The Field of Science — Unlike engineering, the natural sciences are not motivated by immediate utility. But when science ranges from the abstract toward the applied, and when engineering shifts its focus from immediate applications to underlying principles, the two fields merge in a borderland area in which it is impossible to distinguish one from the other. Thus many of the great advances in engineering depend on the merging into it of science, through this borderland.

In order for science to contribute to the borderland area, and thus for engineering to progress as a result of the progress of science, it is essential that the more creative and abstract aspects of science continually forge ahead in the direction of the new,

original, and hitherto unexplored. Strengthening of engineering by science is therefore best achieved if the environment is such that science can be preëminent in its own right.

Engineering can contribute to science in numerous ways: (1) by the provision of facilities that open up new possibilities for exploration, (2) by directing attention to practical needs that may suggest the investigation of unexplored aspects of natural phenomena, and (3) by inspiring a sense of satisfaction among scientists when practical uses are demonstrated for the various developments that arise from fundamental science in its more abstract aspects. Thus there are distinct advantages to the development of the natural sciences in association with engineering.

There are also disadvantages to the close association of engineering and science. An atmosphere in which practical applications are emphasized may lead scientists to become preoccupied with immediate and utilitarian problems at the sacrifice of attention to fundamental explorations of the unknown. Scientific inquiry often leads along a tortuous road, full of misadventures and disappointments, from which it is tempting to turn aside into the greener pastures of design and development.

Despite the remarkable strengthening of the natural sciences at the Institute since the early thirties, there is still criticism of the extent to which applied rather than fundamental aspects are stressed. Much of this criticism may be unjustified, but we believe that it has sufficient basis in truth to indicate that there is a major challenge to meet in achieving the preëminence in the more fundamental aspects of the several natural sciences to which the Institute should aspire. The present time seems to be an opportune one in which to face this issue since the decline in European science as a result of World War II places a particular responsibility upon American institutions to increase their contributions to fundamental as contrasted to applied science.

We believe, therefore, that more effective means must be found for attracting the most able scholars in the field of science and for providing them with an environment favorable to contemplative effort and free from harassing pressures toward the achievement of practical goals. As the first step, we suggest that still greater opportunity be given for the development of the natural sciences in their own right.

The Field of Humanities and Social Sciences — In addition to new aspects presently under development or that may be developed in the future, we include in this field the various humanistic, cultural, and social studies now concentrated in the following departments or groups: Economics and Social Sciences, Business and Engineering Administration, English and History, Modern Languages, and the Institute libraries. It is by no means conventional to group these various individual categories together in a single field. Nevertheless it is our opinion that, in

an environment such as that at M.I.T., which is strongly influenced by science and technology, there is sound reason for such a grouping in order to achieve a focusing of attention on the mastery of the problems arising from the impact of science and technology upon society.

Modern trends have greatly augmented the importance of this broad area. In our increasingly complex society, science and technology can no longer be segregated from their human and social consequences. The most difficult and complicated problems confronting our generation are in the field of the humanities and social sciences; since they have resulted in large measure from the impact of science and technology upon society, they have an intimate relationship with the other aspects of the M.I.T. program. As a scientific and technological institution, M.I.T. has obvious and challenging opportunities in this area: the opportunity to make a larger contribution to the solution of urgent social problems, the opportunity to help prospective scientists and engineers to understand better the forces that are molding contemporary society, and the opportunity to give students of the social sciences and the humanities a better insight into the meanings and implications of science and technology.

No one can now chart with precision a detailed course to follow in meeting this challenge. We believe the first step is to provide greater opportunity for scholars to undertake creative work in this field at M.I.T. at the same high professional level as that characteristic of other fields. By encouraging full development of the field as an important one in its own right, rather than as one that is chiefly useful as a service facility for other professional groups, we believe that the quality of education in the humanities and social sciences at the Institute can be improved materially.

The Field of Architecture — Architecture deals with the physical environment of people. It includes the planning of the physical environment for both living and work, and in this and other respects is both influenced by and has its influence upon engineering. In its development of new methods for handling the physical environment, it leans heavily upon both engineering and science. It involves both utilitarian and aesthetic motivations.

Education in architecture has been a feature of the Institute since its founding. During a portion of the earlier years, the emphasis in architecture was upon the aesthetic rather than upon those aspects that merge into engineering or depend for their strength upon science. During this period the School of Architecture was far less closely integrated with the rest of the Institute than it is today. In recent years, the focus has shifted to include various aspects of architecture and planning that are closely allied to science and engineering. Increased emphasis has also been given

to the solution of environmental problems arising from the impact of science and technology upon everyday living and working.

Thus architecture as presently constituted derives much of its strength from the areas of engineering and science. In turn, in its close association with these latter areas, it affords an opportunity for engineers and scientists to broaden their cultural and general backgrounds.

The increasing population and the growing complexity of such technological aspects of living as transportation and communication require ever greater concern with the planning of the environment that man creates for his working and leisure hours. Hence, we foresee great opportunities for the field of architecture and planning at M.I.T., where it can be closely associated with engineering and science on the one hand and with the investigation of social and cultural problems related to science and technology on the other.

We believe that the School of Architecture and Planning would benefit from the strengthening of the humanities and social sciences that we have already suggested. We also believe that it would benefit from a more widespread recognition by the whole faculty of the fact that it is not only a school of equal status with the others at the Institute, but is closely integrated with them in many of its interests and activities.

Four Schools

Together these four fields constitute an appropriate range of educational and research activity for M.I.T. Each one has important common interests, problems, and objectives that distinguish it from the others. We believe that the time has come for the Institute to permit the activities within each of these fields to develop in their natural directions. We believe that it is consistent with its long tradition of leadership for the Institute to take advantage of the new opportunities in these areas, and that if this is done in accordance with the policies for choosing activities that have been discussed previously, a proper limitation of over-all scope and diversity will be retained.

Two steps are necessary to accomplish this broader mission. *First*, means must be provided for developing a community of interest, an enthusiasm for stimulating creative activities, and a united concern with common problems in each of the four fields. This can best be achieved through evolutionary changes in the school organization that will focus attention upon the common objectives and problems of each field. *Second*, the field of humanities and social sciences must be given a status equivalent to that of the other fields. This can be achieved by establishing a fourth school, that of Humanities and Social Sciences, in addition to the present Schools of Engineering, Science, and Architecture and Planning.

We recommend that the School of Humanities and Social Sciences be established at once. We recommend further, as a means of focusing attention upon common problems and objectives in each area, that each academic dean appoint an advisory council to include all department heads within his school and such other members as he may wish. Each council should meet with its dean regularly to discuss objectives and educational problems in the field of the particular school, in accordance with the over-all plan for developing educational policies that is discussed in Chapter V.

The representatives of a school would advocate to the faculty proposals that had been worked out carefully in the school council and perhaps even considered by all the faculty members in that school, but the final decision would rest with the unified faculty. In theory, the vigorous efforts of the school groups might lead to a division of the Institute into four autonomous educational and research areas. In practice, we see no danger of such a contingency, since there would continue to exist strong forces directed toward preserving the unity of the Institute's educational program, operating through the unified faculty of the Institute, which would retain sole power to act on all major proposals of the schools.

The Educational Value of the Four-School Plan

The growth of the Institute since 1900 and the increase in the number of departments and courses has made necessary, in our opinion, some sort of grouping of the departments into larger units if educational planning is to be most effective. If this grouping be considered solely from the point of view of administrative convenience, there is no compelling logic that leads one inevitably to schools of science and engineering, for example. An argument certainly can be made for the grouping of a basic science with its immediate fields of application. This arrangement was followed for chemistry and chemical engineering at M.I.T. for many years. Such groupings as mathematics, physics, and electrical engineering, or geology, metallurgy, and mining engineering, have also been used. Any such organization can be made to operate effectively, under good administration. Factors other than manageability enter into this problem, however, and the kind of grouping that has naturally developed at M.I.T. is a sound one for reasons of educational policy as well as administrative efficiency.

The subject matter of physics and electrical engineering, of chemistry and chemical engineering, or of biology and sanitary engineering, is in some respects identical; but in spirit, in method, in objective, and in its ethical relationships to society, science is sharply distinguished from engineering. The school organization that we propose to strengthen at M.I.T. is based on this kind of difference between departments. We believe that it is a good kind of organization. It seems to us an

especially good one for undergraduate education, which should inculcate the principles and ways of thinking that are common to all branches of, for example, engineering or science, rather than emphasize the technical distinctions that set off one branch of science or engineering from another.

By encouraging a greater unity of objectives among the departments constituting a school, and by giving the schools a greater responsibility for undergraduate education, we can meet the common criticism that undergraduate education at M.I.T. is overspecialized. The Institute now offers twenty professional curricula to undergraduates, and a number of these are further subdivided into options. This proliferation reflects the growing complexity and scope of science and engineering. We question, however, the wisdom of attempting to reproduce in our undergraduate curricula the fine structure of the modern technological world. While fully recognizing the educational value of a certain amount of undergraduate specialization, we believe that M.I.T. in its undergraduate school is devoting too much attention to details peculiar to civil or mechanical engineering, for example, and not enough to the principles, methods, and values that are common to all branches of engineering.

We believe, then, that M.I.T. should work toward the ideal of offering essentially four principal types of undergraduate education rather than twenty, and we expect that an increased emphasis on educational planning and leadership in the schools as distinct units will lead to a greater differentiation among the types of education offered by the schools, and less differentiation among the undergraduate courses within each school.

Responsibilities of the School of Humanities and Social Sciences

We have recommended that a School of Humanities and Social Sciences be established on an equal footing with the existing schools at M.I.T.; we recommend further that the advancement of knowledge be considered an essential part of its program, that it assume the responsibility for planning and administering the program of general education as a part of the common curriculum, and that it offer professional courses leading to graduate as well as undergraduate degrees.

A primary responsibility of the school will be productive scholarship in fields logically related to the Institute's activities. We see great possibilities for the development within this school of a center for creative work in the field of social technology and for the study of the relation between science and technology on the one hand, and man and his institutions on the other. The field need not be strictly defined. It will grow and change as have the other fields at the Institute. The impact of technology upon society is so far-reaching that every member of the staff of such a school can find an area within which he can contribute significantly to the scholarly output of M.I.T.

The school will serve the Institute by planning and administering a general educational program for all M.I.T. students, designed to develop an awareness of the interrelations of the scientific, technical, and literary cultures, and a sensitiveness to the diverse forces that motivate the thoughts and actions of people. This general educational program, like all components of M.I.T. education, will grow out of the creative work of the departments, and it must be an integral part of the professional curricula. We ask for more than a mechanical mixture of the conventional literary and technical cultures. We ask for an integration of general and professional education suitable for the M.I.T. environment.

The professional curricula leading to degrees, graduate and undergraduate, will include the present Courses in Business and Engineering Administration and Economics and Engineering. New courses will undoubtedly be developed in this school as they have in the others when the need for new kinds of professional education arises, when new resources become available, and when the creative work of the staff makes clear to the unified faculty the desirability of such expansion.

Conclusions and Recommendations

1. We conclude that in choosing its activities the Institute should continue in the future the three policies it has followed in the past, namely:

   (*a*) A devotion of primary effort to education aimed at fitting men for direct contribution to the needs of the society of their day,

   (*b*) A limitation of effort to fields that can contribute to or profit from an environment of science and technology, and

   (*c*) A concentration of activity in fields in which the Institute can use its resources most effectively.

   We recommend that these policies be followed in broadening the Institute's educational mission.

2. We conclude that the four general areas of Engineering, Science, Architecture and Planning, and the Humanities and Social Sciences are appropriate ones for education and research at M.I.T. We believe that M.I.T. is now in a position to make outstanding contributions to education and the advancement of knowledge in each of these four fields. Together these four fields make a good academic community for a cooperative attack on vitally important problems and a good educational unit for the development of leaders for a technological world. To enhance their effectiveness, we recommend a general strengthening of the school structure. We also recommend the appointment by each academic dean of an advisory council to consider with him the common objectives and problems of his school.

3. We conclude that the strengthening of the school structure will contribute to the development of the educational program, especially at the undergraduate

level. We recommend that undergraduate education be directed toward diversity based primarily upon four fields rather than upon twenty courses.

4. We recommend the immediate establishment of a School of Humanities and Social Sciences with responsibility for:

   (*a*) Creative professional activity,

   (*b*) Provision of a program of general education for the whole Institute, and

   (*c*) Advanced education leading to higher degrees.

Chapter IV

Sponsored Research

Sponsored research and development projects now represent a major activity at the Institute. Many of these projects are closely integrated into the graduate educational program. They are supervised administratively by the Division of Industrial Coöperation, which was established shortly after World War I as a part of the Technology Plan for obtaining support for the Institute from industry. Thus the Institute has a long history of experience with sponsored projects in one form or another.

What can we learn from this past history of use to us in our relationships with industry today? What are the advantages and disadvantages of sponsored projects supported by the military services and other government agencies? What policies should be followed to insure maximum benefits from sponsored research with minimum risks? What is the responsibility of the faculty with respect to these policies? These and related questions are considered in the present chapter.

THE END OF THE WAR IN 1945 failed to bring about any great slackening in the pace of life at the Institute. Intense activity in new and old laboratories has gone on unabated, and few of our faculty have returned to the academic tranquillity of prewar years. We live in the aftermath of the most costly conflict of all history, and the restlessness and uncertainties of our time are reflected in the problems that now confront us here at M.I.T.

The Institute was founded to serve the arts and manufactures of a new industrial era. For three-quarters of a century it fulfilled that mission through its graduates, through research, and through the direct services of its faculty to industry. Lately it has moved on to assume other roles. Its laboratories and the specialized talents of its staff are recognized among the country's great resources to be mobilized for the national defense. As this report is written, the sums disbursed for government-sponsored research at M.I.T. exceed by more than fifty per cent all other academic expense. During the fiscal year 1949 approximately $15,500,000 came to us from the military services and the Atomic Energy Commission and was expended largely in the interest of national security.

The serious implications of this situation are apparent. Under the pressure of an expanding program, both our physical plant and our staff have been augmented steadily. In the interest of sound planning it would seem that some reasonable

balance should be achieved between commitments to sponsored research and to the fulfillment of our normal obligations as an academic institution. Clearly if M.I.T. is to retain its independence and to operate at optimum effectiveness our unity of plan and objectives must extend to this large new area of operations, and must affect the selection and management of sponsored projects.

Future policies for the management of sponsored research will profoundly affect the pattern of academic life at the Institute and hence are of the utmost concern to every member of our faculty. Although we anticipate a future reduction in the total amount of funds currently available for research through contract, we consider it unlikely that this aspect of Institute operations will ever again shrink to the scale of 1940. If threats to peace diminish, a considerable fraction of our present efforts may possibly be diverted to projects more directly in the public interest under the sponsorship of other government agencies. In that event our long-term dependence upon government funds must be recognized.

The interdependence of industry, government and the universities with relation to research was made abundantly clear during the war. We must learn now how to incorporate research sponsored by a variety of external agencies into our plan in such a manner as to strengthen and sustain the educational program, without placing in jeopardy the freedom of thought and liberty of action that lend to academic life its very special flavor.

Origins of the Division of Industrial Coöperation

The task of supplying business and fiscal management for the current vast program of sponsored research at M.I.T. falls upon the Division of Industrial Cooperation. The D.I.C. is primarily an agency for relieving the faculty of the administrative details involved in handling contractual relations with government and industry. Its availability in 1940, backed by twenty years of experience in the management of sponsored projects, placed the Institute in a position probably unique among all American universities to undertake the responsibilities imposed by the Second World War. The clear policies formulated for handling wartime research, and the magnificent record of administration during that period, are in no small measure due to this experience. Because of the influence that these policies will have on the future conduct of sponsored research at the Institute, it is of interest to review the circumstances that led to the establishment and growth of D.I.C.

There is a remarkable parallel in all respects except basic financial stability between conditions that faced the Institute at the close of World Wars I and II. The freshman class entering in January, 1919, numbered 860. Prospects for the next few years were for a student body very much larger than anticipated when the new buildings were completed in 1916. The physical plant was wholly inadequate, and

the cost of building was relatively prohibitive. The Commonwealth of Massachusetts was about to withdraw its subsidy of $100,000 a year, and the Institute had suffered other losses of revenue. The tuition fee was increased in 1919 from $250 to $300; small as that seems to us today, it was one of the highest in the country. The actual cost per student was estimated to be about $800 and there appeared to be little prospect of meeting this through ordinary sources of academic revenue. Costs of maintenance and operation were at a peak.

By December, 1918, it was clear that the Institute was faced with an immediate financial crisis, and the Corporation determined that an endowment fund of at least $7,000,000 would have to be provided without further delay. Accordingly, a special committee was appointed to consider ways and means. It was the initial view of the committee that a general appeal to alumni and friends of the Institute for relatively small contributions in large numbers would be unequal to the need. Consequently, an attempt was made to persuade a few men of great wealth to make large gifts.

This first effort was a failure, and after six months of futile labor it became apparent that other means would have to be devised. At this point, George Eastman proposed to make a capital gift of $4,000,000 on condition that other friends of the Institute would contribute an equal amount. Of this sum, $3,000,000 was to be pledged before January 20, 1920. The Endowment Committee then undertook an intensive drive to reach every M.I.T. alumnus, with the request that he contribute one week's salary. At the same time President Maclaurin turned to industry for additional aid.

The Technology Plan and D. I. C.

It was President Maclaurin's idea that the training and services offered by the Institute were indispensable to the healthy development of American industry, and that in return it was in the best interest of industry to give material encouragement to the development of such an institution as M.I.T. These ideas were embodied in the so-called Technology Plan, which aroused nation-wide interest at the time and was the subject of both favorable and unfavorable comment. It was heralded as ". . . the first complete scheme ever worked out by a technical institution in cooperation between a school of pure and applied science and the industries dependent upon this science."[1] The very existence of such a plan thirty years ago seems largely to be unknown to our present faculty, but the ideas it sets forth and the problems it endeavors to solve are of extraordinary timeliness.

According to the Plan, it was proposed to establish a new Division of Industrial

[1] "The Technology Plan," *The Technology Review*, XXII, No. 1, January, 1920, p. 52.

Coöperation and Research that would ". . . draw into focus all the Institute's ability in research, consultation, scientific and industrial experience and creative aptitude, for the service of industrial corporations who shall 'retain' the right to that service, as a corporation retains the services of a legal expert, by the payment of an annual fee."[1] For this retainer the division would undertake to provide certain general services for the subscribers to the Plan. Consultations with qualified members of the faculty were to be arranged; assistance was to be offered in the planning of new research and improved industrial procedures; clients were to be put in touch with specialized knowledge; and the services of the Institute library were to be made available, with competent assistants.

The Institute made no commitment to carry on unlimited research through its own staff, but undertook to serve as a center of information, ". . . a clearing house for scientific, technical and industrial problems. . . ."[2] An additional provision, later the source of much controversy, was the proposal to put clients in touch with M.I.T. graduates for the purpose of employment. Relations between the Institute and a subscriber or client were to be established in terms of a contract, fairly specific in nature, according to which the company agreed to pay the Massachusetts Institute of Technology a retainer of a stated number of dollars, in five annual instalments.

In the words of the Plan itself the Massachusetts Institute of Technology was to become the greatest consulting body in the world, maintaining ". . . a staff larger and more differentiated and an equipment more modern and complete than any institution of its kind. . . ."[3] President Maclaurin on various occasions expressed his concern for the failure to utilize the facilities of the Institute in a more effective manner. Moreover, the proposed intimate relations with industry would serve to maintain the vigor of our engineering instruction. "The Technology Plan will not obstruct or interfere with the present educational necessities of the school. Education will not be sidetracked for commercial research. Coöperation will supplement education. Professors in closer touch with the demands of American industry will teach better, because more vitally, than ever; the teaching staffs will be larger and more alive, less academic; and the students will have a chance as they advance in their course to do real work, to tackle real instead of academic problems, and to do their thesis work to meet immediate questions in research."[4]

The Endowment Committee had every reason to be jubilant over the initial success of the Technology Plan. At the end of seventy days more than 180 corpora-

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[1] *Ibid.*
[2] *Ibid. p. 52.*
[3] *Ibid. p. 60.*
[4] *Ibid. p. 61.*

tions had subscribed and had pledged retaining fees amounting to approximately $1,200,000. By April the number had exceeded 200. Not only did the Plan give promise of a rich source of revenue, but it set the pattern for a new kind of engineering education. The endowment campaign brought the Institute $8,000,000 plus the Technology Plan, ". . . in itself a permanent endowment both financial and educational, the full possibilities of which have only begun to be seen."[1]

Yet there appeared even at this early date seeds of discord. In his last message to the alumni, President Maclaurin felt it necessary to defend the Plan against criticism. He pointed out that the Technology Plan was only the natural development of President Rogers's earliest ideas on the place and character of this institution. "The most striking thing about Rogers," he said, "was the breadth of his vision and the large view that he had of the Institute's place in the industrial development of America." He had foreseen the Massachusetts Institute of Technology as much more than a school of industrial science and had incorporated in its charter ". . . a statement that it was founded for the purpose of instituting and maintaining a school of industrial science and 'aiding generally by suitable means the advancement, development and practical application of science in connection with arts, manufactures and commerce.' "[2] According to Maclaurin, the Technology Plan was a natural outgrowth of this conception of the Institute, and was one of the "suitable means" whereby the Institute could accomplish its true purpose. Physically it consisted of a vast group of buildings, with an extraordinary variety of technical equipment representing almost every branch of applied science. It consisted, also, of a notable group of professors and instructors competent to deal with the scientific knowledge comprised within the Institute's courses. These resources should ". . . aid 'the advancement, development and practical application of science. . . . ' "[3]

Maclaurin endeavored to meet two specific charges. The first was that the Technology Plan called upon industrial corporations to pay for services hitherto obtained gratuitously, and the second that the Plan would result in an encroachment on the part of the Institute upon the fields of private practice of its alumni. In reply to the first criticism, it was stated that the same services would be rendered gratuitously as before, but that the Institute now proposed to render service in a businesslike way and if corporations were to pay a retainer for services, there was a very definite obligation on the part of M.I.T. to insure a fair return on these payments. As to the charge of competition, the great industrialist Mr. Coleman Du-

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[1] *Ibid.* p. 53.

[2] "Dr. Maclaurin's Last Message to Technology Men," *The Technology Review*, XXII, No. 1, January, 1920, p.47.

[3] *Ibid.*

Pont proved to be one of the strongest defenders of the plan, maintaining that its potential benefits to Institute alumni greatly overshadowed the possible dangers of competition, dangers that he considered to be wholly illusory.[1]

Further Development of the D.I.C.

These, then, were the origins of the Division of Industrial Coöperation and Research, now known simply as the Division of Industrial Coöperation. It was set up by the Institute for the purpose of assuring, in a systematic manner, that the services promised by the Institute to the subscribers to the Technology Plan would be provided. The Plan contained notable features. Many of the ideas were sound and are incorporated in our current policies. Nevertheless, in its earliest form it failed, and for reasons that are hard to evaluate fairly at this time. One senses that the Plan over-committed the services of the faculty, and that in effect the promised services were either illusory or not forthcoming. The untimely death of President Maclaurin was a devastating blow and the long delay in appointment of a new president made it difficult for Dr. William H. Walker, the first Director, to obtain swift and forceful executive decisions. Although the Laboratory of Applied Chemistry under his guidance had been supremely successful in its relations with the chemical industry, it seems in retrospect that industry broadly in 1920 was inadequately prepared for this kind of collaboration. Gradually the objectives under the Plan were modified. The annual retainer fee was replaced by contracts with special consideration for the particular needs of individual companies.

Several circumstances about the origin of the Plan profoundly influenced the early policies of the D.I.C. In the first place, the Technology Plan was conceived as a means of deriving desperately needed income, and the D.I.C. was set up with the avowed purpose of insuring a *quid pro quo* to corporations paying general retainers to the Institute. Insofar as the purpose of the D.I.C. was that of obtaining funds, the Institute was often a target for criticism from many sources. From the very beginning influential alumni, as well as non-alumni in industry, pointed out that M.I.T. was placing itself in the general consulting business and was thereby in the competitive field of commerce rather than that of education. This criticism was aggravated in later years when the element of inventions and patents became involved. It is probable that the educational advantages of the Plan came somewhat as an afterthought to the conceivers, but these advantages were very real and there is no doubt but that President Maclaurin shared the vision of Rogers of an institution in the service of the new industrial age.

It is difficult to give a fair assessment of the operations of the D.I.C. during the

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[1] *Ibid.* p. 48.

decade preceding the Second World War. There can be no question but that certain tasks undertaken by members of the faculty under the auspices of the D.I.C. were of very great service to industry. It is much less clear that they were of any particular value to our educational program, or that the function of the D.I.C. was generally understood and approved by industry. As a matter of plain fact it had been set up as a means of securing a revenue, and certain practices relative to patent rights and royalties led many outside the Institute to believe that we were engaged in competition with industrial research and development organizations. Although frequently such views were based on misunderstandings, one must judge, nevertheless, that there were sufficient facts to give some grounds to criticism. One must also remember that at that period M.I.T. was far ahead of most other educational institutions in the field of industrial collaboration and the concept of sponsored research was by no means so clearly and generally understood as in the present day.

The record of service by the Institute in the Second World War is one of which every M.I.T. man and woman should be proud. In contributing to technical development for the military during World War II, every advantage was taken of the flexibility inherent in the management of a private institution, and this was made particularly effective by the boldness and courage with which the M.I.T. administration met its responsibilities. Decisions were followed by immediate action and the work in the Institute's laboratories seldom waited upon the details of contracts. The burden of meeting all such vexing problems as fiscal accounting, patents, royalties, and property accounting, in connection with this vast effort, fell upon the Division of Industrial Coöperation, which handled them in such a manner as to set a pattern for universities throughout the country.

The growth of the D.I.C. was extraordinary. In 1940 there were some thirty-six projects under its cognizance, representing a dollar volume of approximately $135,000. During the war the research projects grew to an annual volume of approximately $5,000,000, to which must be added the expenditures of the Radiation Laboratory, which during the period 1941-1946 amounted to approximately $100,000,000.

It was generally believed that the end of the war would result in the closing out of the major portion of government-sponsored activity and a return to operations resembling those before the war, and in the case of the Radiation Laboratory, which was staffed almost entirely by visiting scientists and engineers, such a discontinuation did actually take place. Activities that are an integral part of the Institute program have, on the contrary, increased in size and number since the close of the war.

The Trend Since the Close of the War

There were 123 sponsored projects active at the Institute in 1946, 153 in 1947, 176 in 1948, and at the time of the present writing in 1949 there are 190.

The degree to which the operations of the D.I.C. have become integrated into the academic affairs of the Institute is apparent from the approximate figures for 1948-49. The total academic staff of the Institute included some 550 in the grade of professor or instructor, and an additional 700 research associates, research assistants, and teaching fellows. Of the 550 professors and instructors, 22% were associated, at least part time, with D.I.C. projects. The teaching fellows, all of whom are graduate students, do not in general participate in sponsored research, but more than 80% of all research associates and assistants were thus engaged.

Technical supervision of all sponsored projects is considered to be a responsibility of the faculty. In order that our academic staff may apply its talents most effectively, it receives the support of a large group employed by the D.I.C. who devote full time to these projects. In June, 1949, this group numbered 1,414, of which 535 were D.I.C. staff and 879 non-staff.

A summary of the 1948-1949 situation from a fiscal point of view shows that contracts for sponsored research amounted to $15,470,000. The academic and auxiliary expenses of the Institute were approximately $10,130,000. Academic staff salaries amounted to $4,400,000, of which sum $1,240,000 or 28% was derived directly from sponsored projects in the form of reimbursement for the services rendered by our academic staff. In addition to such direct reimbursement for faculty salaries, sponsored projects contributed $1,890,000 in overhead to the administrative and plant operation expenses of the Institute. Finally, hundreds of graduate students attending the Institute would have found it financially impossible to do so had they not been employed on sponsored projects.

The primary factor that we must recognize in assessing the present position of sponsored projects in Institute affairs is the change in their relation to the academic program. Although the idea of an obligation to render service to the community, to the state and to the nation appears always to have been present, nevertheless it seems clear that the origins of the D.I.C. were based on the frankly stated need of increasing the Institute's income and imposing a control on the exploitation of Institute facilities by a few members of our staff for personal profit. During the past decade, however, the question of financial return has been made subordinate to that of the importance of the service, and the primary factor governing the acceptance of a project has become the degree to which it may contribute to the educational objectives of the Institute.

In the case of contracts with industry, overhead charges are made sufficiently high to guarantee some return on Institute services, which may be used for the support of research in less favored fields. At the moment, however, an overwhelming proportion of sponsored contracts is with the government, and the wartime policy of "no loss, no gain" still prevails. In short, although it is generally recognized that the sponsored research and development contracts as a whole contribute vitally to the current operations of the Institute, and that the structure that has been built up in enlarged staff, student body, administration, and physical facilities could not be maintained without it, this type of activity is not undertaken primarily for the purpose of obtaining income, as was true in the days of the Technology Plan.

In 1940 a relatively small fraction of the staff participated in sponsored projects, and only in isolated cases does it appear that graduate students derived much educational experience from them. This situation has changed notably. D.I.C. projects account for the financial support of a very sizable fraction of our graduate students, who also benefit materially in terms of educational experience. In certain departments, such as Electrical Engineering and Physics, almost all the graduate students are engaged in such activities.

Thanks to government contracts, the Institute has the use of a large number of instruments, machine tools, and special facilities. Although according to the terms of the contracts this material is returnable to the sponsoring agencies, it is in effect at the disposal of the Institute for an indefinite period. There is also an enormous amount of expendable material made available to laboratories and employed by both staff and students for carrying on research or engineering development.

An extremely important aspect of the situation is the postwar evolution of large engineering laboratories, such as the Servomechanisms Laboratory, the Instrumentation Laboratory, and various others, that offer unusual opportunities to graduate students to become familiar with the actual processes and practical problems of engineering, while carrying on their other more academic studies.

Finally, postwar contracts with the military services have led to the construction of a number of very large facilities and machines that will have an important influence on the Institute's research and development program for many years to come. Among these are the new supersonic wind tunnel, which comes to the Institute through its guided missile program with the Bureau of Ordnance, the synchrotron and 12-million volt Van de Graaff generator, sponsored by the Navy, and several large computer projects, also under Navy sponsorship.

Unquestionably the most notable feature of the Institute's postwar development is the close interweaving of sponsored research and graduate study. Nevertheless, we must not overlook the additional responsibilities of planning and management

that are imposed on the faculty as well as the administration by the acquisition of expensive facilities for research and engineering development.

New Management Responsibilities

The very magnitude of many projects makes it necessary for some of our ablest colleagues to devote their attention largely to administrative rather than technical problems. The extent of this diversion of talent into administration is difficult to assess, and whether it presents a real problem in any instance can be judged only by the man involved. Nevertheless it is a factor that must be taken into account in evaluating the desirability of undertaking new projects or expanding old ones.

In addition to this general problem of management, two special problems arise in the administration of some of our larger enterprises.

First, a problem arises in large projects that exploit new fields in which one or more of our academic staff are prominent, and for which comparable facilities and technical skill are unavailable in industry. The educational merit of most of these enterprises appears to be outstanding. Graduate students associated with them gain direct and basic experience in areas showing industrial promise and acquire a firsthand knowledge of problems of engineering practice that cannot be imparted in the classroom.

There is placed on the leaders of this type of engineering development, however, a peculiarly heavy burden; for only by great ingenuity, imagination, and enterprise can they maintain the undisputed lead that safeguards us from direct competition with industry. The very fact that these fields open new vistas to the manufacturer stimulates industry to establish groups with comparable objectives. As the facilities of industry expand, the need for our own may diminish and the Institute, under its present policy, must not be placed in the position of soliciting new business. Those who are responsible for management must then take steps to see that the groups are diverted to new interests or disbanded.

Let us not underestimate the consequences. In every large project that has continued over a period of years we have an investment in space and in capital equipment, and a responsibility toward our men. The termination of such an enterprise is a more difficult problem by far than the liquidation of a wartime group drawn largely from other institutions.

Second, we consider a different category, namely, those projects that are primarily concerned with the development and construction of a single device or piece of equipment. Among these, we may currently cite the differential analyzer, the digital computer and simulator projects and several high-energy-particle generators. These are the tools of modern, large-scale research, and such undertakings have become widespread in American universities since the war. Neverthe-

less, the risks involved by the contracting institution are large, and the fact that these risks are to a considerable extent of an intangible character makes them all the more serious.

The development of any such large device is a notable engineering achievement and provides an unusual opportunity for the exercise of inventive ingenuity and the application of creative imagination to engineering problems. This contribution to our engineering program offsets the risk of a rapid obsolescence of the completed machine. One gains the impression, however, that there is currently at M.I.T. a disproportionate emphasis on the devising and construction of new facilities. As a consequence many of our most gifted colleagues have been engaged over an extended period in engineering design and the supervision of construction. Although the Institute has shown great boldness, enterprise, and leadership in the development of these new fields, we must keep in mind that instruments, large or small, are not an end in themselves but rather a means to research; and for our ultimate leadership in science there must be the same passionate desire to use these new machines as there has been to devise them. We believe that it is a responsibility of those in charge of these projects to see that the possibilities of use are exploited as fully as are those of design and construction.

Advantages and Dangers of Sponsored Projects

There are at least three major arguments in favor of sponsored projects as sources of strength in our educational program.

First, they make possible education in engineering research and development of a high order. One of the principal problems of engineering education, particularly at the graduate level, is to prevent it from becoming too academic, too theoretical. We want students to have the feel for engineering problems that comes from direct contact with important projects of real utility. The extensive shop and drafting room practice provided in our curriculum a generation ago no longer suffices. The finest aspect of our many contractual arrangements at M.I.T. with industry and government since the war is that they have made possible this kind of training and experience in connection with engineering problems of real worth.

Second, the facilities of our wind tunnels, gas engine laboratories and Servomechanisms Laboratory, to name only a few, are available to us by reason of sponsored undertakings. Projects carried on in connection with them contribute directly to general knowledge of basic engineering problems. The results are available to all and benefit industry broadly. For this reason we believe that industry will show an increasing disposition to participate in the sponsorship of work of this kind.

Third, the cost of many aspects of research in science has risen to such a level

that endowment alone can no longer supply the necessary funds. It has become increasingly apparent since the war that private institutions proposing to maintain a position of leadership in the physical sciences must turn to outside sources for aid. Sponsored projects provide such aid, and permit the undertaking of fundamental scientific investigations, for example in nuclear science, that would otherwise be quite impossible.

There are also at least three potential dangers in this type of activity that make it essential for us to plan soundly toward a reasonable balance between sponsored projects and other aspects of our program.

The *first* arises from the fact that sponsored projects are supported for the most part on a short-time basis, and hence introduce uncertainty in the financial aspects of the operation when their magnitude is very large in relation to the whole Institute program. The precarious nature of our present position is obvious. Any sudden change in the public attitude toward national security must inevitably react directly upon the affairs of the Institute. We believe that great care must be used in future planning to insure that the Institute is in position to readjust readily to possible changes in the magnitude of sponsored project support.

The *second* is related to the fact that many large sponsored projects emphasize design and construction problems, engineering development, or applications of science rather than fundamental scientific inquiry. This in itself is not undesirable, since a major portion of our educational program is concerned with engineering and applied science. But we must be careful lest the great preponderance of activities of this type, and the greater availability of funds for work of this sort, divert interest from the more fundamental aspects of scientific research in which the Institute must also make every effort to excel.

The *third* results from the preponderance of military projects in the sponsored program. This gives rise to two difficulties. First, national security regulations required that some of the work be carried out under secrecy regulations. Although we see no way to avoid this situation at the present time, we regard the conduct of research or development in secret at an educational institution as highly undesirable. We call attention to the discussion of this point in the Report of the Committee on Staff Environment. Second, it would be as unfortunate for M.I.T. to become regarded as an institution that is dependent upon the development of war weapons as it is for an industrial organization to be regarded in similar light. We believe, therefore, that the current effort to broaden the base of sponsored activity through increased industrial participation is to be particularly commended. We suggest that future planning should look forward to the possibility of increased emphasis upon activities more directly related to the public welfare.

Sponsored Projects and University Policy

Up to this point, we have been discussing sponsored projects at the Institute. The participation of universities all over the country in contract research since the war has led to the consideration of various broad policies, not limited in their application to any one institution, that we should also review briefly.

Before 1940, collaboration between American universities and industry was on a relatively insignificant scale and this was likewise true of coöperation with agencies of the federal government, apart from the field of agriculture. As a technical institution with its Research Laboratory of Applied Chemistry and its Technology Plan of 1920 as a background, M.I.T. was a notable exception to this rule. Then during the war years the Office of Scientific Research and Development gave enormous impetus to contracts for research with educational institutions, and the practice has been continued extensively since 1945 by the military services and the Atomic Energy Commission.

Many universities now maintain offices resembling the Division of Industrial Coöperation for the purpose of administering contracts of this character. However, the pattern and objectives of these new organizations appear to be by no means identical in all institutions. Although they have in common the desire to make the most of the present availability of federal funds for the support of science and engineering, one notes also in many instances the establishment of laboratories whose functions appear to be more closely allied to consulting engineering than research, and whose purposes seem to be primarily those of deriving additional income. Apart from a question as to the extent that such activities may eventually jeopardize the tax-free status of the institution, the evolution of contract research along such lines has caused uneasiness in many faculties where it is felt that an excessive emphasis on projects of this character may ultimately run counter to the true academic function.

A university, or more particularly a technical school, has in its laboratories the facilities for experimental investigation far beyond the means of all but the largest commercial organizations. The use of these special facilities is sometimes requested in the interest of local industry. The services required are more likely to be in the nature of testing rather than research, and help in the development of new products. What should be the position of the school? To us that would appear to depend greatly upon the circumstances. This was the kind of task that comprised most of our D.I.C. program in its earlier years. When no other sources are available to provide this kind of technical assistance, one hesitates to condemn a university for endeavoring to place its facilities and specialized staff at the limited disposal of the community. Nevertheless, when the work is largely that of testing

or of overcoming inherent difficulties in the development of new products, we think that it should go more properly to commercial laboratories, such as are operated by industry in its own behalf, or independently for the specific purpose of commercial research.

Although service to the community is most certainly a function of every university, it must fulfill that function primarily through education and extension of the basic fields of knowledge. Contracts for development or testing in connection with the products of individual firms almost inevitably become associated with patent problems, commercial secrecy and questions of industrial competition, none of which contribute to the best in an educational program. A technical school cannot afford in every circumstance to be adamant in its refusal to accept work of this kind, but we believe that as a matter of policy such work should definitely be discouraged.

The monetary consideration involved in contract research is the one most difficult to appraise fairly. In a period of increasing costs and shrinking returns from endowment every educational institution must necessarily explore all possible new sources of income. The principle that charges made for service to industry should be sufficiently high to insure a substantial contribution to the educational and research program as a whole seems sound. Obviously the danger arises when income becomes the actual motive governing the selection of a sponsored project rather than its potential contribution to the advancement of knowledge and the welfare of the student.

As one surveys the current state of contract research in connection with colleges throughout the country one cannot escape the suspicion that many schools are perilously close to engaging in purely commercial enterprises. In our opinion any school that follows such a course will ultimately suffer serious damage to its standards as an institution of higher learning.

The practice of using contract research projects as a means of supplementing the salaries of some members of the regular academic staff either by summer employment or by extra compensation during school terms appears to be prevalent in a number of universities. This we believe to be an exceedingly unwise policy, and it is one that M.I.T. has endeavored to avoid. It is a policy that tends to inflate the salary scale in some departments, giving rise to serious inequities and the promise of future discord when contract work is unavailable. Above all, it emphasizes the motive of financial gain rather than the intrinsic worth of a project in an educational institution.

Faculty Responsibility for Sponsored Research

It should never be forgotten that, in the final analysis, the scope and character

of sponsored research at M.I.T. is determined by the faculty. The policy of our administration is clear. No faculty member is ever under compulsion to engage in sponsored research. These are voluntary activities entered into because, in the judgment of individual faculty members with the concurrence of their department heads and deans, the particular research effort is the most productive use of time and Institute facilities. Faculty policy on sponsored research is the aggregate of these individual judgments, even though this policy may be undeclared.

Thus the faculty has a primary responsibility for sponsored research policy as an integral part of its broader responsibilities for educational policies and practices. In our judgment, this responsibility can be discharged best under broad policies enunciated by the faculty for the guidance of departments, schools, and academic administration.

Conclusions and Recommendations

1. We conclude that the scope and character of sponsored research at M.I.T. is, in effect, the aggregate of the voluntary actions of M.I.T. faculty members, and that the faculty has a primary responsibility for sponsored research policy as an integral part of its broader responsibilities for educational policies and practices. This responsibility can be discharged best under policies enunciated by the faculty for the guidance of departments and schools, but success in avoiding the dangers and pitfalls of a large-scale sponsored research program will require eternal vigilance and wisdom by our top administration.

2. We conclude that a sponsored research program, regardless of size, will succeed only if the faculty members responsible approach the research problems with enthusiasm and with the conviction that the particular activity is the most productive possible use of Institute time and facilities. Over-commitment of the Institute's staff and facilities was a principal cause of the failure of the old Technology Plan.

3. We conclude that sponsored projects contribute materially to our educational program in at least three ways: by bringing graduate students into close contact with real engineering problems; by providing special facilities that contribute to the advance of engineering knowledge; and by supporting fundamental scientific investigations that would otherwise be too costly to undertake.

4. We conclude that the following dangers must be considered in the formulation and implementation of sponsored research policy:

   (*a*) The great increase in the magnitude of sponsored projects since the war has given rise to new and major management responsibilities among many members of our staff and administration. There is a very real danger of too great diversion of technical talent into administrative activities.

(*b*) The predominance of applied engineering projects of large size may unduly divert attention from fundamental scientific inquiry. Sponsored activity concerned with the development of new devices of potential value for research may not be followed by a compelling desire to use these devices in active, fundamental research programs.

(*c*) The development of new devices and special facilities may lead to competition with industry unless great care is taken to change the direction of these research and development activities when they no longer fill a unique need.

(*d*) Sponsored research has placed a large proportion of the Institute's financing on a short-term basis.

(*e*) The secrecy provisions characteristic of some projects may in the long run have undesirable implications. The Institute runs a risk of becoming in the mind of the public an organization whose primary mission is the development of war weapons.

5. We recommend that the faculty and the administration, in the formulation and discharge of their responsibilities for sponsored research policy, be guided by the following objectives:

(*a*) An increased emphasis in future planning on maintaining such a balance between sponsored research and other activities that adjustment to change can be accomplished readily,

(*b*) An expanded effort toward support of fundamental scientific inquiry,

(*c*) A broadening of the base of sponsored project support by increased industrial participation,

(*d*) An avoidance in the future, as in the past, of undertaking sponsored research primarily for the purposes of financial gain or of securing supplemental salaries for staff members.

Chapter V

Organization of the Faculty For Greater Unity and Effectiveness

There has been considerable comment about the importance of revitalizing the activities of the faculty as a deliberative body. It has been said that faculty meetings are perfunctory, and that they accomplish little of moment. Nevertheless the responsibilities of the entire faculty for guiding the broad educational policies of the Institute are universally acknowledged to be important.

To what extent does this anomalous situation exist? What are its causes? How can it be corrected? Can changes toward greater effectiveness be brought about that will at the same time strengthen the unity of the faculty? These are some of the questions that we have endeavored to answer in the present chapter.

UNDER THE CHARTER FROM THE COMMONWEALTH, the Corporation of the Institute is its governing body. Acting through its Executive Committee, the Corporation has delegated certain responsibilities to the faculty. More by tradition and precedent than by formal action, the faculty is responsible for the development and control of curricula, for educational policy, for the supervision and maintenance of discipline, for the development and administration of "such tests of proficiency as shall best promote the interests of sound education," and for the recommendation of students to the Corporation for degrees.

In the early years when the whole faculty could meet in a small room, and when it was possible for the individual faculty member to be familiar with all aspects of the Institute's work, the faculty as a whole could effectively debate matters of broad policy and at the same time exercise effective control over details of the Institute's educational program. In recent years, M.I.T. has grown to be a very large and intricate institution. The administration has been flexible in adjusting itself to these new conditions, and the departments have remained strong and creative. The faculty, however, is now a large, unwieldy body. Its meetings have become perfunctory and ineffective. Much of its educational business is accomplished through a mechanism of uncoördinated committees. We believe that this mechanism is overloaded and obsolete.

These faults are the faults of a system, not the faults of men. We shall therefore

propose certain changes in the organization of the faculty for the purpose of permitting it to conduct its business more effectively. Some of our proposals are a reaffirmation of present policies and practices, with changes in emphasis. Others involve recommendations for change that reflect the differences between modern conditions and those that prevailed when various practices were first adopted. Still others relate to formal endorsement of *de facto* policies and practices that have come into existence to meet changed conditions but that have not been officially legislated. Throughout we have kept in mind the preservation and further strengthening of the unity of the faculty.

The Unity of the Faculty

For many years, the Institute's faculty was limited to a few dozen men, all working with a remarkable singleness of purpose and method. Even throughout our recent great growth, we have retained a unity of outlook and objectives to an extraordinary degree.

From the beginning, the faculty has been organized into departments, each responsible for instruction in its own professional field. Later the departments were grouped into schools, and academic deans were appointed to assist the president in his multiplying administrative responsibilities and to act as educational leaders to coördinate the work of groups of departments that represent communities of interest. Other groups, that cut across departmental lines, such as the Graduate School and more recently the interdepartmental laboratories, have evolved within the faculty, and administrative officers have been appointed to lead and be responsible for them.

Despite the administrative changes that have taken place from time to time, M.I.T. still adheres to the principle of the common faculty responsible for educational policy and operations in all phases of educational work at the Institute. In this respect, the Institute differs markedly from the usual university in which the faculties of law, medicine, arts and sciences, engineering, and other broad fields meet separately as independent deliberative bodies. As has been emphasized previously, we believe that the resulting unity of the faculty is a source of strength at the Institute.

The wide range of our activities today and the expanding numbers of our staff require a subdivision of the faculty into various kinds of working groups. Our problem then is this: how can the faculty of M.I.T. best resolve itself into effective working groups while maintaining the closest possible collaboration in the achievement of common objectives?

We believe that this end can be accomplished by an appropriate division of responsibilities between the departments, the schools, and the faculty as a whole, and by a reorganization of the faculty committee structure.

The Departments

The basic operating units within the faculty are the departments, each of which represents a recognized professional field such as civil or mechanical engineering, chemistry, or mathematics. The department head and his associated staff have determined professional objectives and developed the curriculum, subject only to such general policies and controls as were exercised periodically by the faculty through designated committees.

The department has been and, in our opinion, should continue to be the site for initiating creative academic effort, the center of relationships between students and staff, and the educational unit for constant self-examination of teaching aptitudes, skills, and performances. We believe that the departments should assume the primary responsibility for maintaining high standards of professional education at M.I.T.

Particularly with respect to appointments and promotions, the degree of faculty participation in departmental planning varies widely from one department to another. It has been our observation that the situation at M.I.T. is on the whole relatively good. We are loath to recommend any specific pattern for department councils, but we believe that the suggestions for improvement made by the Committee on Staff Environment in its report are good ones, and should be adopted.

We believe that the conduct of a department should be entrusted to a distinguished leader, that he should bear a personal responsibility for the success of his program, and that to meet that responsibility he must have freedom of independent decision. It seems equally clear that consultation with the staff on matters of important policy is indispensable. We believe that confidence and understanding between the staff and its leader are essential for greatest departmental effectiveness.

We have considered at some length the perennial question of appointments to department leadership with or without term. Both procedures have obvious advantages and disadvantages. Nevertheless, it is our opinion that rotation of office among members of the department is not conducive to strong leadership and continuity of policy. We believe that the administrative appointment without term for all department heads is sound and should be continued. Our conclusion that an unlimited term is desirable is at variance with that of the Committee on Staff Environment as outlined in their report.

Further thought by both the faculty and administration might be given to the problem of the department head who wishes to relinquish some or all of his administrative burden, after an extended period of service, in order to devote more time to teaching, research, or other professional interests. We believe that such voluntary changes of activity should be encouraged, but not, of course, as a universal

practice. A man who is so inclined should find it possible to pursue new interests without fear that this action will be misinterpreted as having been involuntary. We believe such a change of activity should be regarded as an entirely normal choice of alternatives in the rounding out of a distinguished professional career, and we believe that a tradition can be established whereby it will be so regarded.

The Schools

Although the departments constitute the basic subdivisions of the faculty, a grouping of departments into schools has been necessary in recent years.

The manifest reason for the initial establishment of the Schools of Architecture, Engineering, and Science was administrative convenience. Single departments had grown larger than was the entire Institute in its earlier days, and it became impractical for the Office of the President to give direct attention to all the problems of fifteen or twenty department heads. Accordingly, certain administrative responsibilities were delegated to academic deans. Insofar as they deal with budgetary matters, the duties of the deans appear to have been clearly defined from the outset. We believe, however, that the relation of the departments to their respective schools on questions of educational policy has not been so clear.

As has been indicated in Chapter III, we believe that increased emphasis on the school as a distinct organizational entity within the faculty is desirable, and we recommend that each academic dean form an advisory council, to include all department heads in his school and whatever additional members he may desire. This council would deal with the educational objectives, policies, and practices of the several departments in the school. Its primary concern would be with interdepartmental relations and with problems that transcend the primary interest of a particular department, but relate to the broad professional interests of the individual schools. Each school council would be concerned with the total educational process, from the freshman year through postdoctoral study; it would be especially concerned with problems of undergraduate education. It would review departmental curricula proposals and make suitable recommendations to the appropriate faculty committees. On all educational matters that affect other administrative subdivisions of the Institute, each school would work closely with its counterpart to bring joint recommendations before the faculty.

The fostering of a community of spirit and method within each of the four areas represented by the schools would, we believe, afford increasing opportunities for individuals and departments to influence educational policy constructively. Furthermore, we believe that the development of closer educational relationships within the schools would, in turn, be reflected in greater unity in attention to over-all educational problems by the faculty as a whole.

The Present Faculty Committee Structure

The faculty has gradually delegated its responsibilities to committees, and it will be useful to review the present committee structure before making recommendations for changes.

The Committee on the Graduate School is composed of one member from each of the twenty departments giving graduate instruction, the Director of Admissions as Secretary, *ex officio*, and the Dean of the Graduate School as Chairman, *ex officio*. This one committee coördinates all aspects of graduate education for a student group approximately one-half the size of the undergraduate student body. Directly and through its subcommittees, it serves as a single agency in the determination of graduate educational policy.

We recommend that this committee be reconstituted as the Committee on Graduate Policy, with one member from each department giving graduate instruction, the Chairman of the Faculty, *ex officio*, and the Dean of the Graduate School as Chairman, *ex officio*.

The purpose of the change in name is to define the major function of the committee more clearly as that of developing and recommending to the faculty broad policies with respect to graduate education.

The purpose of naming the Chairman of the Faculty as a member is to improve coördination with undergraduate education as discussed later in this chapter.

No such unifying agency exists for the undergraduate school. The various aspects of undergraduate education are divided among the following standing committees:

The Committee on Undergraduate Courses
The Committee on Petitions
The Committee on First-Year Students
The Committee on Second-Year Students
The Committee on Third-Year Students
The Committee on Fourth-Year Students
The Committee on Undergraduate Scholarships
The Committee on Provisional Students and Discipline
The Committee on Conduct of Examinations
The Committee on Admissions

In a somewhat different category are the following two committees charged with the responsibility of administering specific subjects or courses.

The Committee on General Studies
The Committee on Course IX

None of these committees has a responsibility to the faculty for an over-all consideration of undergraduate education, nor does any person or group short of the President or the total faculty have this responsibility. Each professional department

tends to think of the first year only as a source of new students and to concern itself primarily with the second year and beyond, unless it is involved in first-year instruction; in this case, its concern may be very specifically with its own particular first-year teaching problems.

The duties and responsibilities of the undergraduate committees enumerated above vary widely. Some meet as committees only at the end of each semester under the pressure of term-end problems. The principal purpose of such meetings is to determine which students have met academic standards and which are to be warned, suspended, or dismissed. Some committees report to the faculty and some act with power and do not report.

Some committees are kept very busy. Such a group is the Committee on Undergraduate Courses, which handles a mass of detail, much of which represents requests from departments to shift a subject from one semester to another, or to change the stated recitation or preparation hours of a subject, or to add or drop a particular subject. These requests reach the Committee on Undergraduate Courses directly from the several departments, as do requests for adding or dropping options and other more important modifications of undergraduate professional programs. The committee must test the legality of these proposals against its understanding of faculty policy. There are scattered items of faculty policy in the document "Rules and Regulations of the Faculty." Other clues to faculty policy may be found in the introductory sections of the M.I.T. catalog. Still other evidences of faculty policy may be found in the minutes of past meetings in which reports of special *ad hoc* committees were adopted or votes on specific questions were recorded.

The testing of a proposal for legality sometimes depends upon the memory or understanding of committee members or of such administrative officers and others as may be consulted. A new member of a committee is under a particular handicap in rendering effective service unless he has made a hobby of understanding and interpreting the intent of the faculty.

The faculty has permitted undergraduate education at M.I.T. to be administered in such detail and to be complicated by such a flow of paper work that it is often extremely difficult for a faculty committee member to distinguish between policy and clerical routine. Thus, practices that include the requirement of very precise compliance with the printed program throw a heavy clerical load on the Petitions Committee. Each year, several thousand petitions must be considered by the committee and formally approved or disapproved. Each such petition bears the endorsement of a Registration officer or department head. The bulk of the petitions are for minor substitutions in the prescribed specialized undergraduate programs. For each of the petitioned cases, it is necessary to decide whether the request is reasonable or whether granting the request would result in undue dilution of the

student's undergraduate education, or possibly whether it would result in a type of education too far removed from some one of the twenty-odd specialties specified in the catalog. A particularly troublesome problem is what to do about the student who returns to school after a year or two only to find that the curriculum of his department has been modified in his absence.

In short, the Petitions Committee applies to each individual faculty-endorsed request its understanding of faculty policy regarding requirements for the bachelor's degree in the particular department from which the request originates. Considering the mass of detail involved, it is not surprising that the committee's policy has been to protect the interests of the faculty by conforming to rather strict rules, thus avoiding decisions that might later be construed to have established undesirable precedents.

We believe that the present undergraduate committee structure would have fallen of its own weight some years ago if it had not been for the devotion and hard work of the present and past chairmen of certain key committees, and for the continuity of service and skill in mastery of detail of certain administrative officers. But we believe that the faculty has been unfair to administrative officers concerned primarily with the records and the facts by insisting on their service as *ex officio* voting members of faculty committees. More important, we believe that such individuals are placed in awkward positions in their relationships with the rest of the faculty. Positions that are difficult at best are made more so when responsibilities include both recording and reporting educational decisions as well as active participation in the making of such decisions. Freeing officers of this conflicting responsibility should leave them available as a ready source of facts and counsel, and for the administrative execution of faculty policy.

The Multiple Role of the Faculty Member

In considering how best to coördinate the function of the faculty, we believe that it is important to recognize five roles that each faculty member undertakes at one time or another in his daily work. First, he is a voting member of the common faculty. Second, he is attached to a subdivision of the faculty under the administration of an academic dean, one of four broad areas of professional interest. Third, he is a member of a professional department with a focus of interest necessarily more specific than that of the broader administrative subdivisions. Fourth, he is a teacher and scholar with a specialized professional interest. Fifth, he is an administrator.

Although we may seldom stop to think about it, nearly every staff member is an administrator as well as a teacher and scholar. His administrative responsibilities include student counseling, the intimate details of subject administration, the

practical implementation of faculty policy at the departmental and school level, and participation in faculty policymaking in committees and faculty meetings.

Department heads are members of the faculty whose duties require greater preoccupation with administrative matters and a corresponding reduction in the time that can be spent in the classroom or laboratory. The acceptance of still higher administrative responsibilities forces some of our colleagues to withdraw almost completely from teaching and research in order to implement most effectively the educational policy determined by the faculty and to provide the inspiring educational leadership characteristic of the Institute.

The important point is that the lines between teaching and administration are not as sharply drawn as we are sometimes inclined to believe, and that every faculty member should recognize clearly that he has administrative and policy-making responsibilities that he must be willing to assume whenever called upon to do so. Primary emphasis upon teaching and scholarship should make a faculty member no less aware of the problems and importance of administrative effort. Likewise, emphasis upon coördination and general administration by the President, department heads, and deans, should make them no less understanding of the educational problems of their faculty colleagues. While it is always convenient to use the words *faculty* and *administration* to describe different foci of activity, we must never forget that administrators are educational colleagues of faculty members who also have administrative responsibilities.

The top administrative group is compact and flexible. The faculty is a large, and, at present, unwieldy body. Even though both groups are as one in broad objectives and in devotion and loyalty to the ideals of the Institute, there must be sharp contrasts between the mechanisms by which they accomplish their business.

The purpose of the following proposals is to increase the effectiveness of the faculty operation, make it more self-sufficient in the discharge of its primary responsibilities, and create a free flow of communication with top administration through the newly formed Academic Council and otherwise. We believe there is real need and opportunity for the faculty to assume its full responsibilities concerning educational policy and at the same time to make full use of the qualities of administrative skill and educational leadership that characterize the top administrative group.

The Proposed Committee on Undergraduate Policy

We recommend that the faculty establish a Committee on Undergraduate Policy as an executive committee for the faculty on all matters of undergraduate education. We recommend that this committee be composed of ten members of the faculty to be chosen as follows:

Chairman of the Committee on Undergraduate Policy: appointed from the faculty by the President to serve at the pleasure of the President.

Chairman of the Faculty (ex officio).

Eight members: nominated and elected by the faculty in the usual way, provided that each of the four schools shall always have at least one representative among the eight. After the first election, two members shall be elected each year for four-year terms. At the first election, two shall be elected for one-year, two for two-year, two for three-year, and two for four-year terms.

In nominating and electing members of this committee, the faculty should exercise great care to choose the most thoughtful, vigorous and courageous members of the faculty, without regard to rank or age.

The Committee on Undergraduate Policy would formulate the policy for undergraduate education, subject to approval by the faculty as a whole, and would interpret and administer the policy that has been approved by the faculty. On all matters affecting undergraduate education, the committee would act with the broad powers of inquiry and recommendation that have been enjoyed by the Committee on Educational Survey. It would supervise and coördinate the work of all standing committees of the faculty concerned with undergraduate education.

The Committee on Undergraduate Policy would work closely with the schools and departments. It would be responsible for preserving for the several departments and the four schools the flexibility of operation appropriate to the educational objectives and policies of each such group, and at the same time be responsible for coördinating these efforts in conformity with the broad policy decisions laid down by the faculty.

The Committee on Undergraduate Policy, as we conceive it, would be a deliberative and judicial body. It would be responsible also for the administration of faculty policy, but we do not expect that it will itself handle any appreciable fraction of the administrative business of the faculty. The burden of routine administration should be carried, as it is now, by professional administrators and their clerical staffs. The function of this committee is to make policy so clear that educational officers can be expected to exercise considerable discretion in the application of faculty policy to particular cases.

One result of this clarification of educational policy will be that a registration officer will more clearly understand his authority to modify a student's printed program and can be expected to assume responsibility for granting or denying requests from students on educational grounds exclusively. Most educational decisions involving individual students will be made where they ought to be made, on the level of personal relations between the student and his registration officer. A

modification of program approved by the registration officer will become effective upon notice to the Registrar, except when in the opinion of his office it is a violation of faculty policy.

In the course of the administration of the faculty's policy through officers, schools, departments, and committees, cases will arise which in the judgment of an officer or a committee will call for the clarification or interpretation of an obscure or disputed point of policy, or for an individual exception to a particular precedent, or for a modification of general policy. Such matters may be carried to the Committee on Undergraduate Policy for consideration. In the interpretation of faculty policy and its application to particular cases, the committee will ordinarily be able to act for the whole faculty without sending the matter to a faculty meeting for perfunctory action. But in their continual review of educational operations, the Committee on Undergraduate Policy and its subcommittees should be concerned always with the substance of policy as well as with the justice of its application. When a case points to a desirable modification of educational policy, it may be carefully considered by the Committee on Undergraduate Policy and presented with recommendations at a faculty meeting. This is the sort of matter that we expect will constitute the major part of this committee's business. The real issues between one group of the faculty and another should become few, and these can be brought before the faculty for discussion and disposition as educational issues, not administrative details.

The committee will be responsible, with the Chairman of the Faculty, for working closely with the officers of administration, either directly or through the Academic Council, on all matters affecting undergraduate education. These include the cultural, the environmental, and the extracurricular as well as the more formal aspects of education. This committee should work closely with the office of the Dean of Students and establish communication with the various student groups and with such bodies as the present Student-Faculty Committee. We believe more effective ways can be devised for securing consideration by the faculty of problems originating in the various student groups, especially problems dealing with the more informal aspects of undergraduate education.

Disposition of Present Undergraduate Committees

In order to simplify the present committee structure, it is proposed that the following standing committees of the faculty now dealing with specialized aspects of the educational process be designated temporarily as subcommittees of the Committee on Undergraduate Policy, effective upon establishment of that committee:

Committee on Admissions
Committee on General Studies

Committee on Undergraduate Courses
Committee on Petitions
Committee on Provisional Students and Discipline
Committee on Undergraduate Scholarships
Committee on Conduct of Examinations

We recommend that the Committee on Undergraduate Policy conduct an intensive study of the functions performed by each such committee toward the end that, within one year, the various functions may be disposed of in some combination of the following:

1. Responsibility delegated to the schools and related departments, with review by the Committee on Undergraduate Policy.
2. Responsibility delegated to the appropriate administrative office with provision for appropriate reports and with general guidance by the Committee on Undergraduate Policy.
3. Responsibility assumed directly by the Committee on Undergraduate Policy.
4. Responsibility delegated to a designated subcommittee.
5. Abandonment of the function.

It is suggested that care be taken in the appointment of subcommittees not to overburden administrative officers with *ex officio* appointments. It is recognized that faculty policy and the primary administrative responsibility are so interwoven in some areas as to make it imperative that certain administrative officers be made *ex officio* members or chairmen of committees. In other areas, however, it seems appropriate to separate the primary responsibilities more sharply. Where this is done the faculty groups can draw freely upon administrative officers for facts and counsel without placing those officers in an awkward and perhaps misunderstood position with respect to the rest of the faculty.

It is recommended that the Committee on Course IX be responsible to the Committee on Undergraduate Policy through the Dean of the School of Science for its undergraduate Course in General Science and through the Dean of the School of Engineering for its undergraduate Course in General Engineering.

There are certain standing committees of the faculty concerned primarily with operating matters, all members of which are members by virtue of office. These are:

1. *The Committee on First-Year Students*, composed of representatives of each department giving instruction to first-year students, and the Secretary of the Faculty, Registrar, and Dean of Students, with the Dean of Freshmen as Chairman.
2. *The Committee on Second-Year Students*, composed of second-year registration officers, a representative from the Departments of English, Mathematics, and Physics, the Dean of Students, Dean of Freshmen, Registrar, with the Secretary of the Faculty as Chairman.

3. *The Committee on Third-Year Students*, composed of appropriate registration officers, Dean of Students, Dean of Freshmen, and Registrar, with the Secretary of the Faculty as Chairman.
4. *The Committee on Fourth-Year Students*, composed in the same manner as the Committee on Third-Year Students.

The present principal duty of these four committees is to pass upon the records of students at the end of each semester and to report to the faculty the action taken with respect to these records. These committees act with power when their decisions are unanimous. We recommend the continuation of these operating committees under the general guidance and delegated authority of the Committee on Undergraduate Policy. On these committees are the Institute faculty members who are most intimately in touch with individual undergraduate students, as their educational advisers. It is these men who bear the primary responsibility, and each should have the primary authority to pass upon and approve individual student programs under broad policies and instructions laid down by the faculty through the schools and departments, subject to such general reviews as have been proposed.

Through group study of the problems of student counseling, these men are in a unique position to contribute to an enlarged scope and effectiveness for their respective committees. We urge that this opportunity be developed.

The Chairman of the Committee on Undergraduate Policy

We believe that the Chairman of the Committee on Undergraduate Policy should be appointed by the President in order to achieve the maximum responsiveness and coöperation of all groups with the work of the committee, to insure that the Chairman will be freed from other commitments to such an extent as is desirable, and to provide for the position a prestige commensurate with the work and responsibility that will be involved.

The chairmanship of the Committee on Undergraduate Policy is a position of the utmost importance. The work of the committee is not a task that can be accomplished by any one individual, however gifted; it will require the effort of a group. But to be most constructive, that effort demands individual leadership of a high order. The chairmanship will offer a unique opportunity for such leadership in the development of educational objectives, methods, and techniques. The position should constitute recognition of outstanding ability as an educator and should be the reward of constructive contributions and accomplishments in the educational field. It should develop into a recognized professional honor.

For the chairman to be effective, two conditions should be met. *First*, the administration must recognize the importance of the chairman's task and must provide any necessary release of time from other staff responsibilities during the

period of the assignment. *Second*, the term of service as chairman should be varied to secure the maximum contribution of the individual. It will rarely be possible for a chairman to make his optimum contribution in less than two years. On the other hand, his effectiveness will very likely have reached the point of diminishing returns in five or six years. The period of service should be adjusted to use the abilities of the individual for the best educational interests of the Institute.

The Chairman of the Faculty

To increase the effectiveness of the faculty as a deliberate body and to give it a stature consistent with its true educational responsibilities, we propose an equivalent increase in the stature and responsibilities of the position of Chairman of the Faculty. We recommend that he be elected for a period of two years without restriction as to reëlection.

The chairman should determine the agenda for faculty meetings. He should be a member of both the graduate and undergraduate policy committees and share actively in their problems and deliberations. He should be an articulate and vigorous leader. Together with the chairmen of the two policy committees, he should be in frequent communication with the officers of administration, both informally and through his membership in the Academic Council.

We believe that the faculty can be of maximum value to the Institute, and thus to our administrative colleagues, by becoming a stronger and more self-reliant body in its disposition of the educational policy matters for which it has primary responsibility. It can increase its usefulness as an advisory body to the administration by selecting a strong chairman and by giving its chairman duties and responsibilities appropriate to the title.

It is hoped that the officers of administration will take full advantage of their status as faculty members to participate freely and equally in the deliberations of the faculty. We cherish the spirit of friendliness and informality that characterizes the relationships between our colleagues, whether their primary focus of activity is academic administration or teaching and research.

Participation of the Faculty in Policy Making

We have considered a variety of comments from colleagues on the need for greater faculty participation in policy making and for more democratic practices in the government of the Institute. Our auxiliary Committee on Staff Environment has also considered this subject and has made certain recommendations in its report.

We find that many members of the faculty who are deeply concerned over educational problems feel the lack of a mechanism through which they can par-

ticipate effectively in the shaping of educational policy at the Institute. At the same time it is clear that many staff members already feel overburdened with routine administrative work and would be suspicious of any step in the direction of increased participation in the Institute government if it were to take time from the productive work of teaching and research.

Our examination of the faculty governments of other institutions has not been exhaustive, but it is our impression that an extensive development of the faculty-committee system of administration results almost inevitably in an excessive burden of meetings and discussions that divert one from the main purpose of university life, without compensating benefits. We conceive the ideal faculty organization to be one that encourages the maximum staff participation in debate leading to the determination of major academic policy, and that looks to administrative officers to accomplish the tasks of putting policies into effect.

Simple democratic machinery is not enough to achieve the full participation of the faculty. In our faculty meeting we already have the town meeting kind of democracy, in which every faculty member has a voice and a vote. We believe that this is an essential part of the government of the Institute and must be preserved. We also believe that it is not working well. The changes proposed in this chapter are designed to make it work better by providing for a more effective participation in the discussion of educational problems in the various groups within the faculty, and by improving the coördination among these groups so that the proper kind of educational problems may be brought before the faculty after thorough preliminary study by the groups most directly concerned with them.

Conclusions and Recommendations

1. We conclude that the present size and complexity of the Institute are such that methods of conducting faculty business which were once entirely satisfactory are now no longer effective. We recommend that the division of responsibilities between the departments, the schools, and the faculty be revised, and that the present committee structure be modified to make procedures more effective and to permit the faculty as a whole to focus on the important problems of educational policy, through the following changes:

   (*a*) Further development of the school as an important unit for the evolution of educational policies and practices characteristic of the four fields of engineering, science, architecture and planning, and the humanities and social sciences, as discussed in Chapter III, including the organization in each school of an effective advisory council,

   (*b*) Reconstitution of the Committee on the Graduate School as the Committee on Graduate Policy,

   (*c*) Establishment of a ten-member Committee on Undergraduate Policy as an

executive committee of the faculty to act upon all matters of undergraduate policy, with its chairman appointed by the President to serve at his pleasure, with the Chairman of the Faculty as a member *ex officio*, and with the eight remaining members elected by the faculty,

(*d*) Simplification of faculty committee structure by the following steps:

1) Make the present Committees on Admission, General Studies, Undergraduate Courses, Petitions, Provisional Students and Discipline, Undergraduate Scholarships and Conduct of Examinations subcommittees of the Committee on Undergraduate Policy upon its establishment.

2) Later, reassign their functions to newly constituted subcommittees or to other groups as discussed in the text, or discontinue them.

3) Make the Committee on Course IX responsible to the Committee on Undergraduate Policy through the Dean of Science for the Course in General Science and through the Dean of Engineering for the Course in General Engineering.

4) Continue the Committees on First, Second, Third and Fourth-Year Students as now constituted, but with enlargement in scope, under the general guidance and authority of the Committee on Undergraduate policy.

2. We conclude that the chairmanship of the Committee on Undergraduate Policy is a position of great influence and importance and should be awarded in recognition of outstanding educational leadership. We recommend:

(*a*) That the President release the incumbent from other duties to the extent necessary for him to accomplish his task effectively, and

(*b*) That the term of appointment be adjusted in each instance to use the abilities of the individual for the best educational interests of the Institute.

3. We conclude that an increase in the stature and responsibilities of the position of Chairman of the Faculty will assist materially in improving the effectiveness of the faculty as a deliberative body. We recommend that the chairman determine the agenda for faculty meetings and maintain close contact with the two policy committees and with the administration.

4. We conclude that the administrative appointment of department heads, without term, is preferable to such practices as that of rotating departmental chairmanships. We recognize the importance both of selecting distinguished leaders as department heads and of giving them freedom of authority commensurate with their responsibilities. We suggest that department heads should be in position to relinquish administrative responsibility after extended periods of service in order to turn again to research or other professional pursuits without fear that their action will be misinterpreted as having been involuntary.

REPORT

OF

The Committee on General Education

FOREWORD

WHEN THE COMMITTEE ON EDUCATIONAL SURVEY began its work in February, 1947, it was evident that one of the most important problems at M.I.T. was that of how to provide undergraduates at the Institute with broader and more effective cultural training. As the result of preliminary considerations, it became clear that this problem deserved study by a special group that could devote full attention to it, free from distraction by other pressing issues. Accordingly, the Committee on General Education was appointed as an auxiliary committee of the Committee on Educational Survey, and was assigned the task of investigating the problem of general education at M.I.T.

The Committee on General Education included representatives of engineering and science as well as of the humanities and social sciences. It was ideally constituted to undertake its study objectively, without bias, and with full representation of all points of view. Under these circumstances, it seems especially significant that its report stresses the desirability of strengthening and broadening the facilities for education in the humanities and social sciences at the Institute.

In our report we have recommended immediate adoption of several of their proposals. Others, for example the proposal for a new course tentatively entitled *Natural and Social Sciences*, involve exactly the type of issues that we believe should be studied by the faculty through the mechanism of the Undergraduate Policy Committee, establishment of which is one of our major recommendations.

Instead of limiting the discussion to the specific items upon which we have chosen to advocate immediate action, without further study we present herewith the full report of the Committee on General Education and recommend that it be given careful consideration in its entirety by the faculty.

Committee on Educational Survey

WARREN K. LEWIS, *Chairman*

INTRODUCTION

THE COMMITTEE ON GENERAL EDUCATION was appointed on June 9, 1947, by the Committee on Educational Survey. The problem to be considered was described in the following general terms:

"How can general cultural education best be integrated into the training of professional men? How can the best possible creative opportunities and the most attractive environment be provided for staff members concerned with this phase of the Institute's activities?"

At the same time, the new committee's attention was called to the following questions posed by the faculty committee originally named to nominate members of the Committee on Educational Survey:

"What is the real place of the humanities in our educational plan: are they in fact to be tolerated on the fringes of scientific and engineering training or accepted as a real part thereof? How and in what direction can M.I.T. equip men for living as well as livelihood? How should specifications for training differ among various disciplines at the Institute? Is the load of work so great as to preclude unwisely the student's opportunity for reflection and self-improvement?"

As members of the Committee on General Education, we have investigated the principal factors that contribute to the success of general education at the Institute. These are, *first*, the staff, the curriculum, and the instruction in the humanities; *second*, the relation of technical instruction to the humanities; *third*, the character of the technical staff; and *fourth*, the admissions practice in the broad sense, the student environment and extracurricular activities, and the student load.

We have given most of our attention to the first two of the above factors with the result that we outline and recommend an integrated program in the humanities which has greater depth and variety than the present one. This integrated program involves a total of ten term-subjects in humanities and social science, or an allotment of one-fifth of the four-year curriculum in science and engineering. We emphasize the importance of having staff members in the technical areas who are not only competent in their special fields but who have broad civic and cultural interests. We stress the fact that instruction in professional subjects need not be less broadening than instruction in the humanities.

We make the additional recommendation that the Institute adopt a new elective undergraduate curriculum made up of one-half science and basic engineering, and one-half humanities and social science. This would parallel in depth and rigor the curricula now offered in the professional fields. It should meet the needs of students desiring a general education based on science or engineering in an atmosphere such as that of the Institute. Graduates of this curriculum would qualify for the degree of

Master of Science after two years of further study, the first of which would be similar to the present fourth year.

We comment briefly on the admissions practice, student environment, extra-curricular activities, and student load. We outline the perplexing problem presented by the lack of incentive normally offered graduate students for advanced study in the humanities, without, however, indicating how it can be solved.

Our proposals are an attempt to broaden the base of general education at the Institute within our present educational framework.

Our consideration of the questions presented leads us to the following conclusions:

1. That on any absolute scale the Institute is now doing a good job of professional education, but that it should do a much better one.
2. That the subjects of study in the humanities are important in a program of preparation for professional life, that they should have depth and diversity, and that they should form an integral part of the educational plan.
3. That improvements in the professional curricula and better integration of the humanities and social sciences along with technical training cannot be satisfactorily achieved by the uncoördinated efforts of individuals or departmental groups or by mere curricular changes. The faculty as a whole must further review educational goals, eliminate unnecessary programs and techniques, continue experimentation in teaching methods, and grant to the humanities a prestige equal to that of science or engineering.
4. That joint action of the faculty and administration are necessary in order to attract superior students, extend the cultural breadth and professional stature of the staff, and improve the environment for both the staff and the students.

Summary of Recommendations

We recommend:

1. That the required sequence of subjects in the humanities and social sciences in the present curricula be extended from eight to ten terms, and that an integrated program be adopted providing a wider choice of sequences in these areas, planned to give greater depth of study within each sequence. This will mean a reduction of time now devoted to the more highly specialized professional subjects in each curriculum.
2. That the teaching of the formal techniques of composition, rather than being concentrated in a separate first-year subject, be made an integral part of all subjects in the humanities and that the development of the student's ability to communicate orally and in writing be emphasized in the professional subjects as well as in the humanities.
3. That a new curriculum in natural and social sciences be offered for students who desire a four-year general education based on science and engineering.

4. That breadth of cultural interests and demonstrated interest in teaching be considered no less important in the appointment or promotion of faculty members than accomplishment in a specialized field.

5. That the question of humanities for graduate students in science or engineering be given serious study by the Committee on the Graduate School, or other faculty committees. The question has three aspects: (1) requirements for admission to the graduate school; (2) requirements to be met by all graduate students; and (3) the provision of facilities for study in the humanities by graduate students.

6. That vigorous effort be directed toward a continued strengthening of the Institute's reputation as an institution offering higher education in the broad sense. Also, that efforts be made to improve student and staff environment insofar as these offer opportunity for increased cultural breadth.

7. That a faculty committee be appointed to study the relation of student load, especially that of the first year, to overall educational objectives.

Part I

Purpose of Education

EDUCATION IS PREPARATION FOR LIFE. Our assignment is clearly to study the means by which our students may best be prepared for life as well as for professional accomplishment. In attempting such a study we face the fact that our students today must wrestle with accumulations of knowledge and with complexities in the task of making a living far greater than those of their predecessors. Not only must they be trained for a vocation, but they must be made to recognize that the growth of science and technology has a profound impact on society at large.

It is possible for men to have no interests or competence outside of their profession. Such men are not well-rounded individuals. The first objective of education is to develop in students a sense of values in order that they may have those qualities —wisdom, judgment, tolerance, independence of thought, and critical sense — that mark an educated man. Each student must be prepared to accept individual responsibility for leadership in his profession, his neighborhood, and his nation; this implies his acceptance of the moral and ethical burden relating not only to his own acts but to the acts of the society of which he is a part. The ideal of individual responsibility implies a knowledge of the humanities, the social sciences, the physical sciences, and technology, arrived at intelligently and objectively. It implies cultivation of the spirit of free inquiry and rejection of interdiction and prejudice.

Sir Richard Livingstone writes: "The perfectly educated man would have a standard, a perception of values, in every province — physical, aesthetic, intellectual, moral; in his profession or occupation; in personal, national and international life. He would know the first-rate in all of them and run no risk of being deceived by the inferior. Further, as far as this is possible, he would have a hierarchy of values, so that lesser did not dominate greater goods. No age needs a sense of the first-rate more than our own. We are individualists; without standards to control it, individualism is apt to reveal itself as eccentricity and to end in chaos. We are free; without standards freedom only gives greater latitude of error. . . ."[1] And, ". . . as

[1] Sir Richard Livingstone, *Plato and Modern Education*, The Macmillan Company, New York, 1944, p. 25.

Plato says, the ignorance most fatal to states and individuals is not ignorance in the field of technology or of the professions, but spiritual ignorance. So he conceives education essentially as a training in values."[1]

Accumulation of knowledge and the development of intellectual power are essential elements in any education that fits a student to solve the problems he will encounter. But a sense of values and a soundness of judgment must be combined with technical competence in any field if the college graduate is to discharge his responsibilities effectively.

General Versus Specialized Education

College education is a subtle, many-sided process involving interactions within and among the student body, the staff, and the program. The Institute's program has thus far been directed toward the development of men having excellent training in science, engineering, or architecture. Our achievement on this plane has been recognized generally. Such excellence must never be allowed to diminish. All our recommendations are based upon this premise.

Since we attract some of the best youth of this and other countries, the Institute is obligated to educate them to be not only capable technical men, but professional men aware of their responsibilities as citizens. Broadening the scientific spirit of free inquiry to include the study of men and their society requires not only an extension of the methods of logic to this field, but also an extension of time for study and contemplation of the available data on society. A student's ability to use his mind capably when dealing with science does not imply that he can, without acquaintance with social data and training in their use, be able to deal effectively with men, their aspirations and motives. Here we find another demanding area of study if the scientist or engineer is to be adequately equipped to handle human beings. But the competing demand for advanced technical training to equip students for their professional activity inevitably reduces the student's opportunity to obtain the broad education necessary for mature leadership in later years.

This dilemma of undergraduate technical education is being resolved for many students by extending their study into the graduate years. To this extent education for the engineering professions has begun to resemble that for medicine and law. The resolution of the dilemma on behalf of other students may appear if the faculty conceives more efficient ways of teaching.

Our committee believes that the Institute's staff and students measure up to these challenges, that the time has arrived when more than mere advances in science and technology are essential. The point in the twentieth century has been

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[1] *Ibid.* p. 12.

reached where the Institute can and should take a great forward step in education by adopting a program that will bring the study of humanities and social sciences into balance with the study of science and engineering.

General Education in a Technical Curriculum

Any claim to liberal education involves a certain minimum competence in each of the three great areas: natural science, social science, and humanities. Even minimum competence means not only awareness of subject matter, but some facility in the appropriate methods of thought and a sense of values in each area. One weakness we sense in a too exclusive emphasis on physical science is the consequent cast of mind that rejects as unworthy any domain in which the methods of hard logic or quantitative analysis cannot be applied. The ability to collect quantitative data, to evaluate such data, to recognize interrelations among them, all this is clearly an essential product of the education of engineers or scientists. But even more important is the ability to make wise decisions when the available data are not and cannot be expressed in precise quantitative terms. The vast majority of decisions made by every individual must be made in the absence of satisfactory quantitative data.

Education in science and engineering can provide certain attributes useful throughout life, namely, the ability to use elementary logic, the critical faculty including the faculty of self-criticism, the spirit of free inquiry, personal integrity, and professional responsibility. It is weakest in the development of human and social values, and in these it needs to be supplemented through education in the humanities and social sciences. In itself, however, education in science and engineering need not be narrower than education in literature. Education in any field can be broad or narrow depending upon content and method. Narrow education is concerned primarily with special knowledge and techniques; broad education, whether general or professional, is concerned with intellectual power and wisdom.

The serious business of broadening the education of the student is not to be delegated alone, regardless of allocation of curricular hours, to the teachers of the humanities and other nonprofessional subjects. It is equally the business of the staff of the science and engineering departments.

One might well inquire whether the technical subjects are pulling their weight in the general education of the student. Are they in fact inculcating the methods of logic, the critical faculty, the spirit of inquiry, and the sense of responsibility? Disturbing evidence can be found among juniors, seniors, and alumni to the effect that some of these qualities have been neglected or even positively inhibited.

Perhaps improvement can be made in this regard by encouraging teachers to reexamine their methods and by selecting, as new members of the staff, only those

who have some insight into the broad educational value of their subjects. A re-examination of method must raise many questions. Do we teach our quantitative sciences as experiences in logic, verbal logic, as distinguished from mathematical manipulation? Is our teaching of mathematics limited too largely to the rules of the calculus? Do we ignore the "difficult" parts of, for example, the elements of the calculus because our students find application of rules easier than the logic that must be used to justify all rules of mathematics? Do we omit college algebra because our students have mastered algebra, or because it is too exacting a logical exercise?

Engineering practice, as well as the practice of business or of politics, involves decision in advance of complete information. The business school long ago borrowed the case method from the law school. Professor J. W. Culliton says, "The goal of business training by the case system, as it has been described by almost all who have written about it, is not to give students the answers to questions, nor primarily to help them accumulate a store of knowledge, nor to acquaint them with best practices. Rather, it is to help the students learn how to go about answering questions, to help them develop skills in discovering and defining the questions which ought to be answered, and to help them realize that in real life they frequently will have to take action before they can get all the facts which they would like to have in deciding what is the right action."[1]

The case method suggests one way of asking the right question. The answer requires decision based on available data and logic. It is possible that our present educational practice throughout the United States overemphasizes the one-third of a problem that is data.

The question suggested by these remarks is whether technical education at M.I.T. is doing all it can to help the students "to develop skills in discovering and defining the questions which ought to be answered" and to face the realities of professional and civil life. Perhaps something is done in this direction through design courses, but it is probable that present efforts are largely rudimentary. Is it possible that a great opportunity to develop the critical faculty and the sense of responsibility is being neglected?

This committee does not pretend to have the answers to these questions. We believe, however, that recognition of these questions and emphasis on them will serve to encourage the faculty member who has been striving to answer these questions in his own teaching and to stimulate others to similar effort.

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[1] J. W. Culliton, "The Question That Has Not Been Asked Cannot Be Answered," *Education for Professional Responsibility*, Carnegie Press, Pittsburgh, 1948, p. 85.

Necessity for an Integrated Program

In theory, the ideal undergraduate program would integrate the student's total educational experience in order to provide the basis for the breadth of interests and for the sense of values which the graduate should acquire. The problem of providing this integration by juggling curricula has never been solved, and perhaps never will be. It could conceivably be solved by a sort of super-faculty, in which each teacher was not only expert in his own subject but active and competent in a number of others. This was possible in small faculties some centuries ago when the fields of learning were narrower, but today the areas of learning are so broad and the cultivation of specialties so intense that the hope of assembling such a group of teachers may seem remote. Nevertheless, such a faculty remains the ideal of educational institutions.

Actually, it is necessary that the student learn to provide his own integration. The experience of doing so as a student is the basis of education for later life. The character of the staff and curricula, however, can determine whether the process will be stimulated or inhibited. If each subject is narrowly compartmentalized and if the student sees each teacher as a specialist interested only in his own field, then the student's task of integrating his educational experiences will be nearly hopeless. On the other hand, if a professor is known to the student both as a man of professional preëminence and a man with interests outside his professional field, the task of integration will be aided and the success of a program in general education enhanced.

There are two obstacles to the attainment at the Institute of an integrated educational program. *First*, most Institute undergraduates have a strong vocational motivation, and tend to direct their effort towards those subjects which clearly pertain to their chosen professional field. *Second*, Institute standards of professional competence are so high that the outstanding specialists who are sought for faculty posts must work exceedingly hard to maintain and enhance their standing among their professional colleagues in the highly competitive professional world. Necessarily they have little time for other interests. In many ways these situations are the root of the problem of general education at the Institute.

The solution is difficult but plain. We have on the faculty today a number of men who might form the nucleus of the ideal super-faculty. They are men with international reputations for their creative professional work who nevertheless find time for the nonprofessional civic and cultural interests which characterize the ideal teacher. *The most important single thing the Institute can do for general education is to increase the proportion of these people on the faculty. We have such people; we can have more.* This committee recommends that this objective be the major consideration in the promotions and new appointments of faculty members.

The Institute has gained its reputation largely through its excellent programs of professional training, its contributions to the advancement of science and technology, and its pioneer development of new professional fields and new methods of instruction. Many of these advances have been adopted by other schools. The certain way for the Institute to maintain and enhance its preëminent standing is to raise the stature of its faculty by increasing its proportion of recognized specialists who are themselves broadly educated. With such men, the Institute may become known as a place where the professional training and the general education necessary for professional leadership are integrated.

Part II

Proposed Programs in the Humanities

GENERAL EDUCATION at the Institute was advanced substantially by the inauguration in 1944 of the present humanities program, an outline of which is given in Table I on page 96. Those members of the staff in charge of the various subjects have discussed their objectives, methods, and programs with us. We are impressed with the high quality of work that is presently going on. We feel that not only are the various subjects being handled adequately, but that vigorous experimentation is in progress.

We have reason to believe that the students attach more importance to humanities than heretofore. While part of this increased importance undoubtedly stems from the maturity of our present veteran population, a substantial gain is probably due to the fact that the faculty as a whole is taking humanities more seriously. This is but another illustration of the sensitivity of the student to the atmosphere about him.

A major step was accomplished in 1944 when we progressed from the concept of auxiliary "general study" trimmings to a planned sequence of humanistic studies. We have in this process been able to attract staff who give us sound beginnings of eminent professional stature in the social and humanistic fields. There are indications that this staff is of such quality as to be desired by other institutions. It appears, too, that we can offer sufficiently congenial environment and professional opportunity to compete successfully for outstanding staff in the humanities. Since quality of staff is the key to quality of accomplishment in any field, we have here evidence of our ability to achieve respected standing in the nonvocational part of our educational program. This committee interprets these developments not as an indication that we have reached a satisfactory level in the treatment of the humanities and social sciences, but rather as promise that we can, if we will, successfully attain the ideal of a technological education that is widely recognized as a good liberal education.

How, then, can we strengthen the influence of the humanities program within the broad scope of our present course structure? The first and most obvious step is

Present Four-Year Program in the Humanities
1949-1950

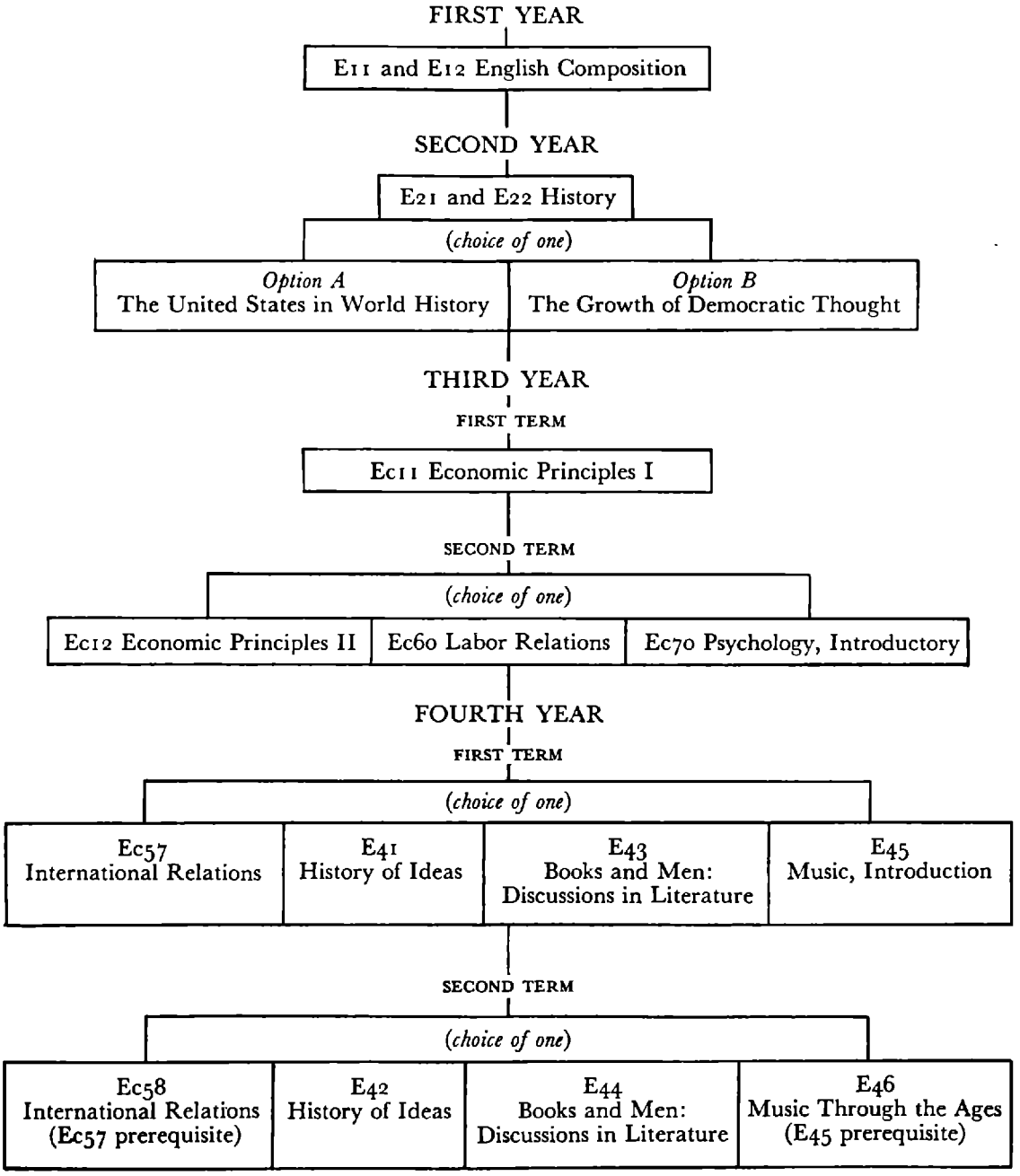

TABLE I

a more complete integration of the program as a whole. Our present sequence has order, but not integration in the sense that the later years build solidly on the earlier. Nor has it integration in the sense of bringing the various disciplines such as history, economics, sociology, technology, philosophy, and psychology concurrently to bear on the study of great human problems. In professional work we accept as obvious the necessity for both types of integration. The specific proposals given below are intended to provide this integration.

Our great problem in developing curricula is the wise allocation of time among three areas, namely, the natural sciences, the social sciences, and the humanities. The vocational interest of staff and students alike exerts a strong and continuing pressure for the exclusion of all nontechnical activity. Such pressure is merely the natural concomitant of the collective activity of able, enthusiastic students and staff jointly working in the field of their major life interest. Such circumstances spontaneously generate this pressure whether the activity be law, medicine, business, or engineering.

In the presence of such pressure, it is important that we strive to detach ourselves from our own interest when considering allocation of curricular time between the scientific and technical areas on the one hand, and the humanistic areas on the other. This is difficult, especially if such detachment indicates a sacrifice of curricular time in one's own particular field. Yet the educational biographies of persons of accomplishment show at most only a modest correlation between specific formal training and subsequently demonstrated capacity in the area of that training. Though intensive and high-level specific formal training can undoubtedly contribute greatly to professional stature, the position is untenable that we must ruthlessly sacrifice curricular time in the social and humanistic subjects to the scientific and technological subjects.

Within the present program, many of our undergraduates acquire more technical training than they find use for in their subsequent careers, and this group includes many successful men. This observation has often been used to support an argument for making our program less analytical and more "practical," an argument which, fortunately, has been rejected. The same observation, on the other hand, is strong support of an argument for a more liberal form of education, an education no less analytical than our present one, but stronger in the humanities and the social sciences. Accepting, therefore, the scientific and technological as the major areas, we must firmly and objectively examine the vital importance of the social and humanistic areas, and wholeheartedly allocate adequate time to them.

Curricula in science and technology commonly include subjects in the basic sciences, a strong major in one professional field, and some subjects in the humani-

ies. The latter are usually tacked on as an afterthought, in no considered relation to the main professional stem. We believe the concept of "some humanities" to be deplorable. It is not adequate in view of our objective: the professional man who is an outstanding citizen. Answering one of the questions posed by the Committee on Educational Survey, we believe the humanities to be important in a program of preparation for professional life; we feel they should form an integral part of the educational plan; and we believe that if the humanities are only tolerated by staff and students the full potentialities of the humanities in professional training will not be realized.

There is some evidence, obtained from both students and staff, that the demands made upon the students in the humanities can be increased. It appears that members of the humanities staff, having in mind the major interest and objective of our students in science and technology, and feeling that the students are exceedingly hard pressed by their work in their major fields, hesitate to demand of them as high a standard of performance as might be required in the same area in a liberal arts institution. It is the belief of those members of this committee who are on the scientific and technological staffs that the humanities staff must assert its demands upon both the time and serious effort of students with all the vigor and conviction shown by the staffs of technical departments. The humanities are just as vital a part of the educational process as the sciences and should be so regarded by both staff and students. We believe that the scientific and engineering staffs will support this point of view, even if it means some reduction in their own demands on the student's time.

The difficult question, which must be faced squarely, is the allocation of time to the nonvocational aspects of education. We present a proposal in the following pages which involves ten term-subjects in the humanities, or 20 per cent of the total curricular time. This is a small increase over the present allotment of eight subjects, which represents about 16 per cent of the total time. Small as it is, this increase will take time away from professional studies.

Only by careful organization of material can an adequate program in the humanities be kept within the proposed limits. It will be necessary to eliminate courses in written and oral expression as such from the existing humanities program, to embody the cultivation of these disciplines in a series of subjects with certain other primary objectives, and to institute a writing laboratory for instruction of the deficient student. Our observation of the success of this plan in existing experimental sections leads us to believe that it is an effective way to teach expression.

To meet fully the spirit of this program, it will also be necessary to comb out of existing courses in the humanities some essentially professional or utilitarian material, such as may be found in courses now offered in industrial economics, labor

relations, and psychology. This is not to imply criticism of these subjects or to deprecate their importance to the engineer and the scientist. It is merely to point out that the small fraction of time devoted to the humanities must be protected against invasion by vocational material whenever the two can be distinguished.

Even so, we shall attain only the 20 per cent of total time recommended as the minimum allocation for humanities by the American Society for Engineering Education. We are not, however, so much concerned with conformity as with our position of leadership in engineering and scientific education. Our proposed program seems to hold reasonable promise of maintaining that position of leadership.

This committee offers two major proposals regarding the humanities. The *first* aims to deepen and strengthen the studies in humanities within the program of our present undergraduate professional courses. It comprises an integrated program of ten terms of subjects that are clearly humanistic in their spirit, outlook, and content. It also introduces a different method of teaching written and oral communication. The program indicated by Table II on page 100 is proposed as a basis for faculty discussion.

The *second* proposal, discussed at length starting on page 106, involves a new curriculum. *Natural and Social Sciences* is suggested as a title. This curriculum is directed, first, to meet the needs of students who have as a prime objective a general four-year education in an atmosphere of science; and second, as preparation for graduate work in business, law, medicine, economics, or political science, as well as engineering or natural science. It will influence the whole educational program by strengthening the position of the humanities staff. Moreover, it should provide an area of experimentation in educational method and should serve to attract students with broad interests.

Proposed Humanities Program for Our Present Professional Courses

First and Second-Year Humanities

In place of the present first and second-year subjects, E11, E12 (English Composition) and E21, E22 (History), we recommend a two-year sequence to serve as an introduction to several areas in the humanities and social sciences and as a foundation for more intensive study in those areas during the third and fourth years.

The two-year sequence would have the following objectives:

1. To give the student an introductory knowledge of the most important issues, ideas, periods, and events of the past, selected on the basis of their relevance to the world today. This objective does not imply a concentration upon "current events," but a study of man's past experience in order to understand the present.

Proposed Four-Year Humanities Program for Our Present Professional Courses

First Year — E11 *and* E12	Second Year — E21 *and* E22	Third and Fourth Years
Introduction to issues, ideas, periods, and events of the past, selected on the basis of their relevance to the world today; interrelation of humanities and social sciences; critical thought	Continuation of the subject matter of E11 and E12	3 terms in one field; 2 terms in a second field; 1 term in a third field (see examples of possible Fields I, II, and III below)

Field I — History and Government

Sequence A: Government	*Sequence B: History*	*Sequence C: Area Study*
1. Constitutional Govt. and Political Processes in U. S.	1. American Political and Social Institutions (1865–1920)	1. Political, Social and Cultural History in Latin America
2. Comparative Government	2. Postwar America (1920–1940)	2. Same as above
3. Political Movements and Political Ideas	3. Problems and Trends in Modern Industrial Society	3. Latin America since World War I

Field II — Philosophy and the Arts

Sequence A: History of Ideas	*Sequence B: Architecture and Fine Arts*	*Sequence C: Literature*
1. Greek and Christian Systems	1. Prehistoric or primitive	1. Homer to Horace
2. Great Modern Systems	2. Classic	2. Middle Ages, Renaissance to Molière
3. Problems in Modern Philosophy	3. Modern	3. 1875 — present

Field III — Economics and Social Science

Sequence A: Economics	*Sequence B: Industrial Relations*	*Sequence C: International Relations*
1. Ec11 — Economic Principles I	1. Ec70 — Introd. Psychology (Modified)	1. Ec11 — Economic Principles I
2. Ec12 — Economic Principles II	2. Ec60 — Labor Relations (Modified)	2. Ec57 — International Relations
3. National Income, or Economics of Patents and Inventions, or Public Finance, or Banking and Finance	3. Ec65 — Industrial Relations (Modified)	3. Ec58 — International Relations

Table II

2. To emphasize the interrelation of the various humanities and social sciences as elements in human experience rather than as distinctive features which characterize them as different areas of academic study.
3. To introduce the student to the process of critical thought as applied in the humanities and social sciences.

The method of study and organization of material would probably follow a modified topical approach to history, as distinguished from the more usual chronological approach. Issues and problems which have persisted in human experience to the present time would be examined in different historical situations. For example:

The relation of the individual to the state (the issue of liberty versus authority) would be examined in terms of the absolutism of the 16th century, the revolutions of the 17th and 18th centuries, and the contest between democracy and totalitarianism in the 20th century.

The relation of technology and society would be examined in terms of the simple technology of the Middle Ages, of the accelerated technological change during the Industrial Revolution (1750-1850), and of the modern industrial system.

The rational versus the nonrational approach to knowledge would be examined in terms of the Newtonian and the Darwinian periods.

It must be stressed that the objective is not to give the students a detailed chronological narrative of history, but to use selected historical data to give meaning to the persistent problems in human society. The chronological order would be followed whenever one topic is prerequisite to another, but in general the order of progression would be governed by logical and pedagogical requirements. The detailed organization of the work in the two-year sequence must rest with the Division of Humanities. The intention here is to indicate only general objectives.

Third and Fourth-Year Humanities

We recommend that three broad fields of study, History and Government, Philosophy and the Arts, Economics and Social Science, be provided in the third and fourth years; that a student be required to pursue a three-term sequence of study in one of these three fields; and that he include some studies in each of the other two fields.

While we reaffirm the vigor and strength of our present humanities program for the third and fourth years, we find in it two weaknesses. First, all the subjects composing it are necessarily taught at the introductory level; second, the variety of subjects offered is too limited for a well-rounded humanities program. The three-term sequence is aimed at removing these weaknesses. Optional sequences are suggested within each field to give the student some freedom of choice. The sub-

jects in each sequence would be planned so far as possible to examine intensively areas which have been treated in an introductory manner in the first and second year. This procedure would assure that every student attains a respectable depth of study in one field of the humanities.

To ensure breadth as well as depth to the student's study of the humanities and to allow him some opportunity to pursue his special interest, he would be required to distribute his three remaining terms of study by electing two terms in a second of the three fields and one term in the third field. For example, at the beginning of his junior year a student might elect his three-term sequence in the field of History and Government. To complete his humanities requirement he might also elect two terms of study in Economics and Social Science and one term in Philosophy and the Arts, or two terms in Philosophy and the Arts and one term in Economics and Social Science.

Some further restriction on the student's choice would be necessary to prevent overlapping with professional courses. Students in Course XIV, Economics and Engineering, and in Course XV, Business and Engineering Administration, for example, should not be allowed to elect Economics and Social Science as their field of concentration in the humanities.

The Three-Term Sequences

We have given enough detailed thought to the matter of the three-term sequences to satisfy ourselves that a suitable set of offerings can be developed and well taught. We have had to consider various concrete sequences if only to get a clear notion of what we were talking about. Suggestions were therefore made by various groups invited from the faculty. It is hoped that the faculty as a whole will gain a clearer understanding of the nature of the sequences from an examination of the examples outlined in Part IV of this report and in Table II.

We must emphasize, however, that the material suggested in Part IV is intended only to illustrate the plan, and must not be regarded as final specific proposals. The details of the sequences would be determined by the material included in the basic course and by the instructors teaching them. Above all, the examples are not exclusive of other possibilities. The problem of a music curriculum has not, for example, been adequately dealt with.

We suggest, therefore, that debate upon the question revolve around the principle of the sequences, and not upon the contents suggested in Part IV. We recommend adoption of the following principles: a humanities curriculum in terms of the three broad fields as described above, a major program consisting of a three-term sequence in one of these fields, and a distribution of the program among these fields.

The sequences given as examples could be offered with only modest additions to

the present staff. They are logical continuations of subjects treated in a general manner in the basic two-year course. They require the close study and the detail which are essential to bring an introductory course to fruition for the student in terms of knowledge and critical sense.

Distribution Requirements

In addition to a three-term sequence this committee recommends that a student be required to take two terms in a second of the three general fields of study and one term in a third field. In Economics and Social Science the two terms should probably be devoted to a basic course in economics; in History and Government, they should be devoted to a basic course in American government. It is quite possible that the first two terms of one of the three-term sequences in these two areas would be suitable for the basic course.

In the field of Philosophy and the Arts a basic course is more difficult to provide. Here again, however, the first two terms of the philosophy sequence or the fine-arts sequence would provide a suitable program of study.

The one-term requirement for the third field insures against the student's complete neglect of any one of the three. His choice would be limited of course to the subjects which do not have prerequisites. By virtue of this requirement, the choice of a single subject in Economics and Social Science narrows down to the first principles of economics, namely, Ec 11, or the equivalent. Thus, all students would be required to take one or more term-subjects in the field of economics.

Written and Oral Communication

The importance of developing in our students the ability to communicate their knowledge and opinions to other people clearly and concisely is undisputed. An effective method of achieving this end is, however, difficult to devise. The conventional approach has been the required freshman course in composition. It has the advantage of calling the student's attention to the fundamental principles of good writing at the very start of his college training. But it has the serious disadvantage of coming at a time when his only motivating factor may be the grade he hopes to receive. As a freshman he does not realize that skill in communication is an important part of his professional equipment, and at this point in his career he has little of technical significance to write about or to talk about.

The freshman composition course also presents a serious staff problem because few first-rate teachers are content for long to teach a subject that is necessarily concerned with elementary techniques. The problem is particularly serious in an engineering college where there are no English majors or graduate students and where literature courses are few in number. The professional growth of the teacher

of English comes through the study and teaching of literature and creative writing, something rarely accomplished in the teaching of freshman composition.

Most serious, however, is the fact that neither good writing nor the ability to speak well can be taught exclusively in an English Composition class. Our students will develop skill in writing only through the united efforts of the teaching staff to demand good writing from them. They will learn to speak well only by repeated practice and vigorous criticism. We therefore propose that the present freshman composition course be discontinued, and that the first year of the two-year basic course in the humanities, as already described, be substituted for it. Written exercises that will give the student practice in analyzing a problem, selecting pertinent data, and arranging them in an orderly, coherent manner should be an integral part of this two-year course. The student's ability to express his ideas should determine his final standing in the subject. Students who cannot handle the written problems satisfactorily because of poor training in the fundamentals of composition should be urged to seek special help from the English Department. This help can be provided in a "writing laboratory" staffed at certain hours during the day and evening.

Freshmen and sophomores would not be required to attend the "laboratory" sessions, but the sessions would be available for students who wished assistance. At the end of the sophomore year, students who still failed to meet an acceptable standard would be given a "Composition D" in their humanities course. This "D" could be removed only by passing a regular three-hour composition course taken either in a regular term or in Summer School.

During the third and fourth years of the humanities program, written problems would continue to be an important part of every subject, and the required standard of performance would be higher than in the first two years. *Likewise in every professional subject where written problems are a part of the work, the instructor should assume responsibility for seeing that the student maintains a respectable standard of composition.* This is not to say that all staff members must become teachers of English, but only that they must refuse to accept bad writing and must see that the offending student reports to the English Department for whatever instruction he needs. Much of the poor writing done by juniors and seniors is not the result of ignorance or lack of skill, but failure to think clearly, failure to organize arguments carefully, and failure on the part of the instructor to demand the best performance of which the students are capable.

Several professional courses have already recognized the need for continuing instruction in written and oral composition in the junior and senior years. In subjects where oral and written reports constitute an important part of the work, a member of the English Department becomes part of the team. He confers with the

student on the preparation of his written report and attends the class meetings to act as critic of the oral presentation. By this method advanced instruction in communication is possible at a point where it is directly related to the student's professional work, and at a time when he realizes the importance of being able to communicate his knowledge to other people. Here also is an area where professional society activity, preparation and presentation of professional papers, and the Stratton Prize Competition can be of real assistance. They are extracurricular activities that can have valuable broadening effects.

Summary

The present program involves two terms of composition and six terms of humanities. The proposed plan involves ten terms of an integrated humanities program, and no formal composition subjects. With this increase in time, an introductory two-year course in the humanities and social sciences could be followed by a three-term specialization which would carry the student's study in one field beyond the elementary level.

The important report of May, 1944, of the Committee on Engineering Education After the War recommends that the "humanistic-social stem" of the engineering curriculum consist of a "*designed* sequence of courses extending throughout the four undergraduate years and requiring a minimum of approximately 20 per cent of the students' educational time."[1] If first-year composition is recognized as covering professional techniques and is not counted as humanistic, the majority of our present curricula are found to contain but 12 per cent of time in the humanities. The proposed program would raise this to the recommended *minimum* of 20 per cent.

We believe that for the scientists, engineers, and architects who commit themselves to these pursuits early in life and who budget only a four-year program, the proposed plan would provide a solid basis for the development of those cultural interests which distinguish the educated man from the technician. We believe that it would remove much of the feeling of inferiority in cultural fields noted in some of our students. It would appeal to student advisers and headmasters of secondary schools, and thereby improve the quality of applicants for admission to the Institute under its basic four-year program. It would appeal to alumni who now send their sons to liberal arts colleges for undergraduate study in spite of a definite preference on the part of the boy for a technical education. Adoption of the plan would improve our ability to interest and hold top-flight educators and scholars on the humanities faculty. It would enhance our reputation for imaginative leadership in

[1] *Journal of Engineering Education*, May, 1944, p. 589. This committee was appointed by the Society for the Promotion of Engineering Education. The Committee on Engineering Education of the American Society of Civil Engineers has the same recommendation in its report of January, 1946.

education in the fields of engineering and science. It would not go as far in the direction of the humanities as the proposed curriculum in Natural and Social Sciences which, of course, is a much longer program for equivalent technical accomplishment. We believe that the proposed program has the minimum humanities content for a four-year curriculum dominantly technical in character.

Proposed Curriculum in Natural and Social Sciences

For Whom It is Proposed

Graduates of the four-year curriculum in engineering seem to fall into three classes: 1) those who go on for graduate study and eventually enter industry for careers in research or similar fields; 2) those who follow careers in engineering for which the four-year program provides adequate professional training; 3) those who go into other professions and occupations. The first group, about ten per cent of the four-year graduates, is the smallest. The second and third groups are about equal in size, with the second probably the larger. The third group includes many men who from the start of their college career have no intention of becoming professional engineers. They study engineering as a variety of general education.

We have presented a program in the humanities and social sciences for the first two groups, which we believe calls for all the time that can be allotted to those areas of study within a four-year curriculum in science and engineering. For the third group, primarily, we now propose a new course under the Division of Humanities to be known by some such title as *Natural and Social Sciences.*

Why It is Proposed

We make this proposal because we believe that any adequate college education today must include a substantial number of subjects in science and engineering. We further believe that for those students who never intend to become scientists or practicing engineers a strong program of subjects in the humanities and social sciences will provide a better college training than a program of advanced professional subjects.

This is not a new philosophy of education for the Institute. Of the six courses offered in 1873, one was Science and Literature. A few years later three general courses were available to students whose purpose was "to become merchants, manufacturers, or bankers" and whose desire was to have "a preparation for active life which should be liberalizing in its tendencies but without any influence to alienate them from the ideas, tastes, and habits which were appropriate to practical business pursuits."

Each of the courses contained a "solid body of scientific study, and of scientific field or laboratory work." In one, the study of physics predominated, in another

chemistry, and in the third geology. In all three, however, far more time was devoted "to the study of languages, literature, history, and political, social, and industrial science" than was "compatible with the requirements of the professional courses."[1]

Since these early days our curriculum has included a Course in General Science or General Engineering. New Courses in Business and Engineering Administration and Economics and Engineering have been added, but these are aimed primarily at training for special vocations. The original intent of a course which would provide a broad general training in science and the humanities has to a large extent been lost. At no time in our history, however, has the need for such training been greater than now.

We believe that the original intent of the early leaders of the Institute in providing "general courses" was sound and that our proposal for a new curriculum will again implement that intent.

Stated more specifically, our reasons for feeling that such a course should be available here are as follows:

1. A general education based upon a study of science is increasing in popularity because of the growing significance of technology in everyday life. This fact is recognized by the many liberal arts colleges which are expanding the science content of their curricula. We believe that we are in a better position than any other college in the country to integrate the subject matter of science and the humanities into a four-year curriculum. Moreover, the basic engineering subjects available at the Institute but not at most of the liberal arts colleges would give the student an advantage of a year or more if he chooses to go on to professional studies.
2. General curricula based on science may eventually displace present curricula which attempt to turn out professionally trained men in four years. The engineer prides himself on being a member of a profession just as much as does the lawyer or the doctor. Perhaps it would be logical to place engineering education wholly on a graduate basis, following a liberal arts curriculum. It is not being done, however, because of the economic disadvantage to the student, and because the four-year curriculum has been good enough, or, better put, not bad enough to justify such a radical change. Nevertheless the 3-2 Combined Plan is growing in popularity, and more and more students are going to liberal arts colleges with the intention of taking postgraduate degrees in engineering. A course such as we propose would provide more general education than the 3-2 Combined Plan and yet make possible a master's degree in a professional field in six years. If, on the other hand, engineering were made wholly graduate work following four years of liberal arts, seven or eight years in college would be necessary.

[1] The quoted passages are from the *Massachusetts Institute of Technology, Seventeenth Annual Catalogue*, 1881-1882, p. 26.

3. The establishment of such a course would strengthen the element of general education in the Institute's curricula, and would provide a School of Humanities with an important focus for its activities. It would provide an intellectual climate attractive to staff of high caliber.

4. The new course would appeal to the many superior graduates of secondary schools who have a genuine interest in science and technology, but who are not prepared to commit themselves to a college program directed towards specialization in a single professional field. The definiteness of purpose of the usual M.I.T. student is seldom shared by his *confrères* in the schools of liberal arts, and not even by all the superior ones. Reluctance to make an early selection of a professional career may be in many instances evidence of breadth of interest.

5. The new course would attract to the Institute for general education many students who plan to take subsequent graduate study in business, medicine, or law. They would bring a welcome variety of interest to the student body.

6. The Institute is looked to by other engineering schools for leadership. The American Society for Engineering Education has repeatedly pointed out the need for broader education of men trained in science and engineering. The establishment of this new course would constitute an announcement that we recognize the need and are ready to meet it squarely with a carefully planned program of study. It is conceivable that in time the undergraduate program at the Institute might swing largely in the direction of such a course, with eventual elimination of specialized professional subjects from the undergraduate years.

Curriculum in Natural and Social Sciences

The curriculum would consist of three main groups of subjects, namely:

1. A strong sequence in humanities and the social sciences, making up 50 per cent of the total time;
2. The group of subjects in science and in mathematics now given in the first and second years; and
3. A group of intermediate basic professional subjects.

Natural Science Content

Compared with our present curricula in science and engineering, the new course would involve, in effect, the replacement of the 25 to 30 per cent of the total curriculum now devoted to professional subjects in civil engineering, mechanical engineering, biology, etc., by a corresponding time allotment for the humanities. It would include the physics, mathematics, elementary chemistry, and military science of the present first and second years. It would include basic professional subjects which serve both to provide strength and depth to a general education

based on science, and to prepare for later professional training of those students who elect graduate study.

Although the student will be required to take all the major subjects of the present freshman year, it is not necessary that his freshman program be identical with that of students following other curricula. This curriculum might be a good opportunity to experiment with a lighter load or a reduced number of contact hours in the freshman year. If in this way an educational advantage may be gained, it could perhaps be demonstrated through the proposed curriculum.

Although such a curriculum would appeal to many students who would terminate their formal education after four years, it is designed so that graduates may continue with professional training in either science or the humanities if they elect to do so. These men should be in position to meet the requirements for a master's degree after an additional two years of work made up largely of the subject matter of the present senior year and the first graduate year. On the other hand, they will be prepared to enter graduate schools of business, medicine, or law.

No detailed curricula will be suggested, since it seems evident that these can be worked out if the educational philosophy underlying the new course is accepted. We have studied various curriculum proposals, however, to make certain that a selection of nonspecialized basic professional subjects suitable for a general four-year program would, at the same time, prepare men for a professional program leading to the master's degree in two additional years. We are convinced that the plan is entirely workable, providing the student be allowed to elect a program of professional subjects directed towards basic preparation in a single professional field.

By way of illustration, the general program taken by all students in the new course might include, in the third year, Descriptive Geometry, Drawing, a first course in Electrical Engineering, Statics, Dynamics, Strength of Materials, and Fluid Mechanics. These taken together would account for half of a normal load, the humanities accounting for the other half. A student considering the possibility of graduate study in mechanical engineering would then elect, in his senior year, Dynamics, Machine Drawing, Machine Tool Laboratory, Heat Engineering, Engineering Metals, and Fluid Mechanics, again accounting for about half of the work for the year. After four years he would receive the degree of Bachelor of Science (without specification of field) and could start a first year of graduate study essentially identical with the present senior year in mechanical engineering.

In some cases it would appear necessary that the student elect a field of special interest at the beginning of the third year. This is true in electrical engineering and in some other branches of science or engineering where the present curricula involve definite two-year sequences leading to the work of the present fourth year. The complication of having to set up "options" does not appear serious. The

optional programs would involve but half of two years' work, and would include many of the subjects that would naturally be selected for inclusion in a single curriculum. They would make it possible for graduates of the new course to proceed with graduate study at the Institute.

Social Science Content

The half of the curriculum devoted to the humanities and social sciences would be focused upon the social order and the man within it. The curriculum would stress the evolution of modern industrial society, the machinery and functions of government, the motives, needs, and objectives of human beings, and the social, moral, intellectual, and economic problems which exist in a complex society.

No attempt is made here to present a well-planned program of studies for the proposed course. The general requirements might be as follows:

1. The basic two-year sequence in the humanities proposed for all students.
2. Two terms of economics.
3. Two terms of psychology or human relations.
4. Eight terms of subjects in an area of concentration such as history and government, or history and philosophy.
5. Four terms of electives in literature, music, fine arts, or in subjects from areas of concentration not elected by the student.

As a result of these requirements, the half of the student's four-year program devoted to the humanities and social sciences would be, if he elected to concentrate in the field of History and Government, approximately as follows:

Required Subjects (*8 terms*)	Area of Concentration (*8 terms*)	Electives (*4 terms*)
Humanities sequence (*4 terms*)	American Government (*1 term*)	Philosophy
Economics (*2 terms*)	American Municipal Government (*1 term*)	Literature
Psychology *or* Human Relations (*2 terms*)	Modern Industrial Society (*2 terms*)	Music
	Modern Political Systems (*2 terms*)	Fine Arts
	International Problems (*1 term*)	Area Studies
	Political Theory (*1 term*) *or* Government Control of Industry (*1 term*) *or* Constitutional Problems in American History (*1 term*)	

The proposed curriculum should never provide opportunity for students merely to dabble in the humanities and social sciences. It need not be rigid, however, as long as it adheres to its purpose of graduating men who have a knowledge of the fundamental facts and methods of science and engineering, who understand the framework of ideas and institutions within which scientists and engineers must work, and men who can recognize and grapple with the social and political problems caused by the advances in science and technology. Such training can be as rigorous as that for any profession.

An objection might be raised to the effect that this proposal would add another course to a catalogue already overburdened by multiplicity of curricula. This committee is in sympathy with those who oppose undue specialization in the undergraduate curriculum. We believe, however, that this is a question entirely separate from that of multiplicity of courses. A course in mechanical engineering, electrical engineering, or biology may be a good means toward a general education; and all three may simultaneously be good means. These vertical subdivisions of the Institute should serve to take advantage of the enthusiasm of staff and students for a particular field of activity for the purpose of enticing a student along the road to education. Only the course that sacrifices education to specialization should be condemned.

The Institute has many advantages in such an undertaking. One of the most important is the fact that close coöperation among courses and departments is here both the tradition and the reality. The barriers which make a coördinated program of study in science and general education so difficult to achieve in many liberal arts colleges and universities do not exist here. The advantages we enjoy as a result cannot be overemphasized. The sort of training to be undertaken in the new course will require a bold, imaginative approach by members of many departments.

Part III

Related Problems

Admissions

OUR EFFORTS to attract young people with potential breadth of vision and qualities of leadership are influenced by the fact that the Institute is widely conceived as basically a vocational school. Its function in terms of liberal education is contrasted to our disadvantage with the function of the college of liberal arts.

This fact is important because the quality of our graduates depends primarily on the quality of the students we attract. This is no more apparent in relation to accomplishment along professional lines than in relation to cultural development. Many of our graduates who never develop cultural interests were perhaps recognizable as lacking in general education upon entrance. The junior in high school whose sole interest in life is powered model airplanes is likely to apply for admission to the Institute. On the other hand, evidence exists to the effect that boys with broad interests and qualities of leadership, especially those in the private preparatory schools, do not apply to the Institute in proportionate numbers. The Institute may contribute greatly to the education of the boy with a narrow professional interest, but the boy with the qualities of leadership can contribute greatly to the Institute while benefiting from it.

If we fail to attract such students in appropriate numbers, it is a matter of grave concern. In looking for the reason, we have examined our admission policies. The admission requirements total 16 units, including four years of mathematics, four of English, and one of physics. They are more rigorous than those of good liberal arts colleges on two counts, the year of physics and the fourth year of mathematics. But neither requirement is a great barrier. Physics is offered in almost all good secondary schools and is taken by most boys having any interest in science. The first three years of mathematics are taken in the ninth, tenth, and eleventh grades; the boys electing M.I.T. (and many others) take an additional year in the twelfth grade. Doubtless occasional students who, through ignorance of our requirements or for other reasons, fail to elect a fourth year of mathematics, may for this reason go to one of the many engineering schools that require but three years.

Some of these students might be attracted to the Institute were we to reduce our mathematics requirement to three years; but the number that would be influenced by such a move is probably not large, and the change would necessitate a serious lowering of the standards of instruction in first-year physics and mathematics at the Institute.

We conclude that the present admission requirements, of themselves, are not important factors in dissuading some of the best all-round boys from applying for admission to M. I. T. There seem to be a large number of reasons why we do not get more applications from such boys, of which the extra admission hurdle is only one. The principal reasons pertain to the general reputation of the Institute. Not the least of the unfavorable aspects is its reputation as a place where general education is not offered.

We believe that this reputation, though partly unjustified, is widespread and firmly established. We can alter it only by offering a better general education than we do now, and by letting people know about it.

Student Environment and Extracurricular Activities

Extracurricular activities certainly form an important part of the education of the whole man, although their relative significance as compared with that of curricular studies is the subject of much debate and cannot be stated quantitatively. This committee believes that extracurricular activities should be an important part of the educational pattern at the Institute. Undergraduate athletics, social affairs, politics, dramatics, publications, professional societies, clubs, debating societies, dormitory life, and many other activities contribute much to general education.

Our extracurricular activities are of two types: organized activities which are common to American universities and colleges, and unorganized ones which are the backbone of the extracurricular life of the British university. Each has a useful role to play and the roles are scarcely interchangeable.

Save for varsity football, the Institute offers essentially as full a range of organized extracurricular activities as is to be found on any American campus. By and large these activities are well run and adequately supported by the administration. Inevitably they cannot be pressed as far as they are in some liberal arts colleges. The activities at Williams College in dramatics, for example, are very effective, but they also require many hours from those who participate, hours comparable with those required of the members of a championship football team. Such an expenditure of hours will not be possible at the Institute unless the student load is materially reduced. On the other hand, the physical equipment and the coaching provided for this type of activity by the Institute are good. There are of course excep-

tions. Both the musical groups and those interested in dramatics need an auditorium. This has been stated as an objective of the Development Committee and we can only say that it should be kept high among the objectives. On the whole, though, the organized activities are well provided for.

Much less can be said for the unorganized activities. The Institute is poor in attractive meeting places, lounges, dining rooms, all sorts of rooms where men may foregather in small, informal groups to enjoy discussion. The dormitories are not provided with adequate local libraries and music rooms; it is difficult for our students to entertain guests from other campuses without social embarrassment. Presumably another committee will have more to say on this point, but it appears clear that much could be done in improving environment which would act to increase the unorganized extracurricular activities to which, in the English universities, is attributed much of the development of the man. Environment is especially important for a student body almost all of which has one type of basic intellectual motivation as compared with one which includes people whose vocational interest is in religion, law, medicine, literature, music, or arts, as well as in the natural and social sciences.

It is important that we advertise our extracurricular activities better than we do now. Our system of student self-government, our sports programs, student publications, and the dozens of other organized student activities provide a basis for student participation to a degree far greater than heretofore achieved. Prospective students and their parents are often surprised to learn of the many opportunities that M.I.T. students have for the development of health and character. As the program is improved and integrated into the total educational plan, we should publicize both the program and our belief in its contribution to general education.

Student Load

One question which was presented to this committee, namely, "Is the load of work so great as to preclude unwisely their (the students') opportunity for reflection and self-improvement," has not been categorically answered in our proposals. Two aspects of the question must be considered, first, the total work load, and second, the number of contact hours.

A conviction prevails among many members of the staff that the heavy load of assignments and scheduled classes characteristic of the Institute curricula militates against education by inhibiting meditation, discussion, and thoughtfulness among students. This committee shares this view and earnestly hopes to avoid aggravation of the difficulty. We think it particularly serious in the freshman year. We have two proposals to make. *First*, a committee of the faculty should study the program of the first year for the purpose of finding means of reducing total load and contact hours.

In this study allowance should be made for some increase in demands upon the student's time in E11 and E12. To increase the rigor of work in the humanities without some compensation in the technical program would be to restrict still further the freedom of the student, although some increased stimulation to thought might result. The *second* proposal is that the first-year curriculum in the proposed Course in Natural and Social Sciences be an experiment in reduced student load.

We feel, however, that the problem of reducing student load and contact hours involves such varied, complex, and interrelated questions that it can be solved only by a committee of the faculty appointed for the purpose. We recommend, therefore, that such a committee be assigned the task of implementing this phase of the problem of general education.

Registration Officers for the Humanities

In order that the proposed humanities program of the third and fourth years may not add to the already heavy burden of the registration officers in the professional courses, we recommend that a separate group of staff familiar with the content of the subjects involved be organized to handle junior and senior registration in the humanities. These advisers should make every possible effort to have each student plan a humanities program that will best fit his needs in the light of his general background, his personal interests, and his professional objectives.

The Graduate School

If general education is important in the program of the undergraduate, it should follow that it is more important to the program of the graduate student because of the correspondingly greater significance of the fruits of his career on society. The greater the technical stature of the student, the more he might benefit by studies that would give him greater perspective on the relation of his technical career to society. At the present time the Institute offers little in the way of formal instruction in the field of general education at the graduate level. We are concerned about this situation, which is admittedly not uncommon in professional schools throughout the country.

There appear to be three principal problems. The *first* is the establishment of requirements of student accomplishment in nontechnical areas for admission to the Graduate School. Many able graduates of other institutions are deficient in humanities even by our present standards. The *second* is the establishment of graduate requirements in general education for advanced degrees. The *third* is that of providing subjects in the humanities and social sciences that would appeal to the mature graduate student who has had the equivalent of the ten-term undergraduate program in general education which we have recommended.

We recognize that these questions are exceedingly difficult ones and we know that the Committee on the Graduate School has given them much thought. We have come to the conclusion that their detailed consideration is outside the scope of this committee. We doubt that we are properly composed to undertake such an assignment. It is our recommendation that the problem of the over-all development of the graduate student and the three specific questions noted be given continuing study by an appropriate faculty group.

Part IV

Possible Three-Term Sequences

THE FOLLOWING is a discussion of the subject matter in the humanities program which would be covered in the proposed sequences outlined in Table II on page 100.

History and Government

SEQUENCE A: GOVERNMENT

First term: Constitutional Government and Political Processes in the U.S.

Second term: Comparative Government

Third term: Political Movements and Political Ideas

The first term's work would present the basic facts of the organization and the workings of the federal government. It would examine such fundamental concepts of political science as "law," "sovereignty," "power," "interest group," "democracy," and "dictatorship"; it would include a study of the United States Constitution, the principles of federalism and constitutional government, the role of political parties, the constitutional problems created by the growth of government responsibilities in recent decades, the workings of the three branches of our government, the functioning of certain types of administrative agencies and, finally, the effects of wartime changes and postwar trends on the constitutional system.

The second term would be devoted to a study of foreign governments, comparing them continually with that of the United States. It would deal with constitutional government in Britain, its difficulties in France, its weaknesses in Italy and Germany between World Wars I and II; with the different patterns of dictatorship as seen in Nazi Germany and Soviet Russia; and with the governmental problems of countries recently emerging into Western industrial civilization such as Japan, China, India, and Argentina. Particular attention would be given to the techniques of identifying the controlling characteristics of a political regime and of assessing the factors which govern its behavior and contribute to its stability or instability.

The third term of this sequence could take several directions. A study of political

movements and political processes would emphasize the forces of nationalism, the problems of national minorities, the emergence of labor as a political factor in different countries, and the concept of federalism as a possible political framework for the peaceful accommodation of different nationalities, political ideologies, and economic interests.

Other studies more limited in extent such as government control of industry, international organizations, or modern political theory could also logically constitute the third term of this sequence.

SEQUENCE B: HISTORY

First term: American Political and Social Institutions (1865-1920)

Second term: Postwar America (1920-1940)

Third term: Problems and Trends in Modern Industrial Society

This second sequence in the field of History and Government would emphasize American history since 1865.

The first two terms would deal with developments in science and technology, the growth and organization of industry, with urbanization, agriculture, organized labor, and government regulation. Continual attention would be given to the interrelation of these developments and to their effect upon the position of the United States as a world power.

The third term would deal intensively with major contemporary problems and trends in industrial society both in the United States and in foreign countries such as Great Britain and Russia. It would include a study of a limited number of such subjects as corporate enterprise, public enterprise, planning, entrepreneurship, bureaucracy, the economic and political activity of labor, natural resources, social and economic security.

SEQUENCE C: AREA STUDY

This third sequence would take the form of an area study. The one suggested would be suitable for students who might be interested in settling in Latin America or for students whose occupations in this country might bring them into contact with that region.

The first two terms would deal with the political, social, and cultural history of the area, with particular attention to developments in Argentina, Brazil, and Chile. The third term would cover the period since World War I, with emphasis upon such topics as natural resources, industrial developments, activities of foreign businessmen and foreign governments, the agrarian problem, racial composition, education, and political trends.

Philosophy and the Arts

Sequence A: History of Ideas

The interest manifested each year in the current subjects in history of ideas and philosophy, although the latter carries no credit toward the humanities requirement, would suggest that a three-term sequence in philosophy would be attractive to a goodly number of students. Although the two-year basic course in the humanities provides some introduction to the history of ideas, a philosophy sequence would have to provide some simple terms of reference.

The first term would explain how and why philosophical questions arose in the time of Greek civilization, and then proceed to a treatment of the Christian system of ideas. The second term would give the solutions attempted by the great modern systems from Descartes to recent times. The third term would submit philosophical questions to modern means of analysis, show which problems still exist, which can be answered by science and which cannot, and to what level of experience and perception they appeal.

Although the organization of subject matter would be historical, in order to give meaning to terms essential to discussion, the sequence would not be one in the "history of philosophy." The merely historical treatment makes for superficial surveys, and gives students the feeling of having understood the question before they have looked into it. The analysis of one system of thought for each period to show the meaning in depth of the answers it provides would be preferable to a survey history of philosophy.

Sequence B: Architecture and Fine Arts

A three-term sequence in Architecture and Fine Arts might devote each term to a separate cultural situation, within which all the arts would be covered. The first might be devoted to a prehistoric or primitive situation where the methods of approach are archeological or cultural-anthropological, and where the near identity of art and technics can be made of interest and importance to technical students. Possible situations for the first term might be Pre-Columbian America, medieval Europe, or early Chinese civilization. The field should be limited chronologically, and a variety of material, from large-scale buildings to minute objects such as jewelry, should be studied.

The second term might deal with one of the great periods of Western Culture: 5th Century Athens, 13th Century Ile de France, 16th Century Florence, or 17th Century Papal Rome. The period would be offered as a sample high period and not as a presumptive single apex of human achievement.

The third term might be devoted to a situation relatively near and familiar to

our students: 18th Century England and America, 19th Century America, or even perhaps the world of the modern arts of the last fifty or sixty years.

These three courses would offer three types of approach to the world of art:

1. The approach to the remote, where our ability to understand is necessarily rather limited, and where our response to the products is certainly very different from that of the producers.
2. The approach to a period whose values have long been accepted and knowledge of which is perhaps rather conventional, but a shared experience with other cultivated men.
3. An approach to a nearer field where the student has a better chance of making up his own mind without being overburdened by preëxisting judgments.

Such an approach would help to give a man an integrated sense of the relevance of this field to the life of a human being, to provide him with discipline in parts of the field, and to create interest and enthusiasm which would carry on in after life.

Sequence C: Literature

Three terms of literature offer some opportunity to study three portions of what has been written. It would be possible to divide literature into poetry, drama, and narrative. But perhaps an understanding of literature requires not alone the vision of structure and appreciation of feeling but, even to understand these, an insight into the society behind what was written which once gave that writing its meaning. Perhaps, then, it would be best to read in three more-or-less grouped areas of time, and to be as diverse in these as possible.

The work of the first term might, then, be given to the literature of the Mediterranean basin, the literature we usually call Classic. Such literature, covering a period from Homer to Horace, expresses the whole growth and development of a civilization. If one adds here portions of the Old Testament and the Scandinavian *Volsungasaga*, perhaps some contrast in fundamental attitudes of other civilizations will become clear.

The second term might well cover that shift from the Middle Ages into the Renaissance which produced our immediate forebears. Here one might begin with the mediaeval mind — St. Thomas, Dante, Chaucer — against which the later men gradually reacted, and lead into the bourgeois democracy of Molière which we are only now, perhaps, outgrowing.

The third term might well be given to the literature written during the last three-quarters of a century, the span of one man's life. We cannot easily foretell what of this literature will remain readable. Perhaps we must select what to read by its relevance to those movements which we believe will determine the character of the coming age.

Economics and Social Science

Sequence A: Economics

This sequence would involve no new subjects, and would permit a fairly wide range of choice in its third term. The first two terms would consist of the present Ec11 and 12, Economic Principles I and II. The third term could be any one of the following: Ec23, National Income; Ec27, Economics of Patents and Invention; Ec49, Public Finance; Ec50, Banking and Finance. Also, Ec11, Economic Principles I, could be taken by those who wanted only one term of work in this field, and Ec11 and 12, Economic Principles I and II, would provide a two-term sequence.

Sequence B: Industrial Relations

The first two terms of this sequence would consist of the present Ec70, Introductory Psychology, and Ec60, Labor Relations, the latter somewhat modified to make a more coherent three-term sequence. The third term of this sequence would consist of a new course, very similar to the present Ec65, Industrial Relations, but again somewhat modified to tie in more closely with the revised Ec60, Labor Relations. The present Ec65, Industrial Relations, would presumably be retained and geared, as it is very largely at present, to follow 15.30, Personnel Administration, for students in Business and Engineering Administration. Again, Ec70, Introductory Psychology, would be available for those who wanted merely one term and Ec70, Introductory Psychology, and Ec60, Labor Relations, for those who wanted a two-term sequence.

Sequence C: International Relations

Two alternate sequences would be possible under this head. The first would consist of the present Ec11, Economic Principles I, together with Ec57, Ec58, International Relations. The second would consist of Ec11, Economic Principles I, a course in comparative economic and political systems and a term of international relations.

Howard R. Bartlett
Douglass V. Brown
Gordon S. Brown
John E. Burchard
Robley D. Evans
William C. Greene
Harold L. Hazen
Joseph H. Keenan
Walter H. Stockmayer
Thomas K. Sherwood, *Chairman*

REPORT

OF

The Committee on Staff Environment

FOREWORD

THE RESPONSE OF THE FACULTY to the first questionnaire circulated by the Committee on Educational Survey presented so strikingly the number and variety of changes that faculty members felt would help to "provide the Institute with an improved environment for effective teaching and creative research," that we believed it essential to have an auxiliary committee give its full attention to the evaluation of these criticisms and suggestions. Accordingly, in April, 1947, the Committee on Staff Environment undertook to consider M.I.T. as a "community of people."

The committee included representatives of each school and of many points of view. Its members had the breadth of vision and experience with which to consider the multi-faceted problem of staff environment in a large urban technological school. With their definition of the objective, the kind of academic environment they wish to have at the Institute, we are in complete accord. They set forth as long-range goals the same concepts that govern both the recommendations of our report and that of the Committee on General Education.

We invite the faculty to consider the report of the Committee on Staff Environment in its entirety. We suggest that it be endorsed by the faculty as a guide to the administration in future planning.

Committee on Educational Survey

WARREN K. LEWIS, *Chairman*

INTRODUCTION

OUR COMMITTEE set out, in accordance with its instructions from the Committee on Educational Survey, to determine what changes "might provide the Institute staff with an improved environment for effective teaching and creative research." To fulfill this task we have analyzed the replies to questionnaires sent to the faculty and have held a series of discussions extending over nearly two years. From our investigations we have derived the recommendations set forth in Part II of this report.

We discovered inevitably that it was impossible to agree upon specific changes in the existing environment without deciding also what we thought the future environment ought to be. Our specific proposals, in other words, had to depend upon some general educational concept for M.I.T. The development of such a concept is the primary responsibility of the Committee on Educational Survey. We have felt it necessary, however, to include as Part I of this report our own statement of this educational concept to provide a general philosophical support for the specific recommendations of Part II.

Part I

IN ATTEMPTING TO DEFINE the kind of academic environment we would like at the Institute, we have asked ourselves two questions: What kind of an undergraduate school do we wish to have? How far do we wish to go in the direction of becoming a university? On the answers to these questions depends, in our opinion, the nature of our staff environment.

In recent years there has been a growing tendency to increase the significance of our graduate school and to introduce the spirit of scientific inquiry into every field of learning with which the Institute is concerned. This has been desirable and healthy. But the emphasis on graduate instruction and research has inevitably left the undergraduates in an anomalous position. We now face the issue of whether or not we want an undergraduate school. We wish to answer this unequivocally. We believe, with the Committee on Educational Survey, that the continuing development of a great undergraduate school is one of the primary educational responsibilities of M.I.T.

Our committee believes also that the undergraduate school must remain professional in character. While we do not suggest that professional training is the only way to obtain a higher education, we think that for many students it is the best way. We further believe that for any student there is much to be gained from obtaining, in the early years of higher education, a sense of the professional spirit and of purposeful inquiry. But we also consider that general education in the humanities and social sciences is a necessary part of modern professional training. Furthermore, we share the view of the main committee that instruction in these fields should be undertaken by men of ability and reputation comparable to that possessed by their colleagues in the professional disciplines.

The values and attitudes of the humanities cannot be obtained exclusively, however, through formal instruction. We should like to make it possible for students to absorb the cultural advantages to be obtained through living on "the campus" in a congenial environment. The Institute has been criticized by students and faculty alike as a cold place with the atmosphere of a factory. These conditions are encouraged by nine-to-five working-hour schedules and the substantial amount of commuting.

The maintenance of this impersonal pattern of behavior is not necessarily in-

consistent with the objective of a great graduate school. The highest form of creative work has often, in the last analysis, to be done alone. There are, too, certain advantages to be gained from the kind of withdrawal which many faculty members now enjoy through living at some distance from their place of work. But there is also very real value in the cross-fertilization of ideas which comes from an association of scholars living in the same community. For undergraduates, particularly, we feel very strongly that the scientific spirit of inquiry and a liberal approach to life can best be acquired by living *within* a genuinely creative atmosphere. Therefore we suggest as a goal the development of a physical and intellectual environment which will provide M.I.T. with a life of its own within the larger life of the metropolitan area.

The creation of such an environment depends in part, in our opinion, upon the physical changes suggested in Part II of our report. It depends also upon certain modifications in our administrative and intellectual environment. Our objective in the undergraduate school should be to provide intimate instruction to a restricted number of exceptionally able young men. This means small classes; and increase in the number of seminar rooms and in seminar methods of instruction; and a more flexible curriculum for the unusually gifted or well-trained student. It means finally an undergraduate school in which more intimate and friendly relations, whether in classroom or in social gatherings, exist between faculty and student body.

Our second general question was whether or not the Institute should become a university. We share, with the Committee on Educational Survey, the conviction that M.I.T. should remain a technological school offering instruction of the highest possible competence to undergraduate and graduate students. This in itself appears to us a challenging task of great magnitude and significance.

M.I.T. must have a faculty equipped to deal with the major technological problems of our times. The impact of technology on society is such that these aims cannot be achieved if the Institute is exclusively a school for science and engineering. In fact we are not such a school today. We now have four major types of professional education in engineering, science, architecture, and administration. Administration is here defined in the broadest sense of the term to include training of M.I.T. students, in whatever professional field, for executive leadership in industry, government, and labor both in this country and abroad. In each of these four areas we feel it essential that M.I.T. be looked upon as one of the principal centers in the world for creative work.

But this is not, in itself, enough. The intellectual environment must provide music, literature, history, philosophy, and the like for the students who are interested in them; moreover, work in these fields must be conducted on the highest plane.

There is a difficulty here that we recognize. How can such talents be attracted or developed unless we are willing to become a university offering specialized graduate instruction in all the principal fields of learning? This is a real problem which can perhaps be solved as follows: first, in certain areas where graduate instruction or research is manifestly inappropriate at M.I.T., music, "fine arts," literature, for example, it will probably be necessary to offer men with creative talent unusual freedom and independence of action. Second, in areas where graduate instruction and systematic research are appropriate, economics, sociology, psychology, history, for example, we propose that scholars from the several fields be grouped into creative research centers to work collectively on problems of common interest. Such centers need not be large, but they must have recognized status and afford an opportunity for the specialist to carry his subject as far as he wishes.

We appreciate the difficulty in selecting from the many possible areas of the humanities and social sciences those which are properly a part of the M.I.T. curriculum. In any case such selection does not lie within the province of this committee. But we wish to emphasize our conviction that men representing these fields of knowledge must, for the general good of the intellectual environment, be scholars of the highest talents and attainments — as are their colleagues in other fields.

Part II

IN SETTING DOWN the specific recommendations which follow, we have not felt limited by financial considerations. It is obvious that many of our suggestions would require increased expenditures by the Institute. Thus, the improved salary scale plus return to a nine-month basis and provision for sabbatical leaves might add nearly a million dollars a year to the operating budget. Similarly, the development of a better physical environment entailing capital expenditures for land and for construction or conversion of buildings would be expensive, although projects such as dormitories and faculty housing near the Institute should be largely or wholly self-liquidating and might well enlist outside financing. As a rough estimate our recommendations might involve capital expenditures in nonliquidating projects of five million dollars.

While this committee hopes that financing may be available through the years ahead for improvements of the type which we recommend, we are convinced that significant gains in staff environment can be effected without added expense. *Men are more significant than their physical environment.* Many of our suggestions are designed to foster more enlightened opinion and deeper appreciation of objectives by individuals. A more intimate association of staff, a better understanding of the interests and contributions of our fellows, and a realization of united purpose toward outstanding educational achievement can be the most vital advances in staff environment. In concluding this section we would like to state our belief that all the members of the M.I.T. family, administration, faculty, and students, must be able to feel a sense of belonging to a great institution with a high moral purpose. To achieve this aim completely there must be (1) general agreement throughout the faculty on the major purpose of the Institute and (2) a master plan for the development of the Institute which is understood and enthusiastically endorsed by the faculty. We believe these objectives are attainable, that M.I.T. is sound and vigorous, and that if we work hard together we will provide outstanding leadership for the intellectual world of the future.

In the preceding pages we have attempted to define an intellectual position on which the future development of M.I.T. may be based. We now wish to present a list of suggested changes in the existing physical, administrative, and intellectual environment. These changes are proposed as specific means to assist in obtaining our general educational objectives.

The following outline presents our principal recommendations:

I. *Physical Environment*

1. Adopt a master plan for the development of the physical environment of the Institute over the next twenty years, designed to increase the opportunities for students and faculty families to live on or near the campus.
2. Provide, through new construction or conversion of existing buildings, a Faculty Club building and a large lecture hall.
3. Develop an East Campus behind the new Hayden Library.
4. Improve existing classrooms and increase the number of seminar rooms.
5. Improve facilities for parking.

II. *Administrative Environment*

1. Limit the normal teaching load for all staff members to two terms a year.
2. Raise the salary scale to equal the highest of any university in the country.
3. Adopt administrative changes designed to obtain greater faculty participation in the solution of our common problems.
4. Strengthen procedures for selecting permanent staff members.

III. *Intellectual Environment*

1. Make certain that in every field we cover there is a flourishing spirit of creative scientific inquiry.
2. Apply only the highest intellectual standards in selecting permanent staff members.
3. Give greater recognition to first-rate teaching.
4. Accept research projects which cannot be freely discussed only in very unusual circumstances.
5. Devise means to obtain more complete interchange of ideas and information between faculty members.

The Physical Environment

The physical environment exerts a direct influence upon the character and quality of the intellectual work done at any educational institution. There must be modern equipment and convenient locations, but these, in themselves, are not enough. The constructive mind is supported, not distracted, by a physical atmos-

phere of order, peace and beauty. At present the Institute does not provide such support.

Changes in our physical environment are inevitable in the future. These changes must take place within the design of a carefully developed plan if the Institute is to become an attractive and satisfying center for student and faculty life.

Master Plan for Area Development

The M.I.T. community, faculty, students and employees, today comprises approximately 9,000 people. Of the 5,000 students, about 1,500 live on the campus. Only a small proportion of the staff live in Cambridge. We should like to see a significant expansion of opportunities for members of the M.I.T. community, who wish to do so, to live on or near the campus. We believe that this objective can be achieved best through a carefully conceived plan for the future physical growth of the Institute. Our committee has made some general suggestions to the administration concerning such a plan, and we should also like to encourage the members of the faculty to make suggestions of their own, as we are certain that they would be welcome. Plans for the future development of the Institute should be worked out through participatory discussion with the faculty.

Specific plans can be suggested, of course, only for land we now own. Such plans would involve the further development, as our major center of intellectual activity, of the East Campus, on which the main buildings of the Institute are located. The West Campus would then be devoted to student life, with the construction of new dormitories to house from 1,500–2,000. The Eastgate apartment building will give some of the faculty an opportunity to live on the M.I.T. campus. It will also be expected that people from other walks of life will live there. Such cross-fertilization is extremely healthy. One advantage of M.I.T. today is that it is not socially inbred; this virtue should be maintained.

The plan suggests that the East Campus (bounded by Massachusetts Avenue, Memorial Drive, Ames Street and Vassar Street) be used for classrooms, laboratories, faculty and administration offices. Gradually as new dormitories are erected, the students would be shifted to the West Campus. The space thus vacated could be effectively utilized for educational expansion. Eventually, also, a new use for Walker Memorial is implicit in these shifts.

The long-range plan also provides for the creation of a beautiful inner campus between the Hayden Library and the swimming pool.

Suggested Specific Changes in the Physical Environment

In addition to a general plan for the physical development and expansion of the Institute, our committee proposes the following changes in or additions to the existing plant:

1. Faculty Club Building

A Faculty Club building in a suitable location is urgently needed. At present the club sponsors social and recreational activities that have helped to increase the friendliness of the faculty environment. The club's luncheon meetings in the Campus Room, quite apart from the interest of the speeches, have been valuable as a means of bringing the staff members together informally. But the efforts of the Faculty Club have been limited by the inadequacy of the existing physical facilities.

We feel that a clubhouse is essential to develop informal intellectual and social interchange between faculty members. To fulfill the required functions a clubhouse should contain one large and several small dining rooms, reading and conference rooms, a lounge, game rooms, etc. There should also be guest rooms for the increasing number of distinguished visitors who come to the Institute.

The most convenient location for a faculty clubhouse would be somewhere on the East Campus. The building thus placed would be in the educational area and near Eastgate.

Three sites suggest themselves as particularly appropriate.

1. If a new building were to be constructed, we suggest that it be placed next to Walker Memorial where the present tennis courts are.
2. If an extension of an existing building is preferable, we suggest a pavilion attached to the undergraduate dormitory which faces the Eastman Building. This pavilion would house a large dining room. The section of the dormitory attached to the pavilion would provide the space necessary for other clubrooms.
3. A third possibility is the conversion of part of Walker Memorial.

2. Faculty Housing

We should like to see a nearby area developed which could be used for faculty homes. We believe that faculty members residing near the campus can do a great deal to create a more attractive and civilized atmosphere. Such proximity would encourage the social gatherings, evening lectures, debates, and other activities which bring faculty and students closer together. In this connection we should like to see warmer atmosphere and more homelike surroundings in future student dormitories. Before any more dormitories are built, we strongly urge a careful architectural and sociological study of such questions as the size of housing and dining units, arrangement of bedrooms and studies, and the possibility of incorporating faculty living quarters with student quarters.

3. Lecture Hall

There is, at present, no suitable hall that will accommodate all the members of a single undergraduate class, or large M.I.T. audiences for dramatic productions,

concerts or other Institute functions. An important objective, therefore, is the construction of a lecture hall with a seating capacity of about 1,000.

4. Parking

Further steps are also required to improve parking facilities. We suggest the purchase of additional land and an investigation of the advisability of building a parking garage.

5. Offices and Classrooms

One of the recurrent complaints appearing in the faculty questionnaire was directed against the unsatisfactory acoustics, heat control, and lighting in our classrooms and offices. We urge the correction of these weaknesses wherever they exist.

We should also like to see more seminar-type classrooms and classes, with tables instead of a rostrum for class instruction. In seminar rooms the instructor and the student should feel some sense of belonging. Such rooms might be shared by several instructors with special bulletin boards for each class and places for instructors' books and exhibits. In this respect the laboratory-type classes have a definite advantage now in the arrangements that are made for demonstration material.

6. Faculty Rooms

Our committee recommends that a number of rooms be set aside on the East Campus for use by individual faculty members. These rooms, without telephones, adequately furnished, would be used by faculty members when they wish to study or work without interruption.

The Administrative Environment

There are clearly many favorable elements in the present administrative environment, notably the degree of independence both in thought and action possessed by the individual faculty member. This relative freedom from some of the restrictions imposed by other institutions is one of the distinguishing characteristics and advantages of M.I.T. But this independence, the product in part of the size and varied character of the Institute, can produce in the individual faculty member a sense of isolation, of failure to identify himself with the major purposes of the Institute. This sense of separation is unhealthy for both the individual and the Institute. Moreover, replies to the questionnaires indicate that a strong desire exists for greater participation in discussions preceding general policy decisions. With this point of view we completely sympathize.

Our committee has therefore considered measures which should increase the staff member's opportunity to participate in Institute matters without placing in

jeopardy the real values he obtains from the freedom of thought and action provided by the existing conditions. We present the following suggestions:

The Faculty Meeting

The faculty meeting is, potentially, a major force in the improvement of staff environment and the conduct of the institution. At present it fails to serve these purposes. There is a feeling that the Institute has become so large and diverse that decisions must be left to administrative officers and standing faculty committees. Under such conditions the faculty meeting takes place primarily to approve motions proposed by the various instruments of administration. Insofar as this situation exists it saves time for faculty members, but it involves an abdication of interest and responsibility that is detrimental to the best interests of the Institute and to the spirit of the staff members.

Under Institute rules and customs the faculty is responsible for the educational program, including such matters as admissions requirements, programs of study, examinations, grades, and the recommendations of candidates for degrees. Necessarily, the details of these matters must be handled largely by committees, but this does not mean that faculty meetings need be routine. We should like to see the faculty more interested and more willing to discuss matters of basic educational policy, thereby furnishing its committees with a guiding philosophy.

Decisions in questions of policy are effective only to the extent to which they are understood and supported by the individuals who, in their actions, carry them out. On such questions of policy, "the first two years," "the summer school," "housing plans" are examples, the faculty meeting should be an open forum. All the pertinent information should be made available to staff members before the meeting and a full debate of the merits should take place on the floor. By the process of informal discussion, the individual is enabled to make up his own mind on important questions and is stimulated to recognize his responsibility to the Institute.

We do not recommend that the legislative powers of the faculty be extended, but we do urge as a most important influence in improving faculty environment that, in addition to discussing and acting on purely educational matters, the faculty meeting be used as a means to exchange information about plans for the future development of the Institute, and to obtain full expression of faculty attitudes on those changes before final administrative action is taken.

Faculty Committees

The potential of regular faculty committees as a broadening experience in interdepartmental understanding and coöperation has not, in our opinion, been sufficiently appreciated and exploited. In the past, faculty committees appear to have

been less interested in developing broad principles as a guide to faculty action than in arriving at immediate and specific solutions for existing problems.

This committee feels that faculty committees should act more frequently in advisory capacities and as sources of mutual education and less often as the working committees that characterize industrial operations.

A Committee on Education

The Committee on Educational Survey, with its auxiliary committees, suggests the kind of faculty participation through committee action that we have in mind. The complete freedom of these committees to consider and recommend in matters of long- and short-range policy is an effective device for stimulating faculty participation in Institute affairs. We therefore recommend a permanent Committee on Education.

This committee, we believe, should be composed of persons of faculty rank and chiefly of those whose duties are not primarily administrative. The permanent committee should, as at present, consider long- and short-range policies and procedures which affect the character of the Institute. It should be kept rigorously free from routine assignments. It should be authorized to appoint such subcommittees as it may require and should have a budget to cover necessary expenses. It should act with advisory power only but without limitation as to subject matter. As far as possible, the President's Office and other branches of the administration should keep this committee informed of impending decisions which are pertinent to its broad interests.

Departmental Administration

Our committee, in connection with the question of staff participation, has also considered measures to improve departmental administration. Since departments vary widely in size and character, we believe the method of conducting departmental business must be left, in general, to the heads of departments, who under such conditions necessarily enjoy a large measure of freedom and authority. This committee is opposed to limiting this independence, but we would urge more staff participation in the development of departmental policy than now generally exists. We suggest meetings of permanent staff members with department heads for consideration not so much of routine matters as of departmental policy.

Our committee has also considered the policy used in many universities of having rotating department chairmen. We believe that on balance our system is better, but we should like to introduce the possibility of some rotation. We suggest, therefore, that future appointments of department heads be made for a five-year term with no rule against subsequent renewals.

Staff Salaries

The replies to the questionnaires indicate that the staff is deeply concerned about salary schedules.

In the last ten years the teaching profession has suffered an absolute decline in its standard of living as well as a relative decline compared with most other occupations. We believe that the M.I.T. administration, as leaders in education in the country, should do everything in its power to correct this position. The increase in salaries in 1948 was an important forward step, but we feel it may be necessary for us to postpone most capital expenditures for buildings and improvements in order to insure a satisfactory standard of living for the faculty.

We have compared our position with that of other universities in the matter of salaries. We find that M.I.T. stands well in this comparison and has in general been improving its position over recent years. However, we feel that M.I.T. should attain a salary scale equal to that of any other university in the country where the cost of living is comparable. We have not achieved this yet.

Appointments

The final decision on the appointment of men who will henceforth be members of the permanent staff rests with the administration. Its deliberations should be assisted by the most competent opinion which can be secured from men outside as well as inside the Institute family. The advice of individual members of the department involved is often most constructive in determining the best qualified candidates, and we believe that the active coöperation of faculty members in considering cases of promotions and appointments to tenure posts should be regarded as a privilege and a duty in this vital sector of Institute affairs.

We urge department heads, as a matter of standard procedure, to keep all permanent members of the department informed in advance when tenure cases are to be reviewed. The staff members ought to feel that they share responsibility for such appointments and promotions. This committee feels strongly that this would help to improve community spirit within the faculty.

It would also be extremely valuable to augment the department recommendations with the advice of people outside the department in question when tenure appointments are being considered. This is true especially in cases of internal review when it is sometimes difficult to maintain an objective standard. We suggest as a possible procedure that all recommendations for permanent tenure be supported by the formal recommendation of two men, appointed by the President of the Institute, not connected with the department in question.

Status of Associate Professors

As we move into an era in which no permanent appointment would be made without a very careful review, we should like to see the present method of rationing full professorships abandoned. Under these conditions no man should be promoted to the rank of associate professor unless there was a conviction, based on tangible evidence, that he would later obtain real distinction as a scholar, teacher, or administrator.

Some men will remain associate professors longer than others. In spite of the most careful selection at the time of the tenure appointment, cases will occasionally arise in which promotion to the rank of full professor could not be justified. But this committee feels strongly that with more thorough scrutiny there should be fewer of these exceptional cases.

Recognition of Teaching

It is our opinion that more emphasis should be placed on searching out and rewarding the great teacher as well as the outstanding scholar. Questionnaire returns from the faculty revealed a widespread feeling that superior teaching has not been adequately rewarded in this institution. We recognize this to be a very difficult problem. Successful scholarship is more readily measurable than successful teaching. We would of course like a faculty of men who are equally good in both fields, but this is an unrealizable goal. Some men are better at research, others at teaching. This distinction is explicitly recognized in some institutions like Columbia and Chicago which have separate graduate and undergraduate faculties. We do not believe that this pattern should be followed at M.I.T., but we would like to stress the importance of *exceptional* undergraduate teaching and the necessity of securing an outstanding faculty who are interested in such teaching. Moreover, men who are given permanent tenure primarily because of their teaching capacity should be allowed free time for preparation, study, reflection, and writing.

Summer School Teaching

The growth of science and technology in the postwar period, together with the close relationship which M.I.T. maintains with industry and the government, places a major portion of the Institute staff under a continuous heavy pressure which affords the individual little time for his own intellectual activities. To compensate for this, a serious effort should be made to allow each member of the staff to spend one term a year as he pleases; in rest, travel, research, or teaching elsewhere.

The present annual plan gives the average faculty member only a six-week free summer period. Some departments have been able to permit greater freedom, but the practice varies widely between departments and more freedom during the summer is desirable.

The Institute operated on the nine-month plan until April, 1945, when the annual plan was adopted. The two significant reasons for making the change appear to have been:

1. To provide a general salary increase necessary to meet the rising living costs.
2. To obtain a wider staff participation in summer school teaching. Prior to this time the summer school was taught by the same few members of the staff every year.

Necessary and desirable as these ends were when the plan was introduced, this committee feels that the annual plan interferes with the development of a proper academic atmosphere. Moreover, the plan is not generally followed in American universities. M.I.T. is thus placed in a weaker competitive position in attempting to attract a staff. Already we are regarded as a "factory" by other members of the teaching profession; the longer academic year tends to support this opinion.

We have discussed the subject of the summer school at length. We believe the present schedule produces a major inequity in our environment. We suggest therefore a return to the nine-month plan at the earliest possible moment. It is estimated that to do so would require an increase in the budget of approximately $300,000. However, the proposed reorientation in our summer school (discussed below) may bring in additional revenues which would reduce this figure.

Under the present plans for an enlarged summer school, special Institute-run educational programs and meetings will probably be added to the existing schedule of classes. The proposed program provides a means of using the M.I.T. plant more effectively during the summer. It would be valuable to industry, to smaller schools and to our graduate students who remain on the campus. But if this program is carried out, it is the recommendation of the committee that the summer school be staffed in part by faculty obtained from outside the Institute. Such an arrangement would have numerous advantages; it would leave the Institute staff with relative freedom; it would provide valuable contacts with persons from other institutions for the students and staff who remain during the summer; it would allow the Institute to hire on a temporary basis persons who might become candidates for permanent positions, and finally, it would provide a means for acquainting outsiders with the M.I.T. program.

Sabbatical Leave

Professional development is assisted by occasional withdrawal from active teaching for purposes of advanced study, reflection, and writing. We would like, therefore, to encourage the practice of periodic leaves of absence for half a year at full pay. A comprehensive sabbatical program cannot be introduced at once, but we

believe the Institute should begin the development of a program in which staff members would be eligible for leave every seventh year.

The additional burden on the Institute's finances of such a program, if adopted immediately, is recognized. For the immediate future, therefore, we recommend that the Institute:

1. Include in "Policies and Procedures" the statement that a professional leave of absence is a legitimate professional activity.
2. Grant such leaves on as liberal a basis as may be consistent with current needs and resources.

The Intellectual Environment

A favorable intellectual environment is one which encourages a faculty member to teach and work successfully with a sense of intellectual satisfaction and personal fulfillment.

We have said earlier that we wish to see a graduate and undergraduate school of technology developed which will provide outstanding intellectual leadership in the world of tomorrow. We believe that great strides have already been taken toward this objective, and we are distinctly encouraged by the outlook.

This goal can be fully achieved only in an intellectual environment in which the creative spirit flourishes in every field we cover, in which funds are readily available for exploring significant new avenues of inquiry, in which there are substantial opportunities for collaboration between men in different fields, and in which the amount of direction and control of research is at a minimum.

Considering the pressures of the times, the present status of intellectual inquiry at the Institute represents a significant achievement. There is a large measure of freedom, and the scientific spirit is flourishing in many fields. There are, however, dangers in the existing situation to which we wish to call attention.

The Scholarly Attitude

The intimate relation of the Institute with industry and the armed services introduces a practical spirit that is a desirable stabilizer in our academic environment; it also produces a sense of pressure and activity which is not always consonant with the aims of education. We must consciously cultivate fundamental intellectual work and an unhurried approach to research. The staff member, especially the young one, must not feel oppressed by the need to produce more and to work harder. In many cases such pressure inhibits the achievement of important results. Any staff member must have the feeling that he can retire and think about his problem and still retain his reputation with his fellow workers.

A technical school has at least as great a responsibility as a liberal arts college to emphasize the scholarly attitude, to show its students what is a genuinely productive research atmosphere. Technical students will live more within the tempo of industry during later years than other students.

Scholarship flourishes where there is easy exchange of information and ideas. There is at the Institute too little opportunity for the spontaneous social interchange upon which scholarly collaboration is in part dependent. There is too little feeling that the life of the staff is tied up with the life of the institution.

In part, this is the result of physical conditions described previously, but before these conditions can be corrected much can be done to increase the possibility of informal friendly interchange at luncheon meetings and elsewhere.

Greater professional interchange can also be developed through an increase in the number of professional projects which enlist specialists from different fields to work towards a common objective. For example, the Institute last summer organized the Lexington Project to solve a problem for the Atomic Energy Commission. About half of the staff were M.I.T. faculty members from the Departments of Physics, Metallurgy, Mechanical, Electrical, Chemical, and Aeronautical Engineering. The experience of working closely with fellow staff members from different fields to solve a difficult common problem brought very real benefits to those who participated.

Sponsored Research

Many of the Institute laboratories have undertaken research projects for industry and for government. In fact, most of our research work is sponsored, and the budget for such activities is more than our total educational expenses. In considering the effects of sponsored research, we have been concerned with its reaction on the intellectual environment rather than with its financial aspects.

Sponsored research is a distinct asset to the Institute's intellectual life as long as the program is chosen and directed by the staff and the work is unrestricted. Under such conditions it can be integrated with our educational objectives. The governmental and industrial support which has been obtained for projects of a fundamental nature has been and is likely to continue to be of invaluable aid.

There are, however, inherent dangers in reliance upon funds given for specific projects. Thus, there may be excessive dictation by the sponsors of the particular area and method of research. Sponsoring authorities naturally wishing to obtain definite applicable results may, therefore, wish to determine the topic and the type of investigation to be performed. If this is done the laboratories become essentially industrial development laboratories; under such conditions isolated groups are created within departments and attention is diverted from problems of a funda-

mental nature. Again, important areas of inquiry may be neglected because such a large proportion of the Institute's energies and physical assets are committed to projects which initially appeared very promising and are important to sponsors, but which have become less significant to the Institute compared with new developments. Research as well as teaching requires flexibility.

A serious threat is secrecy. There are at least two major secret research programs continuing at the Institute. This committee feels that such projects, if continued for long, impair our sound intellectual development. The existence of groups which are forbidden to discuss their work with the rest of the Institute is contrary to the spirit of scientific collaboration and investigation. The people in such groups are essentially members of separate laboratories, no longer teachers and students of an educational institution. For others at the Institute the effort put into these projects is lost. We concede that exceptional cases may arise where the Institute's responsibility to the national interest might require us to accept secret projects, but such exceptions should be recognized as penalizing our educational functions.

Consulting

Many members of the staff of the Institute are engaged in consulting activities for industry or for government. These activities are considered an important contribution to the experience and understanding of a staff member. They may also be an important and necessary source of income.

We believe that consulting work is useful intellectually as well as financially to the M.I.T. faculty. But we are skeptical of the consulting relationship that demands too frequent travel and too much attention. The energies of men are limited.

In any case, consulting work should be undertaken in the spirit of adding to one's professional competence, not as a necessity to maintain a reasonable standard of living. It is particularly important that staff members should feel free to drop or be dropped in consulting relationships without serious financial embarrassment. We have been distressed to learn of instances in which a reduction of consulting relationships has been a very serious financial blow. Such situations can never be completely corrected, but they would be alleviated through an increase in the basic salary scale as recommended above.

Staff and Student

The intellectual environment would also be improved by greater interchange between student and staff members. We suggest that:

1. As large a proportion of the staff members as possible try to have students as guests in their homes during the course of the year. The extension also of the present extracurricular seminar groups, meeting in department recreation

rooms or faculty homes, should be encouraged. Faculty living facilities near the campus should make this program easier to achieve.

2. Each department or school might encourage informal late afternoon or evening meetings in appropriate rooms where refreshments and conversation, free of classroom formality, can be had by students and staff. This committee suggests for the purpose that each department have readily accessible for its use an attractive seminar room with kitchen arrangements which could be used for student teas, seminar discussions, and after-dinner meetings. We believe that the most attractive room now available for the purpose is the Emerson Room in the School of Architecture and Planning. The Moore Room is also good. It is clear, however, that there are not yet enough rooms of this type.

Visiting Professors

We should like finally to urge the development of a program of visiting professorships to bring to the Institute outstanding scholars in various fields who could not otherwise be attracted here. For example, the School of Architecture feels it has profited greatly from the visits of Professor Aalto. We believe this practice could be followed by other departments.

As a necessary corollary we should like to see the Institute curriculum made sufficiently flexible so that subjects given by visiting professors could be taken as electives by undergraduate and graduate students.

Conclusion

In the pages above we have been, as directed, concerned with specific changes in our environment. We would like in conclusion to express our faith in the essential soundness of the Institute. The qualities of resiliency, unity, free inquiry, optimism and, above all, vitality that distinguish the Institute are priceless elements in our environment. We conclude our two years of self-examination proud of our intellectual and spiritual foundations upon which, we believe, our successful future depends and without which no educational institution, whatever its physical plant or administrative structure, can flourish.

Elting E. Morison
C. Fayette Taylor
Victor F. Weisskopf
Walter G. Whitman
Jerome B. Wiesner
William W. Wurster
W. Rupert Maclaurin, *Chairman*

Sketch Plan for Future Development of Massachusetts Institute of Technology

See larger view

Foldout map at end of report