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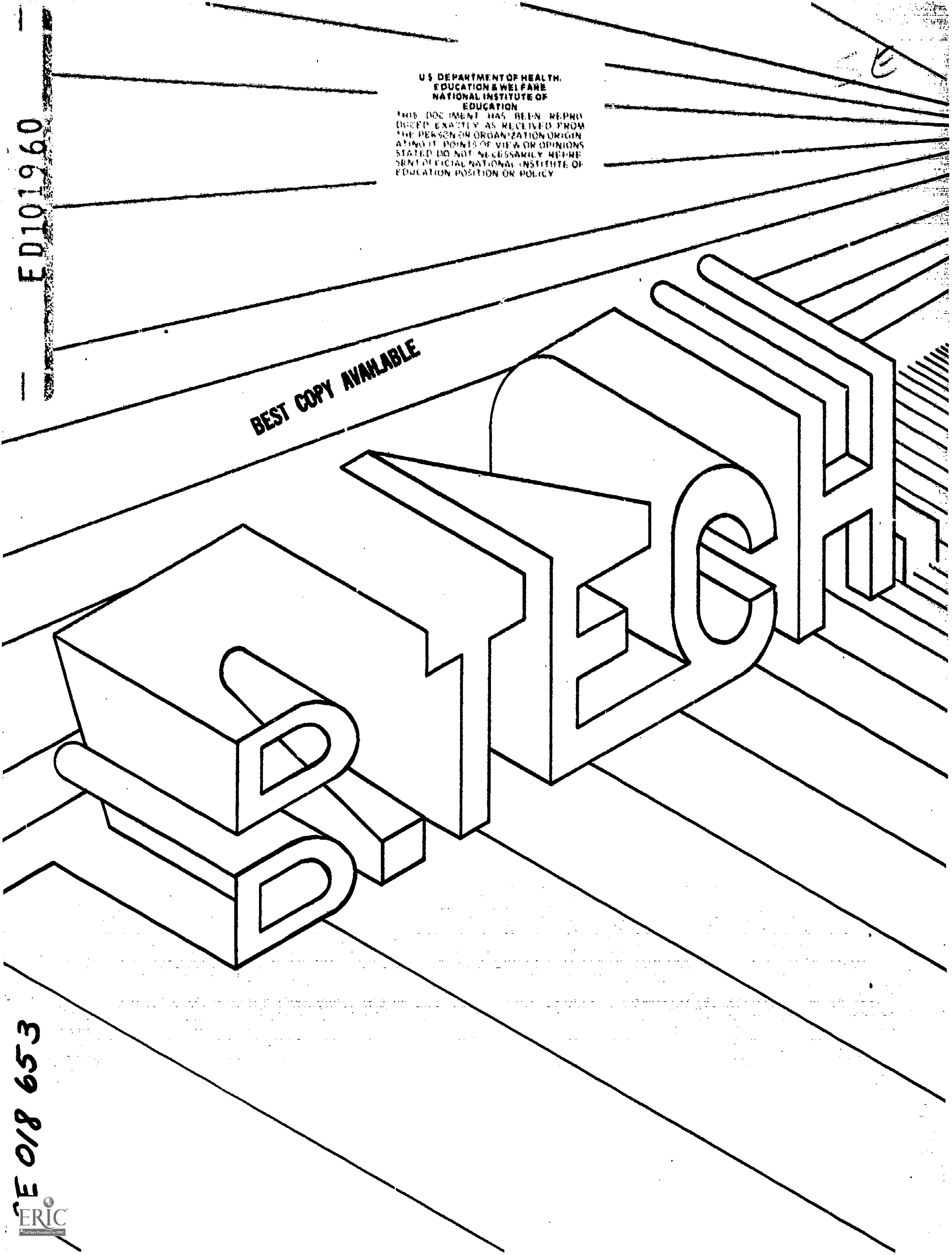
ABSTRACT

This publication describes the undergraduate programs leading to the attainment of the Bachelor of Technology Degree in New York State. An employer survey instrument was utilized and yielded a test sample of 96 employers of Bachelor of Technology graduates. A second survey sought information from the program directors of existing Bachelor of Technology programs in the State. Other sources of information included professional journals, reports, and relevant papers, together with data available from federal and state agencies. The main issue concerned the need for additional Bachelor of Technolgoy degree programs. Findings showed that even the terms, Bachelor of Technology and technologist, suffer from lack of definition. It was concluded that the State does not need expansion of career-oriented programs based on elusive definition, and there is need for rigorous evaluation of existing programs. The document includes a detailed list of the employers sampled, the employer questionnaire and tabular data related to the survey of program directors. (EB)



Bureau of Research in Higher and Professional Education

RESEARCH REPORT

ENGINEERING TECHNOLOGY BACCALAUREATES: THE B.TECH. DEGREE

A Study of the Development of
Engineering Technology Programs
Leading to the Bachelor of Technology
(B.Tech.) Degree

New York State

October 1974

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
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PREFACE

The study of the bachelor of technology (B.Tech.) degree in New York State was conducted by the Bureau of Research in Higher and Professional Education.

Early in the study, several individuals contributed to the development of the employer survey. Assisting in the design of the survey instrument were Edwin A. Butenhof, Manager, Technical Recruitment, Business and Technical Personnel, Eastman Kodak Company; Donald Irwin, Program Manager, Corporate Education Services, General Electric Company; and Joseph Milano, Program Director, Engineering, Programming, and Technology Manpower Development, International Business Machines. The New York State Department of Commerce aided in the identification of employers in the State.

The study would not have been possible without the complete cooperation of the 96 responding employer representatives and the six directors of B.Tech. programs in the State.

This final report was prepared by the Bureau of Research in Higher and Professional Education in consultation with Lawrence J. Hollander, Executive Secretary, State Board for Engineering and Land Surveying. The report benefited from the contributions of Arthur A. Burr, Rensselaer Professor and former Dean, School of Engineering, Rensselaer Polytechnic Institute. Major responsibility for conducting the research and writing the report rested with D. Ross Thomson, associate in education research.

This report has not been formally submitted to the Regents of The University of the State of New York; therefore, its content and recommendations should not be viewed at this time as being reflective of Regents policy.

Lorena M. Worden
Chief
Bureau of Research in Higher
and Professional Education

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The growth in number of baccalaureate engineering technology curricula and the corresponding applications to ECPD for accreditation of such programs indicate clearly that further development of this relatively young field of baccalaureate education is to be anticipated. If the situation could be handled logically, it would be desirable for each state to evaluate its probable needs and its anticipated production of engineering related technologists, and then take action to achieve a balance. Recent experience with an oversupply of engineers on the West Coast has demonstrated that technical personnel do not move readily across regional lines. Hence one can not assume that an unbalanced geographical distribution of technological students will redistribute itself for maximum usefulness through employment nationally.

— from the Foreword, p.iii.[1]
[underlining added]

Balancing Production Against Need

Finally, it is recommended that engineering technology programs at the baccalaureate level be initiated only where conditions are favorable and the need is established. The rapid growth of college enrollments is due to terminate in another decade. We have already seen overproduction of certain professionals who were in short supply a few years ago. The present production of baccalaureate technologists is so small that any problem of oversupply seems remote. However, it is well to balance enthusiasm for this new development with the recognition that the overall need for high level technologists cannot be measured until industry and government have had increased experience with their employment and their productive value. A gradual development of new programs with continuing evaluation of results will provide the opportunity to adjust the production of baccalaureate technology graduates to employment opportunities.

— the Final Recommendation, p.43.[1]
[underlining added]

[1] American Society for Engineering Education. Engineering Technology Education Study: Final Report. The Society, January 1972.

OVERVIEW OF THE STUDY

Introduction

This report has been prepared as a vehicle for bringing together information pertinent to bachelor of technology (B.Tech.) degree programs in New York State.* Its purpose is to assist in policy development by deriving recommendations concerning the adequacy of existing programs in light of educational opportunities and the employment market.

Primary sources of information were two surveys conducted by the Bureau of Research in Higher and Professional Education. The first sampled potential employers of B.Tech. graduates in New York State and was conducted during March and April 1973; the survey yielded a test sample of 96 employers.

The second survey sought information from the program directors of existing B.Tech programs in the State. During July and August 1973, responses were provided by the six public and private institutions:

City College of New York
Clarkson College of Technology
New York Institute of Technology
Rochester Institute of Technology
State University College at Buffalo
State University of New York at Binghamton

Other sources of information were also consulted to place the study in perspective. These included professional journals, reports, and papers on pertinent and related topics, together with data available from Federal and State agencies.

Issues

The main issue concerns the need for additional bachelor of technology degree programs. Are the existing programs fulfilling present needs of industry, and will they have the capacity to provide for future (industrial and student) demand?

Will B.Tech. degree-holders be sufficiently different from those holding either baccalaureate degrees in engineering or associate degrees in engineering technology to warrant the outlay of resources to expand capacity? Are any different roles identifiable which would be more suitable for graduates of 4-year technology programs? Engineering-technical graduates assume a variety of roles in industry; what capabilities does industry want or need?

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*For purposes of this study and for the formulation of recommendations, the term "bachelor of technology (B.Tech.) degree program" is defined as an engineering technology program leading to the baccalaureate degree, in either a 2- or 4-year format. This includes the bachelor of professional studies (B.P.S.) program at Clarkson.

As a result of new technology, the spectrum of technical competencies needed by industry has grown. The consequent argument suggests that, if new engineers are going to receive adequate training in new, sophisticated theories and methods so that they will be capable of useful innovations, the effort devoted to studies in well-established "hands on" engineering techniques has to be limited. Therefore, it is further argued, need is evident for "technologists" to deal with the practical side of engineering achievement with emphasis upon the end product rather than the conceptual process.

> [The engineer is the product of a curriculum that provides for] the development of a capability to delineate and solve in a practical way the problems of society that are susceptible to engineering treatment, the development of a sensitivity to the socially related technical problems which confront the profession, and the development of an ability to maintain professional competency through continued self-study.[2]

> Engineering technology is part of a continuum extending from the craftsman to the engineer. Located nearest the engineer, it requires the application of scientific and engineering principles in support of engineering activities. The support is given whether or not the engineering technologist or engineering technician is working under the immediate supervision of an engineer. The term 'engineering technician' is applied to the graduates of the associate degree programs. Graduates of baccalaureate programs are termed 'engineering technologists.'[3]

If this perception is valid and assists in distinguishing the roles needed by industry, what is at issue? It demands that any investigation determine the extent to which industry expresses need for each distinguishable role. An added complexity is this: if industry perceives its needs for technical skills in a continuum, from technician at the bottom to engineer at the top, and defines a "technologist" as an intermediate function, it is likely that hierarchical status (salary and work responsibility) will be viewed in a similar continuum.

Demand or need by industry is not the sole indicator of need or rationale for bachelor of technology programs. Engineering technology has been a popular curriculum in the form of 2-year college programs. Perhaps many of the students entering such programs (designed mostly as the so-called "terminal" associate degree programs) have acquired greater aspirations through their successful completion of a collegiate program. Thus, student demand for an upper division transfer opportunity may be substantial. However, the issue is a matter of accountability; that is, determination of the "proper" balance between capacity of degree programs to meet student demand and the employability of, or labor market need for, graduates.

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[2]Footnotes for text citations begin on page 59.

Findings

1. Both of the terms "B.Tech." and "technologist" suffer from lack of definition among employers and educators alike; they are either underdefined or variously defined.

2. New York State employers consider technical salesman, technologist, and technical writer to be more appropriate work responsibility areas for B.Tech.'s than technical manager, engineer, and technician.

3. The New York State program directors consider technologist, engineer, and technical salesman to be more appropriate work responsibility areas for B.Tech.'s than technical manager, technical writer, and technician.

4. New York State employers more often view the training and attendant skills of B.Tech.'s as appropriate for work assignments outside the engineering-technical mainstream; the program directors more often view such preparation as appropriate for assignment within this mainstream.

5. New York State employers place B.Tech.'s intermediate to engineers and technicians and to engineering baccalaureates and technology associates with respect to starting and average annual salaries. The program directors concur with this placement.

6. Most graduates of New York State B.Tech. programs have entered "technical employment" upon graduation, as opposed to the very few who have engaged in graduate study or other activities.

7. Graduates of New York State B.Tech. programs have limited opportunity for State licensure as professional engineers. Experience beyond the mandated experience prerequisite for engineering baccalaureates is required; their degree programs are not accredited by the Engineers' Council for Professional Development (ECPD), which serves as one criterion in the licensure process for engineering baccalaureates.

8. New York State employers of B.Tech.'s are the larger employers and those with proportionately large engineering-technical staffs. However, even these employ a small number of B.Tech.'s compared to the number of other technical degree-holders.

9. Of the existing B.Tech. programs in New York State, two offer full 4-year programs and the remaining four offer upper division (last 2 years) programs. Additional technical, rather than supplementary nontechnical, training characterizes the final 2 years of all these programs. Three private and three public institutions offer B.Tech. programs; none of these programs is accredited by the Engineers' Council for Professional Development (ECPD).

10. Most of the program directors believe that New York State's capacity to produce B.Tech.'s is adequate or that additional supporting evidence would be needed to justify more programs. None calls for increased capacity.

11. New B.Tech. programs in New York State have experienced considerable enrollment growth in their first 2 years, followed by a stabilizing of enrollments. The projected growth in full-time enrollment in current B.Tech. programs is moderate or even slight; however, projected growth in part-time enrollment is relatively high. Statewide enrollment in current programs is predominantly in the upper division; most of this consists of students who have received an associate degree from a 2-year engineering-related technology program offered by another institution.

12. Nationally, engineering technology programs, both 2-year and later 4-year, realized initial growth in the absence of universal planning or coordination with traditional engineering education. This growth has stabilized recently.

13. The national growth rate of the number of B.Tech. programs is greater than that of the number of students enrolled in them; the number of students per 2-year engineering technology program has declined steadily. In New York State, the ability of the 2-year programs to attract students is declining.

14. Engineering enrollments experienced decreases subsequent to the employment decline, but are now stabilizing at relatively diminished levels with underutilization of engineering school capacity.

15. Engineering employment has recovered from the decline of the early 1970's and is basically stable with fluctuations only within areas of specialization.

Conclusions

New York State does not need expansion of career-oriented programs based on elusive definition; this conclusion is strengthened by the demonstrated lack of numerical demand by either students or employers. The products of existing programs seem to suffer from a similar under-definition partially brought about by the non-ECPD-accredited status of the programs. It is emphasized that this, in turn, has been perpetuated by dissonance in the development and implementation of accreditation standards.

It is impossible to assess with precision the issue of whether the B.Tech. is different from the engineer or technician by virtue of the difficulty experienced in defining the B.Tech. by either learning objectives or potential work functions. The employer survey revealed differing perceptions of the B.Tech.; these were compounded by the lack of employer familiarity resulting from the newness of the degree in New York State. While baccalaureates in engineering or science were defined with almost the same precision as associates in science or applied science, the lack of definition of the B.Tech. — as a potential employee — prevents clear comparisons. As more and more B.Tech.'s enter the labor market, much of the employer unfamiliarity will dissipate. Increased familiarity with B.Tech.'s will enable employers to assess the value of the degree.

The B.Tech. degree seems to move the student from a defined state (Associate = Technician) to an undefined state:

Bachelor of Technology $\neq$ Technician

Bachelor of Technology $\neq$ Engineer

Bachelor of Technology $\stackrel{?}{=}$ Technologist [sic]

The study addresses the intermediate role toward which the B.Tech. is supposedly directed. This argument suggests that the B.Tech. should be hired into a position on the engineering-technical continuuum, somewhere between the technician and the engineer-scientist. While it was found that such placement is described accurately by the relative level of compensation reported for B.Tech.'s, several work assignments are not in this continuum. Moreover, they fall outside the engineering-technical spectrum in functions such as technical writer or technical salesman.

If the B.Tech. is hired into a job similar to that of the junior engineer (the recent recipient of an engineering baccalaureate who aspires to be an engineer or engineer-scientist), he would not benefit from the same career ladder, being underqualified for an engineering position. Should the B.Tech. aspire to achieve engineer status by way of professional licensure, he will again experience considerable barriers in the form of supplemental experience requirements.

Alternately, if the B.Tech. takes a position as a technician, he will find himself overqualified. This paradoxical conflict in qualifications characterizes a class of employees most subject to labor market perturbations.

The current B.Tech. employers — those most familiar with the applicability of jobs for the new graduates — did not perceive a direct association between the B.Tech. and either the "technologist" or the engineering-technical mainstream; roles other than technologist and outside the mainstream were most often identified with the B.Tech. Since the current B.Tech. employers were primarily those with large full-time staffs and proportionately large engineering-technical staffs, their opinions should be most credible and influential.

Another major conclusion is that there is no demonstrated need - on any of the examined bases - for expansion of New York State's capacity to prepare students for the B.Tech. degree. The present evidence indicates that neither student demand nor industrial need justifies the development of new programs or the expansion of existing programs at a rate greater than that reported by the responding institutions in the course of the present investigation.

While there is a clear transfer path for the holder of an associate degree in technology to actualize himself educationally through the B.Tech. degree, the use of this path does not appear to have great potential for growth within the immediate future (through 1980). If the number of programs, or the size of the existing ones, are allowed to increase by drawing upon the same pool of potential students, each program will have a lesser share of the whole.

Additionally, expanded B.Tech. capacity may detract further from enrollments in traditional engineering curricula, which have declined already to a relatively low, although stable, level. This detraction may occur at both the freshman and junior entry points, when a student can select, firstly, an associate program in engineering technology or a baccalaureate program in engineering, and later, when the choice is between a B.Tech. or engineering transfer program. Further, due to the anticipated enrollment decline in 2-year (associate) technology programs, one major segment of the pool of potential students (also a pool for engineering enrollments), will be adversely affected. Any such diversion of potential engineering enrollments would compound the engineering-technical employment situation by increasing the likelihood of a shortage of engineers by 1980.

Recommendations

1. **No existing B.Tech. programs should be re-registered in the absence of accreditation.**

All existing B.Tech. programs should take immediate steps to achieve accreditation by the Engineers' Council for Professional Development (ECPD). Evidence of progress toward this status should be a condition for continued program registration by the New York State Education Department.

At present, accredited engineering technology associate and engineering baccalaureate programs receive such approval from ECPD. It is entirely proper that the B.Tech. programs follow this pattern. In general, it is inappropriate for any degree program in New York State to operate without official sanction by the nationally recognized accrediting body.

Pressure for accreditation by the New York State programs would be catalytic in developing precise and acceptable criteria for approval of these programs. It is felt that approval on a nationally recognized basis constitutes the most practical way of approaching the problem of underdefinition; the definition of the B.Tech. at the program level will thus be tightened as a benefit to both institutions and students. Institutions will benefit from the better market comprehension of their degree programs and will acquire increased recruitment potential. Students will profit in two ways: enhancement of the ability to pursue professional licensure as an engineer and possession of a more recognizable credential.

This recommendation implies cooperative action by employers and educators in pursuing congruence between learning objectives and required job skills. The resulting qualitative capitalization of current program capacity will aid in removing much of the difficulty in matching degree recipients with career opportunities.

2. No new B.Tech. programs should be approved.

There is no need for expanded capacity. Any expansion would be to the detriment of other technical programs, merely redistributing the same students among more programs. Growth rates for 2- and 4-year technology enrollments are no longer substantial; engineering enrollments have declined and remain at a relatively low level; the overall college-age population is expected to decline; therefore, there is no reason to believe that bachelor of technology programs will be exceptions to these trends.

Employers neither indicated quantitatively nor expressed qualitatively, any particular shortage of, or great need for, personnel with skills such as those perceived as being offered by B.Tech. holders. This may be a result of three considerations: the degree may be too new for most employers to have acquired familiarity and confidence with it; recent engineering baccalaureates may be preferred by the companies; and technicians with associate degrees but considerable experience may be preferred over the underdefined technology baccalaureates.

Evidence from employers illustrates no particular increase in the labor market; evidence concerning student demand demonstrates slight (and even declining) need for additional opportunities via B.Tech. programs. Unless new and dynamic trends are documented, the recommended policy of no new programs should be maintained through 1980.

CONTEXT OF THE STUDY

Discussion of the baccalaureate degree in technology must be placed in context with the broad spectrum of both engineering-technical employment and enrollment, including baccalaureate degrees in engineering and associate degrees in engineering technology. To identify the pertinent issues, selected professional journals in engineering and engineering education, papers, reports, and studies were reviewed. Three topical areas were examined: engineering employment, engineering enrollment, and engineering technology. However, it was often impossible to separate the areas since their effects are strongly coupled.

Engineering Employment

The demand for engineers bottomed out and the number of unemployed engineers peaked in 1971. The trend toward recovery is and promises to be slow with current levels of demand and employment, although substantially better than 1971, which was little better than the depressed employment situation of 1964.[4]

Direct employment by Federal and state governments, according to their own projections, should remain stable or increase very slightly in the long and short term. New hiring will decrease.[5] Industry has provided the bulk of the employment that reversed the recent employment trends and is projected to provide the slow growth in engineering employment over the next decade.

Funding for research and development has a direct relationship to engineering employment. Projections indicate that Federal funding will remain stable or grow slightly, while industry will provide the fastest growing source of new R&D funds.[6] The changing source of engineering employment has been taken to indicate that the cause of engineering unemployment was not so much an oversupply of engineers, but rather a rapid and large scale change in national priorities with a shift from a defense/aerospace economy to a civilian economy.[7]

A very visible issue centers around whether there will be a shortage of engineers a decade or less from now. Based on projections of a slow but steady increase in the demand for engineers, and assuming only constant enrollment in engineering schools, educators and some members of the profession project a shortage of engineers by 1980.[8] Educators tend to wish that recognition of this view would ease their current enrollment problems.

Since World War II, the market for young engineers just completing their education has been consistently favorable.

> Employers find the self-discipline and problem-solving attitude of young engineers highly desirable for many tasks (operation, testing, maintenance, sales, service, production, administration) for which engineering training to the BS level is useful but not

always absolutely necessary. While the supply of engineers appears to be significantly greater than the number actually needed to carry on work that can be done only with an undergraduate engineering background, the demand for engineers to fill quasi-engineering positions ranging from technician to business functions is so large that all BS engineers available are eagerly snapped up.[9]

Expressing the same type of observations, a similar statement was made more recently:

> By any method of counting, engineering is a very large occupation or profession, and this is an extremely important factor in assessing future employment opportunities because a major component of manpower demand is the need to replace those who leave the work force through death, retirement, or change of occupation. The U.S. Department of Labor has estimated that an average of 37,000 engineering openings per year between 1970 and 1980 will be created by these factors alone, in addition to expected growth in overall engineering employment. It is therefore apparent that a large built-in demand for new engineers exists by virtue of the very size of the profession.[10]

In sum, the area of engineering employment is experiencing growth especially through the increasing employment opportunities for recent graduates rather than experienced engineers, and particularly within private industries rather than governmental agencies.

Engineering Enrollment

Nationally, freshman class enrollments for fall 1972 were down 11 percent from 1971; these, in turn, were down 18 percent from 1970. By comparison, freshman class enrollments were down only about 8 percent between 1967 and 1970.[11] Even though the size of the freshman class has stabilized recently, total engineering enrollment will decrease for a few years as the earlier, larger classes are graduated. The precipitous decline in freshman enrollments during the early 1970's will be reflected in correspondingly smaller graduating classes in 1975 and succeeding years.[12]

Enrollments in graduate engineering show a decline also, but more moderately than undergraduate enrollments. (See table 9.)

This decrease in enrollment in relation to the population of high school seniors is felt by expensive private institutions. Colleges must look forward also to a leveling off of the growth, or more likely, outright decline of the college-age population. Many educators feel that if enrollment trends are to be reversed, engineering education must make new thrusts into programs dealing with society's emerging needs.[13]

TABLE 1. ENGINEERING ENROLLMENTS — U.S.A.

Full-Time and Part-Time Engineering Enrollments in the United States by Level of Study
Fall 1967 to Fall 1972

Type of Enrollment and Level of Study	Fall Enrollments					
	1967	1968	1969	1970	1971	1972
Undergraduate, Full-Time						
Freshman	77,551	77,484	74,113	71,661	58,566	52,100
Sophomore	56,975	55,615	52,972	53,419	47,948	42,272
Junior	50,483	50,274	50,039	49,855	48,543	45,874
Senior	47,551	50,736	51,738	51,983	51,377	49,895
Fifth Year	4,589	5,133	4,668	4,812	4,391	4,586
TOTAL	237,149	239,242	233,530	231,730	210,825	194,727
TOTAL - Undergraduate, Part-Time	NA	20,754	20,984	18,445	18,222	14,149
Graduate, Full-Time						
Master's	34,231	24,469	20,014	23,216	22,405	22,877
Doctoral	15,376	15,768	14,298	14,802	14,100	13,460
TOTAL	49,607	40,237	34,312	38,018	36,505	36,337
TOTAL - Graduate, Part-Time	NA	27,246	32,645	30,802	27,302	24,940

SOURCE: Engineering Manpower Commission Annual Surveys.[14]

For the long-term, government, industry, educational institutions, and the profession seem to agree that any possible extraordinary growth in demand will occur not in the traditional engineering fields, but in fields dealing with the application of engineering expertise to the human problems of food processing, environment, health care, transportation, city planning, housing, finance and banking, resource utilization, and other societal areas. As a result, most enrollment projections assume constant enrollment at current low levels. The opinion is expressed that there are too many schools to serve too few students. If increased enrollment is vital to one school, it can be achieved only at the expense of other schools.

The Association of Engineering Colleges of New York State conducted its own survey to determine engineering enrollment as viewed through their institutional capacity. The 1973 survey showed that engineering school utilization was 64 percent. The small freshman and sophomore classes were expected to cause a drop in the average utilization to below 50 percent. The Association concluded, because of an excess capacity of that magnitude, there was "no reason to build new facilities or develop new programs . . . until full use is made of the existing institutions." The Association further concluded that a considerable pool of students did exist — A.A.S. degree graduates of technology programs allied to engineering. In fact, the Association passed a resolution to the effect that it not only recognizes the need to accommodate these students in New York's engineering colleges, but that "adequate facilities and faculties now exist . . . to provide for such graduates."[15] Institutions in the association were not "closing the door" on the development and expansion of new programs; however, they felt strongly that such programs should be developed only to the extent that additional need was demonstrated. This serves to illustrate the interface between engineering and engineering technology and also between the State's 2-year and 4-year colleges.

The statewide enrollment for upper-division engineering students is displayed in the following table.

TABLE 2. UPPER DIVISION ENGINEERING ENROLLMENTS

Upper Division Engineering Enrollments in New York State
1970-71 to 1972-73

Enrollment	1970-71	1971-72	1972-73
TOTAL	11,168	10,587	10,649
Full-Time	9,286	8,701	8,553
Part-Time	1,882	1,886	2,096

SOURCE: New York State Education Department, Higher Education Data System, 1974.

Total upper-division engineering enrollment decreased by 5.2 percent between 1970-71 and 1971-72; total undergraduate enrollment increased by 6.3 percent for the same period. While the total upper-division engineering enrollment increased by 0.6 percent the following year, total undergraduate enrollment increased by 1.4 percent.[16]

In 1969, Terman reported that as many as 20 to 25 percent of the State's 2-year engineering technology graduates eventually transfer to an engineering college. He stated that, "since the engineering technology programs do send many students on to BS programs at engineering colleges, these programs cannot be ignored in studies of the relation of 2-year colleges to engineering education."[17] Terman commented further in the very next paragraph:

> Concern has been expressed that engineering technology students (who are about twice as numerous as engineering science students) would be able to continue their formal education beyond the associate level only by transferring to a traditional engineering program. During this study it became obvious that a few influential persons responsible for the engineering science programs at 2-year colleges are also strong proponents of bachelor of engineering technology (BET) programs in New York State. These individuals feel that if such programs were offered, many students who would not be interested in standard BS engineering programs would continue their education in engineering technology, with the result that certain technical needs of industry in New York State would be better fulfilled.[18]

The report continued by citing three conferences which demonstrated the interest at that time in starting a "BET" program:

> These conferences are noted, not because the bachelor of engineering technology program is a significant factor in this study, but rather to indicate that many persons presently responsible for engineering science programs at 2-year colleges (which "feed" students to third- and fourth-year programs at engineering colleges) are also interested in and concerned about a possible BET program in New York State.[19]

Engineering Technology

The recent growth in 2-year engineering technology programs and in the use of engineering technicians in industry has raised several issues. What are the proper educational requirements for an engineering technician? How should the engineer interact with the newly, more highly educated technician? What is the projected long-term employment demand for engineering technicans? Are existing educational facilities appropriate in size and nature to meet this projected demand? And finally, what is a technologist?

Several different sources have pointed out that associate and baccalaureate technology programs have evolved haphazardly from both the point of view of individual programs and the programs taken collectively. Requirements lack

uniformity and curricula lack unified planning. The problems are more obvious in the B.Tech. programs. Accrediting agencies such as the Engineers' Council for Professional Development (ECPD) have only begun the effort involved in systematically evaluating programs awaiting accreditation.

> Standards for the accreditation of engineering technology and industrial technology curricula are relatively new and in some aspects are still undergoing development. Although accreditation provides a definitive means of categorizing programs, only a minority of schools offering engineering technology curricula are ECPD-accredited and many appear to have little interest in seeking such accreditation.[20]

A typical recommendation suggests that technology programs, be they of the 2-year or 4-year variety, be developed and operated using precise and, hopefully, fairly universal objectives for guidance. These objectives have yet to be developed and accepted, particularly at the upper division level. In fact, perhaps for that reason, none of the institutions currently offering B.Tech. programs in New York State has sought accreditation of its program by ECPD as of June 1974.

Some discussions on the relationship between engineering programs and engineering technology programs have centered on the potential negative results of allowing these programs to overlap and/or to interact. While perhaps allowing engineering and technology students to learn to work together in a manner similar to future industrial roles, interaction in the educational setting can result in the latter being perceived as inferior to the former. Additionally, the economic desire to combine various parts of the two programs would tend to compromise the quite distinct goals of each. A recommendation found frequently in the literature is that there should be a clear separation between engineering and engineering technology programs.[21] Initiation of technology programs at engineering institutions, with proper separation and distinguishable characteristics, may help to reduce the problems associated with the decline of engineering enrollment.

Another indirect educational relationship between engineers and other technical personnel can be observed. The educational requirements for the professional practice of engineering are growing. Becoming an engineer without at least a 4-year degree is difficult; the possession of a graduate or professional degree is becoming more desirable. It has been suggested that a professional degree will be required by 1980, and by 1984, a doctorate in engineering will be required.[22] Others believe that the advent of a graduate degree as the professional degree would occur, but not until the 1990's. Most engineering institutions in the State are still planning on the assumption that the baccalaureate degree will be <u>the</u> professional degree for engineers — at least for the immediate future.

Whatever the future picture, the increased availability and acceptance of more highly trained technicians would seem to promote such changes in professional requirements, providing more competent personnel to do the work for which the more highly educated engineer will be overtrained. The role of the B.Tech. graduate, whether planned or evolved, seems to parallel

the role of the paramedic. Perhaps for this reason, the growth of the bachelor of technology enrollments and programs was substantial at the outset. However, that trend has subsided.

> The Engineering Manpower Commission (EMC) of Engineers Joint Council started surveying technology enrollments and degrees in 1966 at the request of the American Society for Engineering Education (ASEE). Prior to that time the data published by ASEE related only to schools having curricula accredited by the Engineers' Council for Professional Development. The continued growth of technology degrees in such schools is illustrated in table [3]. However, the growth is largely due to the accreditation of curricula in new schools each year. It should be noted that the average number of associate degrees per school has been dropping steadily since 1956, when it stood at 190, to 112 in 1973.[23]

TABLE 3. TECHNOLOGY DEGREES — U.S.A.

Associate and Baccalaureate Technology Degrees Granted in the United States by Institutions Having at Least 1 ECPD-Accredited Curriculum 1953-54 to 1972-73*

Year Ending June 30	Certificates and Associate Degrees		Baccalaureate Degrees**	
	Number of Institutions	Graduates	Number of Institutions	Graduates
1954	27	3,927		
1955	27	4,365		
1956	29	5,499		
1957				
1958	35	5,928		
1959	35	6,478		
1960	34	7,639		
1961	33	6,284		
1962	32	6,035		
1963	32	5,489		
1964	32	5,507		
1965	33	5,695		
1966	37	5,270		
1967	38	6,144		
1968	44	6,264	1	30
1969	46	6,536	2	173
1970	52	7,740	5	720
1971	63	8,443	11	1,144
1972	68	9,084	15	1,736
1973	84	9,386	24	2,161

*Blanks indicate that no surveys were conducted.

**Totals for 1973 included both engineering technology and industrial technology graduates of ECPD-accredited programs.

SOURCE: Engineering Manpower Commission Annual Surveys.[24]

OUTCOMES OF THE SURVEYS

Two independent surveys were conducted as part of the study. The first sampled employers in New York State — companies and organizations that are potential (or current) employers of B.Tech. holders; the second survey sampled directors of existing programs leading to the B.Tech. degree. While each survey utilized its own questionnaire, some of the questions asked of the employers were asked of the educators also. Both surveys solicited "additional comments."

The following presentation of findings from both surveys is organized into three subsections. The first subsection reports on the survey of potential employers and the second on the survey of program directors. Both subsections describe the relevant sample and instrument, and present in detail the derived observations and specific findings; both reference background and tabular material in the appropriate appendixes. The third subsection presents selected additional comments of the respondents.

Survey of Potential Employers

The purpose of this survey was to obtain reactions from companies and organizations concerning the training and hiring of persons holding a bachelor of technology degree. The basic question guiding investigation in the survey was: "Do potential employers of persons holding a bachelor of technology degree believe there is a need for such persons in the labor market?" Germane to this general statement of the problem were the following specific questions:

— What is the profile of engineering-technical employees of companies and organizations with respect to percent of total work force, academic qualifications, average salaries, and starting salaries?

— What is the attitude of potential employers of B.Tech. holders with respect to starting salaries, compensation levels relative to engineers and technicians, and areas of work responsibilities considered appropriate?

— What is the future need of companies and organizations for employees offering skills such as those of B.Tech. graduates?

The Sample - Using three New York State Department of Commerce listings, a sample drawn randomly within each list was used for a mailing to 150 private employers. This was augmented by 25 public employers, for an attempted sample of 175. No effort was made to restrict the sample to only those companies with emphasis in engineering-technical areas, since other types of companies also may be potential employers. (The employer groups in the attempted sample and valid respondents in the test sample are listed in appendix A-1; tables 4 and 5 show the employers who answered and responded.)

TABLE 4. ATTEMPTED EMPLOYER SAMPLE: GROUP AND SIZE

Number and Percent of Attempted Employers Who Answered and Responded, by Employer Group and Number of Full-Time Employees

Employer Groups	Population	Attempted	Answered		Respondents		Does Not Apply (See Text)	
			Number	Percent*	Number	Percent*	Number	Percent*
PRIVATE**	1,074	150	99	66.0%	80	53.3%	19	12.7%
5,000 or more	58	50	35	70.0	27	54.0	8	16.0
1,000 - 4,999	449	50	28	56.0	26	52.0	2	4.0
500 - 999	567	50	36	72.0	27	54.0	9	18.0
PUBLIC	NA	25	16	64.0	14	56.0	2	8.0
TOTAL	NA	175	115	65.7	94	53.7	21	12.0

*Percent of attempted.

**New York State Department of Commerce groupings by number of full-time employees.

TABLE 5. ATTEMPTED EMPLOYER SAMPLE: REGION

Number and Percent of Attempted Employers Who Answered and Responded, by Region*

Regents Region*	Attempted	Answered		Responded		Does Not Apply	
	Number	Number	Percent**	Number	Percent**	Number	Percent**
Western	17	8	47.1%	6	35.3%	2	11.8%
Genesee Valley	15	13	86.7	11	73.3	2	13.3
Central	16	13	81.3	13	81.3	—	—
Northern	1	1	100.0	1	100.0	—	—
Northeast	9	5	55.6	3	33.3	2	22.2
Mid-Hudson	11	8	72.7	6	54.6	2	18.2
New York City	98	62	63.3	50	51.0	12	12.2
Long Island	6	3	50.0	3	50.0	—	—
TOTAL	175***	115***	65.7	94***	53.7	21***	12.0

*Postsecondary Education Regions of the Regents (displayed in figure 2).

**Percent of attempted.

***One employer with an out-of-State address was nonapplicable and one with statewide operations was a valid respondent.

The actual sample yielded from the survey of 175 employers was shown by group in table 4 and by region in table 5. Some of the employers stated that the questionnaire was not applicable to their organizations; these were separated from the valid respondents.

Out of 175 attempted employers, 115 answered the survey producing 94 (53.7 percent) valid respondents. These 94 respondents allowed the use of 96 responses as displayed in figure 1. The two additional responses resulted because one company in the sample responded twice — once for each large division, and because two employers in the sample (different administrative levels of the same organization) provided three responses — once for each of three appropriate organizational units.

The resulting 96 responses available for analysis evidenced slight discrepancies in size, as measured by the number of full-time employees reported versus the Department of Commerce groupings. Three groups of employers are shown by adjusted size in table 6.

TABLE 6: EMPLOYER RESPONDENTS: GROUP AND SIZE

Percent Distributions of Responding Private and Public Employers by Number of Full-Time Employees

Number of Full-Time Employees (Reported)	Private Employers		Public Employers		ALL EMPLOYERS	
	Number	Percent	Number	Percent	Number	Percent
5,000 or More	24	29.6	5	33.3	29	30.2
1,000-4,999	26	32.1	5	33.3	31	32.3
Less Than 1,000	31	38.3	5	33.3	36	37.5
TOTAL	81	100.0	15	100.0*	96	100.0

*Detail does not add due to rounding.

The responding employers provide a sample that is evenly distributed by size in both the public and private sectors. With few exceptions, the "less than 1,000 employees" category is composed of employers having more than 500 employees. Thus, the survey may be described as sampling the larger employers in the State.

Four groups of employers are displayed by adjusted size and reported location of engineering-technical staff by Regents region in table 7.

FIGURE 1. DERIVATION OF EMPLOYER TEST SAMPLE

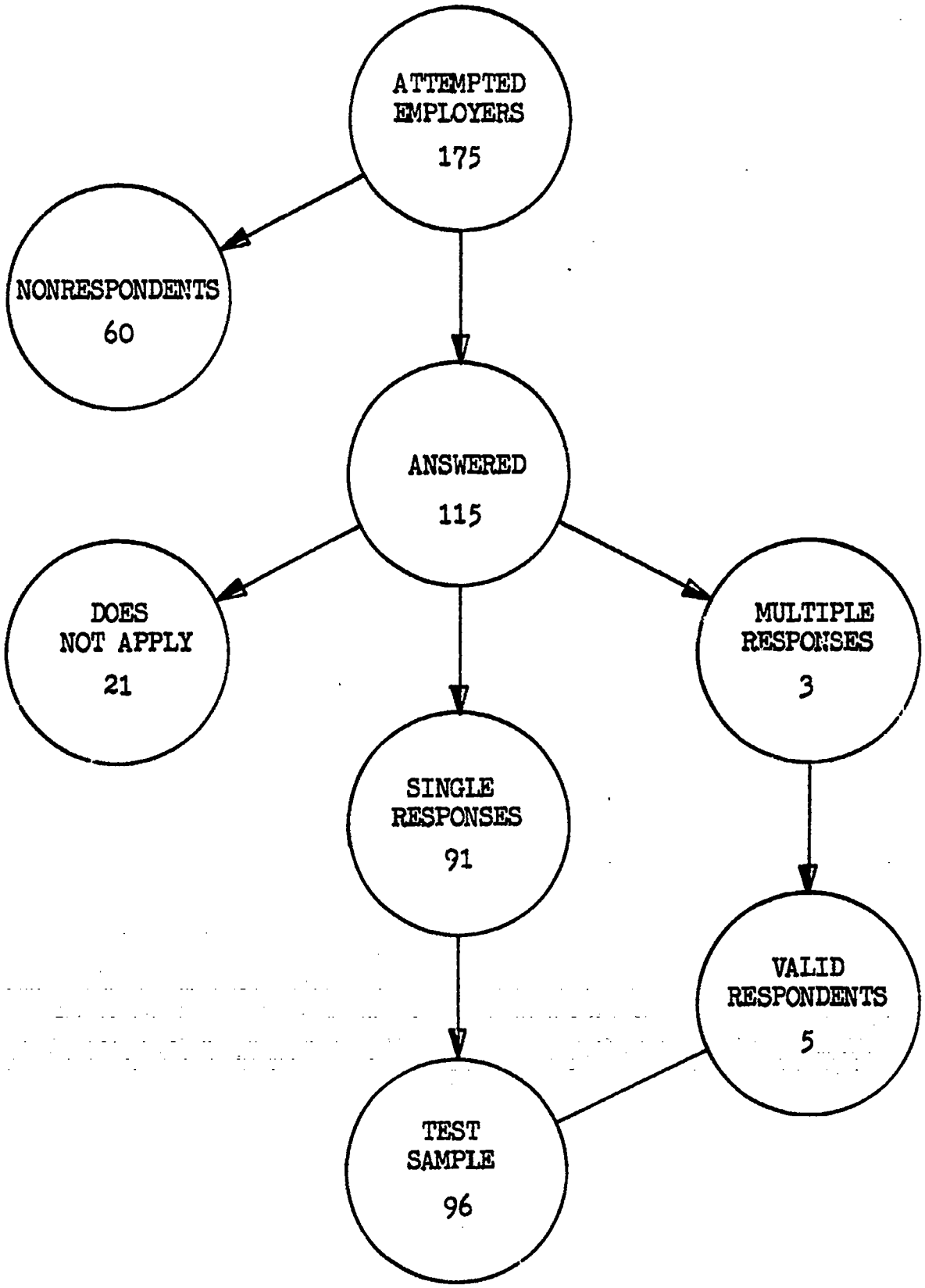

TABLE 7. ENGINEERING-TECHNICAL STAFFS: LOCATION

Number of Responding Private and Public Employers by Number of Full-Time Employees and by Location of Engineering-Technical Staffs

Regents Region*	Number of Full-Time Employees (Reported)								
	5,000 or More		1,000 - 4,999		Less Than 1,000		ALL EMPLOYERS		
	Private	Public	Private	Public	Private	Public	Private	Public	Total
Western	—	—	4	—	2	—	6	—	6
Genesee Valley	4	—	2	—	6	—	12	—	12
Central	4	—	4	1	4	—	12	1	13
Northern	—	—	—	—	1	—	1	—	1
Northeast	1	—	—	—	2	—	3	—	3
Mid-Hudson	1	—	2	—	3	—	6	—	6
New York City	13	4	13	4	12	5	38	13	51
Long Island	1	—	1	—	1	—	3	—	3
TOTAL	24	5**	26	5	31	5	81	15**	96**

*Postsecondary Education Regions of the Regents (displayed in figure 2).

**Includes 1 statewide employer.

The Instrument - The questionnaire (shown in appendix A-2) was designed to obtain the attitudes of potential employers regarding graduates of B.Tech. programs, as well as to obtain descriptive data on the organizations themselves. The instrument provided for data such as the percent of total work force on engineering-technical staffs, starting and average annual salaries, relative compensation levels of associate and baccalaureate degree-holders and engineers and technicians, and appropriate areas of work responsibilities for B.Tech. holders.

The Findings - Throughout the discussion of findings, references are made to applicable tables in appendix A-3. The findings are reported under three general categories: B.Tech. employers; relative salaries; and appropriate functions, based on opinions by both B.Tech. and non-B.Tech. employers.

B.Tech. Employers. Of the 96 employers in the sample, 22 (22.9 percent) responded that they currently have B.Tech. holders in their employ. They are herein referred to as "B.Tech. employers." (Only one of these is a public employer — an employer with 5,000 or more employees.) This compares with 94.8 percent who employ engineering baccalaureates and with 81.3 percent who employ associate* degree-holders.

More than half (54.6 percent) of the current employers of B.Tech. holders report employing between one and four B.Tech.'s. As the number of B.Tech. employees increases, the proportion of B.Tech. employers decreases rapidly until only three employers (13.6 percent) report employing 25 or more B.Tech. holders.

The employers tending to have B.Tech.'s in their employ already are the largest companies; 11 of the 29 (37.9 percent) employers with 5,000 or more employees presently employ B.Tech. holders, whereas only 11 out of 67 (16.4 percent) of employers with less than 5,000 employees employ B.Tech. holders. Based on a chi-square statistic, it may be assumed that whether or not a firm has one or more B.Tech. holders in its employ is not independent of the firm size; that is, in general, the larger the firm in terms of full-time employees in New York State, the greater the likelihood that the firm will have B.Tech.'s in its employ. (The chi-square statistic yielded significance at the 0.025 level.)

Also, the employers with a larger proportion of employees (10 percent or more) on engineering-technical staffs more often reported employing B.Tech.'s than those with a smaller proportion. As would be expected, firms with a larger percent of staff assigned to the engineering-technology area tended to have B.Tech.'s in their employ while those with lesser percentages so engaged tended not to have B.Tech.'s in their employ. (This could be demonstrated at the 0.1 percent level of significance using a chi-square statistic.)

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*Refers to any associate level degree in a technical field.

TABLE 8. ENGINEERING-TECHNICAL STAFFS — B.TECH. EMPLOYERS

Percent of Employees on Engineering-Technical Staff	B.Tech. Employers as a Percent of Total Employers
Over 25%	40.0%
11-25%	50.0
6-10%	11.8
5% or Less	9.1

Almost three-fourths (72.8 percent) of the B.Tech. employers, as compared to 45 percent of all employers, report that their engineering-technical staffs constitute more than 10 percent of their total full-time employees. (See also table 14 in appendix A-3.)

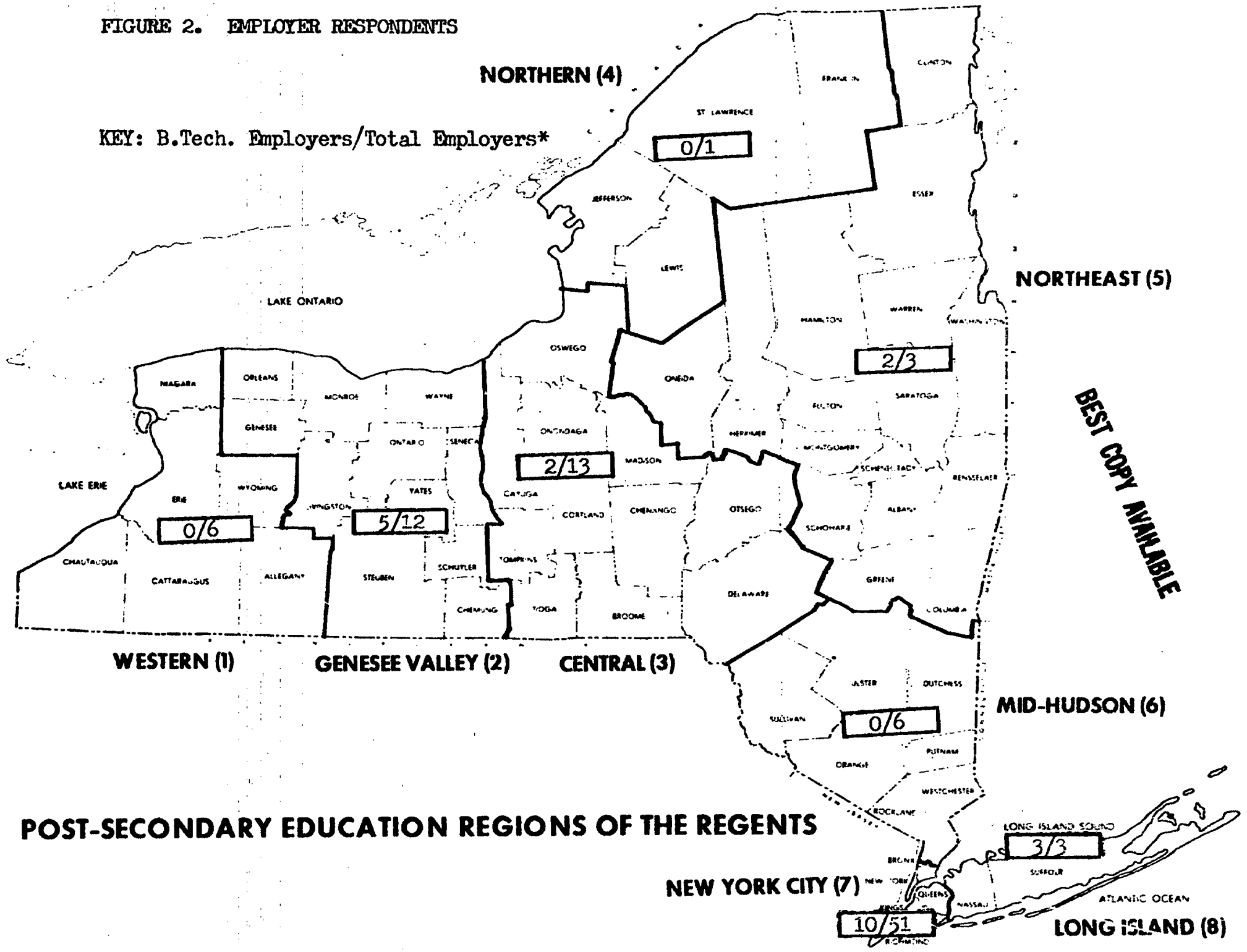
The engineering-technical staffs of employers in the total sample (n=96) are located across all eight postsecondary education regions of the Regents. (See figure 2.) In six of these eight regions, employers report having B.Tech. holders in their employ at the present time.

Relative Salary. The current annual starting salaries for employees with baccalaureate degrees in an engineering field and associate degrees in a technical field were compared to the judgments of the employers as to an appropriate annual starting salary for recent recipients of the B.Tech. (The relative starting salaries for each of the three types of degrees are shown as a percentage distribution of all employers in table 15 in appendix A-3.)

Employers of B.Tech. holders express uniform opinion as to the proper salary level to be paid to a recent recipient of a baccalaureate in engineering, with only one employer giving an answer different from the other 21; when the salary levels for associate degree-holders in technology were reported, absolutely no deviation in the level was expressed. It is reasonable to conclude from these observations that at least the employers in this subsample are well able to evaluate the dollar-worth of a baccalaureate or associate degree. When evaluating the salary levels for a B.Tech. holder, a slightly greater variation occurred; nine of the 22 employers gave the salary range $5,000-9,999 and thirteen the range $10,000-14,999 — this by respondents who report having between 1 and 120 B.Tech.'s in their employ. (It is necessary to caution that the forced-choice salary ranges presented in the questionnaire were too wide for precise discrimination.)

FIGURE 2. EMPLOYER RESPONDENTS

KEY: B.Tech. Employers/Total Employers*



*NOTE: One employer is statewide and is not shown.

A similar observation may be made with respect to the non-B.Tech. employers; that is, the variation in opinion concerning salary for baccalaureate in engineering and associate in technology degree-holders was much less than it was for the B.Tech. holders. This group of employers is also diverse in the individual opinions as to the dollar-value of the B.Tech. Of the 74 non-B.Tech. employers, 67 expressed an opinion as to the appropriate starting salary for a B.Tech. holder: 28 gave a range of $5,000-9,999; 39 a range of $10,000-14,999; and 1 went as high as $15,000-19,999.

Again noting the broad salary ranges used in the questionnaire, there was a 48 percent difference in the mean response for salary level for a baccalaureate in engineering versus an associate in technology and a 30 percent difference between associate and a B.Tech. holder (B.Tech. employers only); there was a 14 percent difference between the mean response for baccalaureate in engineering and B.Tech. degree-holders. Similar data were provided by the non-B.Tech. employers but without as great a dispersion between the salary levels for baccalaureate in engineering and B.Tech. holders. B.Tech. employers would seem to offer a higher salary to a baccalaureate in engineering than would the non-B.Tech. employers, but lower salaries for associates in technology and B.Tech.'s.

Over 80 percent of all employers reported starting annual salaries for engineering baccalaureates to be $10,000 or more, mostly (77.1 percent) in the $10,000-14,999 range. The reverse was true for associate degree-holders, with about three-fourths (72.9 percent) of the employers reporting starting annual salaries below $10,000. As for B.Tech. degree-holders, all employers placed starting salaries in the middle ground, i.e., about one-half (52.1 percent) judging $10,000-14,999 to be an appropriate starting salary.

When the starting salary data are regarded according to the size of employer, no changes are observed which would alter the comparative levels of starting salaries among the three degree types. The percentage distribution of only the employers presently employing <u>at least one</u> B.Tech. holder also shows no great deviation in the attributed salary ranges. Although the distribution of B.Tech. employers shows a slightly higher percentage of employers selecting the $10,000-14,999 starting salary level for B.Tech. holders (59.1 percent), greater increase is observed in the percentage of employers selecting that salary level for baccalaureate in engineering degree-holders (95.5 percent). (See table 15 in appendix A-3.) Furthermore, the 7.3 percent of <u>all</u> employers, who did not judge the starting salary level for B.Tech. degree-holders, must be observed. About 40 percent of both the total sample and the B.Tech. employers alone considered $5,000-9,999 to be an appropriate starting salary for B.Tech. holders.

In addition to levels of starting salaries, the employers were asked to provide data on the current annual <u>average</u> salaries of their employees by degree type. As expected, the greatest proportion of employers consistently attributed the higher salary ranges to baccalaureate in engineering degree-holders and the lower salary ranges to associate degree-holders. The average salary for the former was reported as $15,000 or more by 66.7 percent

of the employers; the average salary for the latter was reported as less than $15,000 by 63.5 percent of the employers. (Of course, there is overlap in the salary levels ascribed to the two types of degree-holders.) It should be pointed out also that the data are somewhat confounded by the too-broad ranges themselves, and by the unfortunate fact that the employer data available on associate degree-holders were limited as compared to the data on baccalaureate in engineering degree-holders. Thus, the findings must be stated in limited terms.

The average annual salaries of employees with baccalaureate in engineering and associate degrees are viewed with the relative level of compensation considered to be appropriate for B.Tech.'s. None of the 96 employers thought that B.Tech.'s should be paid higher than an engineer. The percentage of employers who thought B.Tech. holders should receive compensation equal to an engineer decreases as the salary levels become higher. At each salary level, at least one-half and not more than two-thirds of the employers consider that the appropriate level of compensation for a B.Tech. degree-holder should be lower than an engineer.

Only two employers judged that the compensation level of a B.Tech. should be lower than a technician. None of the B.Tech. employers thought a B.Tech. holder's salary should be less than a technician, just as none of them thought it should be higher than an engineer.

Of the 96 employers, 71.9 percent considered the appropriate level of compensation for a B.Tech. holder to be higher than that of a technician, while 12.5 percent thought it should be equal to that of a technician; for the B.Tech. employers, the comparable data are 86.4 and 13.6 percent. (See table 16 in appendix A-3.) Only slight differences occur among the employers when distributed by size. However, the B.Tech. employers are more in agreement concerning the relative salaries for B.Tech. holders than any of the size-groups of all employers combined. The largest proportions of employers showing consensus are the percentages of B.Tech. employers: 75.0 percent agree that the B.Tech. should be compensated lower than the engineer and 86.4 percent agree that the B.Tech. should be compensated higher than the technician. All employers and each of the size-groups of employers show agreement in the same direction but not to the same degree.

All but four of the 22 B.Tech. employers judged that the starting salary for a B.Tech. should be "relatively lower" compared to that of an engineer (four felt that a B.Tech. should be paid equally); all but three employers thought that the B.Tech. starting salary should be higher than that of a technician. (The three offering a different judgment felt that a technician and a B.Tech. should be paid equally.) The non-B.Tech. employers concurred in the evaluation of relative salary levels with respect to the engineer and technician. (The only exception was that the non-B.Tech. employers displayed greater judgmental variation than the B.Tech. employers when evaluating relative salary vis-à-vis a technician; this is in harmony with the earlier observation that B.Tech. employers display no variation when setting the proper starting salary level for an associate degree-holder.)

Appropriate Functions. Employers were asked to indicate the extent to which they viewed six areas of work responsibilities as being appropriate for B.Tech. holders: technologist, engineer, technician, technical salesman, technical writer, and technical manager. On a 4-level scale, the employers selected a degree of appropriateness for each: highly appropriate, moderately appropriate, slightly appropriate, not appropriate. The employers also could choose not to ascribe appropriateness by responding "don't know." (See tables 17 and 18 in appendix A-3.)

Considering only the "highly appropriate" responses by all of the employers, the areas of work responsibilities may be ranked in descending order as follows:

Technologist
Technical Salesman
Technical Writer
Technician
Engineer
Technical Manager

The comparable ranking by B.Tech. employers is:

Technical Salesman
Technologist
Technical Writer
Technician
Engineer
Technical Manager

The employers with 5,000 or more employees and those with less than 1,000 employees rank technologist at the top, whereas the employers with 1,000 to 4,999 employees rank technical salesman at the top. Each of these groups of employers places engineer and technical manager in the two lowest positions.

Technician was most frequently considered not appropriate to B.Tech. holders. Technologist and technical salesman were considered most frequently highly appropriate to B.Tech. holders, with technical writer receiving third place consistently. While the employers were not inclined to describe engineer and technical manager as highly appropriate, both were placed frequently in the moderately appropriate category. Technical manager was also the area on which employers most often declined to make judgment.

As with salary, the greatest agreement in opinion was noted among the B.Tech. employers. Almost half of them (45.5 percent) considered technical salesman highly appropriate. (Note also table 18 in appendix A-3.) This was the highest level of agreement by B.Tech. employers among their ratings for any of the work responsibility areas. In fact, this was the greatest agreement reached within any grouping of employers.

Another way to view the responses with respect to the appropriateness of the areas is to combine "highly" with "moderately appropriate" responses. Specifically, the work responsibility areas of technologist, technical salesman, and technical writer rank as the highest three for both all employers and B.Tech. employers. (See table 9.)

TABLE 9. WORK RESPONSIBILITY AREAS: EMPLOYER RANKINGS

The Percent and Ranking of B.Tech. Employers and All Employers by the Appropriateness of Six Work Responsibility Areas to B.Tech. Holders

B.Tech. Employers		Work Responsibility Area	All Employers	
Rank	Percent*		Percent*	Rank
1	72.8%	Technical Salesman	60.4%	2
2	72.7	Technical Writer	55.2	3
3	63.6	Technologist	63.5	1
4	56.8	Engineer	54.7	4
5	47.7	Technical Manager	49.4	5
6	40.9	Technician	44.8	6

*Percent of employers responding "highly appropriate" and "moderately appropriate" combined.

Survey of Program Directors

In addition to collecting program data, another purpose of the survey was to obtain reactions from the program directors concerning the need for individuals with such preparation in the labor market and the adequacy of the existing programs in fulfilling that need. Germane to these general purposes of the survey were the following specific questions:

— What is the profile of B.Tech. programs with respect to students, faculty, graduates, and related degree programs?

— What is the expectation of directors of B.Tech. programs with respect to compensation levels of their graduates relative to engineers and technicians, and areas of work responsibilities considered appropriate to the graduates' preparation?

The Sample - Six degree programs were selected to form the following test sample:

State University of New York at Binghamton (SUNY)
State University College at Buffalo (SUNY)
City College of New York (CUNY)
Clarkson College of Technology (Private)
New York Institute of Technology (Private)
Rochester Institute of Technology (Private)

(The report refers to these institutions as: Binghamton, Buffalo, CCNY, Clarkson, NYIT, and RIT.)

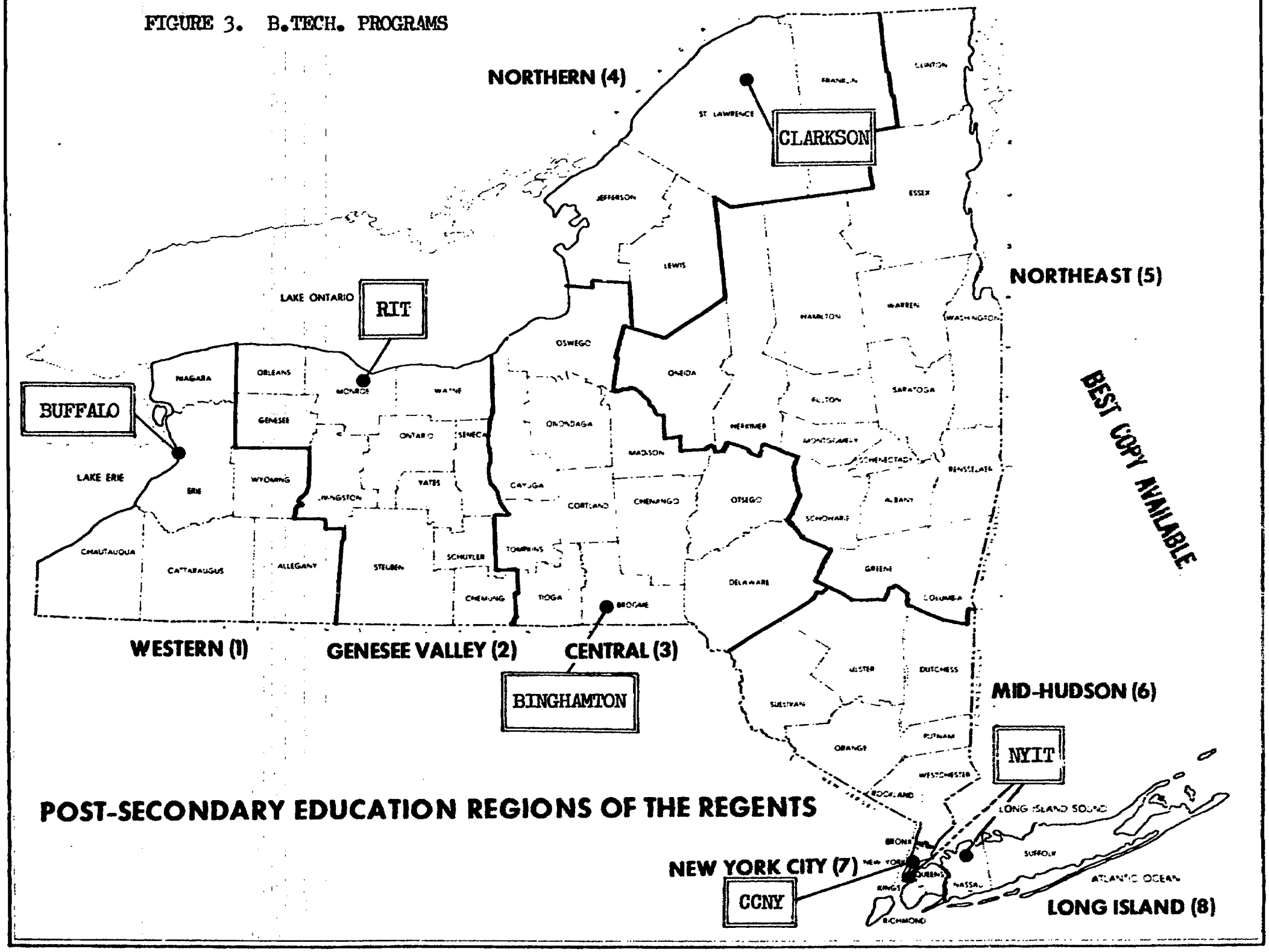
The six institutions are located in different regions of New York State. (See figure 3.) Although NYIT's main campus is located in Region 8 (Long Island), it also operates a metropolitan campus in Region 7 (New York City). Therefore, only Region 5 (Northeast) and Region 6 (Mid-Hudson) do not have institutions currently conducting B.Tech. programs.

The directors of the programs at each institution (appendix B-1) were sampled. Information requests to the two State University of New York units (Binghamton and Buffalo) were channeled via SUNY's Central Office of Institutional Research. All of the program directors submitted responses.

The six institutional degree programs comprising the sample are as follows:

Binghamton. B.Tech. program has primary emphasis in the areas of electrical and mechanical technology. It became operational during the 1972-73 academic year under the School of General Studies and offers curricula designed in the 2-year "upper division" or "transfer" format. (Approval of this program was conditional on: (1) that it be offered only in the later afternoon and evening; and (2) that it be confined to the final 2 years of the baccalaureate curriculum.)

FIGURE 3. B.TECH. PROGRAMS



Buffalo. B.Tech. program in engineering technology has major fields in electronics, mechanical, and electro-mechanical, engineering technology. It became operational in September 1971 under the Division of Technology and offers curricula designed in the 2-year "upper division" or "transfer" format.

CCNY. B.Tech. program has primary emphasis in electro-mechanical technology at present and may offer other curricula now under development. It became operational during the 1970-71 academic year under the Bachelor of Technology Division of the School of Engineering and offers curricula designed in the 2-year "upper division" or "transfer" format.

Clarkson. Bachelor of Professional Studies (B.P.S.) degree program (considered equivalent to a B.Tech. for purposes of the study) has individually designed curricula in engineering technology in the electrical, mechanical, civil, and chemical areas. It became operational in fall 1972 as an interdepartmental responsibility including the Departments of Chemical, Civil and Environmental, Electrical and Computer, and Mechanical Engineering, and offers curricula designed both in the 2-year "upper division" or "transfer" format and the full 4-year format.

NYIT. B.Tech. program has primary emphasis in the electrical, mechanical, and computer technologies. It became operational during the 1971-72 academic year as an interdisciplinary program administered through the Department of Electrical Engineering Technology within the Division of Science and Technology, and offers curricula designed primarily in the full 4-year format. Completion of the first 2-years of study leads to the associate in appled science degree. (The bachelor of science programs in electrical and mechanical engineering technology were not included in the survey.)

RIT. B.Tech. program has primary emphasis in civil, electrical, and mechanical technology. It became operational during the 1970-71 academic year under the School of Applied Science and offers curricula designed in the 2-year "upper division" or "transfer" format.

The Instrument - An institutional report form (appendix B-2) was sent to each of the program directors. It was designed to obtain enrollment data and projections, the number of faculty members, and activities of program graduates; it also allowed and encouraged the program directors to report information beyond the data requested and to make comments about their respective programs or the subject in general.

The Findings - The findings derived from the survey of all six programs are discussed (with references made to the applicable tables in appendix B-3) and are reported under three categories: students, faculty, and graduates.

Students. Students were first enrolled in two degree programs during the 1970-71 academic year — CCNY and RIT; two more institutions started B.Tech. programs during each of the two subsequent academic years. Development has been as follows: 1970-71 - CCNY and RIT; 1971-72 - Buffalo and NYIT: and 1972-73 - Binghamton and Clarkson.

During 1970-71, CCNY enrolled 54 full-time students and RIT enrolled 92 full-time students; no part-time students were enrolled that first year. The following academic year (1971-72), CCNY increased its full-time enrollment by 167 percent to 144 students and RIT increased its full-time enrollment by 132 percent to 213 students. Also that year, CCNY and RIT each enrolled 61 part-time students and Buffalo and NYIT initiated their programs, enrolling 24 and 22 full-time students, respectively. Four part-time students were enrolled at NYIT. The total (full-time and part-time) enrollment in the degree programs in the State was increased by 262 percent between 1970-71 and 1971-72 — from 146 to 529 students. (See figure 4 and table 19 in appendix B-3.)

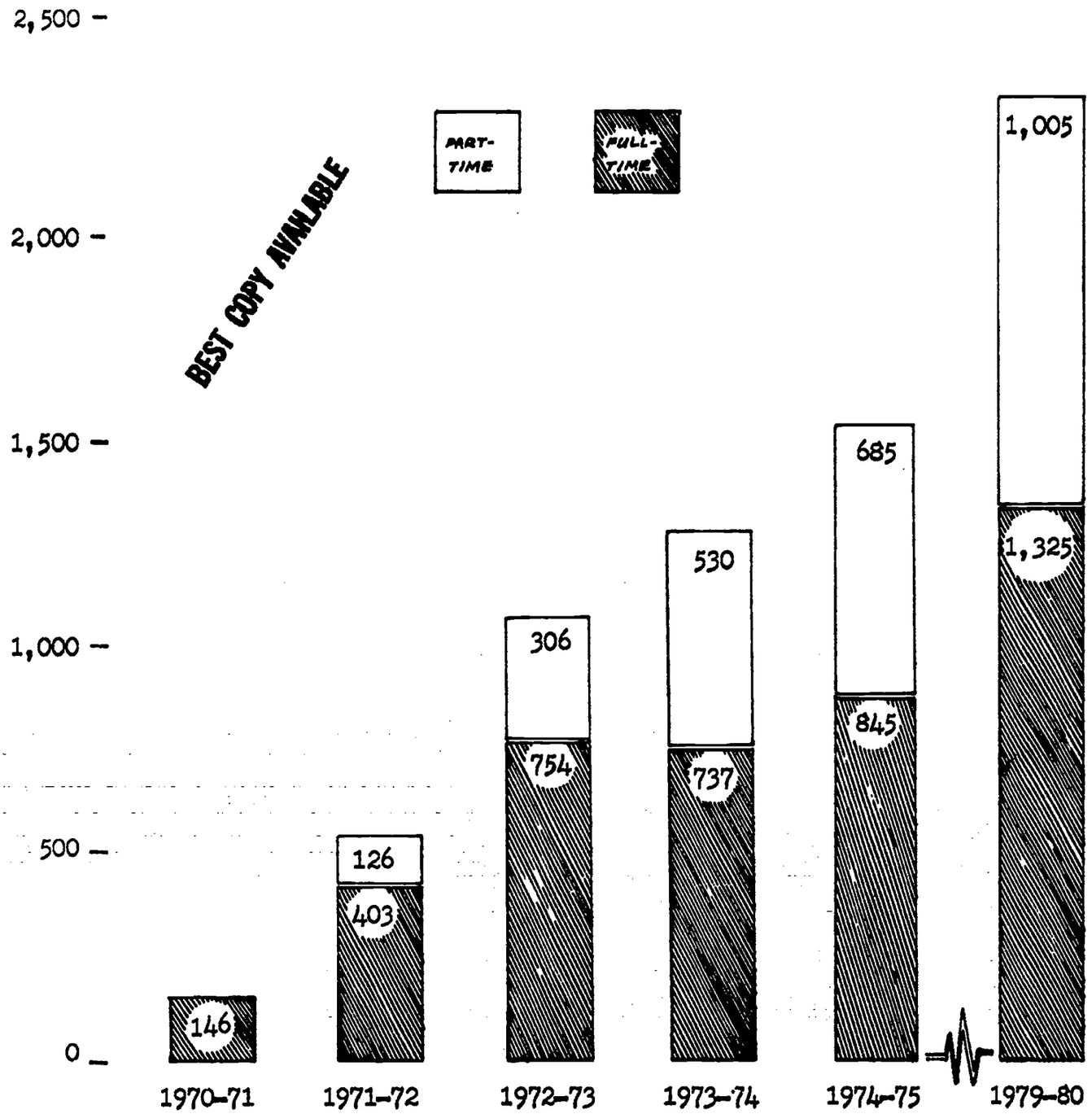
The programs at Binghamton and Clarkson first enrolled students during 1972-73. Binghamton's enrollment was made up predominantly of part-time students (83) as compared to the number of full-time students (6). Clarkson's interdepartmental program enrolled 5 full-time students and no part-time students. These two new programs, together with increased enrollment in the other programs, caused the total enrollment to double over the previous year — from 527 to 1,060 students.

Although this increase is still substantial, projections of enrollments provided by each institution show that future increases will be less drastic. A combined increase in total enrollment of only 19.5 percent over 1972-73 was anticipated for 1973-74 and an increase of 20.8 percent over 1973-74 was expected for 1974-75. In fact, full-time enrollments between the 1972-73 and 1973-74 academic years were projected downward by 2.3 percent; an increase of less than 15 percent in full-time enrollments was projected between 1973-74 and 1974-75. The combined growth projection between 1972-73 and 1973-74 was largely based on a 73.2 percent expected increase in part-time enrollment. Even here, however, the projections for the programs trend off by 1979-80. The average annual increase projected over the 5-year (1974-75 to 1979-80) period was only 10.5 percent in total enrollment — 11.5 percent in full-time enrollment and 9.3 percent in part-time enrollment.

As institutions established new programs, it has taken about 2 to 3 years for enrollments to stabilize and for increases (or decreases) to be less abrupt. Projected enrollments for each of the institutions conducting the "older" programs (CCNY and RIT) are constant to 1980, showing no change in the number of full-time and part-time students. Total enrollments projected by all five institutions between 1974-75 and 1979-80 provide for an increase of about 52.3 percent. But by 1979-80, the proportionate increases of full-time and part-time students will have stabilized. For 1979-80, the projected enrollments in B.Tech. programs across the State add to 1,325 full-time students and 1,005 part-time students.

FIGURE 4. B.TECH. ENROLLMENTS

Full-Time and Part-Time Enrollments in New York State B.Tech. Programs
Actual: 1970-71 to 1972-73; Projected: 1973-74, 1974-75, and 1979-80



RIT conducts the largest program in number of students, claiming slightly more than half (50.2 percent) of the 1972-73 combined total enrollments. Even after projecting its 1973-74 enrollment downward by over 13 percent, mostly in the full-time student figures, RIT retains 48.9 percent of the projected full-time and more than one-third (36.3 percent) of the total enrollment.

Together, RIT and CCNY enrolled 77.6 percent of all B.Tech. students during 1972-73. Their proportion of the total State enrollment is projected to decrease as other institutions expect growth in the newer B.Tech. programs. All the same, the older programs of CCNY and RIT account for more than two-thirds (69.3 percent) of the [projected] 1973-74 full-time enrollment and for well beyond half (58.4 percent) of the total enrollment.

As pointed out, this will change as (and if) programs at the other institutions experience the growth they expect with longevity. Note especially that both SUNY units project substantial increases in their program enrollments by 1980 — Binghamton projects the largest enrollment by way of 500 part-time students (almost five times the number of full-time students projected - as would be expected by the conditional approval noted previously) and Buffalo projects a full-time enrollment of 300 students — second only to RIT's projection of 350 full-time students. In view of the previously noted conditions placed on the Binghamton program, growth can be realized only via part-time enrollment. However, a question could be raised concerning the long-term ability of the Binghamton industrial area to supply such a large number of part-time students.

If these combined projections of the institutions are realized, the total enrollment would be distributed more evenly among the programs compared to previous years. RIT would still claim the largest proportion of the State's full-time students (followed by Buffalo); Binghamton would claim the largest proportion of part-time students (and the smallest proportion of full-time students). Binghamton, CCNY, and NYIT each would have larger proportions of the State's part-time enrollment than of full-time enrollment.

Data on the number of applicants to B.Tech. programs could not be used to formulate conclusions, since they were not available from all six programs. However, it is possible to determine the origin of students transferring into B.Tech. programs.

Transfers make up most of the students in B.Tech. programs; other than the 24 first-year students reported by NYIT, all of the students reported are upper division students. (Clarkson has only recently established the first 2 years of its B.P.S. program and had not as yet enrolled first-year students. Clarkson and NYIT are the only programs offering the full 4-year format.)

Of all 1,308 students ever enrolled in B.Tech. programs, 98 percent were 2-year engineering technology graduates and 96 percent were from institutions other than the one where they enrolled in a B.Tech. program. (See table 20 in appendix B-3.)

Of the six institutions, RIT and NYIT conduct associate degree programs. Although CCNY does not conduct its own associate degree programs, as a senior college of CUNY it primarily accepts associate degree graduates from four community colleges of CUNY. Three of the six institutions offer baccalaureate degree programs in engineering (CCNY, Clarkson, and RIT), but very few students have transferred from them to B.Tech. programs.

Obviously, then, by far the greatest pool of potential B.Tech. students has been the graduates of 2-year degree programs in engineering-related technology.

Faculty. The allocation of faculty is shown in table 10 with respect to the B.Tech. curricula at each institution. The listing points out the wide variety in types of faculties utilized by the six programs. The discrepancies in the number of faculty in the programs suggest some comment. NYIT and RIT (and possibly Clarkson) make available a large number of full-time faculty members (as does CCNY with part-time faculty), as contrasted with the very few devoted to the programs at Binghamton and Buffalo. This may be misleading in that "full-time" describes employment status at the institution and not the degree of service to the specific B.Tech. program.

CCNY relies on engineering faculty since it has established the Bachelor of Technology Division within its School of Engineering.

Graduates. Bachelor of technology degrees were first awarded in New York State during the 1972-73 academic year. The degrees awarded and projected indicate the number of graduates being supplied currently and in the near future by the existing New York programs. (See figure 5 and table 21 in appendix B-3.)

The same pattern of growth observed for enrollments applies to graduations. The older programs (CCNY and RIT) have stabilized in their degree outputs. In fact, RIT plans to award fewer degrees in 1979-80 than it awarded in 1972-73 and CCNY projects but a slight increase over the next few years with no increase between 1974-75 and 1979-80. These two institutions provide the major share of degrees awarded in 1972-73 — 89.2 percent. As the programs at the remaining institutions grow, the anticipated number of degrees will be distributed more evenly. CCNY and RIT will award 71.2 percent of the degrees in 1973-74, 60.9 percent in 1974-75, and only 31.3 percent in 1979-80. By 1980, the proportion of degrees projected by each of the six institutions is: Binghamton and Buffalo — 22.4 percent each; CCNY — 16.4 percent; RIT — 14.9 percent; Clarkson — 13.4 percent; and NYIT — 10.5 percent. The SUNY units expect to almost double their combined proportion of degrees (graduates) between 1974-75 (24.7 percent) and 1979-80 (44.8 percent). To accomplish this, they must increase their projected 1974-75 degree output by 253 percent by 1979-80 — 300.0 percent for Binghamton and 150 percent for Buffalo.

The combined projections of the current B.Tech. programs call for increasing the actual number of degrees in 1972-73 (250) by 26.4 percent for

TABLE 10. B.TECH. FACULTY

Number of Faculty Members Who Regularly Taught Required Courses in New York State B.Tech. Programs During 1972-73 by Department*

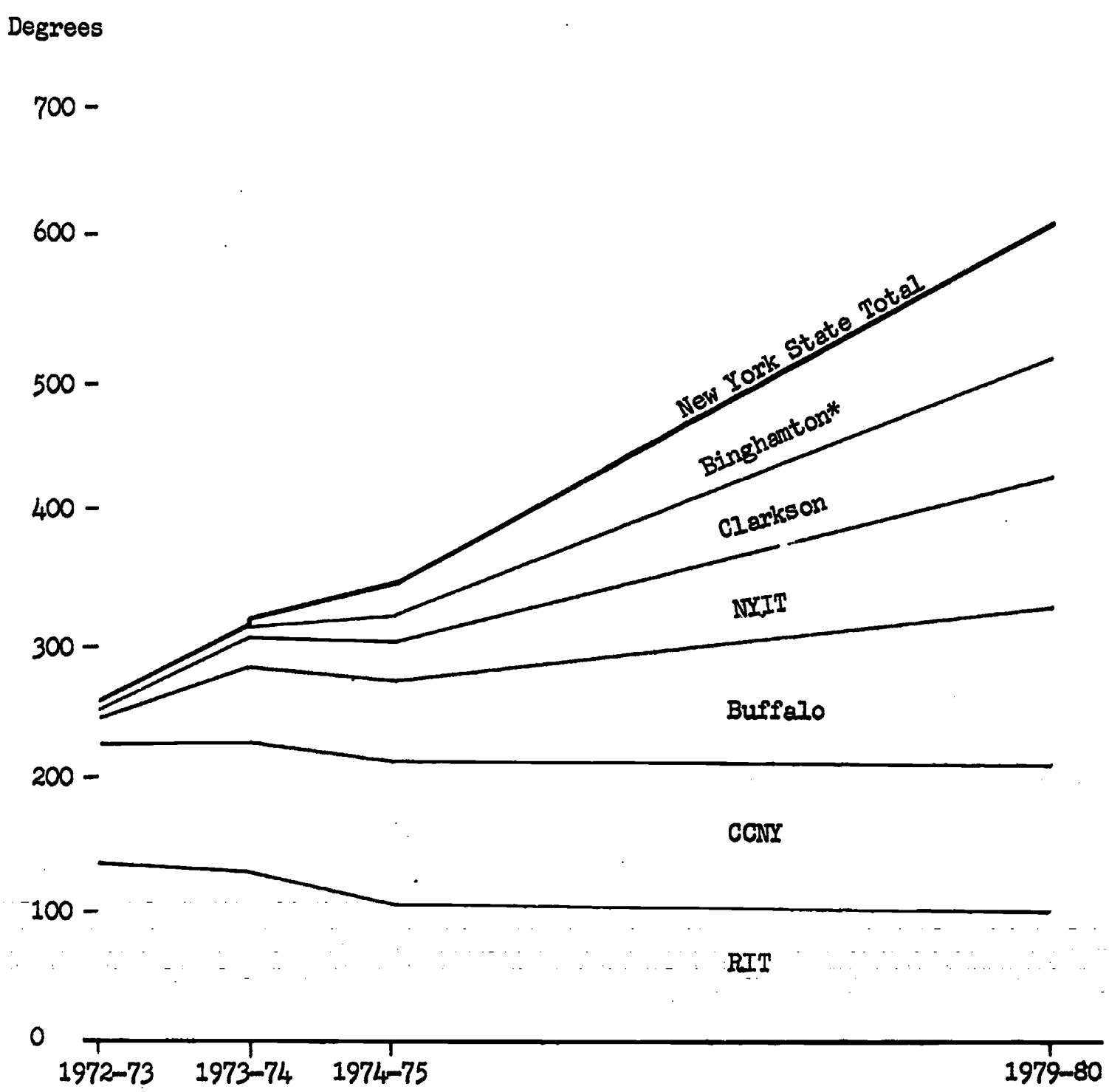
Institution	Department*	Number of Faculty Members		
		Full-Time**	Part-Time**	Total
Binghamton	School of General Studies	1	4	5
	Mathematical Sciences	0	1	1
	All Departments	1	5	6
Buffalo	Engineering Technology	3	0	3
	Industrial Technology	0	2	2
	All Departments	3	2	5
CCNY	Bachelor of Technology Division	4	15	19
	Electrical Engineering	0	7	7
	Mechanical Engineering	0	1	1
	Civil Engineering	0	1	1
	All Departments	4	24	28
Clarkson	Since "programs are individually designed . . . the entire spectrum of departments and faculty are utilized"	DOES NOT APPLY		
NYIT	Mechanical Engineering Technology	10	1	11
	Electrical Engineering Technology/ Computer Technology	10	2	12
	Mathematics	4	0	4
	Physics	3	0	3
	Life Sciences	2	0	2
	Social Sciences	5	1	6
	English	4	0	4
	Behavioral Sciences	2	0	2
	All Departments	40	4	44
RIT	School of Applied Science	14	7	21
	College of Continuing Education	0	2	2
	Mathematics	0	1	1
	General Studies	6	0	6
	All Departments	20	10	30

*Department with which the faculty member is primarily associated.

**Employment status at the institution.

FIGURE 5. B.TECH. DEGREES

B.Tech. Degrees in New York State
Actual: 1972-73; Projected: 1973-74, 1974-75, and 1979-80 (Cumulative)



*No degrees in 1972-73.

NOTE: No degrees were reported prior to 1972-73.

1973-74 (316), by 38.0 percent for 1974-75 (345), and by 168.0 percent (670) for 1979-80. In other words, more than 2.5 times as many graduates are planned for 1979-80 than were graduated in 1972-73.

The small numbers and recency of students who have been graduated from programs in New York State do not allow much comment on the type of activities they pursue after graduation. For the most part, graduates to date have entered some form of technical employment. CCNY and RIT (again the older programs) and NYIT report a few alumni (5 percent or less) involved in graduate study. RIT also reports four percent in the "other" or "unknown" categories. But the overwhelming proportion of students having been graduated from the programs during their brief history are reported in the technical employment category with an institutional average of 96.6 percent.

The program directors were asked what relative levels of compensation were appropriate for their graduates. All six of the directors concurred that a B.Tech. should be paid higher than a technician. None selected higher than an engineer. However, the directors parted company in their thinking on whether they should be paid equal to or lower than an engineer; two thought the B.Tech. degree-holder's salary should be equal to that of an engineer but the majority of four thought it should be lower than that of an engineer.

The directors were asked to judge the appropriateness of work responsibilities for graduates of their programs. All six directors agreed that technologist is a highly appropriate area of work responsibility. In only three other places did they approach that consensus: five directors in each case indicated engineer and technical salesman as moderately appropriate and four indicated technical writer as slightly appropriate. Technician was the sole recipient of not appropriate votes by two directors; no director described technician as highly appropriate. Other than technologist, technical manager was the only area described by more than one director as highly appropriate. But the thinking on technical manager was evenly split across the spectrum — two each for highly, moderately, and slightly appropriate. Considering all responses of the program directors, their rank order of the appropriateness of work responsibilities is:

Work Responsibility Area	Rank
Technologist	1
Engineer	2-3
Technical Salesman	2-3
Technical Manager	4
Technical Writer	5
Technician	6

The responses of the employers described in the previous section contrast with those of the program directors. Although both employers and educators in the sample concur that technologist is of relative high appropriateness, the employers more often indicated technical salesman and technical writer as being of high appropriateness than did the program directors, who instead ranked engineer high — the opposite judgment from the employers.

Additional Comments of Respondents

Both surveys provided an opportunity for additional comments. Statements of potential employers and program directors were selected according to their relevance to the substantive issues. (Anonymity has been preserved through deletions.)

Potential Employers - No categories were suggested for the employers' additional comments, so a variety of areas were covered.

"Our requirements are for specialists, i.e., Ch.E., M.E., C.E. etc. We have no calls for B.Tech. holders."

"Some of our engineering organizations will have a future interest in hiring graduates with B.Tech. degrees."

"A B.Tech. degree is not a good fit with [name of employer]. We prefer specific, specialized strengths such as: ME, EE, Chem.E., or Cer.E."

"This facility has cooperated with [name of institution] in the establishment of their Bachelor of Technology Program and at the present time several employees of this facility are enrolled as students in this program.

"During discussions with [name of institution] and our employees it has been determined that this facility will consider the Bachelor of Technology degree the equivalent of any 4-year degree with particular attention being paid to the area of specialization and the employment requirements of our facility.

"It is felt that this program is the best means to date to enable the holder of a technical AAS degree or equivalent to further his education and to obtain a BS degree." [BS is the term used in the statement!]

"A superficial perusal of some engineering and engineering technology programs may give the impression that they parallel closely. Unfortunately, it is an established fact that some technology students mistakenly believe their studies are equivalent to an engineering program. A prime source of such mistaken notions is a school in [name of city].

"Just as unfortunately, there are companies which hire technologists and give them engineer titles and salaries not too much different than those given bachelor's of engineering.

"There are even some educators who initially professed - some still continue it - that the 4-year baccalaureate program in technology was the equivalent of an engineering program of 20 years ago. This might be true if equivalent schools weren't being compared. However, these same professors don't defend their statements very well, if at all, when asked to identify the schools they are comparing. Among knowledgeable people, there is no doubt that a substantial difference exists between a modern engineering graduate and an engineering technology graduate, each coming from an ECPD-accredited school. The difference exists; but both of them are needed by industry for some of its work.

"It must always be kept in mind that a superior technician or technologist also deserves an opportunity to climb the academic and industrial ladders with reasonable dispatch. A superior technologist with proper experience and a continuing education program [conceivably] could out-perform a mechanical engineer in time.

"An engineering technologist is not an engineer.

"An engineering technologist + experience + engineering license is an engineer."

"There would be opportunities for placement at several of our N.Y. State locations under normal employment conditions for a person with this type of training or education. In addition there would be no obstacles for advancement to higher level management positions but this of course would depend on the individual and particular circumstances."

"The B.Tech. graduate can do some of the tasks normally assigned to an engineer, but his range of starting positions is narrower than that for an engineer.

"His long range advancement opportunities would depend not so much on his degree as on his performance on the job. This in turn would depend on the quality of students that B.Tech. programs are able to attract. If they in practice are primarily for those who "couldn't make it" in engineering then their graduates won't "make it" in industry either - regardless of what is taught them in school."

"Several years ago, I served on [name of committee] which studied manpower needs. At that time there was some discussion of B.Tech. programs which had started in some universities. These degree-holders would have to attend a master's program in order to specialize in some field of engineering.

"I have seen no movement on the part of [type of employer] to hire B.Tech. degree-holders.

"Personally, I think a person pursuing a B.Tech. degree who wishes to enter an engineering discipline is unduly prolonging his education when he is required to specialize at a later time in a master's program. This should only occur when a person is interested in additional education and degrees."

"In Question 15 I indicated that working as a technical writer is in my judgment a highly appropriate field for a holder of a 4-year B.Tech. degree. Please let me expand on this general subject. All the individuals we've hired in recent years as professional engineers hold bachelor of science degrees in engineering. We do not foresee any change in this practice in the foreseeable future. Most of those hired for our nonprofessional engineering associate positions hold associate degrees in a technical field. It's been our experience that in general, most holders of B.Tech. degrees feel over-qualified for our nonprofessional engineering associate positions.

"In Question 12 we indicated approximately [number] holders of B.Tech. degrees are employed by our Company. Although a minority of these individuals are working as nonprofessional engineering associates, most were hired as technical writers. Although these technical writers are professional employees, they are not considered part of our professional engineering population. The salary structures of our technical writers are lower that those of our professional engineers and higher than those of our nonprofessional engineering associates. As might be expected, the same relationship applies to hiring rates.

"To conclude let me address your essential question. With the exception of a relatively small number of technical writers we hired, employment opportunities at [name of employer] for holders of B.Tech. degrees are very limited."

Program Directors - Four areas were suggested for possible commentary and serve to categorize the statements presented below.

Goals, Curricula, or Admissions Criteria of B.Tech. Programs.

"To provide continuing professional education in technology for graduates of Associate in Applied Science engineering-related technology curriculums.

"To provide further technical education which will broaden the students' background through an interdisciplinary emphasis and additional in-depth study in his chosen field of work.

"To prepare graduates for employment as engineering technologists capable of doing design and technical application work for manufacturing, design, development, utilities and consulting organizations in industry."

"Individually designed program, to meet academic backgrounds and career objectives of students. Admission generally from 2-year technology programs or as transfer from engineering programs."

"The Bachelor of Technology programs in [name of institution] are designed to prepare technologists whose main concern and interest is with

existing technology in the fabrication, operation and maintenance of products and processes as well as the design and the development of new 'hardware' via the application of science and technology."

Career Goals of Students in B.Tech. Programs.

"Students in the program tend to be pragmatic and generally quite goal-oriented. Upon completion of the program, most hope to perform as engineers in solving very real problems associated with the day-to-day activities of an industrial organization."

"I would also like to take the opportunity to comment on the career goals of our students. We have aimed . . . to train the graduating senior to work in hands-on industry, supporting the engineer, but at a higher level than the technician. In many cases, he can accomplish some of the detailed design work or breadboarding."

"Technical careers in industry such as technical managers, engineering laboratory personnel, etc."

"Management at operating level, Maintenance and Sales Engineering, Junior Engineers in Utilities and Manufacturing Organizations, [and] Design and Development."

Current and Potential Need for B.Tech. Graduates in the Labor Market.

"The current and potential need for B.Tech. degree program graduates is highly dependent upon economic conditions, supply of engineering graduates and nature of engineering programs. Another factor which will influence [the] market for B.Tech. graduates is the education of industry to qualifications of B.Tech. graduates particularly in this area. Apparently, from statistics released by technical educational organizations, there is a very high demand for B.Tech. graduates in the Southwest and companies in this area are knowledgeable as to capabilities of these graduates. However, in New York [State] B.Tech. graduates are just beginning to enter the job market and many companies (large and small) are being introduced to the B.Tech. graduate for the first time.

"I am reluctant to answer this question so positively but recommend that some intensive study be made to determine potential needs.

"At present our B.Tech. graduates are not having any more difficulty than engineering graduates in finding jobs and at comparable salaries."

"Increasing demand - Engineering Manpower Commission estimates need rising to 33,000 per year in U.S. (Includes 2-year graduates of tech. programs)."

"It is believed that the future need for this type of person will grow as the graduate and his capabilities become better known to industry. At this point in time, however, several factors influence the growth potential for the 'technologist.'

(1) Generally there is no position labeled 'technologist' by industry. Therefore, as a nomenclature, there is virtually no need for technologists.

(2) Within the past few years well over 100 educational institutions nationally have instituted baccalaureate technology programs. It is our opinion from personal contact with a substantial number of these programs, that most do not embrace the same philosophy and concepts that we at [name of institution] as well as most other programs in the State, are attempting to promote. It might be generally stated that programs vary from technically-oriented liberal arts to relatively sophisticated engineering with the majority tending toward what we would classify as being 'low level' technology.

(3) Professional accreditation, to this point, has not been particularly effective in clarifying the conditions described above. This, of course, has presented a confusing picture to industry in terms of the end product, the graduate, of such programs.

(4) The need for engineers and engineering scientists is declining as modern techniques such as computers, the importation of foreign engineering, shifting national priorities and other factors have reduced the need for the numbers of manpower required to do a given job. This situation, however, should increase the demand for more support personnel and hence the need for technicians and (what we educators call) technologists.

(5) To this point in time, most schools and colleges of engineering have been concerned with producing the engineering scientist. Today, however, in the face of greatly reduced enrollments, we see many schools shifting their emphasis to a more 'practical,' hardware orientation in an effort to attract more students and to provide industry with a more practical engineer. Such a program may well be in close competition with a baccalaureate program in technology. Business and industry tend to rely on what they feel they know best - the 'engineer.'"

Establishment and Location of Additional B.Tech. Degree Programs in New York State.

"No more needed. Our program and the others in existence in New York State can handle qualified students for the foreseeable future."

"The matter of establishment and location of additional B.Tech. degree programs in New York State is answerable only as a result of facts gathered on the labor market.

"Initial local opinions prior to start of our program indicated an increasing demand for B.Tech. graduates based upon kinds of job activities A.A.S. graduates eventually advanced to and potential output of technology-oriented community colleges. However, the substantial drop in employment opportunities for all technical and engineering graduates has altered the environment both as to supply of A.A.S. graduates particularly in such areas as Mechanical, Chemical Technology and potential demand. I can therefore only give my personal opinion and that is: at present I am not positive that sufficient facts exist to state that we have an insufficient number of B.Tech. programs or [that] we do have sufficient numbers but improperly located. I suggest that this question bears further investigation."

"I would first comment on new degree programs in this area in New York State. Naturally, I can only speak for our own region . . . but we at [name of institution] feel that, based on our own studies, the current resources here can easily handle the projections for these numbers of students. We believe that it would be unnecessary to add new facilities either at a public or private institution to offer curricula in the Bachelor of Technology."

"Based upon the foregoing, it would appear that the State's needs for baccalaureate programs are currently being met by the existing programs and at least as far into the future as we can now see. (I believe they now number six institutions.)

"If we may use the 2-year institutions as an analogy - it is further noted that the 'strongest' programs reside in those colleges with the largest enrollments. This does not mean that large numbers necessarily create strong programs. Undoubtedly the opposite is more nearly the truth. However, it is shown that the proliferation of programs is definitely detrimental to quality since it does take a significant number of students to support and maintain strong programs. Again, all the more reason to conclude that more than sufficient opportunity presently exists in New York State for students who wish to pursue the baccalaureate degree in technology."

ASSESSMENT OF THE NEED

This section assesses the need for B.Tech. degree-holders (and, in turn, the need for additional B.Tech. programs) by synthesizing information gleaned from a variety of sources. These include the findings of both surveys, selected literature, and additional data derived from appropriate governmental reports. Also, opinions stemming from the surveys of employers and program directors are filtered and incorporated as applicable.

The discussion is twofold. First, need is assessed according to the nature of the degree; the graduates of B.Tech. programs are viewed by virtue of the particular skills they have been prepared to offer and the skills expected on the job by employers. Second, need is assessed according to the number of B.Tech. holders, with an intent of viewing the production of graduates now and in the near future in light of the need of employers for them, i.e, actual job market demand. It has been observed that the number of technology programs has increased substantially in recent years and that ". . . this very growth has made it difficult to ascertain the real trends in technology education, both quantitative and qualitative."[25] To the extent that New York has grown similarly, it is now essential to assess the nature and need of the B.Tech. degree, albeit recognizing the difficulties.

By Nature

The rationale for the programs is to provide industry with individuals prepared in "applied engineering" and able to work as "hands on" engineers. This argument presupposes that most engineers being produced via baccalaureate degree programs in engineering are more specialized and are more typically characterized as "engineering scientists." This is a reasonable supposition in view of the greater and more rigorous concentration on mathematics in engineering as opposed to technology curricula. The rationale argues further that industry has realized a void in its engineering-technical personnel continuum—from the engineer to the technician—and has need of individuals to implement techniques developed by the engineer and translate them into actual production via the technician.

Most of the objectives of New York State B.Tech. programs endorse this rationale as evidenced by the program directors' comments. (See "additional comments" section.) However, these program objectives are not congruent with the hiring objectives or needs expressed by the employers in the State. If the programs are actually producing the type of graduates they propose, and if employers actually need the type of employee skills they indicate are preferable, then a close relationship between "supply and demand" is thwarted. The current situation can be viewed in several contexts.

Bachelor of technology programs in New York State are typically and primarily upper division programs aimed at attracting graduates of associate degree programs in engineering technology. Nationwide, B.Tech. programs have been characterized by the Bureau of Labor Statistics as 4-year programs of two basic types: those that provide 2 years of upper division technical training and those that also add 2 more years of training to the first 2 years of technical training—but with emphasis on humanities and business administration.[26] The American Society of Engineering Education (ASEE) makes a similar separation between curricula for "engineering technology" and "industrial technology;" that is, a differing degree of concentration on math-science-technical studies versus nontechnical studies including management.[27] According to the types of faculties utilized in New York State programs (refer to table 10), and the catalog descriptions of curricula, the current B.Tech. programs in the State resemble the technical/engineering format. However, employers in the State, and particularly those already enploying B.Tech.'s, indicate that the B.Tech.'s most appropriate work responsibility areas are as technical salesman and technical writers, and decidedly not as engineers or technicians. (See employer survey section on "appropriate skills" and table 9.)

Statistical analysis of a subsample of 17 B.Tech. employers who expressed an opinion concerning the appropriateness of the technologist area of work responsibility, leads to rejection of the hypothesis that this is a highly appropriate function.* Based on the same sample it was impossible to reject the hypothesis that technologist is a moderately appropriate function for the B.Tech. graduate. This would support the contention that the title technologist does not appropriately describe, ironically, a person who has a 4-year degree in "technology!" Analysis of the employers who did not presently have B.Tech. graduates on their staffs confirmed both these findings; that is, the 55 employers who expressed an opinion about the technologist work function, rejected the idea of highly appropriate. However, in the case of non-B.Tech. employers, the certainty with which the hypothesis of "moderately appropriate" could not be rejected was not quite as great as in the case of B.Tech. employers.**

Even though the B.Tech. employers tend to rate the appropriateness of the engineer function between moderately and slightly, and the hypothesis that the appropriateness actually falls between highly and moderately could be rejected, it was not possible to reject at the same high level of significance as in the case of evaluating the technology function (1.0 percent versus 0.5 percent significance level). Based on a scale of 1 to 4, with 1 being highly appropriate, the hypothesis that B.Tech.'s rank 1.8*** on the scale of appropriateness could be rejected at the 1.0

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*Significance test based on a calculated Student-t test statistic of 3.053, significant at the 0.5 percent level.

**The statistics of 5.785 (parameter equals 1) and 2.172 (parameter equals 2) were computed for the n=55 non-B.Tech. employers.

***The hypothesized population mean value of 1.8 was based on the program directors' responses.

percent level using the sample of 20 B.Tech. employers; that is, the B.Tech. employers rank the appropriateness as 2.4 on the same scale (between moderately and slightly appropriate). Although the non-B.Tech. employers appear to be slightly more optimistic with a ranking of 2.2 on the scale, the hypothesis of 1.8 could again be rejected at a much higher level of significance.

The B.Tech. employers rated the function technical salesman as having the highest degree of appropriateness of the six rated functions. In addition, the variation in opinion amongst the employers was less for the technical salesman function than for any of the other functions; not only do the employers rate technical sales as the most appropriate function, but there is the least amount of disagreement on this rating when compared to any other function rated by both the B.Tech. employers and the non-B.Tech. employers. (See figure 6.) With the exception of technologist and technical writer, as a function was rated more-and-more appropriate by the B.Tech. employers, the dispersion in opinion became less-and-less. The B.Tech. employers rated technical salesman at a level of appropriateness 1.5 on the 1-to-4 scale (versus 1.8 for the program directors). The hypothesis that the true ranking is 1.8 can be rejected at a lower level of significance than can either of the hypotheses that the true ranking is 1 (highly) or 2 (moderately).

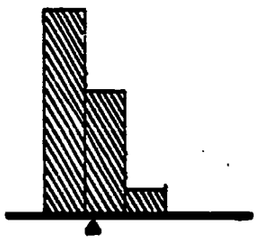
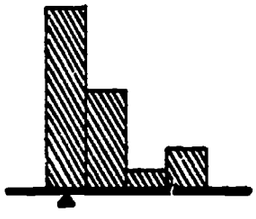
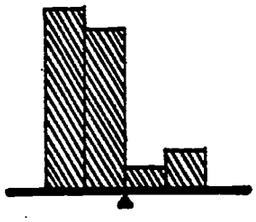
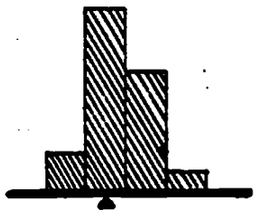
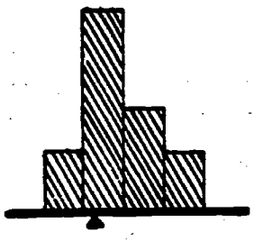
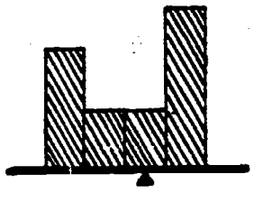
The interpretation of these findings is that, although technical salesman was rated by the B.Tech. employers as the most appropriate function (half-way between highly and moderately appropriate), even it was not rated as "highly appropriate." This leads to two conclusions: either the questionnaire did not display the function in which a B.Tech. would excel or the employers, as representatives of all B.Tech. employers, could find no function well suited to the educational background of the B.Tech.!

The non-B.Tech. employers ranked technical salesman more toward the "moderate" level than did the program directors or the B.Tech. employers, but their ranking is closer (1.9) to that of the program directors (1.8), than is that of the B.Tech. employers (1.5). Those having experience with B.Tech. holders on their staffs are more inclined to believe that technical salesman is an appropriate work area for the B.Tech. holder than employers not having such experience. It should be observed that the non-B.Tech. employers rank technologist as the most appropriate of any of the six rated functions and technical salesman as the second most appropriate; this may be possibly attributable to the title of the degree — Bachelor of Technology = Technologist. What factor causes the B.Tech. employers to rank technical salesman above technologist based on degree of appropriateness is unknown, but it is evident that the B.Tech. employers would place the B.Tech. holder outside the mainstream of engineering-technical work responsibilities.

The program directors are of the opinion that the function technical writer can only be ranked halfway between moderately and slightly appropriate (most program directors ranked technical writer as slightly appropriate, with only two giving a different rating); the B.Tech. employers

FIGURE 6. WORK RESPONSIBILITY AREAS: PROFILES

Appropriateness Profiles of B.Tech. Work Responsibility Areas
Based on the Judgments of B.Tech. Employers

Mean Responses Ranked in Order of Decreasing Appropriateness*	Profile (High — Low)		Ranking in Order of Increasing Judgmental Variance
1.5		Technical Salesman	1
1.8		Technologist	5
1.8		Technical Writer	4
2.3		Technical Manager	2
2.4		Engineer	3
2.6		Technician	6

*Scale of appropriateness: 1-highly; 2-moderately; 3-slightly; and 4-not.
NOTE: Markers [▲] indicate program directors' mean judgment.

contradict this opinion by ranking technical writer close after technologist in degree of appropriateness, that is, just above moderately appropriate (1.8), between moderately and highly.* The non-B.Tech. employers are more in agreement with the program directors although scaling their opinions more toward moderately appropriate than toward slightly appropriate. However, the hypothesis that the B.Tech. holder falls halfway (2.5) between moderately and slightly appropriate when ranking the technical writing function can be rejected (using the sample of 55 non-B.Tech. employers at the 1.0 percent level of significance); since no significant mean difference was observed when comparing the technical writer ranking of the B.Tech. and non-B.Tech. employers it may be concluded that both employer groups disagree with the program directors.

With respect to the ranking on technical manager as a work area, the B.Tech. and non-B.Tech. employers agree, each giving a rating between moderately and slightly appropriate, toward the moderately end of the scale.** In addition, the observed variation in opinion of employers in the two categories was very close. The program directors felt that technical manager was a moderately appropriate function; however, the program directors were divided with some ranking the function highly appropriate, some moderately, and some slightly. (This same distribution of disagreement was observed in ranking technician.)

Another context in which to view the need for B.Tech.'s concerns the pragmatic nature described previously. If an individual prepared as a B.Tech. is considered able to implement or carry out the designs envisioned by an engineer, training should necessarily provide the skills required to perform such function. A question arises as to whether 2 years of work experience in industry, augmenting an associate degree in technology, is preferable to 2 additional years of technical training in an educational institution. New York State employers suggest that the work experience is preferable from their vantage point and salary data support this preference. Further, the employers indicate that recent baccalaureate in engineering degree recipients, often hired as "junior engineers," actually perform the roles of "hands on" engineers. Are B.Tech. programs then attempting to fill needs of industry that are already being met? As far as the mainstream of engineering-technical personnel is concerned, the answer would appear to be "yes." Employers express a preference for on-the-job experience (an associate degree with experience) over B.Tech. educational preparation. In the survey of employers, respondents indicated that engineer and technician responsibilities were not very appropriate for B.Tech.'s.

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*The program directors estimation of the "true level" of appropriateness can be rejected using a sample of 19 B.Tech. employers at the 0.5 percent level of significance on the Student-t distribution.

**Non-B.Tech. employers ranked technical manager as the least appropriate option among the six they were asked to rate, while the B.Tech. employers ranked, for possibly different reasons, both technician and engineer lower than technical manager.

The employers also demonstrated greater confidence in the engineering baccalaureate (with no experience) than for the relatively new B.Tech. degree. It must be emphasized that increasing familiarity will likely follow new B.Tech.'s into industry. Presently, the employers indicated that they would rather hire a B.Tech. for other purposes, albeit based on technical competencies, such as technical salesmen and writers.

The expectations of students entering B.Tech. programs must be broached on two specific topics. First, their salary expectations should coincide with the fact that B.Tech. graduates earn more than a technician but less than an engineer. They should also expect greater overlap between their salaries and technician salaries than between their salaries and engineer salaries. This is the case with both starting and average annual salaries, as demonstrated by employer responses. (See discussion of "relative salaries" in survey of employers section.) To the extent that B.Tech. students perceive themselves as more allied with engineering, salary frustration may be realized. Second, if B.Tech. students expect to qualify for licensure in the profession of engineering in New York State, they must recognize that added experience (of a satisfactory grade and character) must be gained relative to that of a holder of a baccalaureate in engineering. At present, the additional experience requirement is 4 years for all B.Tech. holders; in the future, there will be added differential requirements for B.Tech.'s from non-ECPD accredited programs. Also, if a B.Tech. acquires work experience not descriptive of an engineer's responsibilities, then the experience prerequisite for the examination might persist as unfulfilled. This is particularly relevant to the present study, given the types of work responsibilities considered appropriate or not appropriate for B.Tech.'s.

The nature of a B.Tech. is an amorphous one. The program objectives do not quite match what employers seem to need, who, in turn, do not offer a consistent definition of a technologist.

By Number

The proliferation of B.Tech. programs (the establishment of new programs at different institutions or the expansion of the State's capacity to produce B.Tech. graduates) has been justified by proponents on two bases: labor market and student demand. The former basis suggests that employers will have a relatively large number of openings for high level "engineer practitioners;" the latter basis suggests that an increasing pool of 2-year college graduates exists, a large portion of which desire additional educational opportunity via the baccalaureate degree in technology. Neither of these populations (jobs or students) has sufficient numbers to indicate the insufficiency of present programs.

Observing employment opportunities, the U.S. Department of Labor has forecast a decline in labor force growth; furthermore, the supply of college graduates will increase faster than the demand for them.

The nationwide report indicates that the demand for college graduates outstripped supply during the 1950's and 60's but in the 1970's supply and

demand are roughly equal. The report projects that in the 1980's the supply will increase faster than the demand and the surplus may amount to 140,000 per year during the 1980-85 period — more than 10 percent of the projected demand. These projections may suggest "promising prospects" for employer participation in "cooperative education." For example, the number of professional and technical jobs requiring a college degree will continue to grow faster than the number of jobs in any other occupational group. Paradoxically, however, the report projects that the "vast majority of the 60 million job openings" expected to become available between 1972 and 1985 will be open to persons who have not completed 4 years of college. The forecast is that post-high school training, such as apprenticeships and 2-year colleges, will take on increasing importance. "Four out of every five jobs to be filled in the next decade will be filled with persons who have less than 4 years of college education."[28]

The following statewide figures represent the average annual percent increase projected for each specified group between 1974 and 1980.

TABLE 11. PROJECTED GROWTH RATES: SELECTED GROUPS

Projected Annual Percent Increases of
Selected Population Groups in New York State
1973-74 to 1979-80

Population Group	Average Annual Percent Increase (New York State)
Employed Engineers and Engineering and Science Technicians	0.98%*
Employed Engineers	0.77%*
Employed Engineering and Science Technicians	1.32%*
Undergraduate Students	1.95%**
2-Year College Students	3.25%**
Bachelor of Technology Students	13.98%***
Bachelor of Technology Degrees	18.67%***

*Extrapolations based on U.S. census data for New York State,[29] and New York State Department of Labor projections.[30]

**Office of Planning in Higher Education, New York State Education Department.

***Combined projections of existing B.Tech. programs.

The average annual percent increase indicated for the bachelor of technology degrees was based on the number of degrees projected to be awarded each year by the six institutions — not on the cumulative number of degrees projected over the 6-year span.

Nationally, it has been noted that:

> Bachelor of technology programs should produce slightly fewer graduates this year [1974] and next because of the reduction in junior and senior enrollments between 1972 and 1973. The class of 1976 may well show an increase because of a greater input from 2-year graduates of earlier years, and by 1977 we should see the results of the big increase in freshmen entering last fall [1973]. It will be interesting to see whether these trends continue or are interrupted by another disruption in the employment of graduates. There is also some evidence that the increased interest in 4-year engineering technology programs is occurring at the expense of, rather than in addition to, enrollments in regular engineering curricula.[31]

TABLE 12. UPPER DIVISION B.TECH. ENROLLMENTS — U.S.A.

Full-Time, Upper Division B.Tech. Enrollments in the United States
Fall 1967 to Fall 1973

Year	Enrollment*	Percent Change
1967	223	—
1968	863	287.0
1969	2,982	245.5
1970	4,414	48.0
1971	6,513	47.6
1972	5,129	(21.2)
1973	6,526	27.2

*For institutions having at least one technology curriculum accredited by ECPD.

SOURCE: Engineering Manpower Commission Annual Surveys.[32]

The increase in the number of B.Tech. students is largely due to the accreditation of more new programs each year; programs increased at a greater rate than enrollments.[33] The pool of 2-year graduates, eager for upper division opportunity and fulfillment (for a bachelor's degree!) is not growing at any phenomenal rate. In April 1974, a subcommittee report of the Association of Engineering Colleges of New York State included the data presented in table 13.

Statewide increases between 1972 and 1973 for the number of freshmen and sophomores in engineering science programs do not represent phenomenal growth. Even the parallel increases in technology programs are characteristic of very slight growth. In fact, one-half of the institutions experienced decreases in their freshman classes in both engineering science and technology programs; almost one-third of the sophomore classes decreased in size.

Even if a large proportion of engineering science and technology students wished to pursue a B.Tech. program, the existing programs could probably accommodate them. This assumes that all of the 2-year programs are appropriate precludes to B.Tech. programs. Also competing for these students are engineering schools seeking transfers and employers seeking technicians (for which a 2-year degree is highly appropriate).

A recent statewide study asserts that New York State's 2-year engineering technology programs are inhibited in recruiting students because of a relatively dull image on their own campuses. However, it concludes that New York State is fulfilling its technical manpower needs more effectively than the rest of the nation in general, that the State's growth rate for technical manpower is estimated to be lower than the rest of the nation, and that "the available evidence does not justify any hasty efforts to bring about significant expansion of these [2-year engineering technology] programs."[34]

The national outlook for recent engineering-technical graduates at the baccalaureate level should be noted.

> There is no question that the strongest continuing demand at the bachelor's degree level is for graduates with a sound education in one of the basic branches of engineering. Graduates whose specialty is too narrow may find themselves eagerly sought-after one year and in surplus supply the next, while those whose education is too general may find that their choice of jobs is limited because of the specific preferences of most employers.[35]

Graduates of B.Tech. programs are considered unfamiliar entities, yet to be fully tested, according to the perceptions of many employers — who, when in doubt, tend to hire the "real engineer." As employers become more familiar with what a B.Tech. can do, and as educators become more consistently cogent about what a B.Tech. is trained to do, the degree may be able to acquire the benefits derived from clearer definition. One major such benefit can be characterized as appropriateness of demand; capacity for producing B.Tech.'s should be expanded only to the extent that the appropriateness of demand has fermented to maturity.

TABLE 13. ENGINEERING SCIENCE AND TECHNOLOGY ENROLLMENTS

Full-Time Freshman and Sophomore Class Enrollments in Engineering Science and Technology in New York State 2-Year Colleges 1972 and 1973

Institution	Freshman Classes				Sophomore Classes			
	Engineering Science		Technology		Engineering Science		Technology	
	1972	1973	1972	1973	1972	1973	1972	1973
Adirondack	14	8	32	80	9	5	26	21
Auburn	26	32	36	41	11	14	16	12
Broome	46	47	159	164	32	33	92	123
Canton	41	34	414	356	14	17	166	172
Delhi	22	20	200	250	18	18	150	180
Dutchess	19	24	96	95	13	15	45	51
Erie	60	49	741	717	31	46	465	406
Farmingdale	84	98	—	—	54	44	—	—
Fashion Institute	—	—	58	72	—	—	30	30
Hudson Valley	36	61	393	440	12	28	222	286
Jamestown	37	25	75	65	6	15	18	24
Mohawk Valley	41	50	172	169	27	28	103	107
Morrisville	24	22	378	339	6	12	239	238
Nassau	83	52	115	179	36	41	42	63
Onondaga	—	—	62	48	—	—	—	—
Orange	23	36	92	84	10	7	36	47
Suffolk	18	34	—	—	9	6	—	—
Ulster	12	19	25	43	8	5	10	8
TOTAL	586	611	3058	3082	296	334	1660	1768

SOURCE: Association of Engineering Colleges of New York State.[36]

EPILOGUE

The need for additional B.Tech. graduates has been scrutinized as the principal issue in this report and major problems accompanying the issue have been described. Such issues and problems are accented by the question: "Is the bachelor of technology a needed link between the engineer and technician . . . or simply the educator's answer to sagging enrollments?"[37] The author of the question points to problems of definition:

> Educators probably feel they are on solid ground with definitions that are supposed to distinguish between engineer, engineering technologist, technician, and several other subspecies spawned by their degree-granting departments. Industry, however, has shown little reverence for such careful distinctions in the past, and there is no reason to expect a change of heart now.[38]

After reciting definitions of engineering and engineering technology (developed by the Engineers' Council for Professional Development) and of industrial technology (prepared by the National Association of Industrial Technologists), the author continued:

> If these definitions were accurate, full-fledged engineers would be committed to theory and idealism leaving technologists to handle practical day-to-day problems, while industrial types—light on conceptual understanding but primed for leadership positions—would be directing the whole operation. Actually, such dramatic divisions of expertise are not always evident to the main consumers of engineering talent, industrial employers.
>
> Responding to the 'Preliminary report of the American Society for Engineering Education's (ASEE) engineering technology education study,' the Bechtel Corp said, 'The hard, cold, practical fact is that anyone with any type of engineering education will aspire to be called an engineer, and there is not the nice, clean interface that educators think there is between the duties of the many people engaged in an engineering-oriented program, be it design, construction, manufacturing, or operations.'[39]

The ASEE final report[40] (recounting this report's prologue) advocated the evaluation of B.Tech. programs at the State level and their gradual development with continuing evaluation. The conclusions of the present report report evolve from a statewide study; they call for no new programs and for rigorous evaluation of existing programs.

FOOTNOTES FOR CITATIONS

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[2]Engineers' Council for Professional Development, 41st Annual Report: Year Ending September 30, 1973, p. 44.

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[4]Coss, Frank, "Engineering Employment Moves Upward," Professional Engineer, January 1973, pp. 43-45.

[5]Wanlund, William, "The Job Scene in 1973 for Federal Engineers," Professional Engineer, April 1973, pp. 58, 59.

[6]"What's Ahead," Professional Engineer, April 1973, p. 36.

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[8]Kopp, Eugene H., "Engineering Education," IEEE Spectrum, October 1972, pp. 12, 14.

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[11]Professional Engineer, April 1972, p.9 and May 1973, p. 11.

[12]Alden, "Opportunities," pp. 3, 4.

[13]Hansen, Arthur G., "New Thrusts in Engineering Education," Engineering Education, March 1973, pp. 401, 402.

[14]Alden, "Opportunities," p. 3c.

[15]Association of Engineering Colleges of New York State, "Undergraduate Engineering Enrollments and Capacities," Survey Report, February 19, 1973, p. 1.

[16]New York State Education Department, Higher Education Data System, 1974.

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[18]Ibid.

[19]Ibid., p. 58.

[20]Alden, John D., "Trends in 2-Year and 4-Year Engineering Technology Programs," (Paper presented at annual meeting of American Society for Engineering Education at Rensselaer Polytechnic Institute, Troy, New York), June 19, 1974, p. 1.

[21]Grinter, L.E., "Baccalaureate Technology - A Dilemma in Engineering Schools," Engineering Education, November 1972, pp. 141-143.

[22]Pletta, Dan H., "Pressures in Engineering Education," Professional Engineer, February 1973, pp. 52-55.

[23]Alden, "Trends," p. 1.

[24]Ibid., p. 26.

[25]Ibid., p. 1.

[26]U.S. Department of Labor, Bureau of Labor Statistics, Occupational Outlook for College Graduates, 1972-73 Edition, Bulletin 1730, Washington: U.S. Government Printing Office, 1972, p. 204.

[27]American Society for Engineering Education, op. cit., p. 23.

[28]Bienstock, Herbert, "The Emerging Manpower Resource," U.S. Department of Labor, Bureau of Labor Statistics, April 2, 1974, pp. 1, 2.

[29]U.S. Bureau of the Census, 1970 Census of Population, "Characteristics of the Population: New York," (Vol. 1, Part 34, Secs. 1, 2), Washington: U.S. Government Printing Office, March 1973, passim.

[30]New York State Department of Labor, Division of Research and Statistics, Manpower Requirements: Interim Projections, New York State 1968-1980, July 1971, passim.

[31]Alden, "Trends," p. 2.

[32]Ibid., p. 2c.

[33]Ibid., p. 1.

[34]Corcoran, Thomas B. and Ross Burke, Factors Affecting Enrollment in Engineering-Related Technical Programs in Community Colleges, (Prepared for the Bureaus of Occupational Education Research and Two-Year College Programs, New York State Education Department, by the Syracuse University Research Corporation, Educational Policy Research Center), February 1974, pp. 21, 40.

[35]Engineering Manpower Commission of Engineers Joint Council. Engineering Manpower Bulletin. No. 26, October 1973, p. 4.

[36]Association of Engineering Colleges of New York State. Subcommittee Report. (Presented during meeting at Alfred University, Alfred, New York.) April 1974, passim.

[37]Mennie, Don. "The B.E.T.: Engineer or Supertechnician." IEEE Spectrum. May 1974, pp. 60-63.

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[39]Ibid.

[40]American Society for Engineering Education. op. cit., pp. iii, 43.

APPENDIX A

Survey of Potential Employers

Appendix A-1: Employers Sampled

Appendix A-2: Employer Questionnaire

Appendix A-3: Tabular Data

Appendix A-1: Employers Sampled

EMPLOYER GROUPS in New York State used for sampling:

Employer Group	Population	Number Sent Questionnaire	Percent of Population
PRIVATE EMPLOYERS WITH 500 OR MORE EMPLOYEES*	1,074	150	14.0
Private employers with 5,000 or more employees*	58	50	86.2
Private employers with 1,000-4,999 employees*	449	50	11.1
Private employers with 500-999 employees*	567	50	8.8
PUBLIC EMPLOYERS	NA	25	—
Federal government	1	1	100.0
State government	1	1	100.0
City governments of five major cities** (excluding New York City)	5	5	100.0
New York City government and non-governmental public employers in New York City	NA	18	—
ALL EMPLOYERS	NA	175	—

*According to the New York State Department of Commerce.

**Albany, Buffalo, Rochester, Syracuse, and Yonkers.

Appendix A-1 (continued)

PRIVATE EMPLOYERS considered to be valid respondents (n=81):

Agway, Inc.

Allied Chemical Corporation

American Airlines, Inc.

American Broadcasting Company, Inc.

American Cystoscope Makers, Inc.

American Electric Power Service Corporation

Ayerst Laboratories, Inc.

Bausch & Lomb, Inc.

[The] Bendix Corporation

Boss Linco Lines, Inc.

Caltex Petroleum Corporation

Carrier Corporation

Cellu-Products, Inc.

Champion Products, Inc.

Coca Cola Bottling Company of New York, Inc.

Columbia Broadcasting System, Inc.

Consolidated Edison Company of New York, Inc.

Continental Can Company, Inc.

Corning Glass Works

Crowley Foods, Inc.

[The] DeLavel Separator Company

[R. E.] Dietz Company

Eastman Kodak Company

Fasco Industries, Inc.

Federal Bearings Company

GAF Corporation

General Electric Company

General Foods Corporation

Genesee Brewing Company

Grand Iron Works, Inc.

[W. T.] Grant Company

Grumman Aerospace Corporation

Hooker Chemical Corporation

Houdaille Industries, Inc.

Industrial Acoustics Company

International Paper Company

ITT World Communications, Inc.

Kinney Services, Inc.

Lamda Electronics Corporation

[R. H.] Macy & Company

Markel Electric Products, Inc.

[J. W.] Mays, Inc.

Metropolitan Life Insurance Company

Mixing Equipment Company

Nassau Smelting & Refining Company

National Biscuit Company

National Broadcasting Company, Inc.

New York Life Insurance Company

New York News, Inc.

New York State Electric & Gas Corporation

New York Telephone Company

Niagara Mohawk Power Corporation

Ogilvy & Mather, Inc.

Orbachs, Inc.

Otis Elevator Company

Parkchester Management Corporation

[J. C.] Penney Company

Philip Morris, Inc.

PRD Electronics, Inc.

RCA Communications, Inc.

RF Communications, Inc.

Reynolds Metals Company

Rockwell Manufacturing Company

St. Regis Paper Company

Schuler's Foods

SCM Corporation

[H. P.] Snyder Manufacturing Company

Socony Mobil Oil Corporation

[GTE] Sylvania, Inc. (Division 1)

[GTE] Sylvania, Inc. (Divsion 2)

Trans World Airlines, Inc.

Turner Construction Company

Union Carbide Corporation

Walsh Construction Company

Ward Leonard Electric Company

Washburn Wire Company

Western Electric Company

[The] Western Union Telegraph Company

White Industrial Power, Inc.

Worthington Turbine International, Inc.

Xerox Corporation

Appendix A-1 (continued)

PUBLIC EMPLOYERS considered to be valid respondents (n=15):

[The City of] New York*

Board of Education, Office of School Buildings

Environmental Protection Administration

Housing and Development Administration

Municipal Service Administration, Department of Public Works*

Bureau of Building Construction

Bureau of Building Design

Bureau of Gas and Electricity

Office of the Controller

Transportation Administration, Department of Highways

[The State of] New York, Department of Civil Service

New York City Health and Hospital Corporation

New York City Housing Authority

New York City Transit Authority

[The] Port of New York Authority

[The City of] Syracuse

Triboro Bridge & Tunnel Authority

*Name of larger organizational unit; each subunit was counted as a respondent.

THE UNIVERSITY OF THE STATE OF NEW YORK
THE STATE EDUCATION DEPARTMENT

DEPUTY COMMISSIONER FOR
HIGHER AND PROFESSIONAL EDUCATION

OFFICE OF PLANNING IN HIGHER EDUCATION
99 WASHINGTON AVENUE
ALBANY, NEW YORK 12210
518: 474-3910

Appendix A-2: Employer Questionnaire

INITIAL REQUESTING LETTER

March 9, 1973

Dear President or General Manager:

Several post-secondary educational institutions in New York State have expressed interest in expanding the number of 4-year programs leading to a bachelor of technology in engineering (B.T.E.) degree. Very briefly, these programs would be designed to emphasize technological applications in preparing individuals for positions which require technical backgrounds.

The Regents believe that an effort should be made to assess the potential employment outlook in New York State for graduates of such programs before further expansion is encouraged.

With this end in mind, I am seeking your opinion on the need for these new 4-year programs by means of the enclosed questionnaire. It is requested that the questionnaire be completed by the person who is most knowledgeable on conditions in your organization with respect to this issue. All individual responses will, of course, be treated as strictly confidential information by the Department.

I believe that this is an opportunity to attain more educational relevance with value to both employers and students, and I hope that I may have the benefit of your advice. Since the Regents plan to address this topical issue in the immediate future, I respectfully request that the completed questionnaire be returned by March 23, 1973.

Sincerely yours,

W. N. Smith
Director

WNS:db

THE UNIVERSITY OF THE STATE OF NEW YORK
THE STATE EDUCATION DEPARTMENT

DEPUTY COMMISSIONER FOR
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OFFICE OF PLANNING IN HIGHER EDUCATION
99 WASHINGTON AVENUE
ALBANY, NEW YORK 12210
518: 474-3310

Appendix A-2 (continued)

FOLLOWUP REQUESTING LETTER

April 9, 1973

Dear President or General Manager:

One month ago, a survey questionnaire was sent to you on the topic of the 4-year bachelor of technology in engineering (B.T.E.) degree. We have not received your response as of this date.

Since it is quite important for our sample to be as representative of the employers of New York State as possible, I am enclosing another copy of the questionnaire by way of a followup survey. Your response will be greatly appreciated and, as stated in my previous letter, will be treated as strictly confidential information by the Department.

The results of this survey will help to assess the potential employment outlook for graduates of B.T.E. degree programs before the development of additional programs in New York State. I believe that this is an opportunity to attain more educational relevance, with value to both employers and students.

The Regents will be addressing this topical issue in the very near future. So that the survey may benefit from your advice, please return the completed questionnaire by April 20, 1973.

Sincerely yours,

for W. N. Smith
Director

WNS:mn
Enclosure

EMPLOYER QUESTIONNAIRE

(code no.)

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Bureau of Research in Higher and Professional Education
Albany, New York 12210

ALL QUESTIONS REFER ONLY TO FULL-TIME EMPLOYEES IN NEW YORK STATE

1. How many persons are employed full-time by your company (organization) in New York State? 1. _____

2. What percentage of those in #1 are engineering-technical employees? (Check one)

a. ☐ 5% or less
b. ☐ 6% to 10%
c. ☐ 11% to 25%
d. ☐ 26% to 50%
e. ☐ 51% to 75%
f. ☐ over 75%

3. Where in New York State is the largest number of engineering-technical employees located? 3. _____ (County)

Questions 4, 6, 8, and 10 refer to all employees who hold a 4- or 5-year bachelor of science (B.S.) degree in engineering, and no higher.

Questions 5, 7, 9, and 11 refer to all employees who hold a 2-year associate of science (A.S.) degree in a technical field, and no higher.

4 & 5. How many of these degree-holders are employed by your company in all types of positions?

4. _____ (B.S.) 5. _____ (A.S.)

6 & 7. What percentage of these degree-holders are engineering-technical employees?

6. (B.S.-check one)

a. ☐ 25% or less
b. ☐ 26% to 50%
c. ☐ 51% to 75%
d. ☐ 76% to 95%
e. ☐ over 95%

7. (A.S.-check one)

a. ☐
b. ☐
c. ☐
d. ☐
e. ☐

8 & 9. What is the average annual salary of these degree-holders?

8. (B.S. - check one)		9. (A.S. - check one)
a. ☐	$4,999 or less	a. ☐
b. ☐	$5,000 to $9,999	b. ☐
c. ☐	$10,000 to $14,999	c. ☐
d. ☐	$15,000 to $19,999	d. ☐
e. ☐	$20,000 or more	e. ☐

10 & 11. What is the current annual <u>starting</u> salary for recent degree recipients?

10. (B.S. - check one)		11. (A.S. - check one)
a. ☐	$4,999 or less	a. ☐
b. ☐	$5,000 to $9,999	b. ☐
c. ☐	$10,000 to $14,999	c. ☐
d. ☐	$15,000 to $19,999	d. ☐
e. ☐	$20,000 or more	e. ☐

The remaining questions concern the 4-year <u>bachelor of technology in engineering</u> (B.T.E.) degree. Since B.T.E. degree programs are relatively new, the following brief description of their educational purposes (based on the composite opinion of educators who conduct existing programs in New York State) may be helpful. These 4-year programs are intended to provide a technological background with emphasis on application and adaptation skills, rather than on creative skills, in engineering. Such preparation may allow graduates to fill voids created by engineers moving into research or to perform non-engineering tasks, which would benefit from technical training.

12. Are any holders of a 4-year bachelor of technology in engineering (B.T.E.) degree presently employed by your company? (Check one)

a. Yes ☐ - how many? _____

b. No ☐

13. In your judgement, what is an appropriate starting salary for a recent recipient of a 4-year B.T.E. degree? (Check one)

a. ☐ $4,999 or less

b. ☐ $5,000 to $9,999

c. ☐ $10,000 to $14,999

d. ☐ $15,000 to $19,999

e. ☐ $20,000 or more

14. In your judgement, what relative levels of compensation are appropriate to a holder of a 4-year B.T.E. degree? (Check one for a and b)

	Higher Than	Equal To	Lower Than	Don't Know
a. relative to that of an engineer	☐	☐	☐	☐
b. relative to that of a technician	☐	☐	☐	☐

15. In your judgement, how appropriate are the following areas of work responsibilities to a holder of a 4-year B.T.E. degree? (Check one each for a through f)

	Highly Appropriate	Moderately Appropriate	Slightly Appropriate	Not Appropriate	Don't Know
a. working as a technologist	☐	☐	☐	☐	☐
b. working as an engineer	☐	☐	☐	☐	☐
c. working as a technician	☐	☐	☐	☐	☐
d. working as a technical salesman	☐	☐	☐	☐	☐
e. working as a technical writer	☐	☐	☐	☐	☐
f. working as a technical manager	☐	☐	☐	☐	☐

If you wish to make additional comments on the 4-year bachelor of technology in engineering degree, please write them on the back of this page.

Appendix A-3: Tabular Data

(Survey of Potential Employers)

NOTE: Tabular detail may not add due to rounding.

Appendix A-3 (continued)

TABLE 14. ENGINEERING-TECHNICAL STAFFS: PROPORTIONATE SIZE

Percent Distribution of All Employers by Size, and of B.Tech. Employers,* by Percent of Employees on Engineering-Technical Staff

Percent of Full-Time Employees on Engineering-Technical Staff	All Employers by Number of Full-Time Employees			B.Tech. Employers* (n=22)	ALL EMPLOYERS (n=96)
	5,000 or More (n=29)	1,000-4,999 (n=31)	Less Than 1,000 (n=36)		
Over 25%	3.5%	12.9%	13.9%	18.2%	10.0%
11% - 25%	24.1	29.0	22.2	54.6	25.0
6% - 10%	20.7	22.6	11.1	9.1	17.7
5% or Less	48.3	35.5	52.8	18.2	45.8
Not Available	3.5	0.0	0.0	0.0	1.0
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%

*Included in distributions of all employers by size.

Appendix A-3 (continued)

TABLE 15. STARTING SALARIES

Percent Distributions of B.Tech. Employers and All Employers by Reported Salaries of Recent Degree Recipients by Degree Type

Starting Annual Salary	Degree Type						ALL DEGREE TYPES	
	Engineering*		B.Tech.**		Associate*			
	B.Tech. Employers (n=22)	All Employers (n=96)	B.Tech. Employers (n=22)	All Employers (n=96)	B.Tech. Employers (n=22)	All Employers (n=96)	B.Tech. Employers (n=22)	All Employers (n=96)
$15,000 - 19,999	0.0%	3.1%	0.0%	1.0%	0.0%	0.0%	0.0%	1.4%
$10,000 - 14,999	95.5	77.1	59.1	52.1	0.0	1.0	51.5	43.4
$5,000 - 9,999	4.5	14.6	40.9	39.6	81.8	72.9	42.4	42.4
Not Available	0.0	5.2	0.0	7.3	18.2	26.0	6.1	12.8
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

*Reported actual starting salary.

**Judged appropriate starting salary.

Appendix A-3 (continued)

TABLE 16. RELATIVE COMPENSATION

Percent Distributions of All Employers by Size, and of B.Tech. Employers,* by Appropriate B.Tech. Compensation Level Relative to an Engineer and a Technician

Appropriate B.Tech. Compensation	All Employers by Number of Full-Time Employers						B.Tech. Employers* (n=22)		ALL EMPLOYERS (n=96)	
	5,000 or More (n=29)		1,000-4,999 (n=31)		Less Than 1,000 (n=36)					
	Engr.	Tech.	Engr.	Tech.	Engr.	Tech.	Engr.	Tech.	Engr.	Tech.
Higher than	0.0%	75.9%	0.0%	67.7%	0.0%	72.2%	0.0%	86.4%	0.0%	71.9%
Equal to	22.4	6.9	19.4	16.1	38.9	13.9	20.5	13.6	27.6	12.5
Lower than	63.8	3.5	64.5	3.2	52.8	0.0	75.0	0.0	59.9	2.1
Don't know	6.9	3.5	6.5	3.2	2.8	5.6	0.0	0.0	5.2	4.2
Not Available	6.9	10.3	9.7	9.7	5.6	8.3	4.6	0.0	7.3	9.4
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

*Included in distribution of all employers by size.

NOTE: Engr. = Engineer; Tech. = Technician.

Appendix A-3 (continued)

TABLE 17. WORK RESPONSIBILITY AREAS

Percent Distributions of All Employers by the Appropriateness of Six Work Responsibility Areas to B.Tech. Holders

Work Responsibility Area	Degree of Appropriateness				Don't Know	Not Available	TOTAL All Employers (n=96)
	Highly	Moderately	Slightly	Not			
Technologist	38.5%	25.0	4.2	7.3	12.5	12.5	100.0%
Engineer	11.5%	43.2	21.4	6.3	7.3	10.4	100.0%
Technician	25.0%	19.8	20.8	15.6	9.4	9.4	100.0%
Technical Salesman	35.9%	24.5	10.4	6.3	10.4	12.5	100.0%
Technical Writer	26.6%	28.6	12.5	9.4	12.5	10.4	100.0%
Technical Manager	8.3%	41.1	17.2	7.3	16.7	9.4	100.0%

Appendix A-3 (continued)

TABLE 18. WORK RESPONSIBILITY AREAS — B.TECH. EMPLOYERS

Percent Distributions of B.Tech. Employers by the Appropriateness of Six Work Responsibility Areas to B.Tech. Holders

Work Responsibility Area	Degree of Appropriateness				Don't Know	Not Available	TOTAL B.Tech. Employers (n=22)
	Highly	Moderately	Slightly	Not			
Technologist	40.9%	22.7	4.5	9.1	9.1	13.6	100.0%
Engineer	13.6%	43.2	20.5	13.6	0.0	9.1	100.0%
Technician	27.3%	13.6	11.4	34.1	9.1	4.5	100.0%
Technical Salesman	45.5%	27.3	4.5	0.0	4.5	18.2	100.0%
Technical Writer	38.6%	34.1	4.5	9.1	9.1	4.5	100.0%
Technical Manager	9.1	38.6	25.0	4.5	18.2	4.5	100.0%

APPENDIX B

Survey of Program Directors

Appendix B-1: Directors Sampled

Appendix B-2: Institutional Report Form

Appendix B-3: Tabular Data

Appendix B-1: Directors Sampled

Dr. George DePuy
Director, Bachelor of Technology Program
School of General Studies
State University of New York at Binghamton
Vestal Parkway East
Binghamton, New York 13901

Dr. Edward T. Misiaszek
Associate Dean of Engineering
Director, Bachelor of Professional Studies Program
Clarkson College of Technology
Potsdam, New York 13676

Dr. Myron E. Lewis
Director, Division of Technology
State University College at Buffalo
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Dr. Theodore K. Steele
Vice President for Academic Affairs and Dean of Faculty
New York Institute of Technology
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Old Westbury, New York 11568

Prof. Anton Steinhauser
Director, Bachelor of Technology Division
Department of Mechanical Engineering
City College of New York
138th Street and Convent Avenue
New York, New York 10031

Dr. James D. Forman
Director, School of Applied Science
Rochester Institute of Technology
One Lomb Memorial Drive
Rochester, New York 14623

Appendix B-2: Institutional Report Form

BACHELOR OF TECHNOLOGY DEGREE PROGRAM

Program Offered By: _____
(Institution)

_____
(Department)

Program Director: _____
(Name)

_____
(Title)

The following is intended as a format for providing information on the B.T.E. degree program offered by your institution. It is divided into five parts, under the headings:

STUDENTS

FACULTY

GRADUATES

RELATED DEGREE PROGRAMS

ADDITIONAL COMMENTS

Although specific questions are posed which require particular data, it is hoped that this general framework will allow and encourage the reporting of additional items about your program as you believe important.

All questions refer to your institution's B.T.E. (or equivalent) degree program, unless otherwise indicated.

STUDENTS

Enter data for questions 1 and 2 in the table below.

1. What was the actual student enrollment during each academic year of the program's existence? (Enter zero where appropriate.)

2. What is the projected student enrollment during each subsequent academic year, as indicated?

Academic Year	Number of Students		
	Full-time	Part-time	Total
(1)	(2)	(3)	(4)
Actual 1969-70			
1970-71			
1971-72			
1972-73			
Projected 1973-74			
1974-75			
1979-80			

3. What was the number of applicants (for full-time and part-time study) during each academic year of the program's existence? (Enter zero where appropriate.)

Academic Year	Number of Applicants		
	Full-time	Part-time	Total
(1)	(2)	(3)	(4)
1969-70			
1970-71			
1971-72			
1972-73			

4. During the program's existence, including the 1972-73 academic year, how many students (full-time and part-time) have entered the program as beginning first-year students? _____

5. During the program's existence, including the 1972-73 academic year, how many students (full-time and part-time) have entered the program as transfer students with advanced standing? If these data are available for each year of the program, please provide them on similar tables.

Basis for Advanced Standing	Number of Transfer Students		
	From Your Institution[1]	From Another Institution	Total
(1)	(2)	(3)	(4)
Has 2-year degree in engineering-related technology			
Has 2-year degree in any other area			
Was in B.S. degree program in engineering			
Was in any other 2 or 4-year degree program			
Other			
TOTAL			

[1]Another program at your institution.

FACULTY

6. During the 1972-73 academic year, how many faculty members regularly taught courses that are required in the program?

Name of Department[1]	Number of Faculty Members		
	Full-time[2]	Part-time[2]	Total
(1)	(2)	(3)	(4)
ALL DEPARTMENTS			

[1]The department with which the faculty member is primarily associated.

[2]Employment status at the institution.

GRADUATES

Enter data for questions 7 and 8 in the table below.

7. During the program's existence, what was the actual number of degrees awarded during each academic year. (Enter zero where appropriate.)

8. What is the projected number of degrees to be awarded during each subsequent academic year, as indicated?

Academic Year	Number of Degrees Awarded
(1)	(2)
Actual 1969-70	
1970-71	
1971-72	
1972-73	
Projected 1973-74	
1974-75	
1979-80	

9. According to your own information, estimate what percentage of the program's graduating classes go into these activities:

a.	technical employment	____%
b.	teaching positions	____%
c.	graduate study	____%
d.	other activities	____%
e.	unknown	____%
		100 %

10. In your judgement, what relative levels of compensation are appropriate to a holder of a 4-year B.T.E. degree? (Check one for a and b)

	Higher Than	Equal To	Lower Than	Don't Know
a. relative to that of an engineer	[ ]	[ ]	[ ]	[ ]
b. relative to that of a technician	[ ]	[ ]	[ ]	[ ]

11. In your judgement, how appropriate are the following areas of work responsibilities to a holder of a 4-year B.T.E. degree? (Check only one for a through f)

	Highly Appropriate	Moderately Appropriate	Slightly Appropriate	Not Appropriate	Don't Know
a. working as a technologist	[ ]	[ ]	[ ]	[ ]	[ ]
b. working as an engincer	[ ]	[ ]	[ ]	[ ]	[ ]
c. working as a technician	[ ]	[ ]	[ ]	[ ]	[ ]
d. working as a technical saleman	[ ]	[ ]	[ ]	[ ]	[ ]
e. working as a technical writer	[ ]	[ ]	[ ]	[ ]	[ ]
f. working as a technical manager	[ ]	[ ]	[ ]	[ ]	[ ]

RELATED DEGREE PROGRAMS

12. If your institution currently offers 2-year associate degree programs in engineering-related technology, then list the programs by area below and check those from which students have transferred into your B.T.E. degree program.

13. If your institution currently offers bachelor of science degree programs in engineering, then list the programs by field below and check those from which students have transferred into your B.T.E. degree program.

ADDITIONAL COMMENTS

Any further information or discussion you wish to provide may be presented in this part, according to what you believe is important. Examples for possible commentary include:

1. the goals, curricula, or admissions criteria of B.T.E. degree programs;
2. the career goals of students in these programs;
3. the current and potential need for B.T.E. degree program graduates in the labor market; and
4. the establishment and location of additional B.T.E. degree programs in New York State.

Also, you are encouraged to send along any literature or other prepared descriptions of your institution's own B.T.E. degree program and its development.

Appendix B-3: Tabular Data

(Survey of Program Directors)

NOTE: Tabular detail may not add due to rounding.

Appendix B-3 (continued)

TABLE 19. B.TECH. ENROLLMENTS

Full-Time, Part-Time, and Total Enrollments in New York State B.Tech. Programs
Actual: 1970-71, 1971-72, 1972-73; Projected: 1973-74, 1974-75, and 1979-80

Institution	Type of Enrollment	Actual Enrollments			Projected Enrollments		
		1970-71*	1971-72*	1972-73	1973-74	1974-75	1979-80
Binghamton	Full-Time			6	20	65	125
	Part-Time			83	200	275	500
	Total			89	220	340	625
Buffalo	Full-Time		24	84	120	140	300
	Part-Time		0	1	10	20	50
	Total		24	85	130	160	350
CCNY	Full-Time	54	144	190	150	150	150
	Part-Time	0	61	100	130	130	130
	Total	54	205	290	280	280	280
Clarkson	Full-Time			5	12	40	200
	Part-Time			0	0	0	0
	Total			5	12	40	200
NYIT	Full-Time		22	56	75	100	200
	Part-Time		4	3	90	160	225
	Total		26	59	165	260	425
RIT	Full-Time	92	213	413	360	350	350
	Part-Time	0	61	119	100	100	100
	Total	92	274	532	460	450	450
NEW YORK STATE	Full-Time	146	403	754	737	845	1,325
	Part-Time	0	126	306	530	685	1,005
	Total	146	529	1,060	1,267	1,530	2,330

*Blanks indicate programs not yet operational.

TABLE 20. B.TECH. TRANSFERS

Number of Transfer Students to New York State
B.Tech. Programs by Educational Background
1970-71 to 1972-73

Institution	Basis for Transfer and Origin*									ALL TRANSFERS		
	Has associate degree in engineering-related technology**			Was in baccalaureate degree program in engineering			Was in any other 2- or 4-year degree program					
	Same	Another	Subtotal	Same	Another	Subtotal	Same	Another	Subtotal	Same	Another	Subtotal
Binghamton	0	88	88	—	1	1	—	—	—	—	89	89
Buffalo	0	85	85	—	—	—	—	—	—	—	85	85
CCNY	0	317	317	—	—	—	—	—	—	—	317	317
Clarkson	0	3	3	2	—	2	—	—	—	2	3	5
NYIT	0	9	9	2	4	6	—	3	3	2	16	18
RIT	40	748	788	3	3	6	—	—	—	43	751	94
NEW YORK STATE	40	1250	1290	7	8	15	0	3	3	47	1261	1308

*"Same" - Transferred from another program at the same institution.
"Another" - Transferred from another institution.

**No transfer students with any other type or level of degree were reported.

Appendix B-3 (continued)

TABLE 21. B.TECH. DEGREES

Number and Percent of Degrees by New York State B.Tech. Programs
Actual: 1972-73; Projected 1973-74, 1974-75, and 1979-80

Institution	Actual Degrees*		Projected Degrees					
	1972-73		1973-74		1974-75		1979-80	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Binghamton	—	—	3	1.0%	25	7.3%	150	22.4%
Buffalo	19	7.6%	60	19.0	60	17.4	150	22.4
CCNY	90	36.0	95	30.1	110	31.9	110	16.4
Clarkson	1	0.4	8	2.5	20	5.8	90	13.4
NYIT	7	2.8	20	6.3	30	8.7	70	10.5
RIT	133	53.2	130	41.1	100	29.0	100	14.9
NEW YORK STATE	250	100.0%	316	100.0%	345	100.0%	670	100.0%

*No degrees were reported prior to 1972-73.