THE FUTURE OF TWO TOWERS

PART I

WPI

A PLANNING PROGRAM FOR WORCESTER POLYTECHNIC INSTITUTE

THE FUTURE OF TWO TOWERS

I

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SUMMARY

During the past three months the President's Planning Group has developed a planning procedure for the college, assembled a list of possible objectives, devised a set of criteria for evaluation of objectives, and initiated an evaluation process.

The Planning Group recommends that by 30 June, 1970, WPI firmly commit itself to a single objective and establish effective quality control procedures in both the administrative decision-making process and in the faculty structure in order to ensure achievement of that objective. To this end a planning schedule is recommended with target dates: (1) completion of the listing and preliminary evaluation of suggested objectives by 30 June, 1969; (2) selection from the list those three or four objectives (or combinations of objectives) which seem most appropriate by 1 September, 1969; (3) completion of a thorough analysis of requirements (financial, faculty, curricular, staff) for the selected objectives by 1 March, 1970; (4) selection of the final objective by 30 June, 1970.

In order to evaluate any chosen objective or combination of objectives, the present status and resources of the college must be known and a set of criteria must be established. A partial analysis of the present status is given in Part II. Summaries of most of the objectives so far suggested and detailed discussions of four of them are given in Part III.

I   INTRODUCTION.

A.   Intent and Organization of Report.

The writers of this report would attempt by analysis and recommendation to help make our good college an excellent one. We have tried to summarize and evaluate the helpful written and oral contributions sent to the President's Planning Group by many members of the faculty, administration, alumni, and student body as we have assembled this first progress report.

The Worcester Polytechnic Institute is at a critical point in its history; it is the unanimous conclusion of the Planning Group that the trustees, alumni, administration, faculty, and students of the College should at this time examine closely what WPI is now and what she might become.

The INTRODUCTION of this progress report contains: A Statement on Earlier Planning at WPI (B), The Role of the President's Planning Group in Promoting the Development of Planning Procedures at WPI (C), Some Possible Objectives for the College with Criteria for Evaluation and Criteria for Implementation and Quality Control (D), and A Planning Schedule for WPI (E).

The main body of the report contains: A PARTIAL ANALYSIS OF WPI AT PRESENT (II), showing some important strengths and weaknesses which have been too long overlooked; and summaries of SOME POSSIBLE OBJECTIVES FOR WPI (III), showing how objectives may be measured against criteria for evaluation and criteria for implementation and quality control.

B.   A Statement on Earlier Planning at WPI.

Almost from its dichotomous beginnings there has been a certain reluctance toward planned operations at the Worcester Polytechnic Institute. It is clear that the statements of John Boynton concerning his desires for the school were less than definitive (1), while those of Mr. Washburn were more obvious. A reading of the document to which citizens of Worcester affixed their names in pledge of funds discloses no purpose other than the founding of a "Scientific School" (2). In spite of the apparent lack of definitive statement of objective, WPI emerged as a unique school and established a justified, but not very wide, reputation as a source of soundly-trained, practically-oriented engineers. The initial pattern remained unchanged for nearly ninety years during which time WPI's unique approach filled an educational need for the country.

By the end of World War II technological change in American industry (largely a consequence of advanced research in technical schools)

began to require changes in technical education, and it was clear that WPI
had to change as well. With the arrival of Presidents Cormeny and Bronwell
the Institute began to respond to the new demands. Generally speaking, its
responses have been modelled on those originating from the leaders in
American technical education, the Massachusetts Institute of Technology and
the California Institute of Technology. WPI's uniqueness began to disappear.
Instructions to President Storke (1962) were, "Keep things going."

The first published, Institute-wide planning efforts of which
the writers are aware appear as the several drafts of "A Plan for WPI,
1965-75" of which the last (fourth) draft is dated 15 May, 1966. For the
original version of this document most of the departments of the Institute
contributed statements or discussions of what they judged to be key consid-
erations. Subsequently, at the fall meeting of the Corporation, 26 October,
1968, a statement of "Future Educational Policy, General Plan for Action"
was produced, listing nine areas in need of immediate attention. A sub-
committee of the Executive Committee of the Facutly had earlier written a
preliminary statement of goals for the Institute dated 10 November, 1967,
but this document was neither published to the faculty generally nor
developed further.

In spite of numerous planning efforts on the campus (the work of
the Department Heads and committees, the Executive Committee of the Faculty
and its sub-committee on goals, the local chapter of the AAUP, and the work
of individual members of the faculty and administration), no long-range
plan had evolved. Further, the predominant attitude of growth by consensus
limited the singleness of purpose characteristic of good planning and
dissipated limited resources. Lack of a unique program also limited the
potential for obtaining new funds. On 11 December, 1968, the President
appointed a group of six faculty and charged them with developing a compre-
hensive proposal of feasible educational directions the Institute should
take.

C. The Role of the President's Planning Group in Promoting the
    Development of Planning Procedures.

For this college to function effectively, its educational goal
or objective must be much more clearly defined than it is at present, and
that goal or objective must be promoted and implemented consistently
throughout the Institute. Without a definition of what we are attempting
to do, our entire enterprise will weaken and splinter into divergent and
competing functions.

There are several planning tasks which must be immediately under-
taken, and the responsibility for their development and implementation
cannot rest with a planning group alone.

(1)   A firm commitment to a specific and realistic goal for Worcester
       Polytechnic Institute at the earliest possible time. Such a commitment
       requires a set of alternatives from which to choose. Our current
       philosophy of "growth by consensus" accepted various changes in
       technical education without any clear evaluation of the educational
       role of WPI.

(2)   Development of a structure appropriate to the chosen goal. It is
       clear that the structure of the college cannot be optimized until
       the objective is chosen. Nevertheless, it is safe to say that there
       will be faculty, administrative, and service units.

(3)   Stimulation of planning at all levels. As disclosed by conferences
       with departments and individual faculty the planned operation is the
       exception rather than the rule at WPI. Each member of the staff who
       expressed an interest in the Planning Group's activities appeared to
       be searching for a plan which would immediately affect his own area
       of endeavor. A planning group cannot and should not dictate plans
       to the campus. There are several levels of planning required. While
       it is clear that the administrative structure which leads to the
       various levels cannot be optimized until an overall objective is
       chosen, levels are indicated below in terms of the college's present
       structure; their enumeration must not be taken as a recommendation
       that the present structure be maintained. There are currently about
       four levels: (a) The Institute as a whole (Trustees, President,
       Faculty, Planning Group) (b) The broad categories of Science,
       Engineering, Humanities and Social Studies, Library, Business, and
       Student Affairs (Deans, Business Office, etc.), (c) Departments and
       Divisions (including student and living groups), and (d) Individual
       staff and students.

(4)   Provision for continual reassessment of the chosen goal, its premises,
       and the extent of its attainment. At each planning level there must
       be provision for cross-check of objectives with the levels on either
       side and with the overall objective of the school.

       It is well to bear in mind the structure of the planning
sequence:

            (a) Preliminary selection and evaluation of possible roles WPI
                 might serve.

(b) Selection of the best from (a) for further quantitative
     evaluation in terms of the critical factors for implementing
     and establishing quality controls.

(c) Selection of appropriate, tentative faculty sub-groupings
     and specific curricula and detailed cost estimation for
     each element in (b).

(d) Final selection of specific goal for the school.

(e) Implementation.

D. <u>Some Possible Objectives for the College, with Criteria for
    Evaluation Criteria for Implementation and Quality Control</u>.

As a preliminary step the President's Planning Group has selected
some possible goals which are listed below. This is not intended as an
exclusive list, for it is recognized that as the planning continues there
will be additions, deletions, and condensations. <u>The Group recommends, how-
ever, that before 30 June, 1970, WPI firmly commit itself to a single
objective and establish effective quality control procedures in both the
administrative decision-making process and in the faculty structure in order
to ensure achievement of that objective</u>.

Possible goals for preliminary evaluation are:

1. To provide high-quality pre-graduate education in engineering
    science. *11 - 17*

2. To educate for leadership and decision-making in a technological
    society. *15 - 11*

3. To provide a classical education in engineering and science
    in the Oxford-Cambridge manner. *16 - 12*

4. To become a research-oriented graduate center in engineering
    and science.

5. To become a middle college. —

6. To train students for a Bachelor of Science degree in Technology.

7. To specialize in educating the underprivileged.

8. To promote invention and entrepreneurship.

9. To transform ourselves into a general university. *21 -*

10. To join the State University. — x

11. To maintain the status quo.

12. An appropriate combination of the above.

Of these twelve possibilities, four (1,2,4, and 6) have been given
some study (see section III). The others have been given only initial
appraisal.

Criteria for evaluation are:

1. Relevance to the needs of the student.
2. Relevance to the needs of the society
3. Compatibility with WPI resources, present and possible.
4. Interaction with other colleges.

It is clear that some of the criteria overlap. Careful appraisal of the possible goals in terms of these criteria will cull out the impractical, but should not limit attention to the relatively narrow possibilities as currently practiced by WPI and other technical schools.

Finally, as a part of the evaluation of any objective, it is necessary to ask, "What kind of school will we have?" The following check-list of items for implementation and quality control should be considered:

1. The Two Tower Tradition: a general definition of WPI, its purpose and ideals, its size;
2. Organizational Structure and Decision-Making Throughout the Institute: Board of Trustees, alumni, administration, faculty, student body, and parents' groups;
3. The Alumnus: development of a permanent relationship;
4. The Public Image of WPI;
5. Development of Income;
6. The Faculty: recruitment, expectations, encouragement, campus life;
7. The Campus: development and maintainance of the campus and the college's resources;
8. The Student Applicant: recruitment of the undergraduate, graduate, and other students;
9. The Undergraduate Student: expectations, campus life;
10. The Graduate Student: expectations, campus life, subject matter, presentation, and standards;
11. The Graduate Curriculum and Research;
12. Relationships of WPI to the other Worcester Colleges; the Consortium;
13. Placement of the WPI Graduate;
14. Relationships of WPI with the Professional Engineering and Scientific Communities;
15. Relationships with the University in General;
16. Relationship of WPI to Society: service to society;
17. Specific Relationships with Local, State, and National Governments;
18. Specific Relationships with Industry.

E. A Planning Schedule for Worcester Polytechnic Institute.1969-70.

Although planning should be a continuing operation at any institu-tion, there is the immediate problem of getting WPI on the "planning track". The adoption of the following schedule, designed to put WPI on a thoroughly planned operation by 30 June, 1970, is recommended:

11 December, 1968 to 1 March, 1969.

1. Decide on planning needs and formulate methods.

2. Make preliminary analyses of possible objectives and select and test evaluation criteria.

3. Begin gathering data and make a preliminary analysis of present status of the school.

4. Report to the President.

1 March, 1969 to 30 June, 1969.

1. Complete preliminary analyses of remaining possibilities.

2. Gather additional suggestions for evaluation.

3. Complete an analysis of present status of the Institute with evaluations of strengths and weaknesses and potential resources.

4. Report to the chief executive officer of the school.

30 June, 1969 to 1 September, 1969.

1. Request faculty to elect planning group to continue the work.

2. From the preliminary analyses select those objectives or combina-tions of objectives which seem best.

3. Set up structure for detailed analyses of selected objectives and assign chairmen for full development of each.

4. Report to policy-making agencies of the school.

1 September, 1969 to 1 March, 1970.

1. Enlarge planning group to include students.

2. Complete detailed analyses of "best" objectives.

3. Prepare final reports for each objective.

4. Prepare proposal for continued planning.

5. Report to policy-making agencies of the school.

1 March, 1970 to 30 June, 1970.

1. Collect evaluations of alternative objectives from campus groups.

2. Reach final recommendation on objectives.

3. Request policy-making agencies of the school to select a specific
    objective.

Unless some schedule closely approximating that proposed is
adopted, WPI's time as a private operation is limited. Obviously, the
number of people involved with planning will have to be increased markedly
to insure the success of the proposed schedule.

References:

(1) Tymeson, M.M., "Two Towers", p. 10, Worcester Polytechnic Institute,
     Worcester (1965).

(2) Tymeson, M.M., ibid, p. 22.

II. A PARTIAL ANALYSIS OF WPI AT PRESENT

II. A PARTIAL ANALYSIS OF WPI AT PRESENT

The President's Planning Group would emphasize that the following areas are of importance in understanding the functioning of WPI at the present time; there are factors in each of these areas that should be accounted for in determining the feasibility of any long-term goal of the college:

A. The Alumnus

B. The Student Applicant

C. The Undergraduate Student

D. Graduate Study

E. The Campus Resources

F. The Faculty

G. The Administrative Structure and Decision-Making

H. Research at WPI

I. WPI and The Greater Worcester Community

J. WPI and the Academic World

K. WPI and Industry

L. WPI and Society at Large

M. The Public Image of WPI

N. The Financial Status of WPI

O. The Two Tower Tradition

A. The Alumnus

While WPI does not produce very many outstanding alumni, it is an exaggeration for WPI facts, a widely circulated publication of the College, to suggest that there have been no outstanding alumni since the Class of '08. The WPI alumnus generally does not rise above a middle-management position; his top capacity seems to be chief engineer in a medium-sized company. There are some outstanding exceptions to the general pattern; the school frequently fails to publicize their achievements, and these exceptional men do not often seem to identify their success with WPI. As a result, many of these people give little financial support to the college. Very few of them send, or attempt to send, their children to WPI.

The average alumnus is conservative, sincere, honest, and hard-working. He is not particularly distinguished by communicative skills, and his interests are relatively narrow (1). He wants Tech to remain as it was when he was here; he often seems indifferent to the recent changes in the campus and the curriculum. While he may support the college to the extent of his ability, he had no interest in a carefully-planned alumni continuing-education program announced for Commencement Week, 1969. The alumni as a

group, however, do supply fifteen of the thirty-five members of the College's Board of Trustees.

Today's average student may not become an alumnus too much different from his earlier counterpart. Many possible leaders for industry, education and society could be stimulated much more than they are now in their undergraduate programs here so that they would strive for high goals in their careers.

The image of the WPI graduate is not changing. Company executives who employ large numbers of WPI graduates have little different to say about them in 1969 than they did in 1963. It would seem that the WPI graduate is still sought for "hardware" jobs more often than for jobs requiring theoretical thought. The employer reports that the WPI graduate is less adept in some areas than graduates of some of the other private Eastern colleges.

WPI's reputation in industry is based on the technical competence of its graduates, particularly in design and development engineering, not in the leadership of its graduates in theoretical fields or in high level administrative posts.

The college now takes a large responsibility for the graduate's first employment search, and the Institute does an exceptionally fine job in this undertaking. There is less coordinated assistance to the graduate who wishes to pursue graduate study and seek university or national fellowships.

B. The Student Applicant

The past history and reputation of WPI as a top-flight trade school cannot be ignored in the consideration of the student applicant. Guidance counselors and secondary school teachers have a decided opinion regarding the College's previous attitude toward engineering and toward the type of positions our alumni now hold in industry.

Conversations with guidance counselors and perusal of application forms indicate that the student applicant is usually one whose secondary school record in science and mathematics has been considerably above average, although seldom exceptional; but whose record in English, foreign languages and the social studies has often left something to be desired. The applicant scores well on the Math section and adequately on the verbal section of the Scholastic Aptitude Tests. The applicant often reports that he likes "to work with his hands" and is interested in practical engineering more than in theoretical research in science or technology. Until very recently most applicants were not contemplating graduate study.

Some factors about the competition WPI faces in admissions can be seen from the replies of one hundred students who have been accepted for early admission in 1969 and had selected WPI as their first choice of colleges. These men would have listed one of the following schools as their second choice in the following order of preference: University of Massachusetts, Northeastern, Lowell, RPI, MIT, University of Connecticut. When WPI is a second choice of an applicant, his first preference tends to be MIT, RPI, Tufts, Case, Lehigh or Carnegie-Mellon.

Another important matter in defining the applicant to WPI is the financial and educational background of his family. A significant proportion of our students come from families of modest means, where both parents have little formal education beyond the secondary level. The student often has chosen engineering primarily for the earning potential of such a career and only secondarily for his interest in engineering per se. The applicant does not usually appear interested in social problems or in the concerns of the liberal arts and sciences, but there is increasing evidence that we are underestimating the number of interests and talents that the applicant has.

In recent years, an increasing number of applicants have chosen WPI because of its departments in science and mathematics, and now a few are starting to apply in order to enroll in the unique program in Humanities-Technology, Economics-Technology, Business-Technology or the other new interdisciplinary programs.

WPI has been fortunate in maintaining and advancing the quality of its applicant in spite of some additional difficulties. Financial-aid funds available to the WPI student are woefully small, while tuition is much higher than at the engineering colleges of the state universities. The budget for admissions recruiting has not been large enough to maintain a nation-wide secondary school visitation program, and until recently not many of the faculty have been aware that the Dean of Admissions needs assistance in defining what kind of applicant we now want. A severe need exists, for example, to define standards for the increasing number of transfer applicants and to provide guidance regarding the admission of the disadvantaged student.

Finally, in discussing the student applicant, it is important to remember that WPI is in many ways an unhappy victim of its geographic location. The current student body, like all before it, comes mainly from New England. In fact, it was not until six years ago that less than fifty percent of the undergraduates came from Massachusetts. Many superior students from New England, at the same time, have often ignored the possibility of WPI in

favor of the more prestigious MIT or Brown, each less than fifty miles away. To complicate matters further, neighboring New York State, with its large student population, contributes a disappointingly small number of applicants, partly as a result of a good number of quality engineering faculties in its many colleges and universities and partly because of the substantial Regents Scholarship program requiring attendance at institutions within the state.

C.   The Undergraduate Student

In spite of the rather negative impression one receives in analyzing the applicant for admission to WPI, there are some fine features about the undergraduate student at the Institute. One of the most encouraging signs about him is that he is becoming more articulate in his evaluation of himself and of his education here. One student wrote recently:

"We Techmen have few original ideas. Our compulsive conformism, expressed by our fraternities, coupled with our ultraconservatism, inhibits the type of freely investigating spirit that was the driving force behind the development of the scientific method. Not many of us can really express ourselves in a free manner. Nor are we encouraged toward this end by our free-manner contemporaries or our professors. Be safe. Go by the book. Some people get really turned on by being introduced to new ideas and by learning to think in unfamiliar ways. Not many of them go to Tech."

Perhaps some other recent comments by students about their college assist us in better comprehending the present undergraduate:

"Is the school committed to education or to technical training?"

"There should be more crossing of department lines."

"Some English courses are taught with far more care and imagination, even to engineering students, than are crucial engineering and science courses."

"WPI needs even more independent projects for the undergraduates."

"So often even theoretical material is 'dished out' of the textbook."

"Tech has not faced up to its responsibility in helping to educate more black Americans."

"Why do we not have more open-book exams?"

"What student center there now is needs a host or hostess to keep it going."

"Required ROTC is probably a hindrance to good applications."

"Many labs are still geared to 'cookbook' procedures."

"Teaching faculty are not yet playing a large enough role in directing the educational matters of the school."

"Many students would like a freer flow of students to and from the
other Worcester colleges."

Such student comment shows us that some of our undergraduates
are intellectually alive and perhaps more eager to face new challenges than
the college has expected, but as of yet the goal of the average WPI
undergraduate seems to be rather vague. When asked about his goal in life,
he would probably say he wants "to be successful, influence a few people,
and be able to do as I please most of the time."

Some faculty members are not optimistic about the school's being
able to change the attitudes of this kind of student. They would point out
that he is cultivated to be non-idealistic, is stimulated to look forward
to getting the highest possible starting salary in some field or other and
not to dare think of much beyond that and a rather quick marriage. There
is a definite pattern in the undergraduate's attitudes which prescribes
that he   not get too involved academically, not too involved in fraternity
life or in campus political or social life. The Peace Corps or other programs
where technological graduates are needed are generally scorned by the WPI
undergraduate.

The undergraduate here hesitates to compete for the outstanding
university and national fellowships. One colleague does counsel that when
the new curriculum becomes better established and more of the faculty begin
to think of the undergraduate as a "lamp to be lit" and not as a "bucket to
be filled", we can expect more vitality and idealism from our graduates.

More effective counselling of the undergraduate might also
contribute to his maturation. The freshman faculty advisor system is
potentially a good one, but should be re-enforced with a sufficient battery
of placement and psychological tests and measurements to assist the advisor
in seeing more objectively the strengths and weaknesses of his advisees.
The advisor could contribute more effectively if the Committee on Students'
Academic Standing published regular reports of their decisions, if there were
a formal procedure for communication between the freshman advisor and the
new departmental advisor after the freshman has selected a degree department.

The freshman himself would further benefit if he could be certain
that his dormitory counselor would be a graduate student or a mature member
of the senior class. At the present time some counselors are on probation
themselves; some others seem to be rather immature members of the junior
class.

Finally, if an undergraduate at the present time has a minor or
catastrophic psychiatric problem, he will find the psychiatric reference

system at WPI dangerously inadequate. Furthermore there should be an adequate de-briefing and counselling procedure for the undergraduate suspended from the college.

D. Graduate Study

From a glance at the college catalogue, one cannot help but draw the conclusion that WPI's graduate program, like Topsy, "just growed". The catalogue lists a total of 187 graduate courses, and there are a total of 207 students registered for the current term. However, most of the courses are offered every fourth term. In the current semester 68 courses are offered of which 48 involve classroom work. If the average graduate student takes three classroom courses per term, the average enrollment per course is 12.94. This estimate is on the high side, but if the program is to be economical, the figure should be 20 students per course.

There is another aspect to the graduate study situation which is shown in Table V, where the graduate courses listed for seven areas are

Table I

Study Areas	Graduate Courses Listed
1. Thermodynamics and Statistical Thermodynamics	CM561, CM562, ME541, ME542, ME641, ME585, ME5471 (7 courses)
2. Fluid Mechanics (not including gas dynamics)	CM574, ME546(part), ME561, ME562, ME5621, ME563, ME571, ME573, PH512 (9 courses)
3. Mass and Energy Transfer	CM571, CM572, ME546(part), ME547 (four courses)
4. Quantum Mechanics	CH551, CH553, PH514, PH515, PH616, PH666 (6 courses)
5. Statistical Mechanics	CH552, ME642, PH522 (3 courses in 3 departments)
6. Applied Mathematics	CM504, EE518, EE543(?), EE501, EE584, MA509, MA510, MA507, MA508, PH501, PH502 (11 courses)
7. Solid State	CH554, EE561, PH554 (3 courses in 3 departments)

shown. Such multiplicity may indicate a lack of overall direction, departmental provincialism, slanting the needs of a course to the needs of a specific department or degree, or a combination of all three. One would think that some consolidation is possible.

The full intellectual development of the graduate student, particularly for Ph.D. students, would be enhanced markedly by a program of minors separate from the major field. It would be interesting if a Ph.D. graduate knew something about philosophy.

It is clear that a small graduate program is fantastically expensive to operate when it is based on formal class presentation. Directed self-study is a possibility.

In discussions of the graduate program at WPI one often hears the statement, "We need the graduate program in order to attract the staff required to maintain quality in the undergraduate program." Traditionally, graduate study has separated the scholars from the students. Recently, however, social pressure is forcing graduate work more and more to be an extension of undergraduate work, and this has ramifications for WPI.

If graduate work is for scholars only, then the course offerings should be scholarly. Such courses require preparation far different from that of undergraduate courses, and it is unrealistic to expect a staff member to be current in more than one or, in exceptional cases, two areas. Many of our staff now teach graduate courses in more than one area, which seems inconsistent with the requirements of scholarship.

If graduate course work is to be an extension of undergraduate work, then it is unlikely that it will satisfy the objective of attracting the desired staff. Further, it is unreasonable to expect the students attracted to such a program to make a significant contribution to research activity. In this case WPI would have to depend almost entirely on its Ph.D. program for the research necessary to enhance its reputation in the academic community (see section II.H.).

It appears that the graduate study objectives of the school are ill-defined, the overall administration of the program is weak, and there is far too little interchange of information among the faculty offering the various courses.

E. The Campus Resources

There has not been time for a full evaluation of the resources of the campus, an evaluation that must be made subsequently. Our present facilities are designed specifically for traditional educational procedures. Three areas should, however, be mentioned here.

One of the very positive statements one hears about WPI concerns its physical plant. Parents of prospective students comment on the quality of maintenance of our buildings and grounds and on the courtesy of all of our staff. These are important, positive assets of which we should all be aware.

A second campus resource which should be considered thoroughly is the Library. We have an excellent facility and the nucleus of a good

staff. A library is not just a collection of books to be loaned; it is a learning center, an integral part of the educational process. For this reason it is imperative that the library staff be kept closely informed as to changes in educational policy in general and curriculum in particular. These matters should be reflected in the Library's book and journal budget. The American Library Association recommends that an average of five percent of the overall operating budget of the school should be devoted to the Library's annual expenditures (not including filling in the collection). In addition, the professional staff of the Library, if they are to be professional, must be a part of the educational process and not isolated from the faculty. Faculty status for the professional staff of the Library should be seriously considered.

A third campus resource which can be mentioned now is the facilities for physical education, including the staff of the Department of Physical Education. Of all departments visited by the Planning Group, only Physical Education has supplied a clearly defined set of departmental objectives. The image of the school presented in the intercollegiate competition, the high percentage of students participating, and the program of "carry-over" sports are all positive aspects of the program which justify the fine new facility.

F. The Faculty

It is difficult, if not impossible, to analyze precisely the quality of the faculty of any school. Some aspects of the successful teacher or research scholar and of his contribution to a college over a long period of time defy analysis. One of the attributes of a member of the academic community is a certain kind of independence that is often more valuable to the enterprises of the community than objective measurements may ever record. An educational community needs the researcher and scholar; the teacher and tutor and counselor; the administrator and the committeeman; the old experienced professor with his fixed idea as well as the young inexperienced man with his.

In spite of the difficulty of thoroughly analyzing faculty quality, the small college must constantly apply what objective measurements it can. In contrast to the large university where specialization in many disciplines can well be afforded and where competition is likely to be keen in all areas, it is a life and death matter whether the small college maintains a balance of specialists and generalists and standards of quality appropriate to the college's goals.

The informed community outside WPI can only measure our faculty strength by looking at the academic credentials, research productivity, and the quality of our graduates. Both research and graduate achievement are discussed in other sections of this report. The reader may decide that WPI is not as strong as it might be in either of these areas of judgment.

It is appropriate and necessary here to show some facts about the percentages of doctoral degrees earned by WPI faculty in relationship to total faculty of this College.

The awarding by a prestigious university of the highest earned degree to a scholar is a sign that that man has examined the "cutting edge" of his discipline and that he has assumed the rights and responsibilities of furthering knowledge of his field. WPI is not as strong as it should be in the proportion of its members with such earned doctor's degrees as compared with other private colleges of engineering and science and with divisions of engineering and science in good universities. Furthermore, as the importance of the Ph.D. for engineering has increased, the number of faculty doctorates in the engineering departments at WPI has not increased as much as it might have.

Sixty-seven, or forty-six percent, of the one hundred forty-seven full-time faculty employed by the College hold earned doctorates. Of the science and mathematics faculty, sixty-three percent hold an earned doctorate. Only forty-eight percent of the engineering faculty here hold the earned doctorate compared with the approximately eighty percent of the engineering faculty at RPI. Only twenty-seven percent of the humanities or social studies faculty at WPI are Ph.D.'s. (2,3).

Those who know the WPI faculty well are aware that there is outstanding teaching and research and engineering development accomplished here without regard to the doctoral criterion. Some observers outside WPI, however, have assumed from these statistics, from the lack of vigorous exchange of truly outstanding research scholars from such schools as MIT, from the evidence of excessive imbreeding of WPI degree-holders in three engineering departments, and from the fact that neither the Board of Trustees nor the individual departments appear to depend upon distinguished visiting scholars to judge the quality of our operations, that there is really not as healthy flow of ideas and high standards into this College from outside as there should be.

Using quite different criteria, some observers on the WPI campus itself have found three categories of faculty members among those concerned for the welfare of the school. The first category would include our

colleagues who are basically research-oriented, loyal first to their disciplines, interested particularly in the student who responds to their field and wishes to proceed into graduate study to undertake that discipline himself. The second category might include those of our colleagues devoted to a better WPI who wish to do competent innovative teaching in their own field and to encourage the students to develop to their full capacities by attempting to show them the relationships of their field to the other disciplines. This group has provided much of the research and motivation that has led to recent Institute-wide innovations in curriculum, faculty participation and interdisciplinary experiment. The third category would include our colleagues, devoted to the school, to their technical specialty and to a formula of teaching and Institute structure which would produce a practical, reliable engineer ready to go to work in industry. Such approximate categories would probably overlap, and members of each might be found in every degree and non-degree department.

In recent weeks a number of faculty members and others have contributed to the Planning Group formal and informal comments about the WPI faculty and faculty life; perhaps a few of these diverse comments provide a suitable conclusion to this partial analysis:

"The WPI faculty are a more exciting group than either alumni or students, but even the best of them are going stale because of heavy teaching loads, insufficient time for reading and research, no center for conversation with other faculty members, and no sabbatical leave policy."

"Generally speaking there is a lack of intellectual excitement and curiosity expressed by WPI faculty members."

"WPI appears to have few men whose stature is seen beyond New England."

"Some of the Humanities or Social Studies areas are staffed to handle the new minors programs but not the new majors programs."

"There are no negro faculty members."

"The lack of a faculty lounge or faculty club seriously limits a vital life here, now that the faculty is so much larger."

"Little news gets to WPI from the rest of the academic world."

"Most of the faculty choose to live out of town. The quality of campus life and of Worcester's already weak cultural and political life is furthered weakened by their absence."

"Professional members of the staff who perform educational functions in the Library and at Alden labs and elsewhere do not all have faculty rank at present."

"WPI faculty would benefit greatly from much more interaction with the faculty of the other Worcester colleges and with the faculty of other New England colleges."

G. The Administrative Structure and Decision-Making

In establishing a long-term plan for WPI, attention will need to be given to precisely where responsibility and accountability will lie for various types of decisions. Several questions come immediately to mind: What matters should the Board of Trustees give primary attention to? What decisions belong solely to the President of the College? What decisions and accountability should be delegated to other specific administrative officers so as not to burden the President with trivial matters? What decision-making and accountability belong to the teaching faculty? What decisions and accountability belong to the students?

Some members of the faculty and administration believe, rightly or wrongly, that the present Board of Trustees have not been as vigorous as they might have been in supplying the President of the College with the financial contacts he has needed for his development programs. These observers suggest that a Board with a larger percentage of non-alumni and with greater collective professional and geographical breadth than the present Board has, might help provide the President with a wider variety of development contacts.

In the Spring of 1968, when for the first time they elected a committee of their own, the faculty as a whole finally began to assume their professional responsibilities in studying and recommending to the administration possible educational policy. Several recently elected committees of the faculty have functioned more efficiently than some of the traditionally appointed committees because they knew from whom they received their mandate and to whom they were accountable for their study or proposal.

It would seem that such faculty responsibility should be encouraged and developed. An educational policy which has been developed and ironed out by a committee responsible to the teaching faculty, then approved by the faculty as a whole, will generally be carried out with enthusiasm when it comes time to administer it.

If the faculty can be encouraged to assume such responsibility, the President of the College can be relieved of the necessity of worrying about educational details. At the same time, the administrative heads could be relieved somewhat of their presently impossible role of teaching, representing their department, administering their department and of being asked to determine Institute-wide policy.

Perhaps a majority of the faculty now think that the rigid departmental structure is restricting educational and research development within the college. They would welcome an administrative structure which would allow more flexibility while still maintaining the integrity and quality of individual disciplines.

At any rate, in a collegiate body morale is highest when an officer, committee or individual knows whether he is clearly responsible for a policy or decision, or whether he is clearly designated only to advise regarding a decision. Academic people generally appreciate being consulted as much as possible in the formulation of educational policy. Morale is reduced when they first learn of a crucial educational decision by having a neighbor point it out in the city paper, such as was the case with the Trustees' decision to admit women students and with their announcement on student law and order. In contrast, the efforts made by this administration of WPI to keep the teaching faculty informed have been widely appreciated.

H. Research at WPI

Research activity at those schools generally recognized as leaders in technical education began to flourish in the 1930's. A recommendation (circa 1940) for increased research activity from a committee of WPI faculty, headed by Professor Merriam, apparently was rejected. The foresight of the research oriented schools permitted them to make vital contributions to the nation during World War II, thus establishing a reputation so that they subsequently became leaders in the government-sponsored research boom during the two decades following World War II. In contrast, WPI apparently did little to encourage its faculty to undertake research, although the administration did not actively discourage such pursuits.

With the arrival of President Bronwell, the research picture at WPI began to change. Expansion in enrollment resulted in hiring of additional faculty and attempts were made to secure new staff who had research interests. However, Institute policy did not provide time released from teaching duties for research. While this was at least partly justified by a desire to avoid the problems of the "Research Professorship", it meant that those of the faculty who did obtain research grants were forced to execute those obligations by working overtime as compared with their colleagues. During President Storke's tenure the administration continued to encourage research by the faculty, adding further impetus by the introduction of the "released time" concept and the hiring of a director to aid in co-ordinating the work. It is important, however, that in the opinion

of most faculty, current teaching loads, applied equally to all faculty, are too heavy to permit scholarly study and research. Nevertheless, both sponsored and unsponsored research have grown rapidly in the past decade.

In spite of the increased emphasis on research by the administration, the school in general does not seem to have used its salary and promotion prerogatives to encourage research. Indeed, consistent methods for evaluating faculty in any respect seem to be lacking - every faculty member seems to have the potential for becoming a full professor regardless of his commitment to the intellectual reputation of the college.

While the faculty of the main campus were arguing over the research call, the Alden Research Laboratory was continuing to build a strong international reputation in the field of practical hydraulics. Today the Laboratory enjoys a reputation wider than that of the school itself. Curiously enough, in spite of the purported research emphasis on the main campus of the Institute, the Alden Laboratory has not been able to expand into fields allied to its main thrust. Many students and faculty pass their entire career hardly aware of the Laboratory's existence. The reasons for this situation need careful examination, both in terms of the Laboratory's relationship to the educational mission of the school and in terms of the administration of the laboratory by the school.

The present state of research at the Institute is much better than that obtaining ten years ago. Table II shows figures on sponsored research for the fiscal year 1968 (4). A comparison with other schools (5), (data for 1967) is shown in Table III. While arguments against the premise in Table III are too obvious to include here, it is clear that WPI is far behind its competition in the area of sponsored research by its teaching faculty. Further, while it might be argued that scholarly study and unsponsored research would modify the picture considerably in favor of WPI, one cannot help but think that scholarly study and research would result in publication of some kind, and the recent publication record of WPI faculty is not outstanding.

Finally, the costs of the Institute's research efforts must be examined thoroughly. It is a popular misconception that the school can realize a profit from sponsored research activity. It is true that sponsored research can decrease the cost of research which is going to be done anyway and can raise the level of the research effort. If one recognizes that grants do not bear the entire cost of the research (cost-sharing), proper maintenance of the position of the Alden Research Laboratory requires salary support when contract funding is low, and a fair amount of unsponsored work

must be done before sponsorship is possible, the notion of making a profit
from research is quickly dispelled. Research is a necessary activity of
the school; it brings the best in staff and students to the campus; it
results in upgrading of facilities; it keeps the faculty alive to changes
in their fields. Research is the epitome of the educational process - learning.
It is not directly a profitable undertaking, but the added gloss on the
school's reputation attracts other support.

Table II

Sponsored Research at Worcester Polytechnic Institute (1968)

Area	No. of Sponsored Projects	No. of Faculty Involved	No. of Faculty in area	Expenditures on Sponsored Projects
Chemical Engineering	8	4	9	$135,258
Chemistry	5	5	12	30,450
Civil Eng.	5	3	11	82,536
Electrical Eng.	3	3	17	33,310
Mat'ls Eng.	1	1	3	453
Mechanical Eng.	6	3-4	23	67,294
Physics	2	2	20	50,123
Alden Res. Lab.	54			977,000
			Total	$1,376,424

Table III

Sponsored Research at Several Schools

School	No. of Engineering Faculty	Sponsored Research Expenditure($x10^{-3}$)	Sponsored Research Expenditure($/faculty)
Cal Inst. Tech	82	2,522	30,600
Carnegie-Mellon	139	1,942	14,000
Case-Western Res	92	3,616	39,300
Clarkson Coll. Tech.	53	223	4,200
Illinois Inst. Tech.	100	1,000	10,000
Lehigh U.	93	2,135	23,000
Mass. Inst. Tech.	386	12,960	33,500
Rensselaer Poly. Inst.	113	2,431	21,500
Rose Poly Inst.	32	90	3,900
Stevens Inst.	90	3,408	37,800
Worces. Poly. Inst.	103	319	3,100(Alden excluded) 8,700(Alden included)
U. of Conn.	76	540	7,100
U. of Mass.	90	465	5,170
U. of Rhode Island	64	298	4,650

I. WPI and the Greater Worcester Community

The status of WPI in the community is a study in paradoxes. This is somewhat understandable if we consider the wide diversity of attitudes in the area and the lack of an educational direction adopted by the College.

In the Worcester academic community, WPI occupies a high position. It must be remembered, however, that only Clark University represents a private non-sectarian college against which most people measure us. In this measurement, many of the academic community at our sister institutions would rate WPI second: there is a tendency for academicians to regard engineers as quasi-professionals; our faculty has not been noted for its research or publications; and the comparative cultural life on the two campuses substantiates the general impression of insularity at WPI and the absence of a true intellectual attitude. Our position was even less favorable prior to the construction of Gordon Library. Yet the College has become a leader in the establishment of the Worcester Consortium for Higher Education, and it is clear that it will occupy an important place in any significant educational development originating with this group.

Among the business and industrial elements of the community, WPI is a source of both pride and annoyance. Local industry has looked to the College for its technical and middle-management personnel and for aid in solving production problems by using our faculty as part-time consultants. For example, the decision of the Sprague Electric Company to build a new plant here was made because of the presence of the Institute in Worcester. For a variety of reasons, neither the average Tech student nor the faculty have been spenders in Worcester, so that downtown merchants have not regarded the College as worthy of much support.

The general public is either in awe of WPI or else indifferent to it. WPI is considered a difficult college, offering a sensible program, and not attractive to the hippie generation. It represents an opportunity for improvement in the economic and social status of the children of a large share of the community. Yet, where education is not of paramount concern, local people generally ignore the College. The extent to which this attitude is common to area residents is easily measured by listening to any local radio newscast or by day-to-day perusal of the local newspaper.

In recent years, there has been mounting criticism of WPI's lack of community concern and involvement. Most of the faculty do not live in Worcester, and the varied and important contributions they make in the area towns are often overlooked. The public has generally considered its problems entirely in terms of their socio-economic aspects and has failed to recognize

the value of the engineering approach to their possible solution. Consequently, civic leaders have usually turned for help to those colleges having strong sociology, economics and psychology departments and have ignored the valuable potential support here. For too many in Worcester, WPI's two towers appear to be made of ivory--the College seems to have been content to stand on Boynton Hill in solitary isolation. Yet WPI has been a leader in working with the local school department in improving science offerings in the public schools and in helping to establish a meaningful program for the culturally disadvantaged in Worcester.

Finally, WPI has long been regarded with affection by a number of the older prominent Worcester families whose progenitors helped in its establishment. For a few of them there has been an opportunity for devoted service on the Board of Trustees. For all, WPI has been a non-profit organization to which contributions could be made with the assurance that the contribution would not be spent on foolish or experimental projects. Unfortunately, as the community has grown, there has not been a comparable growth in interest on the part of the necessarily larger group of civic, financial and industrial leaders. Many of these have commitments to their own colleges, but they could still be of considerable assistance to us. Some, for example, have expressed regret that WPI has not established an advisory group of prominent local and national individuals, as Clark University has done, to help chart the course of the college. If they were to become involved, the interest engendered might well lead to increased financial support.

J. WPI and the Academic World

The relationship of the Worcester Polytechnic Institute to the academic world is difficult to characterize. The Institute is largely an unknown quantity. In part this is due to the fact that our graduates have not been adept at garnering the tangible symbols of academic or intellectual success (6).

Reaction of the students at the prestige schools to the students at WPI is usually negative. The Worcester Tech student comes from a relatively narrow socio-economic background while the student at the prestige school generally comes from a family of somewhat higher economic and educational attainment. Because of the strong correlation between academic achievement and socio-economic background of the student (7,8), it is not surprising that intellectually the WPI graduate does not match well with graduates of the prestige schools.

Reaction of "educators" may be somewhat different. For example, the Gourman Report (9) is an attempt to rate schools independently by standards deemed valid by educators. Gourman assigns grades (A, B, C, D) to each of several categories and attempts to convert the averages of these to a figure comparable with SAT scores. Two ratings are given for each school, one for administration and one for academic departments. The _academic_ ratings of 34 schools are shown in Table IV. In our judgment, assignment of a tolerance of $\pm$ 25 points to the figures is not unreasonable. In any case, it is clear that WPI fares pretty well. (Gourman's rating of our administration is less complimentary.) It should be noted that for WPI, only the engineering and science departments were rated. For M.I.T. and R.P.I. other departments were included, which lowered their rating considerably.

Table IV

Institution	Gourman Academic Rating	Institution	Gourman Academic Rating
Harvard University	787	U.S. Naval Academy	568
Dartmouth	731	Poly. Inst.Brooklyn	557
Cal. Inst. Tech.	709	Newark Coll of Eng.	520
Mass. Inst. Tech.	664	Illinois Inst. Tech.	507
Oberlin	650	Lehigh U.	500
Carnegie-Mellon	636	Pratt Institute	500
Haverford	611	Trinity	484
Wesleyan	609	Middlebury	482
Swarthmore	608	Harvey Mudd	473
U. of Rochester	606	Clarkson Col. Tech.	467
Amherst	600	Texas Tech.	460
U.S. Military Academy	600	University of Mass.	458
Worcester Polytechnic Inst.	600	Lowell Tech. Inst.	422
Case-Western Res.	600	Drexel Inst. Tech.	412
Stevens Inst.	578	Rochester Inst. Tech.	400
Tufts	578	Virginia Poly. Inst.	400
Rensselaer Pol. Inst.	570	Northeastern U.	393

Other academic people tend to rate schools by the performance of the faculty either in creating new knowledge or in developing new instructional techniques. Here WPI fares rather badly, being generally regarded as a glorified trade school. One academician recently called our faculty "undistinguished", and others have said "WPI strikes us as not being a very

lively place academically." This kind of reaction has a very damaging effect, for graduate students choose schools with the help of their professors. In consequence, WPI does not get the best graduate students, and since good graduate work goes with good staff, WPI is unable to attract the best faculty. Even our own faculty recognize our low appraisal by the academic community, for in briefing sessions with the various departments we have heard a plea for "changing the name of the school." The claim is that because of our name we are considered a trade school. Faculty and student achievement in academic areas could obviate the need for a change of name.

K. WPI and Industry

Industry is obviously a major element of our society. The relationship between an engineering school and industry is fairly direct. The school looks to industry to a considerable extent for its change and need patterns which must feed back into curriculum and teaching improvements. Industry looks primarily to schools like WPI for its engineers and managers. Most technical (and some other) schools look to industry to defray a part of the deficit between tuition and costs -- a deficit which is advantageous to the users of technical manpower.

There is also cooperative effort between schools and industry 1) in industrial problem-solving through consulting or sponsored research, 2) in academic problem-solving through industrial support, 3) via membership on Boards of Trustees, 4) in sponsoring of chairs, lectures and off-campus semesters. Large companies tend to involve themselves in all or many of these activities. Smaller companies are necessarily limited to activities which can be entered into with modest financial outlay.

In our College's primary service area, New England and especially central Massachusetts, the tradition of the small firm is well established. Those which have become parts of larger combinations tend to operate still in their local communities much as small firms do. There are of course a number of relatively larger firms. Tech alumni or faculty have been instrumental in founding or expanding some of both types.

The College has recently established an "Associates Program" with industries to further mutually beneficial relationships. There are at present 23 industrial members of this grouping who make specified financial contributions to the school annually and who will (in addition to participating in direct support) have privileged access to consultants and facilities. It is the intention of the College to expand this program to include many more companies and to broaden the areas of cooperation.

While WPI will always want the financial support of industry,

other relationships will in the future depend on the goal of the college.
For example, were the school to emphasize a four-year technological degree,
then work-study programs with industry would be indicated. On the other
hand, were the college to promote theoretical, pre-graduate studies, our
relationship with industry would focus on cooperative research.

L.   WPI and Society at Large

Neither WPI curricula nor campus life seem adequate for informing
students about modern problems or how the students must soon be participating
in solving them. Perhaps we are lulled to some extent by the type of
students we have -- students who have often not thought deeply or felt
deeply about the lesions in society, students whose parents may have passed
on to them a feeling that everything is going to come out about as it always
has if they simply work hard and patiently at yesterday's daily tasks.

Problems of social interrelation and change affect all levels --
world, nation, region, municipality. New England itself, which is the
source of most of our students and the place where our influence will be most
felt, has already undergone successful revolution in some areas (for instance,
replacing textiles with electronics). It seems woefully behind in others
and will presumably be involved heavily in change of all kinds from now on.
Worcester is in a similar situation, the old mixing with the new, the changed
with the need for change.

Throughout the world change is assuming an ever more cramping
and frenetic pace. In the process we are losing a surprising amount of
individual freedom of action. There arise two diametrically opposed reactions:
first, the intense apathy of the majority coupled with the extremisms of
the zealous minority; second, an effort to comprehend and control everything
by all-encompassing thought and planning.

Those reacting in the first manner abandon old standards without
thought of what will take their place; there is a tendency to strike out
in all directions -- C.P. Snow's "sleep of reason." Those reacting in the
second manner respond to these new challenges with "systems" thinking,
involving all facets of society's problems, including the social and psychologi-
cal. This response appears in various guises, from Whiz Kids in the Pentagon
to curricula in operations research and courses in systems theory, from
faculty planning groups to efforts to computerize decision making.

In these times, WPI is, in the opinion of many, being forced to
change in order to survive. But it would also seem that the College may
have an unusual opportunity deliberately to change itself and then contribute

leadership to the needed and inevitable changes in the region and beyond.
It may even be that WPI can contribute significantly to the changes in
technologically-oriented education.

M. The Public Image of WPI

Many people on the campus believe that WPI's public image, both
within and without Worcester, is very much oriented to the past. A recent
advertisement in a national magazine emphasized John Boynton's horse-and-
buggy and WPI's trade-school tradition. A revolutionary aeronautical
discovery recently announced on the front page of the Sunday edition of
The New York Times failed to identify the inventor with WPI -- his alma
mater. In Boston, Providence, Hartford or Springfield, even WPI's past
history is often not known, and one must usually respond to a "Worcester---
what?"

The public image of the College is still not helped as much as
it could be by the College Catalog, which is almost as difficult to read
as is the Massachusetts State Income Tax form. WPI facts gives an even
less encouraging picture of the College, since it suggests that all outstanding
alumni graduated before 1910, that the faculty is undistinguished, that
military training, fraternities and sports are of much greater concern here
than academic and research pursuits.

The public image cannot be the praise or blame of any one office
of the Institute. There have been failures at many levels of Institute life
which mar the many fine courtesies of this school. The good publicity which
the new curriculum had received in secondary school circles was almost
obliterated in one hour when high school guidance counselors were invited to
a briefing on the new curriculum, only to discover that the freshman advisors
had not been given an opportunity to iron out some of its confusing aspects.

Fortunately the school's image is bright and clear in some
areas. Many visitors comment on the well-kept campus and on the friendliness
of the buildings and grounds staff. One recruiter who employes a number
of our seniors has just reported to the College that no placement office
he visits knows as much about the personal attributes of its students as
does our own. Many detailed matters, such as the reporting of student
accomplishments to home-town newspapers, are handled well by the Public
Relations Office. There are, from time to time, interesting feature articles
in the Worcester papers about the school and its past, but there is much of
value about WPI still to be projected beyond Worcester County. Here our
alumni, our students, our faculty and our athletic teams are our assets.

N.   The Financial Status of WPI

The Worcester Polytechnic Institute, along with the rest of
the private sector in higher education, is faced with a serious financial
problem, the solution to which depends on the future fiscal policies of the
federal government. The concept that income from endowment can be used to
operate a school is fast disappearing. Thirty years ago, for example, it was
possible for a school to adopt the policy that income from tuition could be
expected to pay salaries, and income from endowment could be expected to
maintain the physical plant. The effects of inflation and the growth of
public education have since forced a change.

In an effort to get some picture of WPI's relative financial
position, the data of Table IV (10, 11) have been assembled. The figures are
subject to some uncertainty because of varying accounting methods and fiscal
year variations, but they form an interesting set.

From the data in Table IV it appears that Rose, Drexel, M.I.T.,
Lehigh, and Clarkson and, probably, Case-Western Reserve, among the technical
schools, have abandoned the concept of having endowment make a significant
contribution to the operating costs of the school. W.P.I., R.P.I., Stevens,
and Cal. Tech. among the technical schools, and Dartmouth and, probably,
Amherst are using endowment income to a significant extent.

We note that endowment per student at WPI has dropped since
1955, meaning that the Institute can afford less and less to rely on income
from endowment for support. Stevens Institute and Cal. Tech., on the other
hand, have markedly bettered their endowment positions since 1950.

The last column in Table IV, income per student in 1968 as measured
in thousands of 1958 dollars, shows that WPI, RPI, and Case-Western Reserve
have similar positions. Carnegie-Mellon is not far behind, but it is behind.
Stevens Institute and Dartmouth fall into a second group with M.I.T. and
Cal. Tech. leading by a considerable margin.

From these data it appears that WPI's current financial position
is not less sound than that of its immediate competitors. It is nonetheless
apparent that at this point the Institute must make some decision with respect
to its financial future. Further increases in enrollment without correspond-
ing increases in (1) endowment, (2) student:staff ratio, or (3) outside
income could put the school in a bad position. The first option seems to
depend on substantial alumni contributions. The second possibility involves
a basic change in our philosophy of education and would require larger class-
rooms and/or more contact hours per staff member. The third alternative

depends on having a unique objective with a strong appeal either to the government, the foundations, or the more progressive industrial giants who have the necessary funds to distribute.

Table IV

Institution	Market Value of Endowment per student (thousands of 1958 dollars)					Total 1968 Income (as percent of endowment)	1968 Income per Student (thousands of 1958 dollars)
	1950	1955	1960	1964	1968		
Worc. Poly. Inst. (11)	8.02	16.1	13.62	--	12.1	30.7	3.73
Clarkson Col. Tech. (11)	2.13	2.97	2.83	--	1.92	----	----
Rensselaer P. Inst. (10)	7.06	--	--	9.9	13.7	28.3	3.89
Rose Poly. Inst. (10)	7.98	--	--	5.5	3.98	39.2	1.56
Stevens Inst. (11)		1.28	5.15	13.6	14.8 19.	44.1	8.38
Lehigh U. (10)	9.57	--	--	6.24	6.1	42.9	2.62
Drexel Inst. (10)	6.59	--	--	1.7	1.31	102.3	1.34
Carengie-Mellon (10)	8.85	--	--	13.5	12.6	24.9	3.03
Case-Western Res. (10)	4.56	--	--	9.08	8.2	49.	4.02
Cal. Inst. Tech. (10)	24.	--	--	48.9	52.5	29.	15.25
M.I.T. (10)	22.5	--	--	11.4	23.5	85.6	20.1
Amherst Coll. (11)	16.9	34.1	45.7	--	49.8	----	----
Dartmouth Coll. (10)	9.57	--	--	23.4	27.7	23.6	6.54

O. The Two-Tower Tradition

In 1871 Stephen Salisbury II said, referring to our college, "The Institute has a claim to public favor, and indulgent consideration because it is the first attempt in our country to combine theoretic knowledge and practical training." For a century this concept has persisted on the campus, and in the minds of those who think of or come in contact with the school. For instance, in a recent survey some employers still felt this combination to be a major element in their Tech employees' success.

The concept has undergone major evolution from its original "instruction in the use of tools and machinery" of founder Washburn. Once prevalent 'shop courses' (except for minor vestiges in Mechanical Engineering) have been dropped. Engineering drawing slipped recently from its traditional two-semester required status, first to a single required semester, then to an elective. Surveying is no longer compulsory for Civil Engineering students.

What does this "Two-Tower" tradition mean today -- in a world drastically different in many ways from Washburn's and Salisbury's? In the minds of some, extensive engineering laboratory work is now the "practical" part of a Tech education. But a large part of the student body and some of the faculty profess to see nothing or little relevant in this work, describing it as mostly "cookbook", repetitive, of no interest to what they see them- selves doing after graduation. In the minds of others -- possibly including the employers mentioned above -- today's Two-Towers is stress on practical application and 'common sense' attitudes and approaches -- a stress they feel is more effective here than in other engineering schools and engineering divisions of universities. But such an idea is at least nebulous.

Higher education in the 1870's primarily concerned itself with such disciplines as Hebrew, Greek, Latin, Ancient History, formal Religion, and formal science (then natural philosophy). Modern languages, applied science and applied mathematics were only beginning to appear. So Tech's original double concept was seen then as remedying a common fault -- the irrelevance of collegiate education to most everyday professional pursuits -- particularly for the growing technical and mechanical fields.

Could this same problem be the unifying theme between the 1870's and 1970's? Is the Two-Tower concept still that of making "theoretic knowledge" relevant to the student by "practical training" in its application to today's problems?

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III.   SOME POSSIBLE OBJECTIVES FOR WPI

Part A: <u>Summaries</u> <u>of</u> <u>Possible</u> <u>Objectives</u>

OBJECTIVE 1:   <u>To Provide High Quality Pre-Graduate Education in Engineering and</u>
<u>Science</u>.

<u>SUMMARY</u>   (Discussion in next section)

Advances in the engineering and scientific disciplines in the last
quarter century and the concommitant revolution in undergraduate college educa-
tion have created a situation in which completion of a bachelor's degree program
is no longer sufficient formal education for professional engineers and sci-
entists. Few of the country's educational institutions have revised their under-
graduate programs to provide superior preparation for the better graduate schools.
Therefore, the adoption of the above objective would appear to be a logical ex-
tension of WPI's traditional emphasis on undergraduate education into an area
still relatively noncompetitive. The program should assist the College in
attracting a highly-qualified faculty and in increasing the sources of student
applicants, thereby enhancing our reputation and improving the probability of
being able to remain a private college.

Part I discusses the premises upon which the desirability of adopting
the objective is based. Part II reviews the implications of the adoption of
this objective for the College.

OBJECTIVE 2: To Educate for Leadership and Decision-Making in a Technological Society.

SUMMARY   (Discussion in next section)

A changing American culture is dramatically affecting the function of the engineer. Engineers are more and more needed as decision-makers at many levels of society in the consideration of technical-social problems. The implications of this change have not been realized by the great majority of engineering colleges. This section discusses the possibilities for WPI to gain national stature by educating engineers to assume positions of leadership and decision-making in our technological society.

OBJECTIVE 3:   To Provide a Classical Education in Engineering and Science in the Oxford-Cambridge Manner.

SUMMARY

The objectives of this program would be: (1) to provide a means to enable the student to educate himself; (2) to emphasize the whole man — intellect, physical well-being, sense of purpose, constructive role in society; (3) to permit the student to grow at a rate determined by his background and capability rather than his skill at adapting to a predetermined pattern; and (4) to insure that students and faculty are working toward the same objective. The student must know at the outset that learning is his responsibility.

A vital feature of this program would be the minimal number of formal classes. The student would not be required to master a specific skill at a specified point in his academic career. He would acquire skills as he finds them necessary for his understanding. His objective would be to pass two qualifying examinations drawn up outside the Institute. These would be in (1) mathematics, natural sciences, and humanities, and (2) the student's major field. Students would be attached to a department for examination purposes only.

This program is sufficiently different that it could attract money from the foundations, and, because it is also adaptable to education of the under-privileged, some Federal funds might be available. The program would require a major change in our Library funding, for the Library would become a real learning center. Staff:student ratio might be decreased slightly, and requirements for new equipment would be minimal. The transition to this program from our present program would have to be planned with great care.

OBJECTIVE 4: To Become a Research-Oriented Graduate Center in Engineering
and Science

SUMMARY   (Discussion in next section)

The transformation of WPI into a research-oriented graduate center
would place us in a highly competitive position for attracting the most
desirable young faculty. Research results of a dramatic nature would
materially enhance the nation-wide reputation of the Institute; the change
in image could be a potent attraction for first-class undergraduate students,
as well as for the better graduate students. Those staff members involved
in teaching undergraduate students might be expected to be conversant with
the latest trends in their fields; furthermore, the research equipment available
on campus would provide undergraduate students with a glimpse of the "state
of the art."

This program could be expected to increase the importance of the
undergraduate departmental major at the expense of the interdisciplinary
and humanities-technology major. It would also lead to the utilization of
many more graduate teaching assistants in the undergraduate program. The
research-teaching balance among faculty would vary widely throughout the
Institute.

A decision to embark on this program must hinge decisively on our ex-
pectations of being able to attract sufficient outside funding and sufficient
numbers of quality graduate students.

OBJECTIVE 5:   To Become a Middle College

SUMMARY

The marked nationwide increase in the number and quality of publicly-supported two-year colleges is extending the concept of public education through the sophomore year of college. Concurrently, there has been a rapid rise in graduate school enrollments, reflecting increased emphasis on the need for graduate degrees, particularly in science and engineering.

The transformation of WPI into a middle college appears to be an attractive objective in the light of these changes. The primary academic program, encompassing the course work of both the upperclass years and the master's degree, would have implications of considerable importance to the College. First, the elimination of most basic courses would permit far greater specialization by the faculty, and this should be of material benefit in attracting and maintaining a distinguished staff. Second, there would be a substantial infusion of graduate students at the master's level. As a result, the College should be able to strengthen its Ph.D. program measurably and at a cost far less than a comparable improvement under our present program would entail. Finally, the graduate assistants, now all at a post-master's degree-level, would provide a ready source of instructors for the necessary interface courses, designed to provide careful articulation between the varied preparation of the entering student and the demands of our own curricula.

OBJECTIVE 6: <u>To Train Students for a Bachelor of Science Degree in Technology</u>.

SUMMARY   (Discussion in next section)

Many colleges of engineering have turned since the 1940's from the training of technologists to an educational pattern more closely allied with the parent sciences of mathematics, chemistry, and physics. There is substantial indication of a more and more serious shortage of qualified technologists. The need for this type of graduate is not now being filled. The two-year schools of technology offer rather superficial technological training, and in many cases they tend to ape the four-year more scientifically oriented engineering and science colleges.

There is much evidence that in the forties WPI did a superb job of training this type of engineer. Since that time a polarization of views has taken place: one group advocating this type of training and another pressing for a more scientific orientation. It would appear that if the decision is made to train technologists, then the Institute has some very major assets.

OBJECTIVE 7: To Specialize in Educating the Underprivileged

SUMMARY

A disproportionate number of engineering students have traditionally
been drawn from the lower socio-economic classes. The ethnic and racial
composition of this class has been undergoing marked change in recent times.
The "new" lower class has suffered many social and educational disadvantages
not experienced by its predecessors; the entrance of its members into
colleges and universities, therefore, entails unique problems and solutions.

An undergraduate education in engineering and science might well
have great appeal to the present-day underprivileged because (1) it offers
the possibility of personal advancement; (2) it provides skills which
could be used to create employment for other disadvantaged persons; (3)
it is not founded on ethnically-controversial assumptions; as are many
social sciences. The desirability and necessity of educating the dis-
advantaged has received wide recognition throughout the country; a program
specifically designed for this purpose might be capable of attracting con-
siderable amounts of Federal and foundation funds. They would be very
necessary, as the program promises to be expensive (full tuition and living
expense scholarships).

Unusual curricular flexibility would be required to accommodate the
disadvantaged students with their motley backgrounds. Consideration would
have to be given to a pre-college program and to expanded summer programs.

The question of maintenance of entrance standards must be carefully
explored. We might also anticipate pressure on the humanities and social
science departments to design courses more relevant to the background of
our student body.

OBJECTIVE 8: To Promote Invention and Entrepreneurship

SUMMARY

WPI's truly outstanding graduates have been inventors; they have
been ingenious developers of new hardware which could be patented. Many of
the present applicants to the College still say they "like to work with their
hands and make things." They wish to come to Tech because of our tradition
of practical engineering -- a tradition going back to the days of the Wash-
burn shops and to the more recent period when students were not over-encumbered
with theoretical courses and could spend more of their time in the shops and
labs experimenting with all kinds of devices and gadgets. At present we
stultify much potential ingenuity in our undergraduates by not giving them
enough time to experiment on their own in developing new machines or processes
which if perfected might one day greatly benefit American industry.

If the College were to center its entire undergraduate and graduate
program on an interdisciplinary-invention-laboratory-shop, WPI could once
again stimulate the latent ingenuity and creativity of many young students who
are now imprisoned in theoretical studies which do not appeal to their best
talents.

It would no longer be feasible in the school shops to develop
products, machinery or processes peculiar to the passing mechanical age, but
it would make great sense to emphasize here a spirit of practical experiment
in developing the machines and products of the future, utilizing and expanding
our present talents, resources and testing facilities.

Would it not be feasible to select some general field, such as
robotics or hydraulic or fluidic devices, in which WPI could yet become the
national or even international research center?

If invention were to be the chief aim of the college, all in-
struction would need to center on the shops and labs. Concentration in an

area such as robotics would particularly require interdisciplinary cooperation in such areas as computer science, electronics, materials, mechanics, business management, linguistics and sociology. The Alden Reserach labs would, of course, have to become more directly an arm of undergraduate and graduate training than they are now. Resources, both in faculty and equipment, would have to be geared to an emphasis on independent work if such a program in innovative engineering and technology were to flourish.

OBJECTIVE 9:   To Transform Ourselves into a General University

SUMMARY

This objective is based on several implied assumptions:

(1) New England needs a privately endowed university to satisfy the
needs of its population.

(2) There would be added flexibility in the programs offered which
would permit engineering and science majors to shift to a liberal
arts program (et contra) without changing schools. This would
tend to attract more and better-qualified students.

(3) The greater potential for graduate study would attract better-
qualified faculty.

A thorough study of the needs of the New England industrial complex
would be used to determine the nature of the programs offered and thus garner
support. Such an objective would require a close alliance with Clark University
in order to establish a competitive position with the public universities of
the area. Establishing that competitive position would require either a unique
educational program or a staff of excellent reputation which would be expensive.
Funds for the union of WPI and Clark might be realized from combination of the
several duplicated programs in physical education and basic sciences, combination
of extra-curricular programs, decreased teaching loads consequent to larger
classes, and a broader range of degree programs by combining staffs of the lesser
departments in both schools.

The proposed alliance has many difficulties apart from the awkward
geographical situation, and it is clear that attainment of excellence in any
particular area will not result from combining two poorly qualified groups.
Thus, this objective would require the re-structuring of two schools, not one,
and there would have to be a detailed study of the logistics of the operation
before it could be fully implemented.

OBJECTIVE 10: To Join the State University

SUMMARY

Public education has grown dramatically in the past two decades. Only
the Northeast, because of its tradition of private education, has not yet felt
the full effects of expansion of public higher education. If the pattern here
follows that in other states with strong public systems, three major conse-
quences should follow:

1) Free public education through the junior college level will be available;

2) .In the state supported four-year colleges, the graduate program will probably
shift to the Amherst campus;

3) Many private colleges will become part of the state system.

If the Institute wishes to remain an undergraduate engineering in-
stitution, it would be well to consider seriously becoming part of the state
system while its financial base and its bargaining power are still strong.
Joining the state university would have relatively little effect on the
educational mission of the Institute. It would remain a predominantly under-
graduate institution, while experiencing a sizeable increase in enrollment.

OBJECTIVE 11: To Maintain the Status Quo

NO SUMMARY IS ATTEMPTED HERE.

OBJECTIVE 12: An Appropriate Combination of the Above

NO SUMMARY IS ATTEMPTED HERE.

III. SOME POSSIBLE OBJECTIVES FOR WPI

Part B: <u>Discussions of Four of the Possible Objectives</u>

<u>OBJECTIVE 1</u>: <u>To Provide High Quality Pre-Graduate Education in Engineering and
Science</u>.

PART I

PREMISE I. A BACHELOR'S DEGREE IS NO LONGER SUFFICIENT FORMAL EDUCATION FOR
EITHER THE PROFESSIONAL ENGINEER OR SCIENTIST.

To substantiate this premise, it is necessary to review the revolution
in undergraduate education in the last thirty years. Prior to 1940, only a
relatively small portion of the country's youth attended college. A college
education was regarded as a privilege by most Americans. For the wealthy, it
was a privilege accorded to the well-to-do, and their children went to college
either out of a genuine interest in things academic or because college represented
the most genteel form of unemployment. For the remainder, college degrees were
opportunities to improve both their economic and social status. It was still
possible to be successful in the business community without a college degree (1),
so that most of those who attended college planned to enter a profession. In
summary, those who attained a bachelor's degree were in a distinct minority, and
of these, only a small percent represented degrees in either engineering or
science (2). A B.S. in either field was a valuable commodity.

The passage of the G.I. Bill at the conclusion of the Second World War
served as a catalyst in the transformation of the American attitude toward a
college education. Today, America regards this education as the right of every
one of its youth (providing they are white), and we have yet to see a signif-
icant diminution in the expansion rate of higher education across the country.
The release of hundreds of thousands of soldiers at the end of the war, each of
whom was given the opportunity for further education with subsidy, ended the
privilege concept.

To accommodate the vast horde of students descending upon nearly every
campus, the academic community was forced to expand its facilities, both physical
and human, and thus began a chain reaction which is still in effect. To main-
tain their enlarged facilities, colleges and universities actively sought a
greater share of the high school graduate market to replace the waning supply of
veterans. And as these students entered the employment pool following graduation,
it became increasingly important for the individual seeking a position to list
a bachelor's degree among his qualifications. This need, in turn, increased the
number of admissions applicants at every college.

At the same time that the student explosion was occuring, America was in the midst of another revolution involving both science and engineering. The incredible increase in scientific discovery and technological innovations and improvements was spurred on by the American-Soviet rivalry and by the demands of an affluent society desiring more of the trappings of the "good life." Subjects heretofore the exclusive province of the specialist became part of the bulk of essential knowledge for those entering careers in engineering, the sciences and mathematics. It is worthy of note that few positions have been available for scientists and mathematicians without advanced degrees for some years.

We are thus led to the conclusion that in the areas in which WPI students have specialized, the old currency of a bachelor's degree has been devalued. It is a matter of regret that the proliferation of graduate programs in almost all universities and larger colleges, many of which are of inferior quality, will tend to cheapen graduate degrees, unless they are obtained from our more highly regarded graduate centers. (3).

PREMISE II. VERY FEW INSTITUTIONS IN THIS COUNTRY PROVIDE QUALITY UNDERGRADUATE PROGRAMS IN THE AREAS OF ENGINEERING AND SCIENCE WHICH WOULD PERMIT THE MAJORITY OF THEIR STUDENTS TO ATTEND SUPERIOR GRADUATE SCHOOLS.

To begin with, quality education in the areas of engineering and science is costly. Extensive, sophisticated laboratory equipment, a computation facility of some magnitude, and a competent faculty in highly-paid disciplines combine to raise the cost of maintaining worthwhile programs far above the level of comparable programs in the liberal arts.

In the second place, the student explosion has not been without its detrimental effects on the quality of undergraduate education. It has always been difficult to attract good faculty to the campus, particularly in the areas under consideration. To meet the demands of a burgeoning student enrollment, colleges were forced to sweeten the fringe benefits for those they particularly desired and to employ less qualified personnel to supplement their staffs. The most successful of the fringe benefits, at least in terms of attractiveness to prospective faculty, were two: the opportunity to teach in a graduate program, and the opportunity to do research. Both of these are highly desirable in any well-run academic program, but too often, they have been abused. The better teacher has had little to do with the undergraduate student in far too many instances. In particular, the basic courses, most crucial in providing a proper

foundation for further study, are usually left to the inexperienced and fre-
quently indifferent graduate assistant for supervision. Moreover, increased
student enrollment has virtually eliminated the close personal contact between
teacher and pupil--not even the most devoted teacher can give his students the
personal attention his counterpart did thirty years ago. Finally, college
faculties have bent their efforts to innovations in mass instruction, at the ex-
pense of more important innovations in syllabi of the courses themselves. On
many campuses, science and engineering courses cover material remarkably similar
in content to what their instructors had studied when they were students.

In the last place, not enough has been accomplished in breaking down
the barriers between the various departments. As enrollment has increased and
faculties have followed, it has been common to house each department in its own
building, even on relatively small campuses. Isolation and the continual com-
petition for limited financial support have led to an increase in "empire
building." Thus, while the current advances in science and engineering reiterate
almost daily the interdependence of these branches of knowledge, those who direct
the education of potential engineers and scientists create barriers to keep rival
departments away from their charges. It is not uncommon to find essentially the
same course taught by several departments on the same campus! Apart from the
sheer inefficiency of such a situation is the far more serious loss of interplay
between future scholars in these disciplines.

At this stage, it is necessary to consider the cases of the science and
mathematics students apart from those majoring in engineering. For many years,
the chief sources of superior graduate students in the sciences and mathematics
have been the prestige universities and the small, quality liberal arts colleges
such as Amherst, Swarthmore, Oberlin, and Reed. These institutions will continue
to provide many qualified students in these fields. Yet, in general, they suffer
from an important deficiency: their students have little opportunity to study
applied courses in their majors. In the case of the small college, such courses
are not available; in the university, they are often out of bounds, as it were,
since they are offered in the school of engineering rather than the college of
arts and sciences. (Departmental rivalries, bad as they may be, are insignifi-
cant when compared with university divisional rivalries.)

The engineering student is a different matter altogether. There are
relatively few engineering colleges, as such, and the only other source of

supply has been the large state university. A few private universities, such as the University of Rochester, may have small engineering departments representing some area of specialty, but the number of engineering graduates is limited. In general, the engineering college has already made its choice: for some, the emphasis is solidly on the graduate program; for the remainder, including WPI, the emphasis has been on an attempt to provide professional training at the bachelor level. In the former instance, the colleges have been quite successful with their graduate and superior undergraduate students. However, they have often failed miserably in developing the capabilities of their more average students, most of whom would have the necessary intelligence and interest to become good engineers, if they could be assisted through the initial complexities of their subjects. In the case of colleges similar to WPI, the attempt to maintain a professional training program fails to recognize the changing attitudes in engineering education. It is impossible to cram all that is necessary into a four-year course of study. Too often, the graduate from such a program comes out a technician, not a professional, or else a confused and insecure engineer, more apt than not to desert his profession in favor of sales or management. Some graduates do go on to further study--the best, to good graduate schools, but by far the greater number, to their own college's graduate school or to a similar program in a similar college.

In summary, then, we can say that the opportunities for the prospective college student to attend a college providing a quality undergraduate program, one that will prepare him for entrance into a good graduate school, are extremely limited, if he wishes to study engineering or science.

PREMISE III. WPI MUST CHANGE ITS SOURCE OF SUPPLY FOR UNDERGRADUATE STUDENTS IF IT IS TO SURVIVE AS A PRIVATE INSTITUTION.

A perusal of the appendix section on the analysis of our present student applicants will indicate that WPI has catered to a very special type of student, the youth from a relatively low socio-economic background who has chosen engineering, and occasionally science, as a means of attaining some measure of financial security. It is significant that sons of successful alumni have generally gone elsewhere to college--in many instances to colleges reflecting the improved economic and social status of their fathers. As the student explosion continues unabated, it is highly questionable whether WPI will be able to attract sufficient numbers of students from among those whose parents have attended college, unless

WPI is willing to change its role in the academic community. The college could, of course, continue its present role and serve the black student, who will represent today's typical applicant tomorrow. But the merits of such a role are not germane to the objective under consideration and will be considered elsewhere in our report.

It would seem apparent, if the above analysis has any validity, that WPI must look to a new role sufficiently distinct from its present one to overcome its reputation as a "trade school" and sufficiently interesting to attract able students to its campus. If we now consider the myriad of statistical reports, both public and private, covering America's requirements for qualified engineers and scientists in the foreseeable future, it appears that one role worth careful consideration is that suggested by the title of this section of the report.

PREMISE IV. FINANCIAL SUPPORT GIVEN ANY COLLEGE IS DIRECTLY PROPORTIONAL TO THE REPUTATION ENJOYED BY THAT COLLEGE.

There would be few to argue the logic of this premise. Yet the manner in which a college creates and maintains its reputation is not easily analyzed. WPI's current reputation, based almost exclusively on its past performance in producing technically competent, practically oriented engineers, is that of a first-class trade school. This may be attractive to industrial recruiters, but such a reputation does not capture the interest of the investing public. No one would question WPI's need for financial support. If this support is to be forthcoming, however, we shall need an exciting program--one that will attract nationwide attention.

One way of enhancing our image is to develop a program that will attract a distinguished faculty and will produce students able to receive nationally recognized awards such as NSF, Fullbright, Woodrow Wilson fellowships. The above objective would be a step in this direction, for it would attract the type of intellectually capable student who could compete well in the annual fellowship competition, and a faculty qualified to direct such a program would have to be concerned with research in one form or another and would be far more inclined than our present faculty has seemed to be to publish the results of its investigations. And it is precisely these tangible bits of evidence-- fellowships and publications--that form the criteria on which most large bene- factors of education base their decisions of financial support.

Part II

We now turn our attention to the implications of adopting this objective. Nearly all phases of the campus life will be affected, and some changes will create important problems that must not be ignored. Yet, whether we are discussing this objective or others, the fact remains that if we are to survive, we must take some drastic action.

THE STUDENT APPLICANT. If our goal is to provide a quality pre-graduate education, then we must be more selective in our admissions procedures. The student who gains entrance to the good graduate school must be capable, not only in his field of specialty, but also in articulation, and he must be able to master sufficient skill in at least one foreign language to pass the required proficiency examinations for graduate study.

It is not necessary that the student enter with a career firmly in mind. What is necessary is that he have demonstrated a capacity to go beyond the ordinary work of the secondary school, either by enrollment in advanced placement courses or honors courses, or by participation in special projects. It will be imperative that we seek those students ranking in the top decile of their secondary school classes and that we broaden our area of supply to include the better secondary schools outside of New England.

This will cost money, for many of these students will require financial support. If the students are selected from schools outside our immediate area, then the support must offset the attractiveness of a less expensive education at a closer state institution. It is essential that this support be given, for we cannot hope to attract enough qualified students who can pay their own way. It will not be sufficient to admit a token group of superior students--they must represent a clear majority if we are to have a quality program. In this connection, it is important to remember that no group of students is more sensitive to the selectivity of a college's admissions procedure than those who are genuinely interested in obtaining the best possible education. Once our reputation is established, it will assist us in maintaining a steady flow of desirable candidates.

During the past year, the Admissions Office has placed increased emphasis on the promotion of the early decision plan. A questionnaire sent to the one hundred forty-nine successful early decision candidates in January 1969 indicates that already we are developing a nucleus of able students, well qualified for a program of the type under consideration. (See Appendix A).

Nevertheless, we cannot hope to find enough qualified students from the area from which our students are generally drawn. We must develop procedures that will permit our Admissions Office to cover a much larger group of secondary schools. We might, for example, employ resident admissions officers in such cities as Chicago and San Francisco, who would be responsible for schools in the northern Midwest and on the West Coast.

The above implies that we would be rejecting applicants heretofore admissible, and it is inevitable that there would be some unhappiness among local secondary school guidance counselors. Yet these people do respect quality and would respond properly if they were given to understand the cause of our changed attitude. With the advent of improved community college facilities throughout New England and the general expansion of the state university systems, it is also questionable whether the more marginal admissions candidate, who has represented a fair portion of our total enrollment, might continue to apply for admission. Indeed, this fact supports our basic contention that we must turn to other programs if we are going to be able to attract sufficient numbers of students to support our faculty and physical plant.

THE CURRICULUM: SCIENCE AND MATHEMATICS. We have already noted that as far as these fields are concerned, graduates have found the way to a scientific career closed unless they were willing to pursue graduate study. As a result, the undergraduate programs in all three departments concerned (chemistry, mathematics, and physics) have been designed to prepare the student for graduate study. In this, they have been reasonably successful. (4). It is also interesting to note that each of these departments has been involved in a revision of its under-graduate curricula, a revision designed to improve the overall major program. If we are now to emphasize preparation for graduate study, it is incumbent on each of the departments to expand the opportunities for students to engage in independent study, to become involved in small group projects or seminars, and to have greater freedom of choice in course selection at the advanced level.

THE CURRICULUM: ENGINEERING. Our engineering curricula have been based on
the premise that the majority of engineering students would seek employment
upon graduation. Clearly, the emphasis must change if the majority are to
enter graduate school. It will no longer be necessary that the student cover
as many different topics within a discipline as he presently does. It would
appear logical to provide a standard core of essential courses, beyond which
the student could either specialize or not, depending upon his interests and
possible uncertainties. In particular, there should be enough flexibility in
each student's program so that he could select courses from other departments,
either in those areas that might give him additional support for his eventual
graduate study, or in other areas that would broaden his general education.
Clearly, it is also obvious that, as in the case of science and mathematics,
much greater emphasis must be placed on small-group projects and independent
study.

THE CURRICULUM: HUMANITIES AND SOCIAL SCIENCES. If WPI is to provide a
quality undergraduate education, then that education must be provided in all
departments. Since the departments representing the humanities and social
sciences areas have never been given proper support by the College, it is im-
perative that the attitude toward them be drastically altered. The level of
performance in every course in these areas should be no less demanding than
the best of the science and engineering courses. The present attitude that
our students must be marked on a more lenient basis in these areas cannot be
justified; good students respect academic discipline, and where it is lacking,
performance and interest will be inferior. The student will regard the weak-
ness of this portion of his academic program as symptomatic of a general weak-
ness in his entire program.

     There seems to be agreement by those most concerned with engineering
and scientific education that the role of humanities and social sciences must
be broadened considerably. There is a need for all of our students to acquire
some sense of ethical and sociological values. This sense can be developed
best by exposure to the thoughts and writings of others and sharpened by dialogue
between students and faculty. There must be good courses in sociology, philosophy,
and psychology, for example, as well as increased offerings in the existing
humanities and social science departments. We must also provide the opportunity
for all students to acquire proficiency in at least one foreign language. If

we cannot justify particular classes in French and Russian because of in-
sufficient enrollment, then we should utilize the capabilities of some of our
sister institutions in the Worcester Consortium. It is essential, however, that
where language courses are taught on this campus, the level of instruction be
equivalent to a comparable course in the better liberal arts colleges.

GRADING. With the "trade school" attitude altogether too prevalent, we have
maintained a grading system which may have been easy to administer but which has
ignored two essentials of any good educational program. First, it is necessary
to consider the type of student whom we should attract: he should be the student
who has taken advantage of advanced placement or honors courses in the secondary
school. This means in most instances that the student has had considerable
freedom in determining his study habits and in selecting special projects which
have been of interest to him. For such a student, a grading system which places
emphasis on class attendance and on regurgitation of facts supplied by the teacher
and text book will not be palatable. Continual attendance in class does not by
itself suggest competence; the more intelligent student, able to think and read
for himself, might find his interests better served by occasional absence from
the classroom. Either the student gets his work done or he doesn't, and this
is the only consideration that should be made regarding the effect of absences
on a student's grades. Second, we have placed far too much emphasis on the
grades themselves, so that the average student has worked for a grade rather
than for the knowledge which he might gain by electing the course. Recent sur-
veys of college students have indicated that the better students feel "turned off"
by the general emphasis on grades and either leave college or produce desultory
performances as an expression of their dislike for the "system." California
Institute of Technology, Yale, and a number of small, good liberal arts colleges
have embarked on programs involving the extensive use of the pass-fail system.
Our hesitancy to embark on anything but a token program in this direction is
perhaps the best indication of our lack of confidence in the student body. The
more we seek well-qualified students, the greater this problem will become. We
should give considerable thought to some form of a pass-fail system which would
free the student from unnecessary emphasis on grades, particularly in those areas
that would broaden his education or supplement his particular field of interest.

THE FACULTY. There is no question that the objective under consideration has implications of considerable consequence to the faculty. First, a quality pre-graduate program requires superior teaching. The determination of exactly what constitutes superior teaching in this context must be clearly understood. The teacher must communicate his enthusiasm to the students and create an atmosphere of excitement about his subject that should make them desire to follow in his footsteps. He must lead his students toward greater self-reliance and independent study; this may mean that his lectures do not always give the answers to every problem. There is a need to acquaint students with some of the still un-answered problems which exist in each discipline; occasionally, the instructor should discuss his own research efforts, if only in a general way, so that the student might gain an insight into what constitutes research in that discipline and observe how a highly trained individual approaches the task of solving his own problems. All of this suggests that every instructor be actively involved in some form of research, and to do this, he must be current in his discipline. No staff member can teach, engage in research, and remain conversant with developments in his subject without a considerable reduction in his teaching load.

If we are to attract faculty of high caliber, it will be absolutely essential that our graduate program be vastly improved. The truly professional faculty member would wish the opportunity to be directly involved with his specialty at the graduate level. His relevance to the undergraduate program will be meaningless unless he also is willing to take part in the preparation of undergraduate students. Since each member of the faculty ought to be allowed the opportunity of some specialization, some care must be exercised to insure that the areas of special interest complement rather than duplicate each other. It is essential that in all departments a concerted effort be made to preserve the professional integrity of the staff. By this, we mean that we can no longer assume that a faculty member hired in any discipline should be expected to teach any course offered in that discipline.

A superior undergraduate education, regardless of its emphasis, can brook no compromise with faculty competence. We need faculty who can stir the imagination of their students, who are sensitive to the viewpoints of our youth, who are not afraid to demand a high level of performance at the risk of losing some (temporary) personal popularity, and who are willing to be identified in some measure at least with causes leading to the improvement of human society.

There is little room for the ivory-tower dweller--the better student, vitally con-
cerned with the moral and social problems of our society, needs to find models for
his own attitudes from among his teachers.

Finally, since the emphasis of this objective is on the undergraduate
program, our teaching staff must strive to improve the dialogue between the
disciplines, so that no matter what the student may select as his major, his
course program has a cohesiveness instead of the present fragmentation.

PHYSICAL PLANT. WPI is fortunate in the quality of much of its physical facilities;
the suggested objective, nevertheless, would require some alterations. Consonant
with the increased importance of small-group projects and independent study, there
would be a need for a number of small seminar rooms and/or laboratories in every
academic building. In addition, there should be an increase in the number of lecture
halls, accommodating student groups of various sizes, since some courses could be
taught more expeditiously by a combination of lectures and small discussion groups.
The incorporation of these ideas in the planning of the proposed humanities building
would be essential. Clearly, any new construction and all renovation should include
such outlets, conduits and wiring needed for maximum utilization of audio-visual
equipment.

It has been stated elsewhere in this report that much of the learning process
does not take place in the classroom; this is more apparent if the emphasis in our
educational program is placed on greater individual self-reliance. Fortunately,
the Library was designed to provide individual study facilities for some six hundred
students at any one time. Yet, there is much to be gained by providing an atmosphere
conducive to study, as well as to discussion, in the students' living quarters, and
here, WPI is not well-equipped. Our dormitories have been singularly unimaginative
in design and structurally inadequate to meet the demands of a proper living-study
relationship. Small rooms, filled to or beyond reasonable capacity, and a lack of
sufficient sound insulation virtually eliminate any hope for constructive study by
the residents. The large lounges in the dormitories do not lend themselves to
informal discussions by small groups of students, which, given students of some
intellectual ability and a proper educational direction by the faculty, form a vital
and useful part of learning. Renovation of the existing dormitories to provide
small lounges in each section of each floor and better soundproofing may prove
costly at this point, but certainly any new dormitory construction should incorporate
these features.

By the same token, the faculty needs a facility of its own, containing an interdepartmental commons room, to which the staff may go and be assured of no inter- ference; a dining room, where a more imaginative selection of food than the catering service in Morgan Hall has provided is available; and one or two small lounges for committee meetings, entertaining visiting scholars, and general small group discussions. The need for this facility becomes crucial, if we are to encourage increased inter- action between faculty representing different disciplines.

THE PLACEMENT OFFICE. Any change in the undergraduate program will directly affect the role of the Placement Office. While the goal of the College may be to educate its undergraduates for superior graduate schools, there will always be some who will wish to seek employment upon graduation, either for academic or financial reasons, and the Placement Office must be prepared to assist them. Of far greater significance, however, is the fact that an improved faculty and the concommitant improved and en- larged graduate program will mean that the Placement Office will be needed to place an increased number of M.S. candidates and perhaps a few more Ph.D.'s in positions in industry. This should be welcomed by the Office, for the trend toward the M.S. as the first professional degree is well-documented, and it will be increasingly difficult to place B.S. candidates in professional positions in the future.

THE GRADUATE PROGRAM. Mention has been made several times above in this section of the report regarding the need to improve the graduate program, primarily in order to attract and maintain a superior staff. The proposed objective, even though it stresses an undergraduate education, should prove beneficial to our graduate program. (See THE FACULTY above)

Implicit in any plan to improve the graduate program is the need to increase the number and quality of our graduate students. It must be remembered that large numbers of graduate students do not, per se, necessarily guarantee a worthwhile graduate program. It will be absolutely essential, therefore, that the College adopt policies controlling the size of each graduate department's enrollment, so that a proper balance between graduate and undergraduate efforts may be maintained. It will also be necessary for the College to revamp its admissions attitude towards its own alumni. Specifically, great care should be taken to eliminate, in so far as possible, the current practice of admitting our own graduates whose academic strengths are such that admission elsewhere is somewhat doubtful.

The addition of highly-qualified faculty will, of course, help to attract better students. It will probably be necessary, however, to increase graduate student

financial support until such time as the faculty is involved in sufficient sponsored research to support a good number of well-qualified graduate assistants. This raises an interesting question regarding the proper utilization of those assistants not actively involved in research projects. An effective way of employing them in a role that would support the undergraduate program is to have them direct small-group projects and seminars for upperclassmen. Here, the graduate assistant can be most effective, for he would bring to the project or seminar his own special interest and some measure of understanding of the current research efforts in that area.

There is another advantage accruing from a good graduate program, one that is particularly pertinent to a quality pre-graduate education. The better seniors in the student body should be given every opportunity of electing courses in their specialty at the beginning graduate level. (Wholesale admission of undergraduates to graduate courses would have the obvious effect of lowering the level of performance for the graduate students.)

FINANCIAL CONSIDERATIONS. The objective of providing a quality pre-graduate program will not be attained without the expenditure of a considerable amount of money; if the program is worthwhile, there is some evidence to suggest that financial support from outside the College resources can be obtained. The most significant increase in expense would represent the increase in the instructional portion of the budget. Specifically, the College must revise its attitude toward a normal teaching load, so that no faculty member would carry more than 9 hours of classroom contact in any semester and most would carry only six such hours, so that they might be engaged in some research activity. It is worth observing that if the current employment registers of the various professional societies are read, many of the better colleges and universities in the country already have teaching loads in this or even less demanding ranges. At first glance, it would appear that such a normal teaching load would require an enlargement of the teaching staff of significant proportions. Yet, and this has been a serious weakness of WPI, a substantial portion of the implied increase can be avoided by really creative thinking in terms of course presentations and the use of instructional aids, both human and mechanical. The recent publicity on student evaluations of courses at various educational institutions across the country have made this fact abundantly clear; some of the most popular courses in terms of their relevance to the students' programs and the amount of knowledge gained from them have been taught on a large lecture basis or some combination of lecture and recitation. Even small liberal arts colleges have realigned their

thinking in terms of small class size for every course and now use a wide variation in class sizes, depending upon the subject, the level of the course, and the educational soundness of such a method of presentation. Even with careful consideration given to creating optimum class sizes for the undergraduate courses-- where again we emphasize that optimum numbers will vary from course to course--it is obvious that there would be some increase in faculty salary requirements, resulting from an increase in the teaching staff and from the obvious fact that well- qualified teachers must be compensated properly. There should be no place in the quality program for the hack teacher, who is willing to spend hours in the classroom at relatively low compensation because he could probably do no better elsewhere.

Furthermore, as we have indicated above, the College must be prepared to supply substantially more scholarship aid to undergraduates, and increased aid to graduates--not so much in the form of additional assistantships, as in more competitively valued assistantships, so that we can compete for the better graduate students. In this respect, the College should be able to turn to the industrial and business communities for greater financial support, since the students we would graduate at both the undergraduate and graduate levels should be more valuable to them.

There is another area where WPI's financial support has been severely limited in the past and where much needs to be done if it is to have a quality program: this is in the area of lectures, colloquia, etc. The calendar of any educational institution with a fine reputation is crowded with such events. It is not necessary that these serve the entire college community, for in general such events, unless they are to be classed in the popular meaning of cultural, would be superficial of necessity. What is necessary is that they occur with enough frequency so that the student comes to realize that we are not an island in the academic sea but rather part of a highly complex, interrelated community, concerned with all types of questions and problems relating to science and engineering. By the same token, the faculty need the constant bombardment of ideas and interests brought to the campus by the lecturers and the opportunity to discuss their own ideas and interests with competent people from outside the campus. In short, the College must be prepared to underwrite an active program of this type.

The acquisition of endowment funds, gifts from foundations, and general contributions is becoming increasingly difficult and certainly more competitive.

We believe that a program of the type discussed in this section would have some appeal to those in a position to support the College. The substantial investor demands quality; more than that, he demands some uniqueness, for he would want his expenditure of funds to provide him with an investment that might not be available to everyone. One has only to look at the specific bequests or gifts made by individual philanthropists to be aware of how often the bequest or gift represents an attempt by the donor to offer something unique in the educational world. Few colleges of engineering have made much of an attempt to provide the type of education we suggest here, and it would seen that in this respect, we have the opportunity of assuming a position of uniqueness that might well prove attractive not only to the students and faculty involved but also to those in a position to give financial support to WPI.

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OBJECTIVE 2: <u>To Educate For Leadership and Decision-Making in a Technological Society</u>.

(Discussion)

<u>Engineering and Society</u>

At the beginning of this century when engineering colleges, both in-dependent and university-connected, began to flourish in the academic world, it was relatively easy to describe what engineering was. Engineers, drawing upon the specialized scientific disciplines, primarily physics and chemistry, developed and produced the technology required for the industrial growth of society. As a natural result, the curriculum development was narrow and con-centrated with a large percentage of structured laboratory experience. En-gineering schools from this vocational base were then, and remain to the present, relatively isolated from the liberal arts college. At the independent en-gineering college, as well as the university-connected engineering school, the arts and humanities provided a distinctly vocational service, e.g. report writing, ethics of engineering, industrial psychology. The Grinter (<u>1</u>) report of the fifties, and other reports, recognized a need for broader education of the engineer. However, into the sixties this contact of the engineering student with the humanities and social sciences has had the strong flavor of psychology for the engineer, literature for the engineer, etc.

On the university campus the engineering college is for the most part physically separate, and at some universities the engineering students have separate dormitory facilities. It is also well documented that because of a generally heavier class schedule than students in other disciplines, as well as the attitudes of the faculty, the engineering student has had little extra-curricular and cultural contact with other segments of the academic community. Because of the role played by engineers in society during the period from 1900 until the Second World War, this relative isolation seemed not to present serious problems in terms of fulfilling the goals of engineering education. The students and the profession were vocationally oriented, and society's needs were amply met by increasing numbers of such students.

However, since the 1940's three crucial changes in American culture have resulted in conditions not fully recognized or understood by the engineering

profession.

1) An expanding economy has given rise to a generation of young people, many of whom find vocational goals distinctly secondary to moral and ethical concerns. This trend is expected to continue (2).

2) The exponential rise of the production of knowledge in the natural sciences has forced the engineer to develop radical new technology at an ever accelerating rate.

3) The growth of scientific technology has become increasingly intertwined with the social problems of mankind. The boundaries between social and technical problems have been largely erased.

These three fundamental changes drastically affect the concept of engineering; they alter the very nature of the things engineers do; they demand a new type of engineering student. Today the engineer stands at the interface between the development of knowledge and the needs of society. In order to interpret these needs, he must draw upon more disciplines than in the past, biology, philosophy, political science, psychology, sociology, and anthropology; with this knowledge he must identify and solve important problems of the age. Ours is a technological society, and social decisions must be made in large measure on technological bases. That the engineering success of the automobile also brought detrimental effects to society (air pollution, transportation failure, urban blight) should make clear the needed change in the role of the engineer. Such a role is clearly quite different from that fostered by our current engineering curricula.

If one accepts the concept of today's engineer as "the mediator between knowledge and society," (3), then the role of the engineer should be an increasingly vital and exciting one in our culture. He should be the "competent generalist," the "problem solver," the "decision maker" within a broader spectrum of his environment than in the past. He must accept as part of his task the definition of the consequences of technological advances. That is, he must understand the ecology of man.

Within our society then, with its needs for broad understanding of technology, one would expect the engineering school to be burgeoning with staff and students. This is not the case. Instead, in the past decade engineering enrollments have on an absolute basis been relatively static, and as a percentage

of total academic enrollments they have steadily declined.

Why then do not engineering enrollments exhibit a healthy growth? Although many engineering graduates have been very innovative in adapting to a broader view of their function after graduation, on the whole the engineering profession has remained very conservative in its definition of the function of engineering. The engineering schools have been very slow to change. Some that have changed have in reality not moved toward modern engineering, but actually toward a much closer identification with the traditional disciplines of science, physics and chemistry. The potentially creative young people of our society have clearly recognized these academic trends. They are vitally interested in technology, but as it affects and relates to mankind. Therefore, those interested in science are entering the traditional scientific disciplines, and many of those that could be motivated toward the applications of scientific technology are not interested in the narrow vocational training of the traditional engineering college.

Engineering and WPI

Worcester Polytechnic Institute is a small, private, traditional engineering and science college. All of these adjectives are important. Because it is a traditional technical school of regional scope, it seems likely that in the future it will be difficult for WPI to attract the type of intellectually gifted students who might be interested in engineering as it is defined here. While value judgments are not being made with regard to student background, it is assumed in this section that to educate engineers as leaders and decision-makers, the intellectually gifted student in our society must be recognized and wooed. Thus, our traditional reputation in this context is a detriment.

That we are a small private college is a major asset, for this means that we have high potential for flexibility and significant change. In addition, there is little competition at present among engineering schools to provide a technical education of the type discussed herein. WPI has a high potential to assume national leadership in engineering education in the seventies. The Institute perhaps stands on the threshold of the most exciting period of its history if it chooses to educate engineers to the true function of the profession. In the next sections some of the possible commitments that must be made by the Institute in order to follow this educational direction are discussed.

The Necessary Environment and Atmosphere of the Institute

WPI should be cognizant of and adopt the following educational principles:

1) The purpose of education is intellectual development; therefore engineering education should not be considered as yielding a product but rather as directing and encouraging a continuing process;

2) Since students enter the Institute at different points in their intellectual development, flexibility in form and content is required to best promote individual education;

3) It must be clearly recognized and accepted that students learn from faculty and other students and that faculty learn from other faculty and students. This point is essential to this type of engineering education. It must be accepted that faculty and students are partners in learning and that the teacher does not act as an omnipotent figure. The Institute should be student-centered with students having the right to and encouragement for educational dialogue;

4) The student should be encouraged to accept the major responsibility for his own education. (For example, how does the collecting and grading of home work agree with this principle?);

5) The student should be encouraged to develop a habit of intellectual honesty so that habitual assumptions and ideas can be examined critically;

6) Since the engineer should be educated as a whole person, his participation in the cultural life of his society should be encouraged. WPI must provide some of these cultural experiences and living arrangements conducive to their appreciation;

7) The engineering student must be exposed to real technical-social problems throughout his academic career, and he should be required to reach specific conclusions regarding these problems. These real situations are normally complex and interdisciplinary, and pedagogy is determined to some extent by the nature of the problem. There are two key issues to be faced here. First, conclusions involving real situations must be reached. Gathering of data as an end in itself, and a pre-occupation with glittering generalities are inherent pitfalls that must be avoided. Second, the assumptions

necessary to model the system must be made by the student.   In traditional engineering education, the main emphasis is on analyzing a given model with little attention being given to the assumptions leading to the use of the model. Neither issue can be considered less important. The current controversy over whether to build anti-ballistic-missile systems is a case in point. Diametrically opposed conclusions have been reached by technical people. The technology for analysis is the same for each camp. However, the assumptions employed in modeling the complex technical-social system have been different; producing contradictory conclusions.

The Structure of the Institute in the Implementation of this Educational Goal.

Serious consideration must be given to changes in current structure and procedures at WPI.

1) The Institute might consist of two basic divisions, each with its own Dean: the Division of Engineering and the Division of Arts and Sciences.

2) The first professional engineering degree might be the Master of Science (4).

3) The Ph.D. degree might not be offered in the Division of Engineering. Faculty on the whole cannot supervise creative specialized research required by the Ph.D. candidate and at the same time be immersed in creative interdisciplinary activities. To conduct both types of activity with separate groups of faculty is very expensive. If a Ph.D. degree were offered it would indicate a different graduate activity on the part of both faculty and student than the traditional research degree.

4) A core curriculum might be offered for the first two years drawing upon courses from both the Division of Engineering and the Division of Arts and Sciences.

5) At least one interdisciplinary course per term might be required of the engineering student on a tutorial, project, or seminar basis (5). Each course of this type should be supervised by an Engineering Division faculty member, and he should be assisted by released consultant faculty from within both the Engineering and Arts and Sciences Divisions.

6) The conventional departmental groupings within the Engineering Division should be carefully studied as to their effectiveness in this educational concept. The optimum structure is that which is most likely to encourage interactions across academic boundaries.

7) The Alden Research Laboratories might be expanded into a research institute to support and implement the working scholarship of the Engineering Division.

8) More optimal class sizes should be considered at both ends of the scale from the conventional twenty-five students.

9) Strength in architecture and/or city planning might be developed in the Engineering Division. Since a goal of engineering education as herein presented is the education of an engineer sensitive to his environment, the city with all its technical and social complexities plays a central role in the engineering problems of society.

10) The Engineering Division should provide relevant educational experiences for students of the arts and sciences. At present in engineering education the traffic of students outside their major discipline is almost always in the direction from engineering to the arts and sciences.

11) In order for there to be strong interaction between the Division of Engineering and Division of Arts and Sciences, the disciplines within the Division of Arts and Sciences must have full academic stature.

12) Each area within the Division of Arts and Sciences in the traditional disciplines should achieve a respected level of scholarship.

13) In order for a prestige engineering program with a strong interdisciplinary base to flourish, relevant new areas should be initiated within the Division of Arts and Sciences. Areas which would appear to warrant a high priority are philosophy and biology.

Compatibility of this Goal with Critical Areas of Implementation and Quality Control

The educational goal discussed here would require a major financial outlay by the Institute for initial curriculum development. Interdisciplinary programs have not been implemented to any major extent in the United States (6). A significant portion of the faculty should be released for this implementation; for example, one-half the faculty

working full-time on curriculum development for one year. It might be ex-
pected that a major share of the cost of this initial development would be
borne by government and foundations because of the need for this type of
graduate.

The Faculty; Recruitment, Expectations, Encouragement, Campus Life

WPI has a capable core of faculty to implement this goal. It would
appear that a major difficulty that could be encountered with regard to
the faculty is not one of competence, but one of attitude and involvement.

Flexibility in form and content is important to the attainment of
this goal. As an example, some proposals to aid education are listed below.
This listing is not meant to imply that all these proposals are valid or
inclusive, but only to emphasize that many ideas, perhaps controversial, do
have to be considered seriously for successful implementation.

1) Seminar and project activities in engineering represent the heart
of the educational plan.

2) All freshman courses be pass-fail, and one course per term be
pass-fail after the freshman year.

3) Students sit on faculty committees and in some cases be given
academic credit for participation in the decision-making process
of major committees.

4) Students and faculty be able to propose "one shot" courses of
mutual interest, and after review these be given for academic
credit.

5) Only four courses be taken in any term.

6) Students take examinations given by outside authorities to
promote a sense of cooperation between faculty and student rather
than a sense of competition.

7) Faculty scholarship is essential, and it should be evaluated as
broadly as possible. For example, any of the following represents
genuine scholarly effort:

a. Research leading to publication;

b. Critical study of one's discipline leading to new
ways of organizing its principles and connecting them
with other disciplines;

c. Applications of learning in practice.

The Student Applicant

It is evident that the student applicant should be intellectually gifted and of a questioning nature. He should have high verbal skills as well as mathematical skills. While a number of our current students are very eager to promote this kind of education, on the whole our student body composition would have to be leavened with students of a different outlook.

It goes without saying that the Institute should be coeducational.

The Public Image

Embarking on this path would change the nature of WPI. A major public relations effort would be required to bring this new direction to the attention of the public, guidance counsellors, industry, and government. Indeed, a decision would have to be made to operate the Institute at less than full enrollment until a sufficient number of the type of students desired became aware of the program. Otherwise the change could never be made.

Relations with the Local Community

This goal would involve the questioning by students and faculty of technical and social values. Therefore, WPI would develop an abrasive interface with the local community. This is healthy and necessary, for institutions of higher learning should be interested in how things should be, not how they are. It must be recognized that this questioning attitude challenges the community, and the resultant frictions should be a matter of pride and not concern.

Organizational Structure

A key issue is flexibility in operation. The current rigidity of curricular structure governed by (on the most part illusory) scheduling requirements must be softened to take advantage of the potential flexibility of the small college.

Placement of the WPI Graduate

This goal would lead to a broader placement of graduates both geographically and in terms of career activities. This would aid in attracting financial support and applicant response.

Relations with Industry and the Professional and Scientific Communities

If a profession is defined as a group who set their own goals and standards, then engineering is not a profession. Engineers have been incredibly remiss in regulating technology. For example, they have not assumed positions of leadership in advocating regulations with regard to auto safety, air pollution, or urban blight. This educational goal would result in leaders and decision-makers who desire true professional status in their interaction with society. The graduates would assume responsibility for control as well as design of technology.

The Two Tower Tradition

WPI has a long and proud "Two Tower" tradition, combining theoretical knowledge with relevant experience. This goal builds on this tradition and indeed amplifies it. The student is constantly challenged to put theory and knowledge to practice in real problems. The two tower concept is amplified by applying the principles to not only technological considerations, but to the broader effects of technology on society.

Conclusion

This very preliminary discussion makes no attempt to conduct a complete analysis for this interim report. Further study is required. However, it is hoped that the concept is clear, and that this introduction will provoke further discussion and study. Let us end this section with an anecdote that seems germane.

Dr. Karl Compton's sister, when living in India, watched a handyman driving a nail in a wall of her house, destroying quantities of lathe and plaster in the process. In desperation, she finally grabbed the hammer and said: "My God, man, let me do that. Why don't you use some common sense?" He drew himself up in all his dignity and said: "Madam, common sense is a gift of God. I've only got a technical education."

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OBJECTIVE 4:   To Become a Research-Oriented Graduate Center

in Engineering and Science

The following memorandum is intended to establish the advantages for the In-
stitute of adopting an educational orientation much more heavily weighted to-
ward graduate studies.   The report also makes an attempt to anticipate some of
the more prominent problems associated with such a course of action and to sug-
gest ways of coping with them.

I.   ADVANTAGES OF A GRADUATE-ORIENTED RESEARCH PROGRAM

A.   The Faculty

The Institute is, to a greater and greater degree, hiring its new science
and engineering faculty from among that group of candidates who have obtained,
or are about to obtain, the Ph.D.   The graduate education which this group has
received has, in general, stressed independent research very heavily.   A large
number of these potential candidates find independent research to be intellec-
tually stimulating and personally and professionally rewarding as well.   Since
it is generally true that the brightest graduate students seek out the best-
known departments in their fields, and these in turn are the ones with the
strongest research programs, a major commitment to research on the part of
Worcester Tech would put it in a favorable position to recruit young faculty
members from among the most desirable candidates.

Such a development might have a particularly beneficial effect here, be-
cause of the past tendency to recruit faculty from among a rather restricted
selection, in which our alumni were perhaps over-represented.

Faculty already associated with the College would also benefit from this
change.   The influx of new ideas and viewpoints, much of it provided by the
younger men, would constitute a powerful antidote to professional complacency
and intellectual torpor.   Older faculty would be challenged to test many class-
room abstractions in the arena of experimental verification.   The level of pro-
fessional debate and discussion among members of the faculty would almost cer-
tainly rise sharply.

B.   The Undergraduate Student

A new Institute-wide policy concerning research would make itself felt

in the area of undergraduate education in two distinct ways: it would affect the recruitment of prospective undergraduates, and the quality of their instruction.

A sizeable number of high school students and their advisers form opinions about the desirability of an education at a given college which are based largely on that institution's "general reputation." The ingredients which are part of this reputation are many, and the term as a whole has a multitude of meanings to a multitude of people. It is safe to say, however, that the outstanding achievements of the academic staff in their respective fields of specialization contribute substantially to the reputation. This is particularly true in fields allied with technology; MIT and Berkeley are conspicuous examples.

A burgeoning research program, yielding results of genuine significance, would provide a boost to the reputation of WPI that would be a distinct asset to the admissions staff. This change would aid particularly in obtaining qualified students outside of New England. If our academic staff is somewhat parochial, then our student body is very definitely so. The future of the Institute as a quality institution may depend in part on our ability to attract first-class undergraduate students from the national pool.

As for the general effect of the new program on undergraduate instruction, it would hopefully lead to the assembling of a body of enthusiastic teachers aware of the current status and potentialities of their disciplines. Increased contact between undergraduate and graduate students could be very beneficial to the former, especially if they are going to be encouraged to do more independent research project work themselves. The entire undergraduate curriculum would very likely aim at preparing a large majority of undergraduate students for graduate study.

Finally, the acquisition of sizeable quantities of sophisticated equipment of all kinds necessary to the functioning of the various research programs may, as a peripheral benefit, enable the undergraduate student to become much more familiar with the "state of the art" in his field than would otherwise be the case.

Increased emphasis on research at WPI would probably have an adverse effect on interdisciplinary B.S. programs and the mixed humanities-technology major. The faculty would be very strongly involved in their own fields, and

they would tend to conceive research projects and assignments for undergraduates that followed their own interests. Since this program would not tend to encourage expansion and diversification of the non-technical departments (vide infra), there would be much less impetus for a student to select a mixed humanities-technology major or even a minor sequence in the humanities or social sciences.

C. The Graduate Students

Many of the benefits of this program to the graduate student himself will be rather obvious. There will be an upgrading and expansion of research equipment and support facilities. An increase in both the number and the quality of the graduate students would seem very likely, and this would result in greater, more rewarding interactions among these students. We would require our graduate students to be more articulate than those who presently constitute the norm, because it is likely that most of them will have some teaching responsibilities (vide infra).

D. Future Expansion of the Institute

If the suggested program were truly successful, then it might provide the base for future expansion of the Institute. The promise of absorption of overhead costs by research contracts would lift a good deal of the financial burden from the College. Proven success in attracting contracts and in research output would be a potent selling point for gaining new funds for expansion. Lastly, the equipment and facilities already on campus might provide material support for the birth of new programs.

II. OUR PRESENT STATUS AND THE PROPOSED GOAL

Given the present highly competitive situation in the research market, embarkation on the proposed program would be futile and pointless unless all segments of the WPI community were convinced that it was very desirable and were, consequently, committed to its support. Is such a state of harmony likely, considering the fact that a sizeable number of present faculty are quite indifferent or actively opposed to graduate education at Tech?

There will have to be a wide spread in the teaching-research balance throughout the Institute. It does not seem desirable for a variety of reasons to have Research Professors, but there will inevitably be staff members the majority of whose time will be invested in research. Conversely, it would seem

wise to have all teaching staff involved to some extent in research activities; those who for reasons of personal distaste or lack of professional background do not participate in the graduate program might help guide research and project activities at the undergraduate level.

There will, nonetheless, be many staff members whose contact with and commitment to the research program will vary from minimal to nonexistent. In order to avoid the creation of two classes of faculty members, with its attendant evils, the Institute will have to make it clear that it places value on good teaching and on good research, rather than recognizing merit in only one type of activity. A change in the criteria for hiring new faculty will lead, more and more, to a reasonably homogenous outlook and level of research participation among members of the academic staff.

It is likely that a program which grants priority to graduate study will widen the gap between the science and engineering departments on the one hand and the humanities and social science departments on the other. The Institute would probably not risk spreading its resources too thinly, at least at the beginning of the program, by starting graduate programs in those departments where they do not already exist. In fact, it would be highly desirable for the College administration to examine all the graduate programs presently underway, to see if their continuation at this time is justified, or if others should be substituted. The humanities and social science staff would divide their teaching time between a number of required service courses and a smaller portion of advanced courses demanded by a (hopefully) intellectually alert undergraduate student body. It may be possible, by making greater use of a variety of new teaching techniques, to relieve staff members of much of the drudgery in the service courses. This would allow a greater proportion of time to be spent on advanced material, which would make the recruiting of desirable staff considerably easier.

III. FINANCING

It is widely accepted that no college or university can support more than a small portion of an ambitious research program out of its own pocket. The biggest contributor has been, and will undoubtedly continue to be, the Federal government through its myriad agencies. The large foundations appear to be losing interest in supporting research in science and engineering, and industry

has not been willing (up to now) to contribute enough to make it a dependable source of funds. Any decision to undertake an expanded program of graduate research must turn upon a very critical analysis of our ability to attract a sufficient quantity of Federal funds, and the potential political problems which receipt of those funds might create.

There have been many indications over the last few years that the "Golden Age" of Federal funding for science may be over. Although the present Federal administration seems to favor a modest increase in the NSF budget, for instance, it appears that the Federal research budget will be hemmed in for some time by the demands of other sectors of society for large sums of money. Furthermore, the number of graduate engineers and scientists interested in doing academic research has been increasing steadily, and the demand on the available funds is heavier than ever. Finally, if substantial amounts of research money suddenly appeared, WPI would be competing for them with other institutions which already command solid reputations for research productivity. These colleges and universities present a formidable barrier to WPI's ambitions for research development.

Two courses of action seem to offer some hope of overcoming these obstacles. The first would involve attracting to the Institute a few men in each department who have sizeable research reputations in their respective fields. These invitations would have to be made quite appealing and would undoubtedly involve, among other things, the initial outlay of considerable sums of money. These men would be hired on the understanding that they produce substantial results or leave; at the same time, sacrifices may be required elsewhere on campus to support these critical efforts. Simultaneously, the Institute should encourage research in those areas which have fairly immediate social applicability, since this is a category which seems destined to receive large infusions of Federal money. Urban planning and biomedical engineering are examples which come readily to mind. Encouragement of group research projects, and interdisciplinary research programs, would also seem to be indicated in light of changing philosophies on funding within many Federal agencies.

It would also seem appropriate for us to make a greater effort at obtaining industrial money. Considering the fact that Worcester Tech is the supposed "darling" of much local industry, that industry has certainly not seen fit to extend monetary donations on anything matching the scale of their verbal

appreciation. A somewhat harder sell, including the donation vs. increased taxation argument, might be more fruitful. It is very questionable whether our present accounting procedures, which have provided us with a nationally prominent overhead cost figure, will be much of an asset in attracting research funds.

Finally, the cost of a first-rate graduate program might be considerably reduced through cooperative arrangements with Clark University and Holy Cross College. The sciences and mathematics would benefit most from such an arrangement, and engineering programs to a considerably lesser degree. A joint Center for Graduate Studies is a possibility that deserves consideration, but it is too complex a question to be dealt with here.

IV. THE RELATIONSHIP BETWEEN GRADUATE AND UNDERGRADUATE EDUCATION

A. Faculty Roles

One of the principal objections to the proposed program will be that the quality of undergraduate instruction will be sacrificed to the production demands of graduate research. There seems to be some historical precedent for such a conclusion. It need not be so, however, if adequate safeguards are established. We believe that it is possible to find young candidates for staff positions who have both research talent and pedagogical flair. It will be necessary to be very selective in recruiting; it will be equally necessary to offer suitable inducements.

The aforementioned policy statement, setting forth the Institute's desire for both good teaching and good research, will have to be enforced. The Dean of Faculty will have an important role here and may have to overrule a Department Head on occasion. He may also have to decide which activity is to have priority for a given staff member at a given time.

B. Graduate Teaching Assistants

The prospect of increased use of teaching assistants also disturbs many. Again, this need not lead to inferior instruction if adequate safeguards are maintained. The Ph.D.'s of this year are the college teachers of next year, so there exists no a priori justification for a blanket condemnation of teaching by graduate assistants. Since research is a time-consuming occupation, there will have to be an increase in the full-time faculty of the Institute; but even with this increase, it will probably be necessary, for economic reasons, to

call upon graduate teaching assistants to a greater degree. The Dean of the Graduate School and the Graduate Study Committee may have important regulatory roles to play in this sphere.

It is clear that there will have to be an irreducible minimum number of domestic graduate students. Beyond that they will have to be quality students in order that the research program be successful and that teaching standards be maintained. This set of premises leads then to another critical question: will the Institute be able to attract graduate students of high caliber in sufficient numbers? This question is not unrelated to the one concerning our ability to garner sufficient research funds, for we shall be competing with the same universities for both. Furthermore, our success in each area will probably depend in large part upon a common set of factors. It would be very useful to have some figures on projected graduate school enrollments in science and engineering for the next few years in order that we might further assess whether this is a propitious time to embark upon a program of expanded graduate study.

V. FUTURE DEVELOPMENTS

A. The Middle College

One possible ultimate result of the proposed program would be the transformation of WPI into a middle college—one that accepts its incoming undergraduate students at the junior level. The undergraduate curriculum would consist mostly of specialized courses in specific fields, and project work. There would be little or no need for service courses on the Institute-wide level; this fact would make itself felt most strongly in the non-technical departments. They would have small staff requirements, but would concern themselves only with advanced undergraduate courses.

OBJECTIVE 6: To Train Students for a Bachelor of Science Degree in
Technology

(Discussion)

Many colleges of engineering have turned since the 1940's from the
training of technologists to an education_l pattern more closely allied with
the parent sciences of mathematics, chemistry, and physics. There is sub-
stantial indication of a more and more serious shortage of qualified technol-
ogists. A well-trained technologist, while probably not involved in feasibility
studies or critical overall systems decisions, is responsible for taking the
basic plan of action and carrying forward a design resulting in a hardware
system. He is well trained in the design and selection of components. His
basic strength is his capacity for evolving a discrete system within already
defined boundaries. For example, in the aero-space field, a technologist
would be responsible for a well-designed rocket engine--after the critical feasi-
bility decisions and technological breakthroughs have been made available to
him.

The need for this type of technologist is not now being filled.
The two-year schools of technology offer rather superficial technological
training, and in many cases they tend to ape the four-year more scientifically
oriented engineering and science colleges.

There is much evidence that in the forties, WPI did a superb job of
training this type of engineer. Since that time a polarization of views has
taken place: one group advocating this type of training and another pressing
for a more scientific orientation.

It would appear that if the decision is made to train technologists
then the Institute has some very major assets. Some of the evaluation criteria
are outlined in what follows.

THE PRESENT REPUTATION OF WPI.

The Institute has in the past taken pride in graduates so trained that
they could make immediate contributions within a defined technological area.

Industry and the public have this impression of WPI to a large degree, and if a decision to strengthen this type of curriculum is made, the potential student and industrial markets are already quite well developed.

PHYSICAL RESOURCES

This goal requires that the student be exposed to high-level technology and instrumentation, with specialization in the technical description of various systems. The emphasis on the system studied must change as the technology changes. It would follow then that WPI must develop a number of first-rate experimental facilities and the associated modern instrumentation in order to perform effectively.

THE FACULTY

Many of the engineering faculty are highly motivated in the direction of the above objective and they have considerable strengths. They could form the core of the faculty required to achieve this goal. Considerable re-education in achieving more familiarity with technological facilities would be necessary, but a large financial investment would not be required. Professional activity of the faculty would be chiefly in the realm of testing. It has to be recognized by the faculty that this goal rather clearly defines the direction of effort, and that increased graduate emphasis is contrary to its success.

THE CURRICULUM

If this objective is adopted, then curricular developments would have to be tailored to meet it. Obviously, the Ph.D. degree program would not be relevant. The humanities and social science areas would be service departments; for example, the English Department would emphasize report writing. The computer facility would serve technology programs; the emphasis would be on programming for problem-solving rather than on software development.

The pedagogy would be directed to a strong ability to analyze a model, with less emphasis on the selection of the model. A major concern would be accuracy and attention to detail. The curriculum would have to be flexible to accommodate changes in technology. For example, expertise in gas turbine technology in the fifties would have been replaced by rocket engine technology in the sixties and perhaps by fuel cell technology in the seventies.

THE STUDENT

There is certainly a need for this type of training. The financial

rewards in industry are quite good, and students will continue to be attracted to this vocational orientation. Perhaps the student body could and should be enlarged to reduce the impact of fixed costs in the form of extensive laboratory facilities. Since competition in this direction is probably decreasing, a wider geographic base could be rather easily established.

APPENDICES

APPENDIX A: Student Profile: Princeton Questionnaire

Princeton Questionnaire

In the fall of 1968, Educational Testing Service of Princeton, N. J., ran an extensive questionnaire at 216 colleges for seniors and juniors. WPI cooperated, furnishing responses from 202 students, mostly seniors, selected more or less at random after an assembly and by calling living groups for volunteers. Questions pertained to all aspects of college life as well as to personal and family backround.

Since the questionnaire was answered by volunteers, it is somewhat non-representative--for example, 50% of the respondents were looking forward to graduate work, while the average for the whole school is nearer 30%. But, allowing for this kind of bias, there would still appear to be a good deal of useful information in the survey. It probably represents the more vocal and active part of the student body better than it does the student body as a whole.

Information in the questionnaire can be summarized as follows: (Dean Trask has the entire result)

Students believe that tutorials and independent study are not important features of our undergraduate curriculum. They feel that there are not many students who place their social interests ahead of their academic ones, and they believe that course offerings here are designed to accomodate a wide range of educational-vocational plans. They are mixed on whether there are courses or programs available to students with educational deficiencies. They feel that capable students are allowed to participate in or conduct their own research projects and slightly favor the thought that their professors have set standards difficult to achieve. However, students are encouraged to think for themselves, and a ratio of 6:1 believe that their instructors have challenged them. They believe competition for grades is keen but are mixed on whether students can slip by with less than their best efforts. 74% listed engineering as their field of major study and 20% science or mathematics. Business was named by 3.5%; biological sciences, by 1%; humanities or fine arts by $\frac{1}{2}$%; and $1\frac{1}{2}$% of these upperclassmen did not respond to the question. They estimated their average weekly study time as: less than 10, 7%; 10-20, 39%; 20-30, 31%; 31-40, 14%; over 40, 8%, hours.

APPENDIX A: Student Profile: Princeton Questionnaire

       Our students are mixed on whether one third of the residents leave the campus on the average weekends, are almost universally convinced that campus social life centers on the fraternities, feel that upperclassmen socialize with freshmen, and that the surrounding community is cordial to students. They favor the thought that books in the bookstore include much more than assigned texts or suggested readings, but deny by 2:1 that the Institute sponsors a rich cultural program, including lectures, concerts, plays and art exhibits. They are mixed on whether nationally-known scholars are frequently invited to address faculty and students. They feel that the dramatic group gives performances of high quality. They know religion does not play an important role on the campus. They are convinced most students do not care what the student government does on the campus, and that there are not adequate opportunities to socialize with the opposite sex. They are convinced by 5:1 that most students avoid anything controversial and that they do not show great concern about political, economic, and social issues. A campus visitor, according to them, would not notice any political activity among students or faculty, and they are mixed on whether the campus news- paper comments regularly on ideas and issues of national importance. They are not sure whether a person who advocates extreme, unpopular ideas or actions would be allowed to speak here. They think the prevailing attitude is one of "playing it cool" rather than commitment. They believe not quite by 2:1 that a high degree of academic honesty is characteristic of our students. They are divided on whether the students have a good deal of money to spend on social activities. 65% of the respondents were involved with fraternities and also with career-interest campus organizations. About the same figure applied to individual competitive sports and a bit more to outdoor recreational activities. 86% felt they were active in dating and social life; 40% in campus issues and student government; 49% in out-of-class science activities; 29% in instrumental music; about 55-60% each in intramural and intercollegiate athletic events. Average dating appeared to be about once a week. 20% felt their religious beliefs had weakened; 15% had rejected formal religion; 38% had retained their original beliefs. The most popular topics for dinner table conversation and bull sessions were: social life, sports, current events, topics from class, and science, in that order.

       75% would recommend the school to a high school senior.

APPENDIX A: Student Profile: Princeton Questionnaire

Our students see most faculty members as genuinely interested in teaching and recognize that high ranking faculty members do teach freshman and sophomore courses. However, they feel that the faculty tends to be aloof and somewhat formal with them. They are convinced that students do not have the opportunity to formally rate or react to many of their instructors or courses, and are divided on whether their professors are interested in them as individuals or whether there is much contact outside of class. They are, however, satisfied with the opportunities they have had to meet with instructors and discuss course work and progress, and are equally convinced that their faculty advisors have not been very helpful in planning their academic programs.

Students were divided on whether they had easy access to a counselling service for personal problems. Their library has excellent resources for undergraduate assignments, and they agreed by 20:1 that there are excellent undergraduate laboratory facilities for the physical sciences.

These 202 respondents gave the following statistics on themselves: 34% lived in fraternities; 22% in dorms; 21% off campus; 14% at home. 39% were Protestant; 31% Catholic; 7% Jewish; 17% had no formal religion. 75% had graduated from a public, 15% from a Catholic, and 7% from a private non-sectarian secondary school. 38% were from Massachusetts, and 55% from other New England states or New York, Pennsylvania, and New Jersey. 21% were from towns of population under 10,000; 34% were from cities or towns of 10,000 to 50,000; 21% from 50,000 to 500,000; 5% from larger cities; and 15% from metropolitan suburbs. 24% of their fathers were engaged in a profession requiring a bachelor's or master's degree; 21% represented small owners or members of middle management; 16% were skilled workers or craftsmen; 9%, semiskilled; 8%, owners or executives in large businesses; 5%, service workers, such as the police; 5%, professionals requiring advanced degrees; 10%, salesmen and office workers; and 2%, unskilled. Family income appeared to center between ten to fourteen thousand dollars, with 5% below six thousand dollars and 19% over twenty thousand dollars. 29% of the fathers had completed college, and 16% had had some college; 14% of mothers had finished college, and 18% had had some college.

APPENDIX A: Student Profile: Early Decision Questionnaire

PARTIAL SUMMARY OF QUESTIONNAIRE SENT TO EARLY DECISION CANDIDATES, FEBRUARY, 1969
(107 Responses)

1. Intended major -

Chem	7	Management	2
Chem E	7	Math	11
Civil E	2	M E	14
E E	18	Physics	4
		Undecided	41

2. Number planning to attend graduate school __63__

Engineering __27__   Science __15__   Undecided __21__

3. Number not planning to attend graduate school __25__

Engineering __9__   Science __3__   Undecided __13__

4. Those undecided on graduate school __19__

Engineering __8__   Science __4__   Undecided __7__

5. Students' appraisal of their guidance counselor's knowledge of W.P.I. -

not much __25__   some __46__   a considerable amount __36__

6. Number of those having an interview with Admissions Office __101__

helpful __95__   not helpful __5__   no reply __1__

7. Opportunity to talk with a faculty member -

yes __32__   helpful: yes __35__

no __72__   would have liked opportunity __64__

:not interested __6__

8. In response to the question: "Where else might you have applied if you
    had not been admitted under the early decision plan?" The chief alternates
    for admission applications were as follows:

RPI	37	Lowell Tech	26	Tufts	4
MIT	15	Northeastern	24	Cornell	4
U. Mass.	23	Clarkson	11	Dartmouth	4
U. Conn.	12	Lehigh	10	Stevens	5
Holy Cross	3	URI	3	Brown	2
				Misc.	29

9. The decision to apply for admission was based on the following as chief
    consideration -

reputation of W.P.I.	53	family connection	0
geographic location	2	alumni influence	3
small size	8	particular academic program	3?
type of campus	2	techniquest	
scholarship aid	1		

APPENDIX A: Student Profile: Table of Average SAT Scores

Table of Average SAT Scores

Class of . . .

	1964	1965	1966	1967	1968	1969	1970	1971	1972	
WPI	560	554	542	553	557	567	565	570	580	V
	651	654	652	655	673	675	664	670	680	M
RPI		605	600		600		600			V
		710	700		725		700			M
MIT		650	675		675		700			V
		750	750		750		750			M
Cal Tech	682	674	682		674		700			V
	750	765	760		765		750			M
Carnegie (Eng & Sci)	575	600	600		600		625			V
	675	700	675		725		725			M
Case	574	610	600		625		600			V
	669	700	700		725		700			M
Clarkson		550	525		543		550			V
		650	625		654		650			M
Wesleyan	650	640	650		625		625			V
	650	680	650		700		700			M
Trinity	590	620	600		625		625			V
	635	675	675		675		675			M
Cornell	625		625		625		640			V
	675		675		725		750			M
Dartmouth	642	650	655		675		675			V
	665	700	680		675		675			M
Northeastern							500			V
							500			M

APPENDIX A: Student Profile: Comparison of Entering Students

Comparison of Entering Students at Several American Colleges
(Compiled From: Comparative Guide to American Colleges - 1966 Edition)

	Cal Tech	MIT	RPI	Carnegie	Case	WPI	Stevens	Rose	Clarkson	IIT	Swathmore	Williams	
Math % >500	100	100	100	100	100	100	100	99	98	97	100	100	
>600	100	100	95	95	94	90	88	79	75	81	89	88	
>700	98	95	55	58	51	36	35	27	25	36	59	46	
Verbal % >500	99	100	89	91	86	78	90	64	66	81	100	96	
>600	90	88	50	51	47	28	40	23	25	36	91	73	
>700	38	36	9	7	8	2	5	2	3	5	40	17	
% of Graduates to full-time p.g.	85	75	53	44	41	30	25	26	26	28	77	64	
% Fresh. in upper 1/5 of his class	99	96	83	83	83	74	78	70	52	71	71	78	
% Fresh. in upper 2/5 of his class	100	99	97	97	97	94	95	96	84	82	82	91	
Nat'l Merit Scholars Enrolled	83	206	19	30	23	3	-	10	5	12	81	20	
Enrollment (under-graduate)	665	3497	3138	1918	1631	1268	1144	749	1827	1897	1022	1176	
Nat'l Awards for Adv. Study (5 years)	500	983	102	147*	64	15	39	2	9	40	131	39	
Library Volumes (thousands)	161	946	120	235	121	62	49	35	62	128	263	280	
Tuition		1770	1885	1700	1736	1600	1600	1850	1700	1400	1875	2600	
Total u.g. and p.g.	1392	7151	4957	--	2569	1402	2480	--	1934	6700	--	--	

APPENDIX B: Student Comments

      The President's Planning Group met with a group of about 70 students in the Gordon Library in early February. The following is a distillation of comments offered by the students:

      Role of faculty in the school should be increased. Faculty should be academic center.

      Is there future planning on the University of Worcester idea? Could there not be more cooperation between schools, common use of facilities?

      The November 1968 article in the Atlantic on understanding student rebels is very helpful. I think the Tech student will change when the faculty changes and leads.

      The Tech student doesn't know exactly what he wants at first but is looking for something to go along with his technical education. Many are too bogged down in departments. The grade pressure on students under 2.5 prevents their looking around. Need more pass/fail courses, more freedom of choice.

      35 of my required 144 hours are labs and only 18 electives. Much of what is required is not needed at all.

      Here, as everywhere, there appears to be a standard grade distribution. Unfair. Makes students grade hounds instead of interested learners. De-emphasize grades. Make teacher responsible for carrying something of interest and motivation to student. Grades should not be related to attendance or surprise quizzes, but what is learned and known.

      Some beginning student rating systems on faculty (in our departments) are good but dangerous. They put too much emphasis on just teaching the book back again. Want practical problems instead.

      I am under the impression that the mathematics lectures were not too successful last year.

      Our labs are too cookbook, easy enough for 4th or 5th graders. Instead, we should have education rather than training, be prepared to be engineers and not technicians.

      Emphasis on tools and what we will need is greatly duplicated. We won't need most of this anyway. Science is reduced to a mass of techniques.

      "Literature After Shakespeare" was my first really stimulating course. Why can't technical courses be this way? We should enjoy them and read freely. Solve this and you've gone a long way.

APPENDIX B: Student Comments

I met a man who had transferred from MIT to WPI in 1940 because
MIT was too theoretical. He was hiring at NEREM. Are we losing
this?

There is too much duplication between courses--for example, EE
and physics and EE and math. Sometimes the math is more
practical. You get bored after a while.

I liked my ES-102 and the way the professor taught it. We did
things that were different. I was motivated.

Exams with notes or open book seem so much more worthwhile than
just learning material off board and giving back again by memory.

At first studying and living were two different things for me.
It was not until my junior year that I realized they overlapped.

I like the 5-year work/study programs. Should we do something
similar? We could work in industry and find out what is really
going on.

Shorter terms with fewer courses would be much better--you could
really concentrate on them.

Is there anything that can be done to improve individual teaching
methods? They need it.

Are we considering the negro problem at all?

Are we afraid to try something different? Clark and other liberal
arts schools give people a month or two off to pursue special
projects.

APPENDIX C: Staff Comments

The President's Planning Group has received inputs, written or oral, from nearly half the staff. More than thirty written contributions were received ranging in length from one half to as many as fifteen pages. The comments reveal, as would be expected, that a great deal of individual thought (and writing) had already gone into WPI's future.

It is believed that as many of these contributions as possible should be shared with the whole school, and that in so doing further ideas and fruitful discussion will be promoted. With this in mind, the comments have been condensed and presented herein. It has been necessary to shorten drastically and regroup the comments submitted. Individual comments have been grouped into similar ideas and topics. While much of the flavor and some of the specific language of the original comments has been sacrificed, essentially all of the written and some of the oral ideas submitted have been included.

On planning operations:

> Planning work is essential but must be done fast. The selection of the new President is vital.

> Asking the right questions is vital to planning success. In what area or areas do we want to excel. Place no restrictions initially on this discussion, even if it questions the principle of private support. Ask, "What is it we want to do?", not "What can we do?"

> The Planning Group should not give a list of alternatives without ranking them. The Group has the responsibility to let the faculty know what it thinks. Compromising extreme possibilities will produce the mediocre; it may be better than either extreme but never produces a leader. So far costly mistakes have been avoided, but there have been no dramatic successes. Everyone does not have to agree on the new course, but once announced, it should be supported.

On the faculty and staff:

> The duties, responsibilities, and authority of a full professor are often no different from those of an instructor.

> We have a wonderful collection of people here, but the problem of under-utilization and non-realization of potential is great. This can be ill-afforded by an educational institution.

> The most important contribution to our future will be professional stimulation of the faculty. We are not here simply for students, but for students who want to learn. We must educate the whole man-- move toward a more universal view.

APPENDIX C: Staff Comments

Our reluctance to let non-producers (at all levels) go and our personnel work in general is poor. We need day-to-day evaluation procedures on everyone--clerical, administrative, and teaching personnel.

We need to improve a humdrum faculty.

We need more contact between faculty and students on the one hand and between faculty and practicing engineers on the other. Colloquia, seminars, student society talks, and exchanges between faculty and industrial employment are suggested. More faculty should be recruited from the professional ranks. Engineers with ten year's good experience are better undergraduate teachers than Ph.D.'s with no experience.

If the faculty come from the same (narrow) socio-economic backround as the students, is it likely that they will respond to any attempt to overcome a deficiency in the students coming from this common backround?

We should establish Institute Professorships to encourage and reward scholarly performance. These Institute Professors would report directly to the Dean of Faculty.

On organization of the school:

Some kind of administrative structure is essential in any plan.

Present departmental organization limits interdisciplinary and core-course discussion and action, but it does have some compensating advantages. The departmental structure could best be improved by loosening ties somewhat and overlaying with a "dean structure". Rotating department chairmanships on a three or four year cycle is suggested.

There should be provision for greater faculty voice in making decisions.

Idiosyncracies of the people involved tend to override organizational objectives. Having the right person at the right time should be a goal, but needs frequent adjustment. To get leadership that is right more often than wrong, with eyes firmly fixed on the goal requires good relationships within our organization. There is some fear, lack of strength, and weakness in individual integrity, all adverse to good decision-making.

Are most of our problems administrative--discipline, lack of assigned responsibility, measurement of performance only by teaching load?

We lack conviction, "going along with" rather than heartily supporting.

APPENDIX C: Staff Comments

> Increasing numbers of students will use four years of engineering or science education as a backround for other careers. We must encourage these students rather than treat them as lepers; we must help them identify themselves with WPI.
>
> Like the Sophists of ancient Greece, present WPI students continue to applaud and demand a systematic education based on talent, study, and practice. They are willing to work hard and are essentially technically oriented. However, they demand more freedom of expression, a voice in their own affairs, and additional liberal arts material added to their curricula. They thoroughly endorse the lecture method of teaching. We should move toward being a small technological university.

On supporting facilities:

> We need more rapport between faculty and library staff and more consistent use of library by the staff. Some faculty are utilizing the library effectively for ES-102, but a better library introduction is needed for the freshman year.
>
> A better library collection will enable WPI to take its proper place in intercollege library activities.
>
> Professional librarians might well be given regular faculty status. This would keep them more abreast of faculty thinking on educational matters.
>
> There should be a computer programming course for the non-scientists on the campus.
>
> Duplication of computer facilities between administration and the computation center should be eliminated.

On research and graduate education costs:

> Ph.D. programs simply for grants, without relation to faculty or program interests, are probably self-defeating. Alden is in a better position to do this sort of thing, and we need to get them (Alden Labs) closer to us.
>
> Research Institutes will enable us to draw federal money to support graduate work and advanced studies.
>
> Our graduate activities are a money-losing, sub-threshold operation. If we are to do them right, we need to utilize the route 495 potential for a step-function input to graduate enrollment.
>
> Graduate school recruiters should be programmed into our placement operations even if it competes with our own school.

APPENDIX C: Staff Comments

On strong points of a WPI education:

> Our student body is definitely ahead of most others academically
> and in creative citizenship, and these assets should be used
> more in framing our image.

> Physical education and student-faculty relations are generally
> excellent.

> Our most positive areas are public relations, campus warmth,
> campus appearance, and emphasis on total individual growth.

> Our advantages over State Universities are flexibility, ability
> to tailor to the individual student, and ability to move quickly
> into new areas. We should keep these advantages by making use
> of them.

On weak points of WPI:

> Employers emphasize need for improved written and oral communication
> skills.

> We need improvement in personal/psychological counselling.

> We need improvement in our public relations on and off the
> campus.

> We need to push for more national and international importance for
> the college.

> A strong materials center is needed.

> The name of the school should be changed.

> We need to improve our trade-school image, community participation,
> our poor flexibility. We need a student center.

> Alden Research Laboratories are quite limited because they are not
> funded to support staff during interim non-contract periods. Some
> professional staff are on an hourly basis.

> We need to do something about the education of disadvantaged students.

> We need to give each student much more project experience.

On education in the future:

> The 1955-65 national push on technology has peaked out. The next wave
> of enthusiasm will be on society itself and the relation to total
> environment. These areas need top priority rather than erosion from

APPENDIX C: Staff Comments

status-quo protectors.   Inter-institutional cooperation can help us
here only if it is from strength.   Dealing from weakness can only
weaken us further.

It is recommended that WPI move in the direction of being a techno-
logical university with continued emphasis on the undergraduate.
We need faith to overcome past inferiority complexes and to dare
to innovate and create.

Doing what is good for the student should be our main guide.   In
spite of emphasis on research and graduate work, undergraduate
training is still our top priority.   The main problem in this area
is staff.   We need more effective handling of freshmen and
sophomores--young men who haven't really changed much from what
their fathers were like.   There is an overemphasis on research.
If a man has an inborn interest in research, he'll find a way to
do it.   "Modern Engineering Bandwagon" in July, 1968 issue of
Spectrum has a good discussion of this point.   Overemphasis on
science and research frustrates the undergraduates and engineering
faculty and turns down engineering enrollments.

Our main success should be based on quality undergraduate instruction,
but to do this we must greatly strengthen graduate work--especially
the Ph.D. work.   Undergraduate enrollment should be cut back to
allow for this.

Our goal should be excellence in engineering education.   We
should emphasize four-year preparation with graduate study as a
secondary goal.   Ph.D. work and research are to some extent
antithetical to the undergraduate and master's work which seem to
be our strong points.   We might, therefore, consider minimizing
research and Ph.D. work--restrict to quite selective areas.   Else,
we should change our emphasis completely and take on the opposite
job instead.

Graduate study and research is necessary for quality undergraduate
programs and has been directly benefitting them here.   Neverthe-
less there is currently a detracting overemphasis on research
and graduate work here.   We should not try to change our "personality"
drastically.   We can't do everything and must specialize in some-
thing.   We should be able to provide a better social and intellectual
climate for the undergraduate.

On the students:

Need for social and economic status is no longer going to motivate
enough people to take up engineering, but sound education will.
This means we will have to orient toward the M.S. degree with
someone else's four-year program in technology supplying the
"routine" engineers.

APPENDIX C: Staff Comments

As we stated in the introductory paragraphs of this appendix, the comments of the staff have been included so that they might engender further discussion, particularly in view of the main body of this report, written by the President's Planning Group. It is not surprising that these comments represent virtually all points of view, for they have been written or stated by individuals who are concerned about WPI, each of whom has his own point of view. We suggest, therefore, that the reader remember that these comments are a part of the appendix and not the report, useful in an understanding of faculty opinion. They were of value to the Group in preparing its analysis.

APPENDIX D: Acknowledgements

The President's Planning Group would like to express thanks to all the WPI staff who have aided by comment, criticism, and special talent in getting this important work under way. We would like to express special appreciation to those who did specific reference work for us, and to our very helpful secretaries: (Mrs.) Barbara G. Considine, (Mrs.) Dorothy C. French, and (Mrs.) Marion F. Mundy.

E R R A T A

There is no page 58 and no page 80.