WestVirginiaUniversity
THE RESEARCH REPOSITORY @ WVU

Applications | RRI Input-Output Archive

1978

The Impact of Georgia Tech: Money, People, Ideas

William A. Schaffer
Georgia Institute of Technology

W. Carl Biven
Georgia Institute of Technology

Follow this and additional works at: https://researchrepository.wvu.edu/rri_ioapplication

Recommended Citation

Schaffer, William A. and Biven, W. Carl, "The Impact of Georgia Tech: Money, People, Ideas" (1978). *Applications*. 41.
https://researchrepository.wvu.edu/rri_ioapplication/41

This Article is brought to you for free and open access by the RRI Input-Output Archive at The Research Repository @ WVU. It has been accepted for inclusion in Applications by an authorized administrator of The Research Repository @ WVU. For more information, please contact beau.smith@mail.wvu.edu.

THE IMPACT OF GEORGIA TECH

MONEY PEOPLE IDEAS

William A. Schaffer
W. Carl Biven
Professors of Economics
1978

GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA 30332

PREFACE

This study assesses the impact of Georgia Tech on the State. Unlike typical impact analyses, which concentrate primarily on financial questions, it examines flows of money, people, and ideas through the Institute to the benefit of Georgians. As a result of this enlarged goal, our final report seems large and complex. Actually, however, it is complex because university activities are complex, because we had access to more data than is usually the case, and because we were given considerable resources and support in our work.

Financial support for this study came from the Georgia Institute of Technology through the office of the Vice-President for Research, Dr. Thomas Stelson, and from the Georgia Tech Foundation. The Georgia Tech Alumni Association supplied clerical help and covered printing and mailing costs incurred in the alumni survey. Arthur Andersen and Company provided its services in verifying the acceptability of procedures used in the study. (A copy of a letter from Arthur Andersen regarding its independent verification of the reasonableness of the procedures used in collecting the data and the analytical methods applied is appended.) We appreciate the many thoughtful suggestions of Robert Anclien, Bye Wind, and Simon Moughamian in this regard.

We are indebted to a number of people for their help. Dr. Joseph Pettit, President of Georgia Tech, gave his support and approval. Mr. Joseph Gutheridge, Vice President for Development, has, along with his staff, assisted the project from the beginning. The Office of the Vice President for Finance, the Office for Institutional Research, the

Engineering Experiment Station, the Department of Continuing Education, the Graduate Division, and the Placement Center provided on request a variety of data. The Athletic Association made available its financial records and cooperated with a survey of fans attending football games.

The survey of football fans was conducted with assistance from a class in regional economics including Nestor Alvarez, Stevan Atkinson, Charles Dorsey, Robert Felts, Paul Henry, Robert Herman, James Hixson, Glenn Loftin, Frederick Massey, Franklin Pidgeon, Cynthia Rennolds, Eric Risberg, Wendell Sanders, Susan Sikora, and Leslie Wallace. We are indebted to Ross Herbert, whose assistance in designing the computer programs and supervising data processing was invaluable. We are also indebted to Thomas Booth, who designed the program for the sample selection in the alumni survey, and to Professor Fred E. Williams, College of Industrial Management, who devoted a number of hours to checking the results of the alumni survey for statistical significance. John Fritz, Brian Heath, and Bruce Vanderhoof, graduate assistants, carried out a variety of tasks. Charles Floyd assisted in analyzing the results of the football fan survey and Robert Mee assisted in the alumni survey, in both cases as undergraduate projects. Lawrence Callahan, Elizabeth Doyle, Steven Krebs, Joseph Owens, and David Rezendes, all undergraduates, participated in the design and implementation of the survey of student spending. David Rezendes also assisted with an extensive review of financial records in preparing for the input-output analysis.

Sarah Born and Ilene Hahn typed and retyped this manuscript. We appreciate their efforts to create order and their patience through numerous revisions.

We divided the work load for the study as follows: Schaffer devised the overall plan, took primary responsibility for the study of money flows, supervised computer work, and assisted in developing the alumni survey. Biven took primary responsibility for the alumni survey and for the review of research activities, supervised the student-spending survey, and coordinated the final production of this document.

While thankful for the support and assistance acknowledged above, we remain responsible for our conclusions and would be pleased to discuss the study at any time.

TABLE OF CONTENTS

LIST OF TABLES

Table

Table

Tables in Appendices

Tables in Appendices

LIST OF FIGURES

INTRODUCTION AND SUMMARY

Georgia Tech affects the community of which it is a part in three ways. As an institution through which money flows, Georgia Tech has a direct and immediate impact on Georgia and Atlanta. These direct flows have further significant indirect effects which can be traced through appropriate economic models. As an institution through which people flow, Georgia Tech is an important source of talents to the region - she attracts students of exceptional quality and provides Georgia an opportunity to induce them to settle here. Similarly, she equips Georgia residents to fulfill their own educational objectives and permits Georgia businesses to employ these graduates more easily. As an institution through which ideas flow, Tech makes a long-term contribution to Georgia and the nation. Research originating at Georgia Tech contributes to the country's scientific and technological know-how.

This study of the impact of Georgia Tech is organized around these three lines. Part I of the report traces the money flows by source and by destination in order to identify local and non-local sources and recipients. Much of the data were obtained from records maintained at Tech. Certain types of money flows which Tech causes but which do not enter into the Tech bookkeeping system - student off-campus purchases, spending by football fans or participants in campus conferences - were estimated by direct interview and sampling techniques.

Spending by Georgia Tech or by individuals involved in Tech activities has a multiple effect on State incomes since those who derive funds from these flows respend them and provide still further income for other Georgians in what is known as a multiplier process. This indirect multiplier effect can be estimated with varying degrees of sophistication. Our approach uses a *version of the Georgia input-output model previously developed by one of* the authors.

Part II deals with the people flow. Over 4,300 usable questionnaires were obtained from an alumni mail survey. The data collected made it possible to sketch a profile of Tech alumni including such things as educational experiences, geographical movements, industrial and occupational attachments, and annual income.

Part III covers the flow of ideas with a survey of campus educational and research activities. These activities can be measured by such things as research dollars expended and number of publications. A number of persons on campus were also interviewed for detailed information on a number of individual research projects. Finally an attempt is made to assess Georgia Tech's current standing in education and research compared to other universities and colleges.

This study is organized to trace the impact of the Institute in terms of these flows, which are summarized as follows.

The Economic Impact of Georgia Tech, 1976-77

In terms of money flows generated, the impact of Georgia Tech on the economy of Georgia can be measured by (1) identifying all Tech-related incomes, (2) specifying their geographic origins, (3) establishing expenditure patterns associated with Georgia Tech, (4) showing the parts of these expenditures which flow directly into the State economy, and (5) tracing these direct flows through the industries of Georgia as they become indirect incomes for other Georgia citizens.

These steps have been accomplished through a detailed review of the financial records of the Institute, through surveys of students, football fans and continuing education participants, through numerous interviews with knowledgeable officials, and through a technique called "input-output analysis."

In brief, Tech-related incomes amounted to $122 million in 1976-77. Of this total, $95 million represents unduplicated impact expenditures with persons and businesses in Georgia. Forty-eight percent of these expenditures were made with funds originating outside Georgia. When the ripple effect of these expenditures is considered, the outside funds lead to new activity valued at $111 million and the total economic presence of Georgia Tech is $229 million. The following comments outline our economic conclusions in more detail.

Tech-Related incomes. Total Tech-related incomes amounted to almost $122 million in 1976-77. Of this, only $63 million was accounted for in the official Georgia Tech budget, with 37 percent coming from the State appropriation, 15 percent from student tuition, and 26 percent from the Federal government. Another 10 percent was derived from commercial sales, primarily to students, and the remaining 12 percent came largely from private sources.

The incomes of Georgia Tech's 8,880 students amounted to almost $54 million. Over $20 million originated outside of Georgia and an additional $12 million would have left the State were it not for Georgia Tech.

The revenue of Georgia Tech athletic organizations amounted to $2.5 million, with 96 percent related to football. Over $800 thousand came from outside the State.

Georgia merchants received almost $2.3 million directly from football fans, adult education participants, and recruiters. Football fans spent almost $1.7 million, with $900 thousand originating outside the State. Persons taking adult education courses spent over $493 thousand in the local area, of which $397 thousand was from outside Georgia. And recruiters spent over $90 thousand, with $75 thousand from outside the State.

Geographic Origins. While over half, or $67 million, of all Tech-related incomes originate in Georgia, it is interesting to note that the State appropriation represents only $25 million, a little over one-fifth of these incomes and less than half of Georgia Tech's budget itself. Further, certain parts of the appropriation yield high direct returns. For example, Tech's primary research unit, the Engineering Experiment Station, operated on a budget of over $14 million, almost six times its original State appropriation of $2.4 million.

Expenditure Patterns. Tech-related expenditures with businesses and persons amounted to $95 million. The remainder of $122 million is spent within Georgia Tech itself and largely represents transactions between Georgia Tech budget units and expenditures by students which appear within the official Institute budget. The largest single item in the $95 million total is Georgia Tech's unduplicated expenditure of $59 million. Students spend $31 million with the Atlanta business community, the Athletic Association spends almost $3 million, and football fans and other campus visitors spend over $2 million associated with Georgia Tech.

Of Georgia Tech's expenditures, two-thirds, or $39 million, go for payrolls. The remaining expenditures are various: $2 million for printing, $3 million for equipment, $3 million for utilities, $2 million for business services, $3 million for supplies and materials, over $1 million with the Federal government, etc.

Of expenditures by students, $31 million out of $48 million were off-campus, with major components as follows: $6 million for food, $3 million for clothing and personal supplies, $4 million for recreation and entertainment, $8 million for automobile expenses, and $5 million for housing.

The largest part of expenditures by the Athletic Association was wages and salaries, with food, transportation services, interest charges and miscellaneous services following in importance.

The expenditures by football fans and other campus visitors were primarily for food and entertainment ($1.2 million), lodging ($.5 million), gasoline expenses ($.2 million), and shopping ($.1 million).

Flows from Outside Georgia. To reflect the origins of funds, the total impact expenditures of $95 million may be split into two parts: $49 million which originates in Georgia and $46 million which originates outside the State.

Georgia Tech itself spent more money from outside the State ($30 million) than from inside ($29 million). Students spent more money earned inside the State ($17 million) than outside ($14 million). The Athletic Association had more local funds ($1.9 vs. $.8 million). And expenditures by football fans and visitors were largely out-of-state in origin ($1.4 million vs $.9 million).

The impact of these expenditures is also determined by the proportion of expenditures made directly with Georgia residents and businesses. Local expenditures relating to Georgia Tech and originating outside Georgia amount to $38 million. Total local expenditures associated with Georgia Tech regardless of their geographic origins amount to $77 million, slightly over 80 percent of the $95 million spent in association with Georgia Tech.

The Multiplier Effect. The economic impact of expenditures includes both the initial direct expenditures and the indirect expenditures which evolve from them. With the help of the Georgia Economic Model, which traces changes in demand through 28 industries in Georgia, the multiplier, or "ripple," effect of Tech-related expenditures can be identified.

The effect of funds attracted by Georgia Tech from outside the State is considerable. With new funds of almost $38 million, new activity valued at $111 million was generated, with increase in industry outputs of $59 million and the rest appearing as incomes of people and governments. These new funds were also associated with 2400 jobs, $45 million in personal income, $3.2 million in income for local governments and $3.7 million for the State government.

When all Tech-related expenditures are considered, the initial expenditure with Georgia firms and people of $78 million was amplified to $229 million. Of this, the new effect on Georgia industry output was $122 million. In addition, these expenditures are associated with 4970 jobs, $93.1 million in household incomes, $6.5 million in local government incomes, and $7.5 million return to the State government to offset its initial $24 million appropriation to the Institute.

The Job Market and the Georgia Tech Alumni

The data on which the alumni study is based came from replies to a short questionnaire mailed to 10,000 Tech alumni. The number of usable questionnaires returned was 4,342. In the analysis of the data, a comparison is frequently made between those who graduated prior to 1966 and those who graduated in 1966 and latter.

Eighty-six percent of the respondents received a Tech bachelor's degree. The remaining 14 percent either received only an advanced degree from Georgia Tech or left the Institute without receiving any degree. A fairly complete description of the respondents' educational experience is provided by the data obtained from the survey.

Survey Results: Education Patterns. For those with a Tech bachelor's degree, 25 percent went on for a master's, 4 percent went on for a Ph.D., and 2 1/2 percent went on for an M.D., a D.D.S., or a law degree. The percent doing graduate work differs for different groups. Twenty-nine percent of those receiving a bachelor's degree since 1966 received a master's; only 21 percent of the pre-1966 group received a master's degree. Forty percent of the post-1966 graduates of the College of Science and Liberal Studies and 30% of post-1966 engineering graduates went on for a master's degree. Post-1966 engineering bachelors who get a master's tend to major in engineering at the master's level less frequently than the pre-1966 group (48 percent versus 60 percent). Post-1966 engineering bachelors tend to major in management at the master's level more frequently than the pre-1966 group (47 percent vs. 30 percent). Post-1966 engineering bachelors were evenly split between engineering and management in master's degree work (48 percent and 47 percent). Post-1966 bachelors from the College of Science and Liberal Studies tend to stay in the same field for the master's (71 percent) though not as much as the pre-1966 group (96 percent) Twenty-six percent of the respondents who did not complete an undergraduate degree at Tech obtained a bachelor's degree elsewhere.

Survey Results: Geographic Patterns. A little over half of respondents in the survey were originally from Georgia, almost equally divided between Atlanta and the rest of State. Another 31 percent were from the rest of the Southeast. Florida was the biggest supplier (10 percent) except for Georgia. Almost ten percent came from Northeastern states (mostly from Maryland, New York, New Jersey, and Pennsylvania).

Where Did Georgia Tech Graduates Go? Atlanta is moderately strong in ability to hold Tech graduates. Twenty-seven percent came from Atlanta; 27 percent had their first job and have their present job in Atlanta. The rest of the State employs fewer Tech graduates than the number of starting freshmen it sends to Tech. Twenty-five percent came from Georgia, other than Atlanta; 10 percent had their first job and have their present job in the rest of the State. In summary, 52 percent of the respondents originally came from Georgia, including Atlanta. Thirty-eight percent had their first job in Georgia; 37 percent have their present job in the State.

The rest of the Southeast sent 31 percent of the respondents to Tech and employed 29 percent of the respondents on the first job and employs 33 percent on the present job. The entire Southeast, including Georgia, sent 83 percent of the sample to Tech originally. It now employs 70 percent.

The Northeast is the biggest employer of Tech alumni outside the Southeast (11 percent, present job) as it is also the biggest contributor of entering freshmen (9 1/2 percent).

The sample data reflect the recent rapid rate of growth of the Southeast. The record of Atlanta, Georgia, and the Southeast in retaining Tech graduates is better in the case of the post-1966 group than for the pre-1966 group.

For example, 27 percent of the pre-1966 group came from Atlanta but only 24 percent have present jobs here; 26 percent of the post-1966 group came from Atlanta but 29 percent have their present jobs here. Fifty-four percent of respondents who originally came from Georgia are in the State for their present jobs (58 percent for the post-1966 group). Fifty-five percent of the native Georgians who left the State are in the Southeast for their present jobs (14 percent in Florida). Fifteen percent are in the Northeast. Sixty-two percent of post-1966 males are in the Southeast versus 53 percent of the pre-1966 group. The difference is presumably due to the increasing strength of the Southeast. Twenty-three percent of the respondents with present jobs in Georgia are not Georgia natives. Sixty-five percent of this group came from the Southeast (22 percent from Florida); twenty percent came from the Northeast.

Georgia Tech alumni tend to live in larger cities than is the case for the U.S. population as a whole. Forty percent of the pre-1966 graduates and 45 percent of post-1966 graduates have their present job in the largest cities (over 1,000,000 in population).

Survey Results: Employment Status. Sixteen percent of the respondents are self-employed. The largest proportion of Tech alumni are currently employed in manufacturing (33 percent). Eleven percent are employed in transportation, communications and utilities; 8 percent in engineering or management consulting; 7 percent in the Federal government; and 6 percent in construction. The rest are distributed across an assortment of industries.

Forty-three percent of the respondents listed their current occupation as "engineer;" 20 percent listed themselves as "managers" and 10 percent as in "sales and marketing."

Twenty-one percent of the sample work for "small" firms (those employing less than 50 people). Forty-four percent work for large firms (employing more than 5,000). Sixty-six percent of the sample have worked for no more than two firms. Only 18 percent have worked for more than three employers.

Sixteen percent of the respondents are currently president, chairman of the board, or chief executive officer of the firms for which they work. Eighteen percent of this group head up "small" firms (less than $100,000 a year in sales); forty-three percent head up firms with annual sales over $1 million. Four percent of those who are top officials are with firms with annual sales over $50 million.

Survey Results: Income. The median 1976 income for the entire sample (including salary, commissions, bonuses, and fees, but excluding interest, dividends, rents, capital gains, and inheritances) was $24,400. Twenty-five percent had income in excess of $34,000; 10 percent had income above $50,000; 5 percent had income above $70,000; 2 percent had income above $100,000.

Survey Results: Engineers. A special analysis was done of those respondents who classified themselves as "engineers" in their current occupation (1,848 respondents, 43 percent of the sample). In response to a question as to the branch of engineering in which they are currently employed, 21 percent listed themselves as in electrical and electronic engineering, 18 percent in mechanical engineering, 12 percent in civil engineering, 10 percent in aeronautical and aerospace engineering, 10 percent in chemical engineering, and 10 percent in industrial.

In a breakdown by type of work performed, 24 percent listed themselves as in "executive-administrative," 17 percent in design, 16 percent in research and development, 14 percent in production, quality control, and maintenance, and 11 percent in consulting.

The median income of Tech engineers compares favorably with data developed by the Engineering Manpower Commission for the Engineers Joint Council although the two sets of data are not perfectly comparable.

Education and Research

This part of the report is primarily concerned with the history and current status of research activity on the Tech campus.

The development of graduate education and a substantial research program came after World War II. The first Ph.D. was granted by Georgia Tech in 1950. By the end of the 1977 academic year, 957 Ph.D.'s had been conferred. Ninety-five percent of the master's degrees granted (7,400) have been conferred since 1949.

There are two main centers of research on the Tech campus: the four colleges (Engineering, Science and Liberal Studies, Architecture, and Industrial Management) and the Engineering Experiment Station. The Station was founded in 1919 by the General Assembly of Georgia for the promotion of engineering and industrial research. It was not activated until 1934. In its early days, the Station played a central role in the development of a research atmosphere on the whole of the Institute campus. As graduate work developed in the academic units in the postwar period, the Station and the Colleges gradually became less interrelated.

<u>Research in the Colleges</u>. Describing the research programs in the academic units is not easy since they cover a bewildering variety of topics. They also range across a wide spectrum from basic and highly theoretical work, through research oriented toward application but strongly analytical in methodology, to mostly applied investigations.

Research in the Engineering College involves projects one would expect to see undertaken by engineers: research in aerodynamics, aeroelasticity, and propulsion; research in high-temperature materials, liquid metal properties, new plastics and textiles, water drainage and traffic signal systems; and research in computers, laser systems, lubrication, acoustics, and combustion and flammability. One of the fascinating things about research on the Tech campus today is the way in which expertise developed to solve more traditional engineering problems is now being applied to a host of things far removed from what is usually thought of as the engineer's concern. A good example is the work being done in biomedical engineering.

The College of Science and Liberal Studies is the organizational home of schools and departments with specialties more diverse than those found in the College of Engineering. Research ranges from a study of synthetic molecules with biological implications in the School of Chemistry and the study of lasers in the School of Physics to the preparation of a biography of Charles Hertz, the Georgia native who made a major contribution to the economy of the State by developing an improved technique for gathering turpentine and by proving that slash pine can be used for newsprint.

Examples of research in the College of Architecture include: providing for handicapped pedestrians in structural design; global assessment of built environments; design of a computer-based building information system; a study of professional liability insurance; analysis of environmental noise; energy conservation in new and existing buildings; and community redevelopment projects.

Research in the College of Industrial Management reflects the wide variety of faculty specialization found in that College. Examples of research projects include: economic problems of the petroleum industry, taxation, capital investment in energy, cost-benefit analysis of space communications technology, decision modeling for setting hotel reservation policy, economic development in Latin America and Nigeria, computer-based decision models for cash management, the effect on company value of dividend policy and capital structure, mathematical models of regions, and methods of forecasting and control of accounts receivable.

Research in the Engineering Experiment Station. The Engineering Experiment Station, the other center for research on the Tech campus, is a client-oriented contract organization whose research is mostly mission-directed, sophisticated analysis aimed at the solution of an existing problem.

The station is largely self-supporting, receiving only about 20 percent of its budget from the State. The remainder comes from private and Federal sources.

The strongest research area is in electronics involving defense work with specialization in radar and with peacetime applications in weather tracking and medical research. Other research includes industrial analytical service programs, solar energy research, including experiments with solar collectors, and industrial development research. The Station also maintains an industrial extension service with eight field offices distributed around the State.

Overall Status of Tech Research. An assessment of the overall status of Georgia Tech research suggests that growth in research at Tech over the last several decades is impressive. Tech is strong in undergraduate education; it is fourth in the nation in undergraduate enrollment and first in the Southeast. The Institute has, however, a long way to go in developing its research and graduate program. In terms of number of graduate students per faculty member, Tech is twenty-third when compared to twenty-six engineering schools outside the Southeast. It is seventh among fourteen schools in the Southeast. In terms of research dollars per faculty member (Engineering College only) Tech is twenty-second out of twenty-six leading engineering schools outside the Southeast; sixth when compared to thirteen other engineering programs in the Southeast.

The overall general conclusion is that Tech is distinguished as an institution for training undergraduate engineers. It has moved along rapidly in developing a graduate and research program and is gaining national visibility. But there is still a lot of work to be done in advancing Georgia Tech up the ladder of nationally ranked institutions.

THE IMPACT OF GEORGIA TECH
MONEY, PEOPLE, IDEAS

PART I

THE ECONOMIC IMPACT OF GEORGIA TECH, 1976-77

The impact of an institution of higher learning such as Georgia Tech can be viewed in the short or the long term. In the long term, the dominant effects are those expressed through people and ideas. In the short term, the more evident effects are through money flows. Since they are more obvious, we begin with money flows.

This part of the study is divided into four major sections. First, we identify the sources of revenues of Georgia Tech and Tech-related activities. Second, we look at the expenditures based on these revenues. Both of these preliminary steps are based on detailed reviews of financial reports and on surveys of students, football fans, and other campus visitors.

An important part of this exercise will be tracing the flow of these direct expenditures through the Georgia economy to demonstrate their indirect effects. This tracing is made through a version of the Georgia Economic Model, which describes the interaction of 28 industries in Georgia. (The model is discussed in more detail in the Appendix I-1.) As a consequence, much of the third section is devoted to preparing these direct expenditures for tracing. This requires that we identify the geographic origins of expenditures and the amounts spent with Georgia industries, citizens, and governments. Our fourth and final step is to outline the indirect effects of Tech-related spending.

TECH-RELATED INCOMES, 1976-77

The first step in tracing the total financial flows associated with Georgia Tech is to identify all sources of income related to the Institute. This is important for two reasons. First, a knowledge of the total income associated with various spending units is essential in establishing the importance of Georgia Tech as a generator of business in the State. Second, a knowledge of sources of income is important for analytic purposes. Government officials are interested in how appropriations are amplified by publicly-supported universities as these universities seek additional funds from other sources in pursuit of their goals. And, to the economic analyst, the funds received from outside the State are critical in determining the economic impact of the Institute: What is the effect of external money on the Georgia economy?

As a result of these needs, we identify both the institutional and the geographic sources of Tech-related income.

The Incomes of Georgia Tech

General Institute Revenues. In 1976-77 (the fiscal year ending June 30), the Institute had a total revenue of over $63 million. Table I-1 divides these funds according to major budgetary units at Georgia Tech.

Over $39 million was received by instructional units at Tech, with $20 million from the State appropriation, $9 million from student fees, and $7 million from Federal grants and contracts (including indirect cost recoveries). The remainder comes mostly from private gifts and supplements.

The income of the Engineering Experiment Station exceeded $14 million, of which only $2.4 million came from the State appropriation. The remainder came from research grants and contracts, with the Federal government providing over

TABLE I-1 CURRENT REVENUES OF THE GEORGIA INSTITUTE OF TECHNOLOGY, CLASSIFIED BY UNIT AND SOURCE, 1976-77

Unit and source	Current revenues
EDUCATIONAL AND GENERAL	
Resident Instruction	
Student Tuition and Fees	$ 9,315,162
State Appropriation	20,103,100
Federal Grants and Contracts	5,474,157
State Grants and Contracts	93,344
County and City Grants and Contracts	37,518
Private Gifts, Grants, and Contracts	1,110,315
Endowment Income	128,000
Indirect Cost Recoveries	2,065,846
Sales and Services	770,493
Foundation Supplements	591,486
Other Sources	195,518
Total Resident Instruction Revenue	$39,884,939
Engineering Experiment Station	
State Appropriation	$ 2,433,441
Federal Grants and Contracts	6,281,741
State Grants and Contracts	371,549
County and City Grants and Contracts	154,776
Private Gifts, Grants, and Contracts	1,789,055
Endowment Income	1,483
Indirect Cost Recoveries	2,873,696
Sales and Services	45,748
Other Sources	532,881
Total Engineering Experiment Station Revenue	$14,484,370
Engineering Extension Division	
Registration and Other Fees	$ 433,617
State Appropriation	243,038
Vocational Funds	85,140
Federal Grants and Contracts	9,051
Private Gifts, Grants, and Contracts	14,896
Endowment Income	7,990
Indirect Cost Recoveries	10,796
Total Engineering Extension Division Revenue	$ 804,528
TOTAL EDUCATIONAL AND GENERAL REVENUE	$55,173,837
STUDENT AID	$ 1,441,079
AUXILIARY ENTERPRISES	
Housing	$ 2,575,148
Food Services	1,668,039
Bookstores	1,297,257 a/
Service Units	1,134,005
Total Auxiliary Enterprises Revenue	$ 6,674,449
TOTAL CURRENT REVENUES	$63,289,365

a/ This total represents only revenue from the Georgia Tech Bookstore. The total in the Financial Report for June 30, 1977 includes revenues from a bookstore operated on the campus of Southern Tech for a total of $1,890,145.

Source: The Georgia Institute of Technology Financial Report, June 30, 1977, p. 7.

$8 million and with over $2 million coming from private sources. Each dollar appropriated by the State specifically for research was matched by almost five dollars in funds from other sources.

The Engineering Extension Division, with a primary function of providing continuing education opportunities for adults, took in over $804 thousand in 1976-77. Only $243 thousand came from the State appropriation, with the remainder consisting largely of registration fees for short courses of instruction.

Revenues for student aid amounted to over $1.4 million. The largest single source of this money is private gifts of over $517 thousand. Next was Federal gifts of $474 thousand, followed by endowment income and gifts from alumni clubs.

The auxiliary enterprises, which manage the semi-commercial functions at Tech, take in almost $7 million. The largest income producer is housing, with $2.6 million in income, followed by the bookstores and dining facilities. Modest revenues are produced by other service units such as the infirmary, coliseum concessions, barber shop, parking lots, and vending service.

Sources of Funds. The sources from which the $63 million in total revenue in 1976-1977 came are summarized in Table I-2. The State contributed only a little over a third of the total. The remainder came from a variety of other sources: the Federal government with 26 percent, student tuition with 15.4 percent, auxiliary enterprises with 10.5 percent, and private contributors with 6.7 percent.

Geographic Origins of Funds. To determine the economic impact of Georgia Tech on the State economy, it is necessary to divide revenues into two parts, specifying those which originate within the State and those which come from

Table I-2 Current Revenues of the Georgia Institute of Technology, Summarized by Source, 1976-77.

Source	Total	Percent
Student tuition	$9,748,779	15.4
State of Georgia	23,454,268	37.1
Federal government	16,468,935	26.0
County and city governments	270,198	0.4
Private sources	4,224,665	6.7
Endowment income	283,978	0.4
Foundation supplements	608,003	1.0
Auxiliary enterprises	6,674,449 a/	10.5
Sales and services	816,241	1.3
Other sources	739,849	1.2
Total	$63,289,365	100.0

a/ See note to Table I-1.

Source: Same as Table I-1.

without. This requires a word of explanation.

A common theory of regional change contends that a region, such as a state, must export goods and services if it is to prosper economically. Exporters, including educational institutions such as Georgia Tech, obtain revenues from customers outside the State in exchange for goods and services. These outside funds then enter the local economy in the form of purchases of materials and business services and as payments of wages and salaries, dividends, taxes, etc., and so become the incomes of local citizens. To demonstrate the contribution of Georgia Tech to the economic base and to the prosperity of the State, it is thus important to identify revenues originating outside Georgia.

For the most part, this division is relatively straightforward. However, in the case of funds related to Georgia Tech students, an interesting problem arises. Spending by out-of-state students clearly represents a flow of funds into the State. The problem relates to spending by in-state students. Georgia Tech has a unique curriculum not available elsewhere in the State and a large number of Georgia residents would be forced to leave the State to obtain a technological education if a Georgia Tech education were not available. In providing this curriculum, the Institute prevents the loss of funds which would occur as these students left the State. This function is just as important as acquiring new funds. In the language of economists, Georgia Tech serves as an "import substitute" for these students.

As part of the impact study, we conducted a survey of Georgia Tech students. Of 385 responses, 250 were from Georgia residents. In the absence of Georgia Tech, 108 of these students would have left the State in pursuit of a technological education. Thus, 43 percent of in-state students, or 25 percent of the student body, remained in Georgia only for a Georgia Tech education. Since they are "import substitutes," we have classified tuition and other purchases by these students as "out-of-state" in origin.

Table I-3 shows the geographic origins of Tech revenues. More than half of the money for instructional units comes from in-state sources, the division being influenced substantially by the large State appropriations. The situation is reversed in the Engineering Experiment Station, however, with two-thirds of funds from out of state, the largest contributor being the Federal government.

The Engineering Extension Division derives most of its support from in-state sources although the largest share of registration fees comes from out of state. Auxiliary enterprises, selling largely to students, has an income weighted toward outside sources, due largely to our decision to consider as "out-of-state" the funds spent by students who would leave the State if a Georgia Tech education were not available.

If we had counted as in-state all income derived from in-state students regardless of their desire for only a Georgia Tech education, the totals would be only slightly different. In-state tuition would increase by $1,167,419, miscellaneous sales and services by $192,623, and sales by auxiliary enterprises by $1,668,612, for a total of $3,028,654.

In summary, Georgia Tech receives $31 million from purely in-state sources, representing 49 percent of its total revenue. The remaining $32.3 million represents money from out-of-state sources or money which would otherwise have left the State.

TABLE I-3 INCOME OF THE GEORGIA INSTITUTE OF TECHNOLOGY CLASSIFIED BY BUDGET UNIT, SOURCE, AND GEOGRAPHIC ORIGIN, 1976-77

(millions of dollars)

Source	Resident Instruction[f/]		Engineering Experiment Station		Engineering Extension Division		Auxiliary Enterprises		Total		
	In-state	Out-of-state	In	Out	In	Out	In	Out	In	Out	Total
Student tuition	1,547,509[a/]	7,767,653 [a/]	-	-	190,791[e/]	242,826[e/]	-	-	1,738,300	8,010,479	9,748,779
State of Georgia	20,230,798	-	2,895,292		328,178	-			23,454,268	-	23,454,268
Federal government	-	8,022,021	-	8,436,471	-	10,443				16,468,935	16,468,935
County and city governments	45,810		224,388						270,198		270,198
Private sources [b/]	870,561[b/]	981,697[b/]	1,103,610	1,244,497	11,421	12,879			1,985,592	2,239,073	4,224,665
Endowment income [b/]	129,017[b/]	145,488[b/]	697	786	3,755	4,235			133,469	150,509	283,978
Foundation supplements [b/]	285,761[b/]	322,242[b/]	-	-	-	-			285,761	322,242	608,003
Auxiliary enterprises	-		-	-	-	-	2,135,824[c/]	4,538,625[c/]	2,135,824	4,538,625	6,674,449
Sales and services	246,558[c/]	523,935[c/]	45,748	-	-	-			292,306	523,935	816,241
Other sources	157,336	49,632[d/]	532,881	-	-	-			690,217	49,632	739,849
Total	23,513,350	17,812,668	4,802,616	9,681,754	534,145	270,383	2,135,824	4,538,625	30,985,935	32,303,430	63,289,365

Notes to Table I-3

a/ Tuition payments have three origins: in-state students who would otherwise attend Georgia schools, in-state students who would otherwise go to an out-of-state school, and out-of-state students. Based on the detailed financial report and our survey, we estimate these amounts as follows:

Nonresident tuition	4,178,179
Nonresident matriculation and fees (total tuition/(tuition/quarter)) x fees/quarter (4,178,179/389) x 225.5	2,422,055
Total out-of-state fees	6,600,234
Resident matriculation and fees	
1) For those who would go elsewhere 2,714,928 x .43	1,167,419
2) For those who would stay, regardless 2,714,928 x .57	1,547,509

Since Georgia Tech was responsible for the in-state student who desired a Tech-type education remaining in Georgia, we exclude his tuition from the in-state category.

b/ These funds are split according to the split of 1976-77 annual alumni giving, for which 47 percent of contributions were from in-state sources.

c/ These funds are split according to the results of our survey of students. Only the proportion of students who would stay in Georgia for their education regardless (.32) is attributed to in-state sources. The remainder, including proportions of out-of-state students (.43) and in-state students who would leave the State in the absence of Georgia Tech to seek a technical education (.25), is attributed to out-of-state sources.

d/ These out-of-state funds represent contracts with other states.

e/ The geographic split, with 44 percent in state, is based on data collected by the Department of Continuing Education in the year preceding March 1977.

f/ Includes funds for student aid.

Student Incomes

In measuring the economic impact of Georgia Tech, we must consider not only the income and expenditures of Georgia Tech but also the income and spending of persons closely associated with Tech whose activities are not accounted for in the official Georgia Tech budget. Students make up such a group. In estimating student income and expenditures, we have relied heavily on data obtained from our student survey (see Appendix I-6).

Sources of Funds. Table I-4 reports the sources of income for Georgia Tech students. In-state students who would have gone to another college in Georgia if Georgia Tech were not available are identified in the table as "in-state, regardless." In-state students who would have gone outside the State are identified as "in-state, Tech only." The average student who is "in-state, regardless" had an annual income of $5,658 and earned over 50 percent of this by working in Georgia. His parents or relatives contributed almost 26 percent of his total support.

The average student who is "in-state, Tech only" was slightly more affluent than his neighbor-colleagues, with an annual income of $6,248. He received less than 25 percent of his income from relatives and earned only 33 percent in Georgia. Showing a more intense technological interest, he earned almost 13 percent of his income at Georgia Tech, substantially more than other in-state students; in addition, he was more prone to have a scholarship. His added willingness to travel is reflected by the 7 percent of his income derived from work outside Georgia, a figure contrasting sharply with the corresponding 1 percent for the other in-state category.

Out-of-state students had the same high level of income as the "Tech only" category of in-state students, with the average being $6,250. This

TABLE I-4 SOURCES OF FUNDS OF GEORGIA TECH STUDENTS, 1976-77

	In-state, regardless			In-state, Tech only			Out-of-state		
Source	Percent of sample	Average income	Percent of income	Percent of sample	Average income	Percent of income	Percent of sample	Average income	Percent of income
Relatives in Georgia	75.4	1,921	25.6	57.4	2,405	22.1	3.7	3,340	2.0
Relatives outside Georgia	7.7	800	1.1	14.8	1,083	2.6	80.7	3,219	41.6
Scholarship, Georgia Tech	5.6	770	.8	11.1	1,310	2.3	11.9	1,500	2.8
Scholarship, other Ga. source	9.9	709	1.2	6.5	693	.7	3.0	875	.4
Scholarship, out-of-state source	7.0	1,711	2.1	11.1	1,358	2.4	13.0	3,621	7.7
Loan, Georgia Tech	4.2	725	.5	2.8	533	.2	5.2	979	.8
Loan, Georgia bank	5.6	1,231	1.2	3.7	1,245	.7	.7	3,500	.4
Loan, out-of-state bank	-	-	-	1.9	1,500	.4	11.9	1,622	3.1
Work, Georgia Tech	14.8	1,312	3.4	29.6	2,657	12.6	17.0	1,174	3.2
Work, metropolitan Atlanta	60.6	3,862	41.3	54.6	3,430	30.0	20.7	4,209	14.0
Work, elsewhere in Georgia	21.1	2,527	9.4	14.8	1,467	3.5	3.7	820	.5
Work, outside Georgia	4.2	1,342	1.0	13.0	3,463	7.2	51.9	1,725	14.3
Other	13.4	5,165	12.2	23.1	4,102	15.2	16.3	3,523	9.2
Total	-	5,658	100.0	-	6,248	100.0	-	6,250	100.0

student received a larger share from his parents or relatives, almost 44 percent, and had scholarship income of 11 percent. Most of the scholarship income was from out-of-state funds. Work outside the State contributed 14 percent of his income, as did work within the State.

In general, the student who would have remained in Georgia regardless was more constrained by his limited financial resources, worked for most of his income, had fewer scholarships, and borrowed more. The Georgia student out to get a technological education tended to work more at Georgia Tech, to have higher scholarship income, and to work more outside of Georgia than did in-state friends. The out-of-state student depended more heavily on parents to bear the added burden of out-of-state tuition, had more scholarship support, borrowed more, and earned more outside Georgia than did colleagues.

Geographic Origins. Obviously, the incomes of Georgia Tech students originate both inside and outside Georgia. Table I-5 reorganizes and extends our data to show the total incomes of Tech students.

The "in-state, regardless" students received over 95 percent of their support from Georgia sources for a total of over $16 million. The Georgia "Tech only" students received 87 percent of their income from Georgia sources and had almost $14 million at their disposal.

The out-of-state students, as expected, received 76 percent of their incomes from outside Georgia, taking in a total of over $23 million.

In summary, student incomes amounted to almost $54 million. Over 38 percent of this, $20.5 million, is derived from sources outside Georgia and represents a substantial addition to the Georgia economy.

Table I-5 Geographical Origins of the Incomes of Georgia Tech Students, 1976-77

Student category	Georgia	--Origin-- Outside Georgia	Total
In-state, regardless			
dollars	15,581,565	687,731	16,269,296
percent	95.8	4.2	100.0
In-state, Tech only			
dollars	11,940,939	1,723,397	13,664,336
percent	87.4	12.6	100.0
Out-of-state			
dollars	5,755,178	18,106,468	23,861,646
percent	24.1	75.9	100.0
Total, dollars	33,277,682	20,517,596	53,795,278

Athletic Incomes

The Ramblin' Recks have made a contribution to Georgia Tech far greater than can be measured on an accounting sheet. Tech's football team and fight song brought early national recognition and led the way for an impoverished school in a poor state in tapping national resources for growth and development. Now, with intense competition for the sports dollar from professional teams and with the dramatic increase in research funding in recent years, the income from football has become small in comparison to Tech's total budget. Nevertheless, it is important enough to be recognized.

Sources of Funds. As seen in Table I-6, revenue from the football season completely dominates the athletic income. With over $1.5 million in direct income from football, almost $120 thousand from students essentially for admission to games, and contributions of over $700 thousand keyed to football seating, over 96 percent of athletic income is related to football. Basketball provides most of the remainder.

Geographic Origins of Funds. Table I-7 provides a more detailed view of the geographic origins of athletic funds. According to a survey of football fans conducted during the 1976 season, 27 percent of football fans are from out-of-state. (This football survey is described in Appendix I-2). This leads to over $304,000 in ticket revenue from outside Georgia. The next largest out-of-state source is $211 thousand in contributions to the Alexander-Tharpe Scholarship Fund. This is followed by payments for television rights of $184 thousand and fees paid by out-of-state students of $57 thousand.

In total, $804,955 came directly from out-of-state. Counting the $33,662 associated with students who would leave the State in pursuit of a technological education if Tech were not available, we can attribute $84,617 to out-of-state sources.

Table I-6 A Summary of Athletic Incomes and Contributions, 1976-77

Source	Total
Football	1,551,013
Basketball	66,038
Other sports	209
Student admission cards	119,226
Physical education and locker fees	12,378
Rental of stadium	12,692
Miscellaneous	4,976
Contributions, other	722,925 a/
Total	2,489,457 b/

a/ Contributions and other income are the incomes of the Alexander-Tharpe Scholarship Fund, which is an entity separate from the Georgia Tech Athletic Association.

b/ This total differs from published figures by $89,183 to avoid the double-counting of dining hall services purchased by married athletes with funds provided by the Scholarship Fund.

Table I-7 Athletic Incomes and Contributions, Georgia Tech, 1976-77

Source	Total	--In-state-- Regardless	Tech only	Out of state	Probably out of state
Football a/					
Regular season	1,129,045	824,203	-	304,842	304,842
East Stand options	33,300	33,300	-	-	-
Handling charges	3,046	2,224	-	822	822
Yellow Jacket Confidential	1,589	1,430 a/	-	159 a/	159
Yellow Jacket Club	578	578	-	-	-
Radio nights	30,000	30,000	-	-	-
Television nights	183,600	-	-	183,600	183,600
Scoreboard advertising	5,000	5,000	-	-	-
Concessions	96,413	70,381	-	26,032	26,032
Programs	68,442	49,963	-	18,479	18,479
Basketball, regular season	66,038	66,038 b/	-	-	-
Other sports, admission	209	209	-	-	-
Student ctivities					
Athletic I.D. cards	119,226	38,629 c/	29,330 c/	51,267 c/	80,597
Dining hall operations	89,183 d/	-	-	-	-
Physical education fees	11,715	2,577	4,100	5,038	9,138
Locker rental	663	146	232	285	517
Rental of Stadium	12,692	6,000	-	6,692	6,692
Miscellaneous	4,976	4,976	-	-	-
Contributions g/	702,463	491,724 e/	-	210,739 e/	210,739
Other g/	20,462	20,462 f/	-	-	-
Total	2,578,640	1,647,840	33,662	807,955	841,617

Notes to Table I-7

a/ Totals are divided, with 27 percent derived from out-of-state sources. The exception is revenue from the Yellow Jacket Confidential Newsletter, which is 90 percent in-state according to Mr. John O'Neill, Treasurer of the Georgia Tech Athletic Association.

b/ No survey of basketball attendance was taken. Estimates of out-of-state attendance are small enough to be ignored.

c/ These funds are split according to the results of our survey. Students who would get a Georgia-based education regardless are 32.4 percent, those who would get a technological education are 24.6 percent, and those who reside out-of-state are 43.0 percent.

d/ Since income from dining hall operations comes primarily from the receipts of the Alexander-Tharpe Scholarship Fund noted below, it is not recorded here as an income among our geographical subdivisions.

e/ In-state contributions are estimated at 70 percent of the total by Mr. John O'Neill.

f/ Interest.

g/ These items record the income of the Alexander-Tharpe Scholarship Fund, which is independant of the Georgia Tech Athletic Association.

Merchant Incomes

Although they are not officially associated with Georgia Tech, some major income flows directly to Georgia merchants are initiated by Tech-related events. These flows are those associated with football fans, with continuing education programs, and with placement center activities. Although they are enumerated later as expenditures, we will note their origins here.

Football Fans. From our survey of 791 football fans at games in the 1976-77 season we have derived a set of expenditures associated with football. The sample covered five games -- those with Clemson, Virginia, Tennessee, Tulane, and Notre Dame -- and involved 453 Atlanta residents, 138 fans from the rest of Georgia, and 200 fans from other states. When adjusted to account for the two games missing in our sampled set, these statistics indicate that of 261,369 nonstudent fans, 55.8 percent of attendance lived in Atlanta, 17.2 percent in the rest of Georgia, and 27.0 percent from other states. (A documentation of their characteristics is found in Appendix I-2.)

Table I-8 summarizes expenditure patterns of Tech football fans. Expenditures by Atlanta residents have been counted only for food and gasoline, with the total of over $390,000 consisting largely of expenditures in restaurants. Expenditures by other Georgia residents average $9.34, with 58 percent being spent in restaurants and other entertainment spots, and 18 percent in hotels; their expenditures sum to almost $380,000.

Although substantially smaller in number than Georgia residents, out-of-state fans spend more, averaging $14.93 per person. Of this, 55 percent goes to food and entertainment and 26 percent to lodging. The total expenditures by out-of-state fans was $901,000.

Table I-8 Total Expenditures by Football Fans from metro Atlanta, the rest of Georgia, and outside of Georgia, 1976

	Mean expenditure per person from --		--Total expenditures from--		
	rest of Georgia	outside Georgia	rest of Georgia	outside Georgia	metro Atlanta
Food, away from Grant Field	4.02	5.50	162,860	331,945	342,433
Other entertainment	1.37	2.74	55,502	165,369	-
Shopping	.49	.99	19,851	59,750	-
Gasoline	1.80	1.76	72,922	106,223	48,106
Lodging	1.66	3.94	67,251	237,793	-
Total	9.34	14.93	378,386	901,080	390,539

Source: See Appendix I-3.

Continuing Education Participants. In its 1976-77 operating year, the Department of Continuing Education sponsored 151 programs of adult education, attracting 4,381 participants. Of these, 1,921 attended short courses which averaged 4.55 days in length; 1,287 attended conferences averaging 2.43 days in length; and 1,173 attended miscellaneous events averaging 2.11 days in length.

The geographic origins of short course and conference participants are diverse. Over 43 percent were Georgia residents, and an additional 22 percent were from the six Southern states contiguous to Georgia. Of the remaining 35 percent, almost 3 percent came from foreign countries and the others came from the remaining 43 states.

Table I-9 summarizes expenditure patterns associated with these participants. These patterns are based on the conservative assumption that all attendance for the miscellaneous events was from the Atlanta area. For the more formal short courses and conferences, official tabulations of attendance are available. Atlanta residents spent little, averaging $3.48 for restaurant meals and $0.84 on gasoline, for a total of $3,410. Other Georgia residents spent more, averaging 2.7 nights in Atlanta. Of their average expenditures, 49 percent was for lodging and 37 percent was for food and entertainment. Their total expenditures were $93.132.

Out-of-state participants spent over $397,000 in Atlanta in connection with Continuing Education, averaging $218 over 4.4 nights. Forty-six percent of this went for lodging while 41 percent went for food and entertainment.

Table I-9 Total Expenditures by Continuing Education Participants, Georgia Institute of Technology, 1976-77

	Mean expenditure per person from--		--Total expenditures from--		
	rest of Georgia	outside Georgia	metro Atlanta	rest of Georgia	outside Georgia
Food	45.79	63.31	2,746	27,337	115,351
Other entertainment	11.82	26.71		7,057	48,666
Shopping	8.56	18.64		5,110	33,962
Gasoline	13.97	8.89	664	8,340	16,198
Lodging	75.86	100.53		45,288	183,166
Total	156.00	218.08	3,410	93,132	397,343

Source: See Appendix I-4.

Placement Center Visitors. The placement of graduates into jobs has always been an important function at Georgia Tech. In the 1977 school year, 93 percent of all graduates had finalized their plans prior to graduation. This was accomplished through an effort involving 679 recorded visits by the representatives of 473 companies. Over 100 man-days were expended by companies in preliminary contacts with students and faculty and 1500 man-days were devoted specifically to interviews with prospective employees.

Discussions with members of the placement center staff and selected company representatives led us to accept $75 as a conservative estimate of per diem expenditures by placement representatives of out-of-town companies. These representatives normally stay in an upper-range hotel and have expenditure patterns which approximate two-thirds of per diem expenses for hotel accommodations and one-sixth each for food and transportation. Although we realize that many recruiting contacts involve meals, entertainment, and field trips for the prospective employees, we have not included estimates of expenditures on these items; records on such activities were not available to us.

In 1977, 37 percent of Georgia Tech graduates accepting civilian employment accepted jobs in Georgia. If we accept this as indicative of the source of recruiting expenditures as well, then 592 man-days of effort were associated with Georgia companies and 1,008 man-days with companies from outside Georgia. The money flows from outside Georgia were $75,450, at a minimum. This may reasonably be considered as $50,300 for hotel accommodations, $12,575 for food and other entertainment, and $12,575 for transportation. If we count only the food and transportation expenditures by Georgia firms, $14,800 may be added to account for local recruiting efforts. In total, $90,250 can be conservatively recorded as recruiting expenditures associated with Georgia Tech, with $50,300 for hotel accommodations, $19,975 for food and other entertainment, and $19,975 for transportation.

Summary

Table I-10 summarizes the preceding discussion of Tech-related incomes.

The direct revenues of Georgia Tech are over $63 million dollars, with 37 percent coming from the State appropriation, 15 percent from student tuition and 26 percent from the Federal government. More than half of its income can be classified as from out-of-state sources.

The incomes of Georgia Tech's 8,880 students amounted to almost $54 million dollars. Of this, over $20 million originated outside of Georgia and an additional $12 million would have left the State were it not for Georgia Tech.

The revenue of the Georgia Tech athletic organizations amounted to almost $2.5 million, over 96 percent of which was related to football. Of this, over $800 thousand came from outside the State.

Merchants received direct incomes from Tech-related activities, including funds from football fans, adult education participants, and recruiters. Football fans spent almost $1.7 million dollars, of which over $900 thousand came from outside Georgia. Persons taking adult education courses on the Georgia Tech campus spent over $493 thousand in the local area, of which $397 thousand was from out of state. And recruiters from outside Georgia spent a minimum of $90 thousand in the State.

Table I-10 Summary of Tech-Related Incomes Classified by Geographic Origin

Revenue Category	--Origin-- Georgia	Out-of-state	Total
Resident Instruction	23,513,350	17,812,668	41,326,018
Engineering Experiment Station	4,802,616	9,681,754	14,484,370
Engineering Extension Division	534,145	270,383	804,528
Auxiliary enterprises	2,135,824	4,538,625	6,674,449
Total, Georgia Tech budgets	(30,985,935)	(32,303,430)	(63,289,365)
Students, in-state, regardless	15,581,565	687,731	16,269,296
Students, in-state, Tech only	11,940,939	1,723,397	13,664,336
Students, out-of-state	5,755,178	18,106,468	23,861,646
Total, student incomes	(33,277,682)	(20,517,596)	(53,795,278
Athletic incomes	1,647,840	841,617	2,489,457
Football fans	768,925	901,080	1,670,005
Continuing education	96,542	397,343	493,885
Placement activities	14,800	75,450	90,25[illegible]
Total incomes	66,791,724	55,036,516	121,828,24[illegible]

EXPENDITURES ASSOCIATED WITH GEORGIA TECH

The incomes associated with Georgia Tech and tabulated in the previous section become expenditures by Georgia Tech, associated institutions, students, alumni, and other visitors. We are now ready to identify the patterns of spending at Georgia Tech. This process starts the tracing of money flows from Georgia Tech into the rest of her community, the state of Georgia.

Since we would like to show the net introduction of funds into the State through Georgia Tech, an important function of this section is to eliminate double counting within the Tech community. That is, we eliminate from consideration such items as tuition payments (but not tuition income) and scholarship receipts (but not scholarship payments); this means that we count such expenditures only once. Thus, our emphasis is on impact expenditures.

The Expenditures of Georgia Tech

To identify the spending patterns of budgetary units at Georgia Tech we conducted a detailed review of budgets for fiscal 1976. We assigned expenditures to 19 major commodity categories for each of the four major budget categories at Georgia Tech. These assignments are necessarily approximate, since the financial records of the Institute are not maintained in commodity detail; they are based on a substantial experience with commodity classifications. Our system generally parallels the industry classification used in the Georgia Economic Model.

These spending patterns are identified in Table I-11, which shows total impact expenditures by Georgia Tech regardless of the sources of funds. In each case, the dominant expenditure is for personal services. In the instructional

Table I-11 Total Expenditures of the Georgia Institute of Technology, Classified by Budget Unit and Commodity Category, 1976-77

(thousands of dollars)

	COMMODITY	RESIDENT INSTRUC-TION 1	ENG. EXPERIMENT STATION 2	ENG. EXTENSION DIVISION 3	AUXILIARY ENTER-PRISES 4
1	CONTRACT CONSTRUCTION	641.8	34.9	0.0	0.0
2	FOOD AND KINDRED PRODUCTS	0.0	0.0	0.0	688.9
3	APPAREL AND RELATED PRODUCTS	0.0	0.0	0.0	0.0
4	PRINTING AND PUBLISHING	1001.2	41.3	40.8	990.0
5	CHEMICALS AND ALLIED PRODUCTS	23.9	5.9	0.0	96.4
6	PETROLEUM PRODUCTS	46.9	9.0	2.1	.0
7	FABRICATED METAL PRODUCTS	2294.5	787.2	8.8	0.0
8	TRANSPORTATION EQUIPMENT	55.1	8.3	0.0	0.0
9	MISCELLANEOUS MANUFACTURING	0.0	0.0	0.0	175.5
10	TRANSPORTATION SERVICES	246.0	365.4	1.1	25.0
11	COMMUNICATIONS AND UTILITIES	2038.2	351.9	26.8	707.3
12	FINANCE, INSURANCE, REAL ESTATE	532.8	182.3	6.7	88.4
13	SERVICES	1195.0	769.8	40.1	450.5
14	GOVERNMENT ENTERPRISES	179.8	18.3	17.9	2.8
15	UNALLOCATED PURCHASES	31.2	59.4	22.4	.4
16	SUPPLIES AND MATERIALS	1485.8	1080.6	37.1	181.8
17	PERSONAL SERVICES	27442.6	9054.5	523.6	2330.6
18	STATE GOVERNMENT	302.6	373.5	.1	388.6
19	FEDERAL GOVERNMENT	1098.3	390.9	24.2	110.4
	TOTAL	38615.6	13534.4	751.8	6236.6

units, the experiment station, and the extension division (which conducts adult education programs), personal services approximate 70 percent of each budget. In auxiliary enterprises, which conducts most quasi-commercial activities, personal services drops to 37 percent of the total and dominates only because the other expenditures are spread among the various commodities purchased.

Note that only one small modification is required to convert the Institute incomes to impact expenditures. A substantial number of students receive scholarship support or pay their way through school by working at Tech. According to the student survey, students who would go to school only in Georgia receive 3.4 percent of their income, or $683,310, from Georgia Tech; in-state students who would only attend Georgia Tech receive 12.6 percent, or $2,035,986; and out-of-state students receive 3.2 percent, or $1,431,699. To avoid the double-counting of these incomes, we have reduced the total payments by Georgia Tech to households by $4,150,995. Since we have no idea exactly where these dollars came from, we have split them in proportion to the Georgia and out-of-state totals. Table I-11 reflects these reductions.

Student Spending

Our student survey forms the basis for estimates of student spending. In this survey, we requested estimates of quarterly expenditures on the following items:

a) Tuition

b) Food, on campus

c) Food, off campus

d) Clothing and personal supplies

e) Recreation and entertainment

f) Automobile operating expense and payments

g) Housing

h) Books and school supplies, purchased at Campus Bookstore

i) Books and school supplies, purchased elsewhere

j) Other items and unusual expenses

For purposes of economic-impact analysis, several items must be deleted from this list to avoid double-counting. Items a, b, and h involve student spending already included in the official Institute budget as income and must be ignored. We also exclude item g for students living in campus dormitories or married-student apartments for the same reason, and exclude item g for students living "off campus, with parents" since this item is too closely associated with Georgia residents to be considered as "outside funds" for the impact analysis. Students living off-campus, otherwise, or in fraternity houses make housing expenditures which may qualify as impact spending, depending on their sources of income.

We have thus defined the economic-impact spending of students to include food, off-campus (c)

fraternity meals (from (b) food, on campus)

clothing and personal supplies (d)

recreation and entertainment (e)

automobile operating expense and payments (f)

housing, as restricted above (g)

books and school supplies purchased elsewhere (i)

other (j)

The survey yielded data for calculating average expenditures by students on items c, d, e, g, i, and j in two categories, single students and married students. With a small and variable number of questionnaire replies in which students were unable to estimate their expenditure for a category, we have generally used the average for students replying positively for a spending category. The exceptions are for fraternity meals and housing and for automobile expenditures. In these cases, we have adjusted total spending estimates to reflect the proportions of students in fraternities, living off campus, and owning cars.

For fraternity meals, we accepted an estimate from the Dean of Students of $205 per quarter (five lunches and five dinners per week). This was then weighted for the number of single students living in fraternities (9 percent). The questionnaire contained no entry for "fraternity meals;" since students generally interpret fraternity activities as "on campus" and since fraternity activities are not in the official budgets, this adjustment is necessary.

The second adjustment pertained to automobile operating expenses. In the survey, 76 percent of students responding reported automobile operating expenses. This figure differs from the 60 percent reported by the Department of Campus Safety. To be conservative, we accepted the 60 percent estimate. The average quarterly operating expenses for automobiles was estimated to be $294. This figure is low and probably embodies substantial estimating errors. As a result, we have relied on estimates developed by the American Automobile Association. We assume the average Tech student to be driving a car with an annual operating cost between that of compact and intermediate-sized cars in a high cost area for 10,000 miles annually. This cost is $2,500 per year, or $625 per quarter. This figure includes depreciation. In effect, we are assuming that the entire student body purchases new cars to replace automobiles in the existing inventory, with the new purchases each year being the sum of depreciation expenses. Otherwise, the stock of cars on campus would continually deteriorate in quality.

It seems reasonable to count all automobile costs, both fixed and variable (29 percent of the total), for in-state students. For out-of-state students, we allocate fixed costs (insurance, license, taxes, depreciation) to their states of residence and assume that only variable costs are associated with Georgia. Thus we assume the out-of-state student spends $181 per quarter for automobile operation in Georgia.

The next question to face is whether or not to subdivide the sample for more accurate estimates. Do students differ by geographic origin, sex, or marital status in their spending patterns? Table I-12 indicates that geographic origin and sex are of little significance while marital status is quite important. As a result, we have used individual spending estimates for single and married students in our calculations.

Table I-12 Quarterly Average Spending on Selected Items, Student Survey, by Sex, Marital Status and Residence

Sex, marital status	In-state	Out-of-state
Single male	$ 420.75	$ 456.42
Single female	$ 447.19	$ 484.08
Married male	$1,277.86	$1,236.67
Married female*	-	-

*There were only four in-state married females and one out-of-state married female in the sample.

Table I-13 reports non-campus expenditures of Georgia Tech students. For single students, the largest expenditure was for automobile use, followed by housing. For married students, housing dominated, followed by automobile, food, and other expenses. Total annual off-campus spending followed a similar pattern, with automobile expenditures, housing, and food heading the list.

When total expenditures in Georgia are considered, as in Table I-14, tuition dominates due to the substantially larger fees paid by out-of-state students. Automobile expenses drop to third place behind off-campus housing because we have excluded the large fixed cost of automobile ownership for out-of-state students from funds spent in Georgia.

Among our three categories of students, out-of-state students made the largest expenditures, almost $11.5 million off campus and $21.3 million in Georgia. When the expenditures of students who would leave the state for a technical education if Georgia Tech did not exist are included, the off-campus, or impact, spending rises to over $20.1 million and the total Georgia spending to $33.0 million.

Table I-13 Non-Campus Expenditures by Students at Georgia Tech, 1976-77

	Average quarterly spending		Total quarterly spending			Total annual spending
	Single students (1)	Married students (2)	Single students (3)	Married students (4)	Total (5)	(6)
Food, off campus	163.19	366.31	1,231,758	487,925	1,719,683	5,881,316
Fraternity meals	205.00	-	139,261	-	139,261	476,273
Clothing and personal supplies	82.88	135.51	625,578	180,499	806,077	2,756,783
Recreation and entertainment	118.03	133.75	890,890	178,155	1,069,045	3,656,134
Automobile expenses	625.00	625.00	2,830,500	499,500	3,330,000	11,388,600
Housing, off-campus	288.63	716.37	435,716	954,205	1,389,921	4,753,530
Fraternity housing	125.00	-	84,915	-	84,915	290,409
Books, supplies, off-campus	22.58	25.34	170,434	33,753	204,187	698,320
Other	138.17	285.92	1,042,907	380,845	1,423,752	4,869,232

Sources and calculations:

Column 1: From tabulation and Dean of Students
Column 2: From tabulation and Dean of Students.
Column 3: Column 1 times total number of single students (7,548) with the following exceptions:

a. Fraternity meals are taken by 9 percent of students
b. Automobile expenses are incurred by 60 percent of students
c. Fraternity housing affects only 9 percent of students
d. Off-campus housing is used by 20 percent of single students

Column 4: Column 2 times total number of married students (1,332)
Column 5: Column 3 plus column 4
Column 6: Column 5 times average number of quarters (3.42)

Table I-14 Expenditures by Students Who Remain In State, Regardless, Who Remain In State Only to Attend Georgia Tech, and Who Originate Out of State, 1976-77

Category	Regardless (1)	Tech only (2)	Out of state (3)	Probable Out of state (4)	Total (5)
Tuition	1,547,509	1,167,419	6,600,234	7,767,653	9,315,162
Other purchases from instructional units	246,558	192,623	331,312	523,935	770,493
Auxiliary enterprises	2,135,824	1,668,612	2,870,013	4,538,625	6,674,449
Off-campus (impact) spending					
Food	1,882,021	1,470,329	2,528,966	3,999,295	5,881,316
Fraternity meals	152,407	119,068	204,798	323,866	476,273
Clothing, personal supplies	882,171	698,196	1,185,416	1,883,612	2,765,783
Recreation, entertainment	1,169,963	914,034	1,572,137	2,486,171	3,656,134
Automobile expenses	3,644,352	2,847,150	1,420,158*	4,267,308	7,911,660
Housing, off campus	1,521,130	1,188,382	2,044,018	3,232,400	4,753,530
Fraternity housing	92,931	72,602	124,876	197,478	290,409
Books, school supplies	223,462	174,580	300,278	474,858	698,320
Other	1,558,154	1,217,308	2,093,770	3,311,078	4,869,232
Total impact spending	11,126,591	8,692,649	11,474,417	20,167,066	31,293,657
Total spending in Georgia	15,056,482	11,721,303	21,275,976	32,997,279	48,053,761

Sources and calculations:

First 3 items are derived from Table I-3 for all columns.

Column 1: Column 6, Table I-13, times proportion of students who must stay in Georgia (.32)

Column 2: Column 6, Table I-13, times proportion of in-state students who would attend Georgia Tech only (.25)

Column 3: Column 6, Table I-13, times proportion of students from out of state (.43)
*For automobile expenses, only variable costs (29 percent of total) are included as expenditures in Georgia.

Column 4: Column 2 plus column 3

Column 5: Column 4 plus Column 1 (Total differs from total annual spending in Table 1-13 by the fixed automobile costs of out-of-state students.)

Athletic Expenditures

Now let us look at the expenditures associated with varsity athletic programs. Table I-15 has been derived directly from audited financial statements for the Georgia Tech Athletic Association and the Alexander Tharpe Scholarship Fund. The operating budgets were arranged in over 30 schedules related to activities ranging from football and basketball through cheerleaders and physical education to riflery and concessions. To the best of our abilities, we have rearranged these budgets to match the purchase categories used in our analysis of the official Georgia Tech budget.

Expenditures amounted to $2,776,659, a total in excess of incomes by almost $300,000. (The deficit was covered this year through a surplus remaining from earlier years.) As expected, the largest expense was for personnel, with salaries for coaches and supporting employees amounting to one-third of the total. Food expenditures were next, followed by travel expenses, debt repayment and rentals, and tuition payments.

Expenditures of Visitors

We have documented through surveys reported in the previous section the expenditures of football fans and of participants in continuing education programs, and we have estimated expenditures of placement officers on the basis of interviews. These figures are reported in Tables 1-8 and 1-9 and the earlier text as the incomes of local merchants.

Table I-15 Athletic Expenditures, Georgia Tech, 1976-77
(in dollars)

Expenditure category	Amount
Repair construction	$54,920
Food and kindred products	46,263
Printing	94,958
Petroleum products	1,435
Fabricated metal products	5,227
Transportation equipment	11,708
Miscellaneous sports equipment	104,468
Transportation services	203,791
Communication and utilities	76,992
Finance, insurance, real estate	192,730
Services	138,380
Postal services	34,300
Unallocated entertainment, etc.	105,392
Supplies and materials	48,104
Personal services	927,042
State of Georgia, sales taxes	3,767
Federal government, taxes	42,202
Purchased meals, catering	333,500
Books, school supplies	11,511
Athletic officials	30,630
Ticket processing	8,142
Guarantees to opponents	3,315
Intramural expenses	20,450
City of Atlanta, sales taxes	1,255
Georgia Tech, tuition and fees	186,229
Georgia Tech, room rent	89,948
Total	$ 2,776,659

Summary

Tech-related expenditures differ from incomes only to the extent that we have eliminated items from certain budgets which are included in others. Table I-16 summarizes the relationships between Tech-related incomes and expenditures. With incomes of over $121 million, over $26 million represents expenditures within the Tech community, leaving $95 million which circulates to other parts of the Georgia economy.

Table I-16 A Summary of Incomes and Impact Expenditures Associated with Georgia Tech, 1976-77

(thousands of dollars)

Budget category	Income	Total impact expenditure
Georgia Tech		
Resident instruction	41,326.0	38,615.6
Engineering Experiment Station	14,484.4	13,534.4
Engineering Extension Division	804.6	751.8
Auxiliary enterprises	6,674.4	6,236.6
Total	(63,289.4)	(59,138.4)
Student impact spending	53,795.3	31,293.7
Athletic expenditures	2,489.5	2,776.7
Football fans	1,670.0	1,670.0
Continuing education participants	493.9	493.9
Placement visitors	90.3	90.3
Total	121,828.4	95,463.0

ANALYSIS OF EXPENDITURES

With sources of funds and with the basic expenditures associated with Georgia Tech established, let us review these expenditures with the purpose of identifying the Georgia industries most affected by these flows. First, we will reduce total expenditures to those attributable to out-of-state sources. This step enables us to discuss the new money entering the State of Georgia because of Georgia Tech. Next, since the compilations in the previous section are basically in commodity or expenditure categories and are expressed in terms of what the purchasers pay, we need to transform the expenditures into an industry categorization and to express them in terms of what producers receive. This step permits us to identify who receives money flows rather than just what the money flows were for; further it enables us to see how both the producing industries and the trade and transportation industries benefit from Tech-related expenditures. Third, we reduce these expenditures to those made with local industries. This step permits us to see who in Georgia directly benefits from Tech-related expenditures.

Origin of Expended Funds

Having reviewed the origins of revenues in each of the Tech-related budgets, let us summarize these data in one table and develop an estimate of the origins of expenditures.

As seen in Table I-17, Georgia Tech is associated with total incomes of almost $122 million. Over 51 percent goes through the Institute itself and 51 percent of this, or $32 million, comes from out-of-state sources. Representing the "exports" of Georgia Tech proper, this substantial income from outside sources is primarily from the Federal government.

TABLE I-17 INCOMES AND IMPACT EXPENDITURES ASSOCIATED WITH GEORGIA TECH, CLASSIFIED BY SOURCE, 1976-77

	Source of revenue			Source of impact expenditures		
	Georgia	Outside Georgia	Total	Georgia	Outside Georgia	Total
Georgia Tech budgets	30,985,935	32,303,430	63,289,365	28,951,947	30,186,423	59,138,370
Students	(33,277,682)	(20,517,596)	(53,795,278)	(17,594,050)	(13,699,607)	(31,293,657)
In-state, regardless	15,581,565	687,731	16,269,296	10,656,159	470,432	11,126,591
In-state, Tech only	11,940,939	1,723,397	13,664,336	4,170,376	4,522,272	8,692,649
Out-of-state	5,755,178	18,106,468	23,861,646	2,767,515	8,706,903	11,474,417
Athletic budgets	1,647,840	841,617	2,489,457	1,935,042	841,617	2,776,659
Football fans	768,925	901,080	1,670,005	768,925	901,080	1,670,005
Continuing education	96,542	397,343	493,885	96,542	397,343	493,885
Placement activities	14,800	75,450	90,250	14,800	75,450	90,250
Total	66,791,724	55,036,516	121,828,240	49,361,306	46,101,520	95,462,826

Impact expenditures can now be split in proportion to the geographic split of incomes. We will consider $30,186,423 as funneled through Georgia Tech proper from outside the State, with $28,951,947 originating within the State.

Students had incomes of over $53 million. Of this, 38 percent, or $20.5 million, clearly came from out of state. In addition, however, the Georgia students who would have left the State to get a technological education would have carried up to $11.9 million with them. As a consequence, we should consider Georgia Tech to be an "import substitute" and thus responsible for retaining part of these funds in Georgia. We consider funds derived from Georgia Tech sources and from work in metropolitan Atlanta (45.1 percent of the total) as those which would remain in Georgia whether or not Georgia Tech existed, and we consider the remainder, $5,385,363, to be import-substitute or, what is the same thing, export income. Thus, we should increase the total "out-of-state" student incomes to $25,902,959 and decrease the "in-state" student incomes to $27,892,319.

With regard to student expenditures, we earlier eliminated payments to Georgia Tech from the impact categories to avoid double-counting -- they are already in the Georgia Tech budgets. The remaining expenditures in the community should be allocated in accordance with the source proportions for incomes. This means that non-campus expenditures by students are over $31 million, with 44 percent, or $13.7 million, originating out of state.

Athletic incomes amounted to $2,489,457. Of this, 34 percent, or $841 thousand, originated outside the State. With expenditures on athletics exceeding revenues, we assume that the deficit is covered from Georgia sources. Thus, although only 66 percent of current income originates in Georgia, 70 percent of Tech's athletic expenditures can be credited to Georgia sources, which include bank accounts.

In the remaining categories, which cover the expenditures by campus visitors while they are in Atlanta, incomes equal expenditures by definition. In each case, expenditures by out-of-state visitors substantially exceed those by Georgians, due primarily to the costs of overnight accommodations. In the case of football fans, new money flowing from out of state accounted for 54 percent of the total; for continuing education participants, the corresponding figure was 80 percent; and for placement officers, 75 percent.

In summary, non-duplicated expenditures associated with Georgia Tech are $95,473,226, including State appropriations, Federal and private grants and contracts, student expenditures, athletic expenses and the expenditures of campus visitors. Over $46 million, or 48 percent, of this represents new money flowing into the Georgia economy.

Table I-18 summarizes expenditures in each budget category which may be attributed to new, or out-of-state, monies, distributed according to type of good or service purchased.

Transformation to Industry Flows

With budgets associated with Georgia Tech now assembled and with a division of expenditures between those supported by local monies and those financed from out-of-state sources completed, our next step is to transform the expenditure tables from their broad product detail into industry categories. We would like to be able to identify the industries which receive expenditures related to Georgia Tech. This industry detail is necessary for tracing the indirect effects of money flows through the Georgia Economic Model.

We have compiled a "transformation matrix" for use in completing this task. (Since it covers several pages and is not essential to understanding the process it appears in Appendix I-5.) Each column of this table records the proportions

In the remaining categories, which cover the expenditures by campus visitors while they are in Atlanta, incomes equal expenditures by definition. In each case, expenditures by out-of-state visitors substantially exceed those by Georgians, due primarily to the costs of overnight accommodations. In the case of football fans, new money flowing from out of state accounted for 54 percent of the total; for continuing education participants, the corresponding figure was 80 percent; and for placement officers, 75 percent.

In summary, non-duplicated expenditures associated with Georgia Tech are $95,473,226, including State appropriations, Federal and private grants and contracts, student expenditures, athletic expenses and the expenditures of campus visitors. Over $46 million, or 48 percent, of this represents new money flowing into the Georgia economy.

Table I-18 summarizes expenditures in each budget category which may be attributed to new, or out-of-state, monies, distributed according to type of good or service purchased.

Transformation to Industry Flows

With budgets associated with Georgia Tech now assembled and with a divisi[illegible] of expenditures between those supported by local monies and those financed fro[illegible] out-of-state sources completed, our next step is to transform the expenditure tables from their broad product detail into industry categories. We would li[illegible] to be able to identify the industries which receive expenditures related to Georgia Tech. This industry detail is necessary for tracing the indirect effects of money flows through the Georgia Economic Model.

We have compiled a "transformation matrix" for use in completing this [illegible] (Since it covers several pages and is not essential to understanding the pro[illegible] it appears in Appendix I-5.) Each column of this table records the proporti[illegible]

Table I-18 Expenditures Related to Georgia Tech and Flowing from Outside Georgia, 1976-77

(thousands of dollars)

	COMMODITY	RESIDENT INSTRUC-TION 1	ENG. EXPERIMENT STATION 2	ENG. EXTENSION DIVISION 3	AUXILIARY ENTER-PRISES 4	STUDENT IMPACT SPENDING 5	ATHLETIC EXPENDI-TURES 6	FOOTBALL FANS 7
1	CONTRACT CONSTRUCTION	276.6	23.3	0.0	0.0	0.0	16.6	0.0
2	FOOD AND KINDRED PRODUCTS	0.0	0.0	0.0	468.5	0.0	14.0	0.0
3	APPAREL AND RELATED PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	PRINTING AND PUBLISHING	431.5	27.6	13.7	673.2	0.0	28.8	0.0
5	CHEMICALS AND ALLIED PRODUCTS	10.3	4.0	0.0	65.5	0.0	0.0	0.0
6	PETROLEUM PRODUCTS	20.2	6.0	.7	.0	0.0	.4	0.0
7	FABRICATED METAL PRODUCTS	989.0	526.2	3.0	0.0	0.0	1.6	0.0
8	TRANSPORTATION EQUIPMENT	23.7	5.6	0.0	0.0	0.0	3.5	0.0
9	MISCELLANEOUS MANUFACTURING	0.0	0.0	0.0	119.4	0.0	31.7	0.0
10	TRANSPORTATION SERVICES	106.0	244.9	.4	17.0	0.0	61.8	0.0
11	COMMUNICATIONS AND UTILITIES	878.5	235.2	9.0	480.9	0.0	23.3	0.0
12	FINANCE, INSURANCE, REAL ESTATE	229.6	121.9	2.3	60.1	0.0	58.4	0.0
13	SERVICES	515.1	514.5	13.5	306.4	0.0	41.9	237.8
14	GOVERNMENT ENTERPRISES	77.5	12.2	6.0	1.9	0.0	10.4	0.0
15	UNALLOCATED PURCHASES	13.4	39.7	7.5	.3	0.0	31.9	0.0
16	SUPPLIES AND MATERIALS	640.4	722.3	12.5	123.6	0.0	14.6	0.0
17	PERSONAL SERVICES	11828.5	6052.3	176.0	1584.8	0.0	281.0	0.0
18	STATE GOVERNMENT	130.4	249.7	.0	264.3	0.0	1.1	0.0
19	FEDERAL GOVERNMENT	473.4	261.3	8.1	75.1	0.0	12.8	0.0
20	MEALS, OFF-CAMPUS	0.0	0.0	0.0	0.0	3260.5	101.1	331.9
21	MEALS, FRATERNITY	0.0	0.0	0.0	0.0	264.0	0.0	0.0
22	CLOTHING AND PERSONAL SUPPLIES	0.0	0.0	0.0	0.0	1528.3	0.0	59.8
23	RECREATION AND ENTERTAINMENT	0.0	0.0	0.0	0.0	2026.8	0.0	165.4
24	AUTOMOBILE EXPENSES	0.0	0.0	0.0	0.0	3254.6	0.0	0.0
25	HOUSING, OFF-CAMPUS	0.0	0.0	0.0	0.0	2183.6	0.0	0.0
26	HOUSING, FRATERNITY	0.0	0.0	0.0	0.0	161.0	0.0	0.0
27	BOOKS AND SCHOOL SUPPLIES	0.0	0.0	0.0	0.0	166.4	3.5	0.0
28	OTHER STUDENT EXPENSES	0.0	0.0	0.0	0.0	854.4	0.0	0.0
29	ATHLETIC OFFICIALS	0.0	0.0	0.0	0.0	0.0	9.3	0.0
30	TICKET PROCESSING	0.0	0.0	0.0	0.0	0.0	2.5	0.0
31	GUARANTEES TO OPPONENTS	0.0	0.0	0.0	0.0	0.0	1.0	0.0
32	INTRAMURALS	0.0	0.0	0.0	0.0	0.0	6.2	0.0
33	ATLANTA SALES TAX	0.0	0.0	0.0	0.0	0.0	.4	0.0
34	TUITION GRANTS, ATHLETES	0.0	0.0	0.0	0.0	0.0	56.4	0.0
35	HOUSING, ATHLETES	0.0	0.0	0.0	0.0	0.0	27.3	0.0
36	GASOLINE, VISITORS	0.0	0.0	0.0	0.0	0.0	0.0	106.2
37	TOTAL	16644.4	9046.8	252.7	4240.9	13699.6	841.6	901.1

Table I-18 Expenditures Related to Georgia Tech and Flowing from Outside Georgia, 1976-77 (continued)

(thousands of dollars)

	COMMODITY	CONTINUING EDUCATION STUDENTS 8	PLACEMENT VISITORS, OTHERS 9
1	CONTRACT CONSTRUCTION	0.0	0.0
2	FOOD AND KINDRED PRODUCTS	0.0	0.0
3	APPAREL AND RELATED PRODUCTS	0.0	0.0
4	PRINTING AND PUBLISHING	0.0	0.0
5	CHEMICALS AND ALLIED PRODUCTS	0.0	0.0
6	PETROLEUM PRODUCTS	0.0	0.0
7	FABRICATED METAL PRODUCTS	0.0	0.0
8	TRANSPORTATION EQUIPMENT	0.0	0.0
9	MISCELLANEOUS MANUFACTURING	0.0	0.0
10	TRANSPORTATION SERVICES	0.0	12.6
11	COMMUNICATIONS AND UTILITIES	0.0	0.0
12	FINANCE, INSURANCE, REAL ESTATE	0.0	0.0
13	SERVICES	183.2	50.3
14	GOVERNMENT ENTERPRISES	0.0	0.0
15	UNALLOCATED PURCHASES	0.0	0.0
16	SUPPLIES AND MATERIALS	0.0	0.0
17	PERSONAL SERVICES	0.0	0.0
18	STATE GOVERNMENT	0.0	0.0
19	FEDERAL GOVERNMENT	0.0	0.0
20	MEALS, OFF-CAMPUS	115.4	12.6
21	MEALS, FRATERNITY	0.0	0.0
22	CLOTHING AND PERSONAL SUPPLIES	34.0	0.0
23	RECREATION AND ENTERTAINMENT	48.7	0.0
24	AUTOMOBILE EXPENSES	0.0	0.0
25	HOUSING, OFF-CAMPUS	0.0	0.0
26	HOUSING, FRATERNITY	0.0	0.0
27	BOOKS AND SCHOOL SUPPLIES	0.0	0.0
28	OTHER STUDENT EXPENSES	0.0	0.0
29	ATHLETIC OFFICIALS	0.0	0.0
30	TICKET PROCESSING	0.0	0.0
31	GUARANTEES TO OPPONENTS	0.0	0.0
32	INTRAMURALS	0.0	0.0
33	ATLANTA SALES TAX	0.0	0.0
34	TUITION GRANTS, ATHLETES	0.0	0.0
35	HOUSING, ATHLETES	0.0	0.0
36	GASOLINE, VISITORS	16.2	0.0
37	TOTAL	397.3	75.4

by which a purchase associated with Georgia Tech is subdivided to achieve industry detail. Normally, the product category coincides with an industry category of the same name and the nonzero entries are primarily associated with the distribution and transportation activities required to bring the products from the producer to the purchaser. Essentially, the transformation is one from purchaser's prices (i.e., what Georgia Tech and her friends pay) to producer's prices (what the producers receive). This step is necessary because wholesale and retail trade and the transportation sector are treated as "margin" industries in the Model. That is, we give credit to the retail store only for the value it adds to a product -- the difference between what it pays and what it receives -- and then credit the producing industry with the basic value of the product prior to its sale.

We convert Tech-related expenditures to the form required by the Model by matrix multiplication. Matrix T is the transformation matrix, which is of industry-by-product dimension. It is a table with 31 industries in its rows and 36 purchase categories in its columns; each column sums to 1.00 and each entry shows the proportion of the purchase supplied by the industry. Matrix B is of product-by-budget dimension. It is a table with 36 purchase categories in its rows and 9 budget categories in its columns; the columns show the broad product detail for each of the major budgets associated with Tech and summarize the results of the previous section of this study. The result of this multiplication, $A = T \cdot B$, is a matrix which is in industry-by-budget dimension, showing the industry receiving funds expended in each budget.

Table I-19 shows the result of this step as applied to out-of-state funds. Note that, since the Federal government is not considered a local entity (its decisions to spend are independent of its revenues), we have excluded the

Table I-19 Expenditures Related to Georgia Tech and Flowing from Outside Georgia, Classified by Industry and Sector Receiving Funds, 1976-77

(thousands of dollars)

	INDUSTRY	RESIDENT INSTRUC-TION 1	ENG. EXPERIMENT STATION 2	ENG. EXTENSION DIVISION 3	AUXILIARY ENTER-PRISES 4	STUDENT IMPACT SPENDING 5	ATHLETIC EXPENDI-TURES 6	FOOTBALL FANS 7
1	AGRICULTURE (SIC 01, 07-9)	0.0	0.0	0.0	27.8	94.7	3.5	8.9
2	MINING (SIC 10-4)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	CONTRACT CONSTRUCTION (SIC 15-7)	276.6	23.3	0.0	0.0	0.0	16.6	0.0
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	0.0	0.0	0.0	388.7	1337.3	50.0	125.9
5	TEXTILE MILL PRODUCTS (SIC 22)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	APPAREL AND RELATED PRODUCTS (SIC 23)	0.0	0.0	0.0	0.0	370.0	0.0	14.5
7	LUMBER AND WOOD PRODUCTS (SIC 24)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	FURNITURE AND FIXTURES (SIC 25)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	PAPER AND ALLIED PRODUCTS (SIC 26)	0.0	0.0	0.0	0.0	14.2	.3	0.0
10	PRINTING AND PUBLISHING (SIC 27)	431.5	27.6	13.7	673.2	83.5	30.5	0.0
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	6.7	2.6	0.0	42.8	147.0	.1	5.7
12	PETROLEUM REFINING (SIC 29)	11.9	3.5	.4	.0	293.0	.3	47.9
13	RUBBER AND MISC. PLASTICS (SIC 30)	0.0	0.0	0.0	0.0	71.2	0.0	.0
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	0.0	0.0	0.0	0.0	14.1	0.0	.6
15	STONE, CLAY AND GLASS PROD. (SIC 32)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	PRIMARY METAL INDUSTRIES (SIC 33)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	989.0	526.2	3.0	0.0	15.2	1.6	.6
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	0.0	0.0	0.0	0.0	40.1	0.0	.4
20	TRANSPORTATION EQUIPMENT (SIC 37)	20.5	4.8	0.0	0.0	674.4	3.1	0.0
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	0.0	0.0	0.0	79.8	85.5	21.3	3.2
22	TRANSPORTATION SERVICES (SIC 40-7)	107.5	245.4	.4	32.3	899.8	64.1	9.5
23	COMMUNICATION & UTILITIES (SIC 48-9)	878.5	235.2	9.0	480.9	77.7	23.3	0.0
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	13.6	4.2	.3	99.0	3153.6	71.6	262.7
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	229.6	121.9	2.3	60.1	3125.6	70.7	.2
26	SERVICES (SIC 70-9, 80-6, 89)	515.1	514.5	13.5	306.4	3202.7	41.9	421.1
27	GOVERNMENT ENTERPRISES	77.5	12.2	6.0	1.9	0.0	10.4	0.0
28	UNALLOCATED INDUSTRIES	653.9	762.0	20.0	123.9	0.0	46.5	0.0
29	HOUSEHOLDS	11828.5	6052.3	176.0	1584.8	0.0	281.0	0.0
30	CITY AND COUNTY GOVERNMENTS	0.0	0.0	0.0	0.0	0.0	.4	0.0
31	STATE GOVERNMENT	130.4	249.7	.0	264.3	0.0	1.1	0.0
32	TOTAL PURCHASES	16171.0	8785.5	244.5	4165.8	13699.6	738.4	901.1

Table I-19 Expenditures Related to Georgia Tech and Flowing from Outside Georgia, Classified by Industry and Sector Receiving Funds, 1976-77 (continued)

(thousands of dollars)

	INDUSTRY	CONTINUING EDUCATION STUDENTS 8	PLACEMENT VISITORS, OTHERS 9	TECH-RELATED DEMANDS 11
1	AGRICULTURE (SIC 01, 07-9)	3.1	.3	138.4
2	MINING (SIC 10-4)	0.0	0.0	0.0
3	CONTRACT CONSTRUCTION (SIC 15-7)	0.0	0.0	316.6
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	43.8	4.8	1950.4
5	TEXTILE MILL PRODUCTS (SIC 22)	0.0	0.0	0.0
6	APPAREL AND RELATED PRODUCTS (SIC 23)	8.2	0.0	392.7
7	LUMBER AND WOOD PRODUCTS (SIC 24)	0.0	0.0	0.0
8	FURNITURE AND FIXTURES (SIC 25)	0.0	0.0	0.0
9	PAPER AND ALLIED PRODUCTS (SIC 26)	0.0	0.0	14.5
10	PRINTING AND PUBLISHING (SIC 27)	0.0	0.0	1260.1
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	3.2	.0	208.1
12	PETROLEUM REFINING (SIC 29)	7.3	0.0	364.3
13	RUBBER AND MISC. PLASTICS (SIC 30)	.0	0.0	71.2
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	.3	0.0	15.0
15	STONE, CLAY AND GLASS PROD. (SIC 32)	0.0	0.0	0.0
16	PRIMARY METAL INDUSTRIES (SIC 33)	0.0	0.0	0.0
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	.3	0.0	1535.9
18	MACHINERY, EXCEPT ELECTRICAL(SIC 35)	0.0	0.0	0.0
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	.2	0.0	40.7
20	TRANSPORTATION EQUIPMENT (SIC 37)	0.0	0.0	702.7
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	1.8	0.0	191.5
22	TRANSPORTATION SERVICES (SIC 40-7)	2.6	12.7	1374.4
23	COMMUNICATION & UTILITIES (SIC 48-9)	0.0	0.0	1704.7
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	84.4	7.3	3696.5
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	.1	0.0	3610.7
26	SERVICES (SIC 70-9, 80-6, 89)	242.0	50.3	5307.5
27	GOVERNMENT ENTERPRISES	0.0	0.0	108.0
28	UNALLOCATED INDUSTRIES	0.0	0.0	1606.3
29	HOUSEHOLDS	0.0	0.0	19922.6
30	CITY AND COUNTY GOVERNMENTS	0.0	0.0	.4
31	STATE GOVERNMENT	0.0	0.0	645.5
32	TOTAL PURCHASES	397.3	75.4	45178.8

Federal government from the local sectors receiving funds. The total impact spending from outside the State is now slightly over $45 million.

This step has been necessary simply because of the differences in accounting conventions used in financial reports and in our economic model.

Conversion of Expenditures to Local Purchases

With a vector in hand showing the purchases from various industries by Georgia Tech-associated economic units, the next step is to reduce the values from purchases without regard to location of producer to purchases made in Georgia.

This conversion is based on the import coefficients recorded in the Georgia Economic Model. These import coefficients report the imports into Georgia of the products of each industry as a proportion of total demand by users inside Georgia. This approach forces us to assume that Georgia Tech buys from Georgia producers as do average industries and consumers. While the actual imports by Tech may differ somewhat from these estimates, this method is almost essential. Our time and budget constraints, as well as the nature of the school accounting system, limit our ability to conduct a detailed review of each purchase, forcing us to use this more general approach. It is important in that it clearly recognizes the leakage of money from the Georgia economy in the first round of spending.

This conversion to local purchases takes place as the very last step prior to tracing Tech-related expenditures through the multiplier model. It is shown in Table I-20. Local purchases of industry outputs in Georgia range from 4 percent of total purchases, as for petroleum products, to 100 percent, as for personal services from households and for local governments. Local expenditures related to Georgia Tech and originating outside Georgia are now reduced to slightly less than $38 million.

Table I-20 Final Demands Related to Georgia Tech from Out-of-State Sources, Local Purchase Coefficients, and Local Final Demands, 1976-77

(thousands of dollars)

	INDUSTRY	TECH-RELATED DEMANDS 1	LOCAL PURCHASE CO-EFFICIENT 2	LOCAL TECH DEMANDS 3
1	AGRICULTURE (SIC 01, 07-9)	138.4	56.9	78.7
2	MINING (SIC 10-4)	0.0	75.2	0.0
3	CONTRACT CONSTRUCTION (SIC 15-7)	316.6	91.3	289.1
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	1950.4	45.9	896.1
5	TEXTILE MILL PRODUCTS (SIC 22)	0.0	52.2	0.0
6	APPAREL AND RELATED PRODUCTS (SIC 23)	392.7	29.6	116.3
7	LUMBER AND WOOD PRODUCTS (SIC 24)	0.0	53.2	0.0
8	FURNITURE AND FIXTURES (SIC 25)	0.0	49.6	0.0
9	PAPER AND ALLIED PRODUCTS (SIC 26)	14.5	47.5	6.9
10	PRINTING AND PUBLISHING (SIC 27)	1260.1	65.6	827.1
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	208.1	25.3	52.6
12	PETROLEUM REFINING (SIC 29)	364.3	4.0	14.5
13	RUBBER AND MISC. PLASTICS (SIC 30)	71.2	38.4	27.4
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	15.0	17.4	2.6
15	STONE, CLAY AND GLASS PROD. (SIC 32)	0.0	57.5	0.0
16	PRIMARY METAL INDUSTRIES (SIC 33)	0.0	18.7	0.0
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	1535.9	34.9	536.8
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	0.0	23.5	0.0
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	40.7	12.7	5.2
20	TRANSPORTATION EQUIPMENT (SIC 37)	702.7	18.6	131.0
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	191.5	17.0	32.6
22	TRANSPORTATION SERVICES (SIC 40-7)	1374.4	46.7	641.2
23	COMMUNICATION & UTILITIES (SIC 48-9)	1704.7	88.5	1508.4
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	3696.5	97.7	3610.3
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	3610.7	79.1	2856.7
26	SERVICES (SIC 70-9, 80-6, 89)	5307.5	82.1	4358.5
27	GOVERNMENT ENTERPRISES	108.0	97.8	105.6
28	UNALLOCATED INDUSTRIES	1606.3	69.3	1112.5
29	HOUSEHOLDS	19922.6	100.0	19922.6
30	CITY AND COUNTY GOVERNMENTS	.4	100.0	.4
31	STATE GOVERNMENT	645.5	100.0	645.5
32	TOTAL PURCHASES	45178.8	119.6	37778.7

Summary

The result of this long and involved analysis is a set of expenditures with Georgia industries associated with Georgia Tech and made with monies which entered the State economy due to the presence of Georgia Tech. The total incomes associated with Georgia Tech are almost $122 million. When these incomes are reduced to unduplicated transactions, in which the expenditures of one budget category (e.g. student tuition payments on Tech student-salary payments) which are the incomes of another (e.g. fees received from students on student incomes earned from Tech) are eliminated, total expenditures are reduced to over $95 million. Of this, $49 million comes from Georgia sources and $46 million from outside of Georgia.

These expenditures, outlined in substantial product or purchase-category detail earlier, were transformed into an industry (or business) categorization and were finally reduced to a set of purchases from Georgia industries and attributable to new monies attracted to the State by Georgia Tech.

THE MULTIPLIER EFFECT

Now, with money flows associated with Georgia Tech in hand, let us see how the Institute interacts with the rest of Georgia's economy. To accomplish this task is very difficult in such a large and complex state, and, were it not for competent government statistics and modern computing machinery, it would be nearly impossible. Fortunately, these tools permit us to take advantage of a technique called "input-output analysis" to show how expenditures flow through the economy.

We pursue two lines of reasoning in the following sections. As economic analysts, we attempt to show how non-Georgia funds associated with Georgia Tech flow through the State economy. This approach views Georgia Tech as a new business and establishes a minimum effect of the Institute on its community. It is the result expected from an "economic impact analysis." Our second approach is to identify the influence of all funds related to Georgia Tech. This means tracing the impact of local and non-local funds and is of interest to local businessmen, who have more concern for total flows than for the geographic origins of funds.

The Input-Output Model

But first, let us see how the underlying theory works. A commonly held theory of regional growth states that a region must export goods and services if it is to prosper economically. Called "economic-base" theory, it typically depends upon a division of the region's economy into two sectors, the export (or basic) sector and the local (or support) sector. Exporters such as clothing producers, metal fabricators, hotels, restaurants, major recreation centers, manufacturers of transportation equipment and educational institutions obtain income from customers outside the state. This export income then enters the local economy in the form of purchases of materials, wages and salaries, dividends, etc., and becomes income to other local citizens. But unless the economy is entirely self-sufficient, a portion of this circulating income leaks out of the local economy with each transaction in payment for imported goods, supplies, and services. With each round of expenditures, local incomes increase in a continuing but diminishing chain. The impact of the original export sale tends to decrease with each successive round of expenditures as leakages continue. The series of events following the initial injection of income is known as the "multiplier effect" and traces the indirect effects of the injection. Our task is to see how much we can learn about the paths taken by money entering the economy through Georgia Tech.

Regional input-output models are sophisticated economic-base models. In these models, however, we can now divide the economy into as many industries as available data permit and can trace money flows from industry to industry. As an illustration, consider the simple regional economy shown in Figure 1-1 Its economic activities are divided into four sectors: manufacturing, trade, services, and local households. You are the manager of a manufacturing establishment. You purchase inputs to your production process from other local manufacturers, from the trade and service sectors, and from local households (to which you pay wages and salaries for labor, and depreciation and profits for use of capital). You also purchase inputs from governments (which we consider outside the private economic sphere) by paying taxes for fire and police protection, roads, sewers, etc., and from other manufacturers outside the local area. You sell your outputs to other local manufacturers, to the trade and service sectors, to local private users, and to users

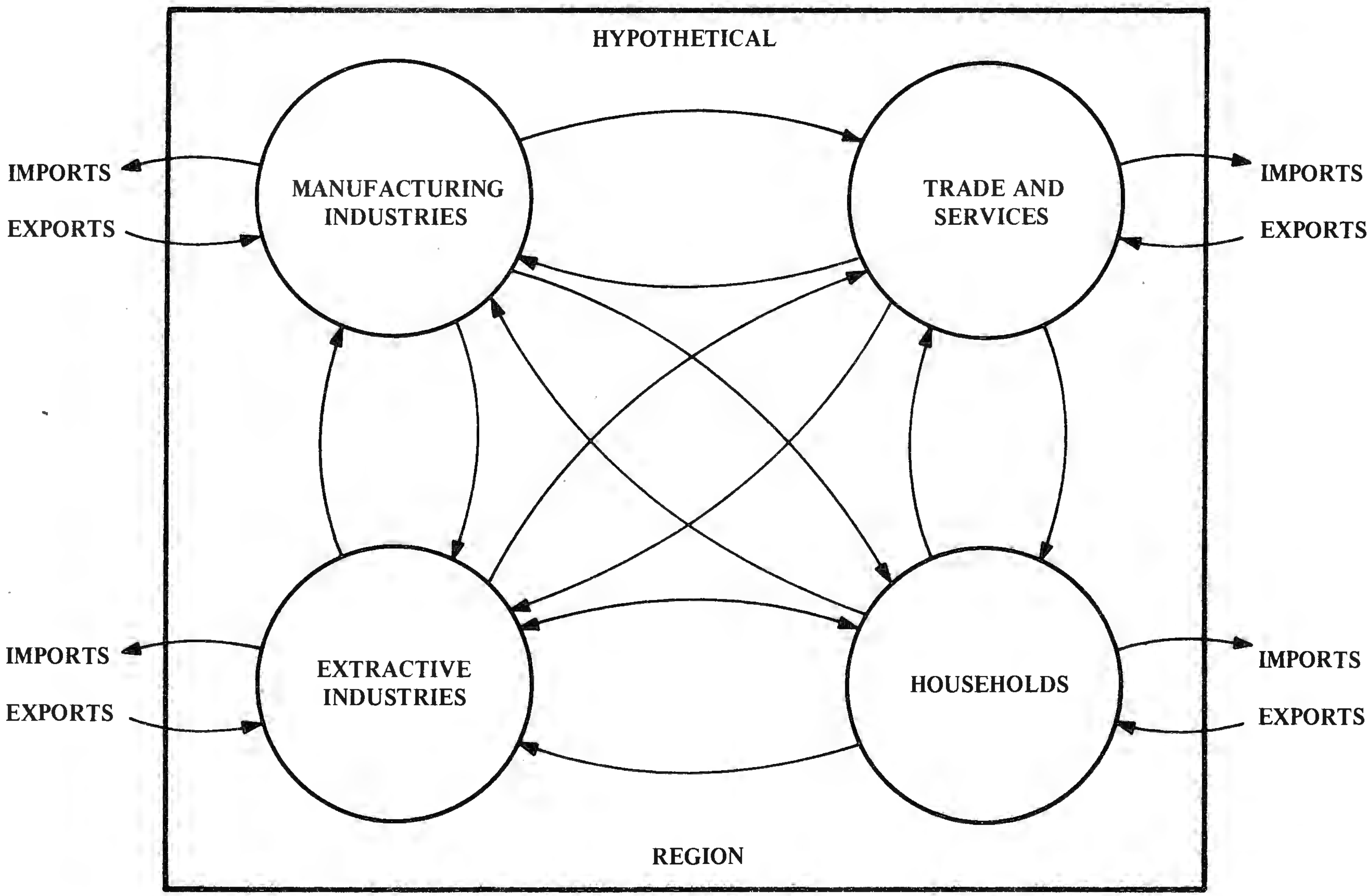


Figure I-1. Economic Flows Through a Hypothetical Region outside the local economy (you "export" these latter goods, hence the relation to economic-base theory). In accordance with well-known accounting principles, inputs must equal outputs, or in monetary terms, purchases (including taxes and profits) must equal sales. Now, assume you sell goods worth $1,000,000 to a user outside the region. You are performing as part of the community's economic base and introducing new money into the economy. You buy more inputs (one million dollars' worth), some from local producers and some from outside the region. Your local suppliers, of course, then have to produce more goods and so must buy more, distributing the fruits of your original sale to others in the region. And so the process continues with your money recirculating through the local economy. But with each round of spending, money leaks out through the purchase of imports, and the pile of money remaining eventually becomes infinitesimally small. Your sale to a customer outside the region has had a "multiplier effect" and has led to increased output by your neighbors. What is this "output multiplier" for education?

In tracing money flows associated with Georgia Tech through the Georgia economy, we have adapted the Georgia Economic Model for use here. This model is a traditional regional input-output model of the State of Georgia for 1970 and is the latest of its type available to us. (A brief discussion of it is provided in Appendix I-1).

The Economic Impact of New Money

The Impact on Outputs. The output multipliers for Georgia Tech are obtained by tracing money flows completely through a table of production requirements. (These requirements are shown in Appendix I-1; each column states how much an industry buys from other local industries and sectors and from outside Georgia to produce output worth $100.)

The results of tracing expenditures originating outside Georgia are presented in Table I-21. The initial injection of $38 million appears as round 0. It is derived from Table I-20 and represents local Tech-related demands. Each industry receiving these direct expenditures responds by purchasing goods and services from other industries in and outside Georgia to produce the goods, or replacements for the goods, originally purchased with Tech-related funds. These purchases are identified as "round 1" in the impact chain. Note that round 1 is approximately 63 percent of the initial round, showing that considerable leakage of funds outside the State took place.

Round 2 repeats the process started in round 1, showing purchases required to replace the goods used in round 1. The process continues, with each round becoming smaller as leakage from the Georgia economy continues. At the end of round 12, only $303 thousand remains to be traced through the system, a small enough remainder to be ignored.

The total output associated with Tech-related funds from outside Georgia is almost $111 million, the sum of the total column in Table I-21. This represents a gross-output multiplier of 2.93, meaning that the initial expenditure of $38 million in new funds lead to an additional 193 percent in additional value of total output in Georgia. This value includes the "outputs" of households, local governments, and State government. If these are excluded, the net increase in industry outputs is valued at $58.6 million, representing a net-output multiplier of 1.55.

Other Economic Impacts. In addition to this estimate of output changes, estimates of changes in employment, household income, and local and State government incomes can be made. These are calculated as the sums of the corresponding changes for each of the 31 industry and sector categories. In turn, these

Table I-21 Multiplier Effect of Tech-Related Expenditures from Outside Georgia, 1976-77

(thousands of dollars)

	INDUSTRY	ROUND 0	ROUND 1	ROUND 2	ROUND 3	ROUND 4	ROUND 5	ROUND 6
1	AGRICULTURE (SIC 01, 07-9)	78.7	388.2	405.5	234.5	173.3	111.4	76.7
2	MINING (SIC 10-4)	0.0	6.2	12.7	14.7	12.2	8.4	5.5
3	CONTRACT CONSTRUCTION (SIC 15-7)	289.1	357.2	629.0	423.7	277.8	184.2	124.9
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	896.1	1168.6	494.5	434.6	255.4	184.9	119.2
5	TEXTILE MILL PRODUCTS (SIC 22)	0.0	92.0	80.0	51.2	35.7	23.7	16.0
6	APPAREL AND RELATED PRODUCTS (SIC 23)	116.3	152.3	62.1	54.9	32.3	23.4	15.1
7	LUMBER AND WOOD PRODUCTS (SIC 24)	0.0	23.2	35.5	37.7	27.9	18.7	12.5
8	FURNITURE AND FIXTURES (SIC 25)	0.0	64.0	26.5	25.1	14.6	10.6	6.8
9	PAPER AND ALLIED PRODUCTS (SIC 26)	6.9	150.0	114.1	64.7	43.3	28.3	19.2
10	PRINTING AND PUBLISHING (SIC 27)	827.1	338.3	169.6	96.7	68.0	44.4	30.3
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	52.6	136.7	96.7	69.1	45.8	31.0	20.7
12	PETROLEUM REFINING (SIC 29)	14.5	3.4	3.7	4.9	3.4	2.2	1.5
13	RUBBER AND MISC. PLASTICS (SIC 30)	27.4	35.7	28.3	19.3	13.6	9.0	6.1
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	2.6	23.6	8.3	8.1	4.5	3.4	2.1
15	STONE, CLAY AND GLASS PROD. (SIC 32)	0.0	43.3	47.8	50.1	36.3	23.5	15.9
16	PRIMARY METAL INDUSTRIES (SIC 33)	0.0	50.7	13.7	10.2	7.9	5.4	3.6
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	536.8	54.9	45.9	42.4	30.3	19.7	13.3
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	0.0	30.4	21.6	13.8	10.1	6.6	4.5
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	5.2	21.8	15.5	11.6	8.2	5.4	3.6
20	TRANSPORTATION EQUIPMENT (SIC 37)	131.0	195.9	79.3	67.4	40.0	28.9	18.7
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	32.6	39.5	21.4	13.5	9.3	6.2	4.2
22	TRANSPORTATION SERVICES (SIC 40-7)	641.2	351.6	165.4	128.2	81.3	56.4	37.2
23	COMMUNICATIONS & UTILITIES (SIC 48-9)	1508.4	974.4	582.2	387.5	258.4	174.3	116.7
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	3610.3	3632.6	1438.9	1331.4	774.7	563.9	362.0
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	2856.7	3258.0	1723.0	1282.0	808.7	561.5	369.9
26	SERVICES (SIC 70-9, 80-6, 89)	4358.5	3146.6	1456.6	1173.8	719.0	507.8	331.4
27	GOVERNMENT ENTERPRISES	105.6	295.0	214.4	120.4	86.3	55.8	38.2
28	UNALLOCATED INDUSTRIES	1112.5	165.5	150.4	77.9	59.7	37.4	26.1
29	HOUSEHOLDS	19922.6	6638.1	6811.0	3730.5	2811.5	1773.6	1232.9
30	CITY AND COUNTY GOVERNMENT	.4	959.4	721.1	519.1	314.2	223.9	146.0
31	STATE GOVERNMENT	645.5	1026.9	744.4	405.5	307.4	195.2	135.1
32	TOTAL	37778.7	23824.3	16419.1	10904.6	7371.1	4929.2	3316.1

Table I-21 Multiplier Effect of Tech-Related Expenditures from Outside Georgia, 1976-77 (continued)

(thousands of dollars)

	INDUSTRY	ROUND 7	ROUND 8	ROUND 9	ROUND 10	ROUND 11	ROUND 12	TOTAL 13
1	AGRICULTURE (SIC 01, 07-9)	50.8	34.4	23.0	15.5	10.4	7.0	1609.4
2	MINING (SIC 10-4)	3.7	2.5	1.7	1.1	.8	.5	70.1
3	CONTRACT CONSTRUCTION (SIC 15-7)	83.5	56.2	37.7	25.3	17.0	11.4	2517.0
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	81.9	54.3	36.7	24.5	16.5	11.1	3778.3
5	TEXTILE MILL PRODUCTS (SIC 22)	10.7	7.2	4.8	3.2	2.2	1.5	328.3
6	APPAREL AND RELATED PRODUCTS (SIC 23)	10.4	6.9	4.6	3.1	2.1	1.4	484.8
7	LUMBER AND WOOD PRODUCTS (SIC 24)	8.4	5.7	3.8	2.5	1.7	1.1	178.7
8	FURNITURE AND FIXTURES (SIC 25)	4.7	3.1	2.1	1.4	.9	.6	160.5
9	PAPER AND ALLIED PRODUCTS (SIC 26)	12.8	8.6	5.8	3.9	2.6	1.7	461.8
10	PRINTING AND PUBLISHING (SIC 27)	20.1	13.6	9.1	6.1	4.1	2.8	1630.2
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	13.9	9.3	6.3	4.2	2.8	1.9	491.2
12	PETROLEUM REFINING (SIC 29)	1.0	.7	.4	.3	.2	.1	36.3
13	RUBBER AND MISC. PLASTICS (SIC 30)	4.1	2.7	1.8	1.2	.8	.6	150.6
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	1.5	1.0	.7	.4	.3	.2	56.8
15	STONE, CLAY AND GLASS PRCD. (SIC 32)	10.6	7.1	4.8	3.2	2.2	1.5	246.3
16	PRIMARY METAL INDUSTRIES (SIC 33)	2.4	1.6	1.1	.7	.5	.3	98.2
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	8.9	6.0	4.0	2.7	1.8	1.2	768.1
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	3.0	2.0	1.4	.9	.6	.4	95.4
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	2.4	1.6	1.1	.7	.5	.3	78.0
20	TRANSPORTATION EQUIPMENT (SIC 37)	12.8	8.5	5.7	3.8	2.6	1.7	596.4
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	2.8	1.9	1.3	.8	.6	.4	134.4
22	TRANSPORTATION SERVICES (SIC 40-7)	25.2	16.8	11.3	7.6	5.1	3.4	1530.7
23	COMMUNICATIONS & UTILITIES (SIC 48-9)	78.5	52.6	35.3	23.7	15.9	10.7	4218.7
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	249.2	165.0	111.6	74.6	50.2	33.7	12398.0
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	250.9	167.5	112.8	75.6	50.8	34.1	11551.4
26	SERVICES (SIC 70-9, 80-6, 89)	226.0	150.4	101.5	67.9	45.7	30.6	12315.7
27	GOVERNMENT ENTERPRISES	25.4	17.1	11.5	7.7	5.2	3.5	986.1
28	UNALLOCATED INDUSTRIES	17.2	11.7	7.8	5.2	3.5	2.4	1677.3
29	HOUSEHOLDS	812.0	550.9	367.7	247.6	165.9	111.5	45175.9
30	CITY AND COUNTY GOVERNMENT	99.6	66.3	44.7	29.9	20.1	13.5	3158.2
31	STATE GOVERNMENT	89.1	60.4	40.4	27.2	18.2	12.2	3707.6
32	TOTAL	2223.5	1493.7	1002.4	673.0	451.8	303.3	110690.6

changes are calculated for each industry as the change in output multiplied by the appropriate ratio. For each industry, the ratios are employment per unit of output, household income per unit of output, local government income per unit of output, and State government income per unit of output.

As seen in Table I-22, in 1976-77, Georgia Tech attracted sufficient funds from out of state to justify almost 2400 jobs, mostly in the trade and service industries. These funds produced household incomes amounting to over $45 million dollars; much of this -- almost $20 million -- went directly through Georgia Tech payrolls, but significant amounts appeared indirectly in the trade, finance and real estate, and service sectors. Local governments, especially in Atlanta, were $3.2 million richer because of these outside expenditures, with over one million dollars derived from personal property taxes. And the State government itself received $3.7 million due to these new funds.

The Impact of Tech's Presence

The impact of outside funds on the whole Georgia economy was described above. Now we can ask: How much business is associated with all Tech-related spending? The answer to this question gives us a feel for the presence of Georgia Tech in the business community. The following comments summarize this presence. Since the logic is the same as in the preceding section, we do not repeat the details here. (The data and calculations are relegated to appendix I-1.)

Effect on Output. The total expenditures related to Georgia Tech were identified in Table I-17 as $95.5 million. Excluding expenditures with the Federal government, this total becomes $93.5 million. When reduced to the level of total expenditures with Georgia industries and residents, the total of local demands generated by Georgia Tech is $77.9 million.

Table I-22 The Economic Impact of Tech-Related Funds from Out-of-State Sources on Employment, Household Income, and Local and State Government Income, 1976-77

(thousands of dollars)

	INDUSTRY	NONAGRIC. EMPLOYMENT IMPACT 14	HOUSEHOLD INCOME IMPACT 15	LOCAL GOVERNMENT IMPACT 16	STATE GOVERNMENT IMPACT 17
1	AGRICULTURE (SIC 01, 07-9)	79.2	587.1	49.5	0.0
2	MINING (SIC 10-4)	2.2	20.0	.7	.2
3	CONTRACT CONSTRUCTION (SIC 15-7)	84.8	664.3	25.8	9.3
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	77.0	675.6	16.8	12.6
5	TEXTILE MILL PRODUCTS (SIC 22)	9.0	73.5	1.2	1.0
6	APPAREL AND RELATED PRODUCTS (SIC 23)	37.0	186.2	.7	1.3
7	LUMBER AND WOOD PRODUCTS (SIC 24)	8.2	49.7	2.6	4.0
8	FURNITURE AND FIXTURES (SIC 25)	7.6	43.6	.9	.4
9	PAPER AND ALLIED PRODUCTS (SIC 26)	9.5	100.8	5.1	2.7
10	PRINTING AND PUBLISHING (SIC 27)	67.7	695.7	9.4	8.4
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	10.6	95.7	5.2	3.2
12	PETROLEUM REFINING (SIC 29)	.7	6.5	.2	.1
13	RUBBER AND MISC. PLASTICS (SIC 30)	4.9	45.3	1.5	1.0
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	3.4	19.5	.2	.4
15	STONE, CLAY AND GLASS PRCD. (SIC 32)	8.9	75.7	1.7	.6
16	PRIMARY METAL INDUSTRIES (SIC 33)	2.3	24.9	1.0	.4
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	21.5	222.3	6.0	4.0
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	3.0	28.4	.5	.4
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	2.4	23.5	.5	.3
20	TRANSPORTATION EQUIPMENT (SIC 37)	11.9	138.3	1.6	4.9
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	6.5	38.3	1.2	1.0
22	TRANSPORTATION SERVICES (SIC 40-7)	92.1	750.8	9.4	16.3
23	COMMUNICATIONS & UTILITIES (SIC 48-9)	124.3	1132.9	143.5	28.4
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	876.4	6134.4	161.9	1605.8
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	204.5	5261.6	289.9	201.0
26	SERVICES (SIC 70-9, 80-6, 89)	509.7	4363.8	305.2	141.0
27	GOVERNMENT ENTERPRISES	0.0	444.2	0.0	0.0
28	UNALLOCATED INDUSTRIES	0.0	0.0	0.0	0.0
29	HOUSEHOLDS	0.0	20206.5	1076.0	973.5
30	CITY AND COUNTY GOVERNMENT	30.2	1816.6	.4	47.7
31	STATE GOVERNMENT	102.9	1325.0	1048.7	645.5
32	TOTAL	2398.5	45250.7	3167.3	3715.8

If the logic of the preceding section were repeated using these total expenditures, we could conclude that funds flowing from all sources through and around Georgia Tech yielded a total increase in economic activity of $229 million. If this gross increase were adjusted to exclude the impact on incomes, the net effect on Georgia industries would be $122 million.

Other Economic Effects. These total expenditures are associated with 4993 jobs in Georgia and with $93 million in household incomes.

Local governments receive $6.5 million. And the State receives $7.5 million back in taxes, substantially denting the negative effect of the $24 million State appropriation originally invested in Georgia Tech by the 1976 State Legislature.

Summary

The economic impact of expenditures includes both the initial direct expenditures and the indirect expenditures which evolve from them. With the help of the Georgia Economic Model, which traces changes in demands through 28 industries in Georgia, the multiplier, or "ripple", effect of Tech-related expenditures can be identified.

The effect of funds attracted by Georgia Tech from outside the State is considerable. With new funds of almost $38 million, new activity valued at $111 million was generated, with increase in industry outputs of $59 million and the rest appearing as incomes of people and governments. These new funds were also associated with 2400 jobs, $45 million in personal income, $3.6 million in income for local governments and $3.1 million for the State government.

When all Tech-related expenditures are considered, the initial expenditure with Georgia firms and people of $78 million was amplified to $228 million

Of this, the net effects on Georgia industry output was $122 million. In addition, these expenditures are associated with 4970 jobs, $93.1 million in household incomes, $6.5 million in local government incomes, and $7.5 million return to the State government to offset its initial $24 million appropriation to the Institute.

PART II

THE JOB MARKET AND THE GEORGIA TECH ALUMNI

The greatest contribution of Georgia Tech to the economy and to the general welfare of the State and national society is its graduates; the thousands of men and women who are living productive and fulfilling lives throughout Georgia, the Southeast, and the entire country.

The first part of this report discussed the economic impact of the money flows that result from activities surrounding the educational process at Tech. This second part of the report looks at the end result of all this activity, the Tech alumni in the job market.

The Alumni Survey: The Sample Group

To get information about our alumni a short questionnaire was mailed to over 10,000 former Tech students. These were selected from the alumni mailing list.

The alumni roster maintained by the Alumni Association provides a good base from which to draw a sample for an alumni survey. It is kept up to date with changes as frequent as on a weekly basis. Tech Topics, the alumni newsletter, is mailed to everyone on the list seven times a year so that there is constant feedback on address changes.

There are about 6,000 persons on the alumni mailing list who never actually attended the Institute (parents, faculty, and friends). These names were deleted before selection of the sample. There are a little over 43,000 persons who actually attended Tech left on the roll after the 6,000 names are removed. Almost all received degrees. The number on the list who attended but did not graduate is, according to an informed estimate, less than 1,500. Since 1946 nongraduates have been added to the roll only upon their request. Graduates are automatically put on the roll.

The survey sample was selected from the 1936-1976 graduating classes. The reason for limiting the sample to this group is that the study has a rather restricted purpose: an analysis of job market and job career behavior. A large number of retired persons in the sample would have reduced the usable responses. There are undoubtedly many alumni who graduated prior to 1936 - particularly those in the classes of 1934 and 1935 - who are not retired. The 1936-1976 interval was selected, however, so as to include the vast majority of actively engaged alumni but, at the same time, keep the returns by retired graduates small.

Civilians with foreign addresses and those in the armed forces were also removed before selection of the sample. Both of these groups represent atypical job market behavior. Graduates working abroad probably receive income premiums to compensate for being away from home. Members of the armed forces have more geographical movement than those in civilian labor markets due to the special needs of the military. Elimination of those abroad and in the armed forces produces a more homogeneous population for analysis: alumni competing in the U.S. civilian job market.

The number of alumni, 1936-1976, is a little over 39,000. When those with foreign addresses and in the armed forces - 655 and 855 respectively - were subtracted, a total population of 37,780 was left. A little over 27 percent of this population, 10,385 persons, was selected for the sample. The entire population of black males and black and white females were sent questionnaires. All members of the following classes of white males were surveyed: 1936, 1937, 1941, 1942, 1946, 1947, 1951, 1956, and 1961. These classes make up 40 percent of the alumni who finished at Tech in the last half of the 1930's, 40% of those who finished in the 1940's and 20 percent of those finishing in the 1950's. For the years 1966-1976, 4,340 white males were sampled out of a total of 15,894, or 27 percent of the group. The number selected in each year is shown in Table II-1.

Of those who were sent questionnaires, 4,664, or just under 45 percent, replied; a good response rate for one mailing. Slightly over 45 percent of males responded; just under 40 percent of females answered. The response rate in terms of usable responses for the selected years is also given in Table II-1. The class of 1966 had the largest response. Almost 60 percent returned usable questionnaires. The class of 1946 was second with a 55 percent response rate. The 1976 class had the lowest return with only 20 percent responding.

Despite the fact that the survey was restricted to 1936-1976 graduating classes to eliminate the retired, and that the alumni file was pre-screened to eliminate those in the armed forces, returned questionnaires were received from these groups. Some persons surveyed either retired early or were above the average age at graduation and reached retirement age ahead of their graduating class. Others currently in the armed forces are listed as civilians in the alumni file. As Table II-2 shows, over three percent of the respondents in the survey were either unemployed at the time of the survey or were full time students. These also were considered to be atypical in terms of labor market behavior. Data received from those retired, in the armed forces, unemployed, and full-time students were eliminated in the final tabulations. The number of usable questionnaires was 4,342.

When a less than 100 percent response is obtained, as in the case of this

Table II-1. Distribution of Sample By Graduation Class and Response Rate, Usable Responses.

Year[1]	Number in sample		Response rate (percent)
	Sent	Received	
1936	250	100	40.0
1937	228	81	35.5
1941	413	214	51.8
1942	454	213	46.9
1946	305	169	55.4
1947	778	268	34.4
1951	1,153	528	45.8
1956	838	353	42.1
1961	1,053	503	47.8
1966	496	294	59.3
1967	357	172	48.2
1968	427	201	47.1
1969	425	196	46.1
1970	422	194	46.0
1971	384	146	38.0
1972	392	158	40.3
1973	422	159	37.7
1974	446	125	28.0
1975	549	148	27.0
1976	593	120	20.2
Total	10,385	4,342	41.8

[1]Some respondents indicated a graduation date not included in the original sample. This inconsistency in the response and the alumni data file from which the sample was drawn is probably due to one of two reasons. Either the data file is incorrect or the graduation date is interpreted differently by the Institute and the respondee. In the latter case, a respondee may have finished course work in one calender year whereas the degree was not officially conferred until the following calender year. In determining the response rate for this table, a respondent's reported year of graduation is shifted to the nearest sample year if the two years differ.

Table II-2. Percent of Total Respondents by Employment Status, Georgia Tech Alumni Survey, 1977.

Employment Status	Percent of Respondents
Employed	93.4
Retired	2.6
Armed forces	0.4
Unemployed	1.2
Full-time student	2.3

survey, the usual assumption is that a higher percent of the more successful persons responded than was the case for the less successful. The successful are more likely to volunteer information. The answers obtained in surveys with less than complete returns are usually thought, therefore, to be biased in favor of high achievers. A bias of this type likely exists in the case of this Tech survey.

In other ways, the sample seems broadly representative of the Tech alumni population. Table II-3 shows the results obtained from responses to Question 4 on the questionnaire asking for the degrees held and the schools from which they were obtained. (The sum of total degrees received is larger than the number of respondents since some people hold more than one degree.) The vast majority of the respondents - 86 percent of the sample or 3,738 persons - received a bachelor's degree from Tech as would be expected. About 4 percent of the sample indicated they received less than a bachelor's from Tech. Four percent of the Alumni Association alumni list also consists of persons who attended Tech but did not receive a degree. Fourteen percent of the sample received a Master's degree from Tech and two-and-a-half percent received a Doctor's degree. The number of total Master's degrees granted by Tech is about 19 percent of the total alumni list and the number of Doctor's degrees is the same as the number with Doctor's degrees in the sample, two-and-a-half percent.

The breakdown of the respondents with Georgia Tech bachelor's degrees by field of study is shown in Table II-4. The sample is broadly representative of the Tech population on this basis also. Data on the Georgia Tech alumni by fields of study are not available. A breakdown of the alumni by major would be reasonably close, however, to the distribution by field of study of the current student body. The sample matches the 1976-1977 school year distribution of students by Colleges rather well. Nine percent of the student body

Table II-3. Number and Percent of Respondents, By Level of Degree, from Georgia Tech and Other Colleges or Universities, Entire Sample.

Degree level	Georgia Tech Alumni Degrees: From Georgia Tech — Number	Percent of Sample	From other College or University — Number	Percent of Sample
Less than Bachelors	181	4.2	142	3.3
Bachelors	3738	86.1	489	11.3
Masters	593	13.7	696	16.0
Ph.D.	107	2.5	111	2.6
M.D., D.D.S., Law	___	___	108	2.5

Table II-4. Number and Percent of Respondents With Georgia Tech Bachelor's Degree, By Field of Study, Entire Sample, Pre-1966, Post-1966 Groups, By Sex.

Sample group	Architecture		Engineering		Industrial Management		Science and Liberal Studies		Total [1]	
	No.	%	No.	%	No.	%	No.	%	No.	%
Entire sample	154	4.1	2372	63.6	930	25.0	271	7.3	3727	100
Pre-1966	84	4.0	1424	68.5	471	22.6	101	4.9	2080	100
Post-1966	70	4.2	948	57.6	459	27.9	170	10.3	1647	100
Male	65	4.2	907	59.2	425	27.8	134	8.8	1531	100
Female	5	4.3	41	35.3	34	29.3	36	31.1	116	100

[1] The total number of respondents with Georgia Tech Bachelor's degrees in this table (3727) differs from the total in Table II-3 (3738) because 11 respondents with Tech Bachelor's degrees did not identify their field of study.

were registered in Architecture, 4 percent of the sample received degrees in that field. The current student enrollment in Architecture is higher than the proportion in previous years so the sample representation is reasonably close to the Tech alumni population. Sixty-one percent of the 1976-1977 student body were in the Engineering College. Sixty-four percent of the sample majored in engineering. Fourteen percent of the student body were in the College of Industrial Management and 16 percent in the College of Science and Liberal Studies. The sample proportion is high for Industrial Management, 25 percent, and low for Science and Liberal Studies, 7 percent.

It was decided early in the formulation of this alumni survey that it would be helpful to compare the behavior of the graduates of the last decade with those who graduated more than a decade ago. This decision is partly the reason for the representation in the sample of graduates from each year from 1966 on. Actually there are 11 years in the interval 1966-1976, including 1966. The extra year was put in since the data furnished by 1976 graduates is not usable for some purposes. Income data from 1976 graduates are misleading, for example, since many of these graduates did not work the full calendar year. In order to get at least 10 full years of data for all comparisons the last decade was defined as including 1966. For brevity sake this group is described throughout the study as "post-1966."

The questionnaire used in this survey - and the letter from President Pettit that accompanied it - is reproduced in Appendix II-1. The questionnaire was deliberately kept brief, one page, in order to encourage a higher return rate. Comments on the design of the questionnaire can also be found in Appendix II-1.

Survey Results: Education Patterns

A fairly complete description of the respondents' educational experiences is provided by answers to the first parts of the questionnaire used in the survey.

Table II-3 shows, as we have already pointed out, that 86 percent of the respondents have a bachelor's degree from Georgia Tech. Table II-5 shows the number and percent of respondents with Tech bachelor's degrees who have gone on for advanced degrees. A fourth of those receiving undergraduate degrees went on to earn a master's degree.[1] As far as the authors of this report are aware there is no national estimate, covering the last 40 years, of the percent of bachelor's degree holders who have also earned master's degrees to which this Georgia Tech figure can be compared. Presumably the percent varies widely from school to school. It is the authors' guess that the Tech figure is above average for state supported schools.

Almost four percent of Tech bachelors went on to get a Ph.D. In the case of both the master's and the Ph.D., almost twice as many Tech graduates went off campus to get the advanced degrees as stayed on campus for this advanced training.

A larger percentage of post-1966 graduates received master's degrees than is true of the pre-1966 group. Almost 29 percent of the post-1966 graduates have received a master's; a little over 21 percent of pre-1966 graduates received this advanced degree. Table II-5 shows the post-1966 group broken down by sex. Twice as high a percent of males as females went on for the master's.

Almost 5 percent of pre-1966 Tech graduates have received a Ph.D. The failure of the post-1966 group to at least equal the performance of the

Table II-5. Number and Percent of Respondents With Bachelor's Degree from Georgia Tech Who Have Received Advanced Degrees, Entire Sample, Pre-1966 Group, Post-1966 Group, By Sex.

Sample Group	Total Tech Bachelors	Masters						Ph.D.						M.D., D.D.S., Law	
		Ga. Tech		Elsewhere		Total		Ga. Tech		Elsewhere		Total			
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Number	Percent
Entire Sample	3738	323	8.6	602	16.1	925	24.7	52	1.4	94	2.5	146	3.9	90	2.4
Pre-1966	2079	150	7.2	296	14.2	446	21.5	33	1.6	65	3.1	98	4.7	48	2.3
Post-1966	1659	173	10.4	306	18.4	479	28.9	19	1.1	29	1.7	48	2.9	42	2.5
Male	1545	166	10.7	295	19.1	461	30.0	19	1.2	28	1.8	47	3.0	40	2.6
Female	114	7	6.1	11	9.6	18	15.8	--	--	1	0.9	1	0.9	2	1.8

pre-1966 group is undoubtedly due to the fact that there has not been sufficient time for the post-1966 graduates to complete a Ph.D. program which can easily stretch out 5 years after the baccalaureate and beyond.

About two-and-a-half percent of Tech bachelor's degree holders have gone for an M.D., D.D.S., or law degree. There is no difference in the behavior of the pre-1966 and post-1966 group with regard to these degrees. In the post-1966 group, however, 45 percent more male respondents than female respondents have received a medical, dental, or law degree.

Figure II-1 shows the percent of Georgia Tech bachelor's degree holders who went on to get a master's degree with the Tech bachelor's identified by field of study at the undergraduate level. A larger proportion of the graduates of the College of Science and Liberal Studies have gone on for a master's degree than is the case for the graduates of the other Colleges. Engineering graduates are second in terms of the percent going on for master's programs. A larger percent of the post-1966 group in both science and engineering went on for a master's than is the case for the pre-1966 group. Almost 40 percent of post-1966 graduates of the College of Science and Liberal Studies and almost 30 percent of post-1966 engineering graduates went on for a master's degree.

Information matching up the type of master's degree with the undergraduate major is also available from the survey. Eighty percent of those who received a bachelor's degree in Industrial Management and went on for a master's degree also received the graduate degree in management. About 55 percent of those who received a bachelor's in engineering and went on for a master's majored at the master's level in engineering. Thirty eight percent received a master's in management. As Table II-6 shows a smaller proportion of the post-1966 engineering bachelors did master's work in engineering than was the case for the pre-1966 engineering bachelors and a larger proportion of the post-1966 engineers

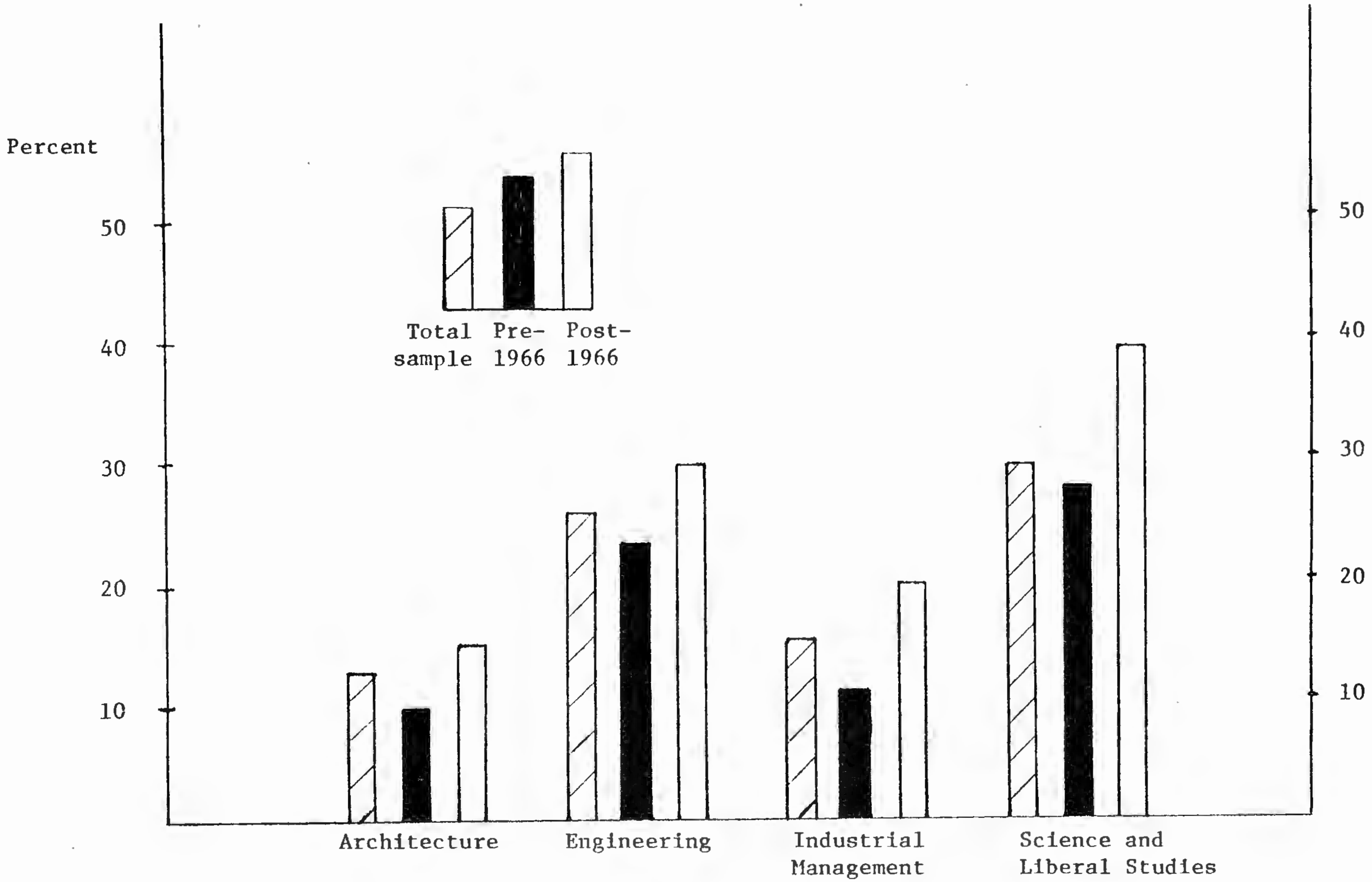


Figure II-1. Percent of Those with Georgia Tech Bachelor's Degrees Who Have Gone on For Master's Degree, By Field of Study at Bachelor's Level, Entire Sample, Pre-1966 Group, Post-1966 Group.

Source: Appendix Table II-1a.

Table II-6. Number and Percent of Respondents With Georgia Tech Bachelor's Degree in Engineering Who Have Gone on For Master's Degree, By Field of Study, Entire Sample, Pre-1966 Group, Post-1966 Group, By Sex.

Sample group	Architecture		Engineering		Management		Science and Liberal Arts		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Entire sample	—	—	333	54.8	231	38.0	44	7.2	608	100
Pre-1966	—	—	199	60.3	99	30.0	32	9.7	330	100
Post-1966	—	—	134	48.2	132	47.5	12	4.3	278	100
Male	—	—	130	47.8	130	47.8	12	4.4	272	100
Female	—	—	4	66.7	2	33.3	—	—	6	100

did master's work in management than was the case for the pre-1966 bachelors. Except for a small number who went into science and liberal arts at the master's level, the post-1966 engineering bachelors were evenly split between engineering and management in their master's degree work.

Those receiving Tech bachelor's degrees from the College of Science and Liberal Studies tend to work in the same field at the master's level. Almost 80 percent of the sample had the same major at both degree levels. The commitment to the same field has been less for the post-1966 group, however, than it was for the pre-1966 group. Ninety-six percent of the pre-1966 graduates from Science and Liberal Studies who went on for a master's did so in the same field, as Table II-7 shows. For the post-1966 group the proportion was 70 percent, with the remaining students dividing their attention between engineering and management.

Table II-3 shows, as we have already pointed out, that 181 respondents out of the entire sample went to Georgia Tech but did not receive a degree. The survey provides additional information about this group. Twenty-six percent of Tech non-graduates went on to receive a bachelor's degree from another college or university. The percent of Tech non-graduates who graduated elsewhere is about the same for those who attended Tech prior to 1966 and those who attended since then.

This 26 percent figure obtained from the survey sample probably understates the percent that would apply to the total population of students who have attended Tech. The listing of non-graduates in the Tech alumni file is not as complete as the listing of those who received a degree. We have already pointed out that since 1946 graduates have automatically been listed whereas non-graduates are put on the roll only when they request it. It is

Table II-7. Number and Percent of Respondents With Georgia Tech Bachelor's Degree in Science or Liberal Studies Who Have Gone For Masters Degree. By Field of Study, Entire Sample, Pre-1966 Group, Post-1966 Group, By Sex.

Sample group	Architecture		Engineering		Management		Science and Liberal Arts		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Entire sample	1	1.0	9	9.6	10	10.6	74	78.7	94	100
Pre-1966	-	--	1	3.6	--	---	27	96.4	28	100
Post-1966	1	1.5	8	12.1	10	15.2	47	71.2	66	100
Male	1	1.8	7	12.3	9	15.8	40	70.1	57	100
Female	-	---	1	11.1	1	11.1	7	77.8	9	100

reasonable to assume that people who left Tech and received a degree elsewhere would be less likely to request listing as Tech alumni than would those who did not receive a degree elsewhere. If this is true, the Tech file and the sample taken from it underestimates the number of people who left Tech but received a degree elsewhere. The 26 percent figure should probably be interpreted as a conservative estimate.

Survey Results: Geographic Patterns

Where Did They Come From? One of the strengths of Georgia Tech, when compared to many other publicly supported schools, has been its cosmopolitan student body. Georgia students who attend Tech are exposed to other students from all over the Southeast and other regions of the country. As Table II-8 shows a little over half of the survey respondents were originally from Georgia, about equally divided between Atlanta and the rest of the State. Another 31 percent came from the rest of the Southeast. A total of 83 percent came from Southeastern states, including Georgia. Florida has been the biggest supplier of Tech students except for Georgia. Almost 10 percent of the respondents came originally from Florida, twice as many as came from the next largest contributor Tennessee. Eleven Northeastern states (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont) along with the District of Columbia supplied almost 10 percent of the student body. Over 80 percent of the students from the Northeast came from four states: Maryland, New York, New Jersey, and Pennsylvania.

Where Did They Go? Atlanta is moderately strong in its ability to hold Tech graduates. About 27 percent of the respondents came from the city originally. The same percent had their first job in Atlanta; the same percent have their present job here. Atlanta is not a heavily industrialized city.

Table II-8. Number and Percent of Respondents in Each of 53 Geographical Choices, Home Entering Tech, First Job, Entire Sample, Georgia Tech Survey.

Entire Sample

	Home on Entering Tech		1st Job		Present Job	
	No.	%	No.	%	No.	%
Metro Atlanta	1180	27.2	1198	27.6	1154	26.6
Rest of Ga.	1099	25.3	451	10.4	466	10.7
Total Georgia	2279	52.5	1649	38.0	1620	37.3
Rest of Southeast:	1307	31.0	1254	29.0	1434	33.0
Alabama	169	3.9	181	4.2	185	4.3
Arkansas	41	.9	13	.3	17	.4
Florida	411	9.5	262	6.0	382	8.8
Kentucky	53	1.2	39	.9	41	.9
Louisiana	55	1.3	105	2.4	89	2.0
Mississippi	50	1.2	25	.6	30	.7
North Carolina	81	1.9	147	3.4	190	4.4
South Carolina	122	2.8	115	2.6	129	3.0
Tennessee	203	4.7	206	4.7	201	4.6
Virginia	82	1.9	132	3.0	149	3.4
West Virginia	40	.9	29	.7	21	.5
Total Southeast	3586	83.5	2903	66.9	3054	70.3
Total Northeast	411	9.5	583	13.3	479	11.0
Total Great Lakes States	113	2.6	276	6.4	199	4.7
Total Plains & Mtn. States	44	.9	66	1.4	95	2.1
Total Southwest	89	3.0	209	4.9	248	5.7
Total Far West	33	.6	142	3.2	220	5.1
Outside U.S.A.	45	1.0	23	.5	—	—

Its strength has traditionally been, and still is, in finance, wholesale and retail trade. Given Atlanta's economic base and the fact that Tech specializes in producing engineers, it is not surprising that Atlanta is not able to make a net gain in terms of Georgia Tech students.

The rest of the State employs fewer Tech graduates than the number of starting freshmen it sends to the Institute. Twenty-five percent of the respondents came from Georgia, other than Atlanta. A little over 10 percent had their first job and now have their present job in the rest of the State.

In summary, 52 percent of the respondents originally came from Georgia, including Atlanta. Thirty-eight percent had their first job in the State and 37 percent have their present job in Georgia.

The rest of the Southeast has a small net gain in Tech students. The rest of the Southeast sent 31 percent of the respondents to Georgia Tech originally. It employed 29 percent of the respondents on their first job and employs 33 percent on their present job.

When the entire Southeast, including Georgia, is considered, the region sent 83 percent of the sample to Tech originally. It employed 67 percent of the Tech graduates in their first job and now employs 70 percent of Tech graduates in their present job.

The other regions of the country are net gainers. In total numbers the Northeast is the biggest employer of Tech alumni outside the Southeast as it also is the biggest contributor of entering freshmen. In percentage terms, the Far West is the biggest net gainer, employing over 8 times as many Tech graduates in their present jobs as it sent to Georgia Tech originally.

<u>Tech Alumni and National Population Movement.</u> For a correct interpretatio[n] these survey results should be evaluated in terms of total national job market behavior. The Southeast is not an isolated economic unit but interacts with

other regions. In a highly mobile labor market, people move in and out of regions in great numbers. Some workers move out of Georgia and the Southeast while other workers are moving in. The behavior of Georgia Tech graduates suggested by the results of this survey represents only one half of the job movement picture. At the same time that graduates of Tech, originally from Georgia and the Southeast, move to other regions of the country, graduates of other colleges and universities are migrating to Georgia and the South. Exchange of this type is normal for well developed and mobile labor markets. If college graduates have followed the pattern of general population movements in the last two decades, then the Southeast has been a net gainer. This point needs further comment.

In the United States regional population changes are not due, to any important degree, to differences in birth rates. They are largely explained in terms of the migration of people in and out of regions. The Southeast has been for some time a net migration gainer. As Figure II-2 shows, the percent change in population for the United States over the decade of the sixties and the first half of the seventies was 18.4 percent. In the traditional heartland of American industry, the New England States, the Mideastern States (including New York, New Jersey, Pennsylvania, Delaware, and Maryland), and the Great Lake States, the percent change in population over the same interval was less than the national average. The population increase in the Southeast, 23.3 per percent, was 5 percentage points higher than for the nation as a whole. Manufacturing employment in the New England and Mideastern States actually declined from 1960 to 1975. Manufacturing employment in the Southeast increased almost 5 times as much as the national average. Only the Southwest and the Rocky Mountain States grew faster than the Southeast in manufacturing employment.

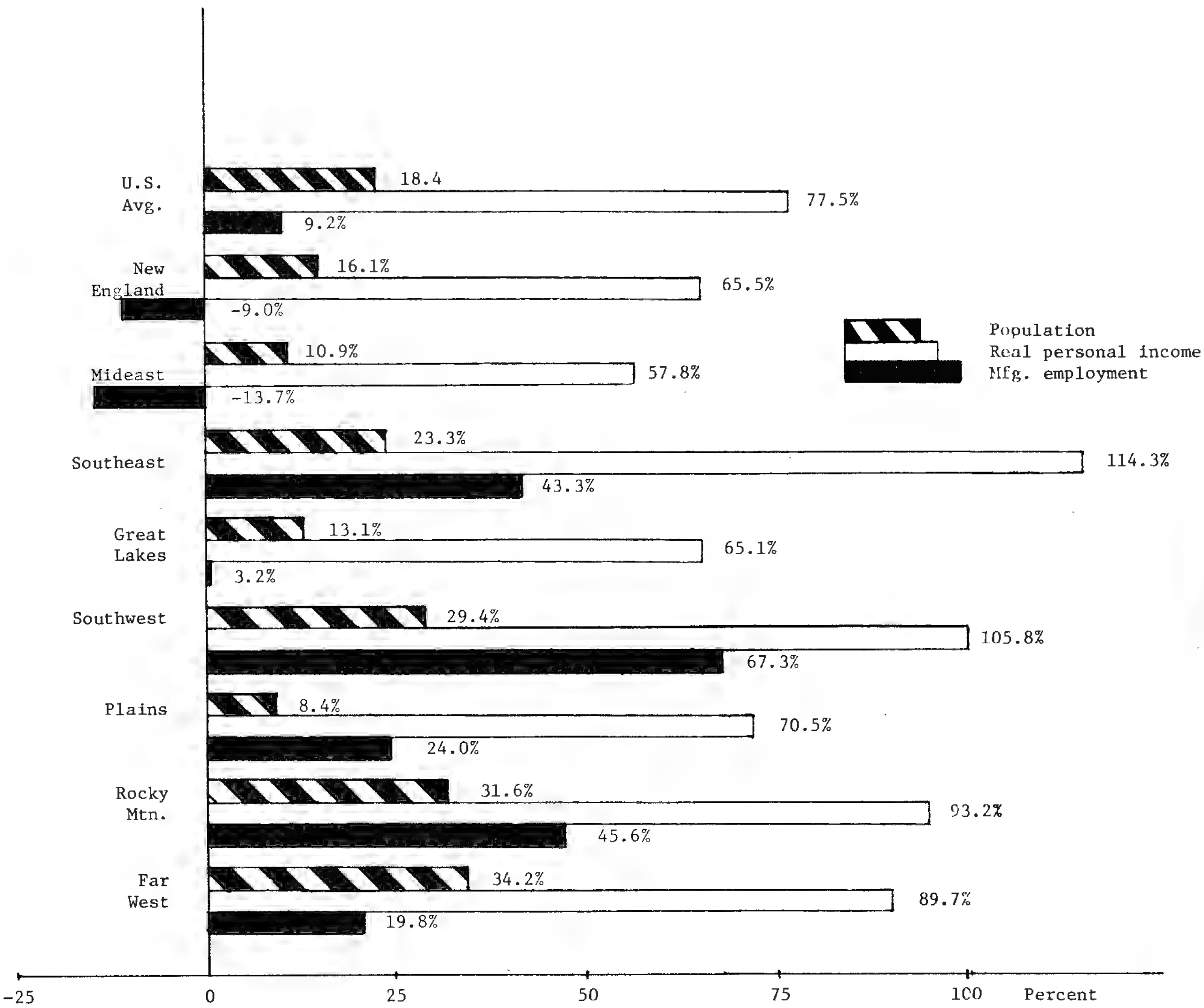


Figure II-2. Changes in Population, Real Personal Income, and Manufacturing Employment, U.S. Average and By Geographic Regions, 1960-1975.

Source, Census Bureau, Bureau of Labor Statistics.

These higher than average percentage gains strongly suggest that, at least in the last two decades, more college graduates have moved into the South than have moved out.

A comparison of data on geographical locations for the pre-1966 and post-1966 alumni groups reflects the more rapid rate of economic growth in the Southeast, and its ability to provide more jobs, over the last two decades. As Table II-9 shows the record of Atlanta, Georgia, and the Southeast in retaining Tech graduates is somewhat better in the case of the post-1966 group than for the pre-1966 group. Twenty-seven percent of the pre-1966 group of respondents entered Tech from Atlanta but only 24 percent have their present jobs here. Twenty-six percent of the post-1966 males originally came from Atlanta but 29 percent have their present jobs here. (The comparison is made with post-1966 males since the pre-1966 group is almost total male.) A smaller percent of post-1966 males came from the rest of Georgia compared to the pre-1966 group (24.4 percent versus 26.4 percent) but a larger percent of the post-1966 males have present jobs in the rest of the State (11.4 percent compared to 10.4 percent). The same pattern is true for the Southeast; a slightly smaller percent of post-1966 males came from the Southeast compared to the pre-1966 group (81.4 percent versus 83.4 percent), but a larger percent now have jobs in the Southeastern region (72.7 percent versus 68.7 percent).

It is interesting to note in Table II-9 that a higher percent of women students in the post-1966 group than men came to Tech from Georgia, including Atlanta (59.8 percent versus 50.3 percent), but their homes tend to be more heavily concentrated in Atlanta. About the same percent of women have present jobs in Atlanta as came from the city originally. The rest of the state retains about half of its women natives in present jobs.

Table II-9. Percent of Respondents in Each of Selected Geographical Areas, Home on Entering Tech and Present Job, Pre-1966 Group and Post-1966 Group, by Sex.

(percent)

	Pre-1966		Post-1966			
	Home on Entering Tech	Present Job	Home on Entering Tech: Male	Home on Entering Tech: Female	Present Job: Male	Present Job: Female
Metro Atlanta	27.2	24.1	25.9	41.2	29.2	42.5
Rest of Georgia	26.4	10.4	24.4	17.6	11.4	9.5
Total Georgia	53.6	34.5	50.3	59.8	40.6	52.0
Total Southeast	83.4	68.7	81.4	81.8	72.7	70.3
Total Northeast	11.9	12.2	9.4	8.8	9.7	6.8
Total Great Lakes States	2.3	4.3	3.0	3.4	4.8	7.4
Total Plains & Mountain States	1.0	2.5	1.1	1.4	2.2	1.4
Total Southwest	1.6	5.5	2.6	2.0	5.7	8.8
Total Far West	.7	5.5	.8	——	4.3	5.4

Georgia Natives: Where Do They Go? A greater insight into the movement of Tech alumni can be gotten by looking beneath the totals which are presented in Tables II-8 and II-9. Table II-8 shows, we have already pointed out, that over 52 percent of the respondents were living in Georgia at the time they entered Tech. A further analysis of these Georgia natives shows that 54 percent of them are in the State for their present jobs. The State's holding power is greater for the post-1966 group. The State retained 52 percent of the pre-1966 group; it retained 58 percent of the post-1966 males.

Where do the native Georgians who leave the State go? Fifty-five percent of the entire sample are in other Southeastern states for their present jobs, as Table II-10 shows. Florida has the biggest group, 14 percent. North Carolina has the next biggest group, 9 percent. The Northeast is the next most popular regional current job location for Georgia natives with over 15 percent of the total.

More Georgia natives from the post-1966 group who are outside Georgia for their present job are located in the Southeast than is the case for pre-1966 group. Sixty-two percent of post-1966 males are in the Southeast versus 53 percent of the pre-1966 group. Presumably this difference in behavior is due, again, to the increasing strength of the Southeastern economy. A smaller percent of post-1966 males are in the Northeast compared to pre-1966 native alumni (13 percent versus 17 percent).

Alumni From Outside Georgia. Survey data show that 23 percent of the respondents with their present job in Georgia are not Georgia natives. Where did they come from? Table II-11 shows that for the entire sample 65 percent came from the Southeast. Florida was the biggest contributor, 22 percent, over twice the proportion contributed by the next largest state, Tennessee. Twenty percent came from the Northeast.

Table II-10. Number and Percent of Respondents Living in Georgia at Time Of Entering Tech, Outside of State for Present Job, By Location of Present Job, Entire Sample, Pre-1966 Group, Post-1966 Group, By Sex.

Geographical Location	Entire Sample		Pre-1966		Post 1966			
					Male		Female	
	No.	%	No.	%	No.	%	No.	%
Metro Atlanta	—	—	—	—	—	—	—	—
Rest of Georgia	—	—	—	—	—	—	—	—
Total Southeast	579	55.5	338	53.1	225	61.6	16	38.1
Alabama	78	7.5	51	8.0	26	7.1	1	2.4
Arkansas	4	.4	2	.3	2	.5	—	—
Florida	144	13.8	89	14.0	52	14.2	3	7.1
Kentucky	16	1.5	7	1.1	7	1.9	2	4.8
Louisiana	25	2.4	11	1.7	14	3.8	—	—
Mississippi	9	.9	7	1.1	2	.5	—	—
North Carolina	96	9.2	48	7.5	44	12.1	4	9.5
South Carolina	62	5.9	31	4.9	29	7.9	2	4.8
Tennessee	78	7.5	49	7.7	28	7.7	1	2.4
Virginia	63	6.0	41	6.4	19	5.2	3	7.1
West Virginia	4	.4	2	.3	2	.5	—	—
Total Northeast	162	15.5	107	16.8	49	13.4	6	14.3
Total Great Lakes States	68	6.5	43	6.7	18	5.0	7	16.7
Total Plains & Mtn. States	41	3.9	27	4.2	12	3.3	2	4.8
Total Southwest	85	8.1	46	7.2	31	8.5	8	19.0
Total Far West	89	8.5	60	9.4	26	7.1	3	7.1
Outside U.S.A.	—	—	—	—	—	—	—	—

Table II-11. Number and Percent of Respondents Living Outside Georgia on Entering Tech, In Georgia for Present Job, By Location of Home on Entering Tech, Entire Sample, Pre-1966 Group, Post-1966 Group, By Sex.

Geographical Location	Entire Sample		Pre-1966		Post 1966			
					Male		Female	
	No.	%	No.	%	No.	%	No.	%
Metro Atlanta	—	—	—	—	—	—	—	—
Rest of Georgia	—	—	—	—	—	—	—	—
Total Southeast	249	64.7	111	68.5	120	63.8	18	58.1
Alabama	28	7.3	14	8.6	11	5.9	3	9.7
Arkansas	9	2.3	5	3.1	3	1.6	1	3.2
Florida	84	21.8	31	19.1	46	24.5	7	22.6
Kentucky	12	3.1	6	3.7	4	2.1	2	6.5
Louisiana	9	2.3	3	1.9	5	2.7	1	3.2
Mississippi	7	1.8	6	3.7	1	.5	—	—
North Carolina	15	3.9	8	4.9	6	3.2	1	3.2
South Carolina	31	8.1	9	5.6	22	11.2	—	—
Tennessee	35	9.1	20	12.3	15	8.0	—	—
Virginia	15	3.9	5	3.1	7	3.7	3	9.7
West Virginia	4	1.0	4	2.5	—	—	—	—
Total Northeast	76	19.7	28	17.3	41	21.8	7	22.6
Total Great Lakes States	21	5.5	9	5.6	10	5.3	2	6.5
Total Plains & Mtn. States	9	2.3	6	3.7	1	.5	1	3.2
Total Southwest	10	2.6	5	3.1	4	2.1	1	3.2
Total Far West	4	1.0	—	—	4	2.1	—	—
Outside U.S.A.	10	2.6	2	1.2	7	3.7	1	3.2

Geographic Patterns: City and Town Sizes

Table II-12 shows the distribution of respondents by sizes of cities and towns on entering Tech, first job, and present job. A little over 8 percent came from towns under 2,500 in population. Another 22 percent came from towns over 2,500 but under 25,000 in size. The remaining respondents were rather evenly divided between cities 25,000 - 250,000 in population, 250,000 - 1,000,000, and over 1,000,000. The difference between the pre-1966 group and post-1966 males is mainly at the higher end of city sizes. Thirty-three percent of the pre-1966 group came from places under 25,000 in population. Twenty-eight percent of the post-1966 males also came from these smaller towns. Only 15 percent of the pre-1966 group came from towns of over 1,000,000 population, whereas 33 percent of post-1966 males came from these largest cities. The larger number of post-1966 males in cities over 1,000,000 in size is at the expense of the cities of the next lowest size, 250,000 - 1,000,000.

One can speculate that the difference in the pre-1966 and post-1966 alumni in terms of percentage entering Tech from the largest cities has less to do with the basic behavior of the respondents than it does with the fact that cities have simply gotten larger. The respondents in the sample entered Tech over a span of four decades. In this interval the country went through a period of substantial urban growth. A student from Atlanta in the early 1950's came from a city under a million in size. A student entering from Atlanta in the early seventies came from a city over a million in size. In the urbanization process that has taken place in the United States over the last 40 years the growth has been more concentrated among the largest cities. Hence the greatest difference between earlier and later Tech graduates in size of town or city on entering Tech has been in terms of the largest cities.

The fact that this difference between the two groups is largely due to urban growth is substantiated by the smaller differences between earlier and later graduates in the sizes of towns and cities in which they are presently located. In this case changes in the sizes of the cities cannot distort the comparison since we are comparing responding groups at the same moment in time. The differences in the behavior of the pre-1966 group and the post-1966 males is again small for cities and towns under 250,000 population. Over 13 percent of both pre-1966 alumni and post-1966 males are working in towns under 25,000 population in size, for example. In the case of the present job comparison, however, the differences in the proportion of the two groups in the largest cities - 40 percent of the pre-1966 group and 45 percent of the post-1966 males - is much smaller than in the case of the comparison of place of origin.

The last line of Table II-12 shows the distribution of the total U.S. population among cities and towns according to the 1970 census. The respondents in the Georgia Tech alumni survey are much more urbanized than the country as a whole. Thirty-four percent of the U.S. population lived in towns under 2,500 in size or in rural areas in 1970. Only 2 percent of the Tech sample lives in towns of this size. Fifty-five percent of the U.S. population lived in towns under 25,000 in size or in rural areas compared to only 13 percent of the Tech sample. Only 9 percent of the U.S. population lived in cities over a million in size compared to 43 percent for the Tech sample.

Table II-12. Percent of Respondents in Cities and Towns of Each of Five Different Sizes, On Entering Tech, First Job, Present Job, Entire Sample.[1]

	Towns and Cities by Population Size				
	Under 2,500	2,500-25,000	25,000-250,000	250,000-1,000,000	Over 1,000,000
Home on Entering Tech:					
Entire Sample	8.3	22.0	25.5	20.4	23.1
Pre-1966	9.6	23.1	26.3	25.5	14.9
Post-1966:					
Male	6.7	21.6	24.8	13.1	33.0
Female	6.1	9.5	20.3	16.9	47.3
First Job:					
Entire Sample	2.1	11.9	27.8	22.3	33.1
Pre-1966	2.4	13.5	29.5	27.8	25.0
Post-1966:					
Male	1.8	10.0	26.0	15.1	43.1
Females	1.4	7.5	18.9	13.5	52.7
Present Job:					
Entire Sample	1.9	11.4	26.7	16.4	42.7
Pre-1966	1.6	12.2	27.7	17.1	40.4
Post-1966:					
Males	2.3	10.8	25.6	15.7	45.1
Females	1.4	6.1	23.0	13.5	56.1
U.S. Population (1970)	34.4[2]	20.9	24.0	11.5	9.2

[1]For the number of persons in each category, see Appendix, Table II-2a.

[2]Includes places under 2,500, unincorporated parts of urbanized areas, and rural areas.

Females in the sample have a more heavily urbanized background and current location than the males. Forty-seven percent of the post-1966 females originated from cities over one million in population in size compared to 33 percent of the post-1966 males. Fifty-six percent of the post-1966 females have a present job in a largest city compared to 45 percent for post-1966 males.

Survey Results: Employment Status, Industry, and Occupation

Employment Status. Sixteen percent of the total respondents who were working in civilian jobs at the time of the survey were self-employed. Table II-13 shows that the percent self-employed is much higher for the pre-1966 group than for the post-1966 respondents. This is not unexpected since experience is ordinarily required before one goes into business for oneself. There are no national figures available on the self-employed with college training to which the 21 percent of the pre-1966 Georgia Tech sample can be compared.

Industry Distribution. The distribution of the respondents by "business of employer" or industry is shown in Figure II-3. The largest proportion of Georgia Tech alumni are employed in manufacturing, as one would expect for a school that specializes in training engineers. The differences in the industrial distribution when the first and present jobs are compared are not large except for manufacturing. More had their first job in manufacturing than present job (42 percent versus 33 percent). A larger proportion of the sample is involved at present in real estate, consulting, and the professions than was the case for first jobs.

Table II-13. Number and Percent of Respondents By Employment Status, Entire Sample, Pre-1966 Group, Post-1966 Group, By Sex.

Sample Group	Employment Status			
	Self-Employed		Employed	
	No.	%	No.	%
Entire Sample	692	15.9	3650	84.1
Pre-1966	532	21.4	1956	78.6
Post-1966	160	8.7	1688	91.3
Male	152	8.9	1554	91.1
Female	8	5.4	140	94.6

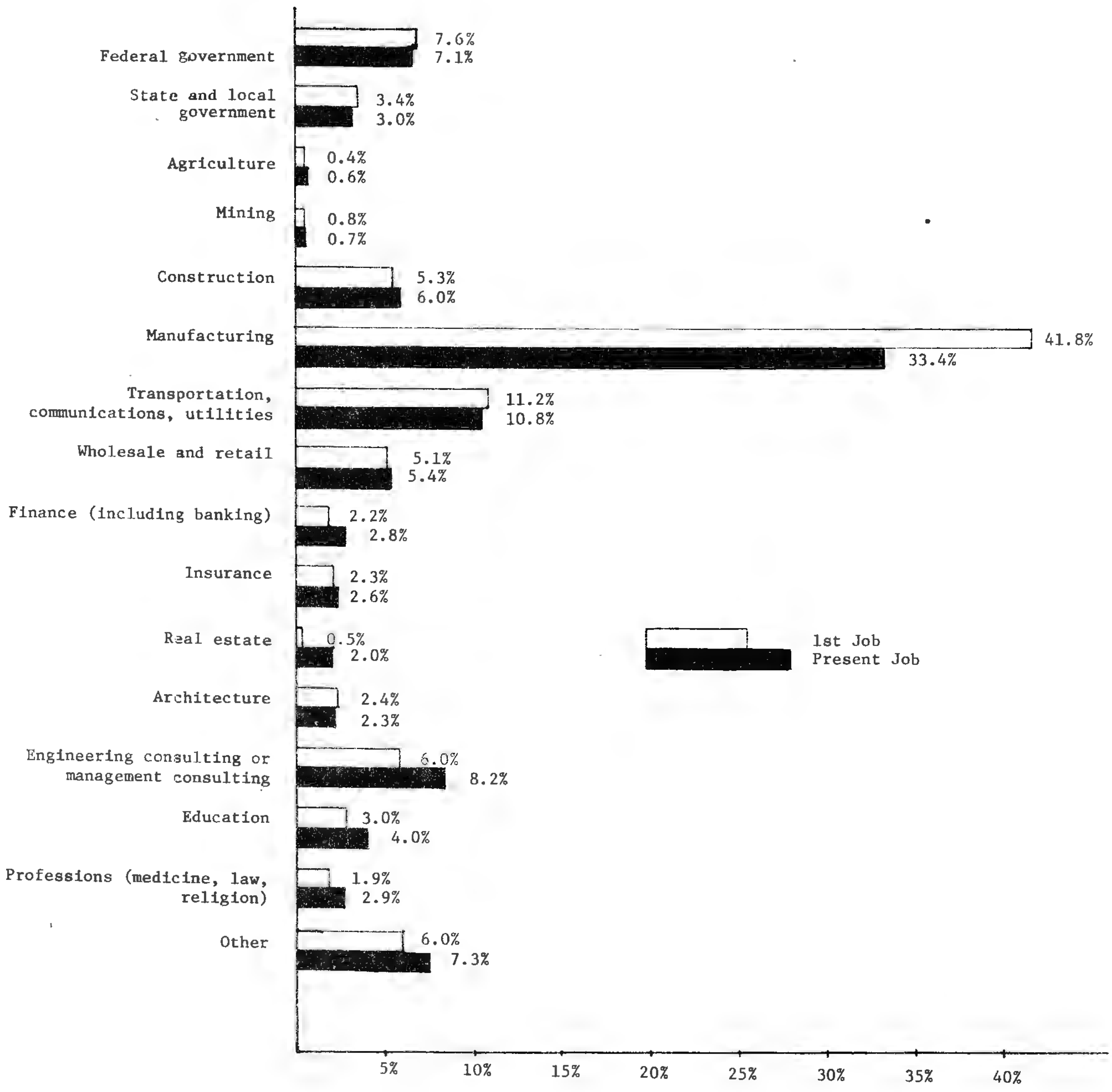


Figure II-3. Percent of Respondents By Business of Employer, First and Present Jobs, Entire Sample.

Source: Appendix, Table II-3A.

Distribution by Occupation. Table II-14 shows the respondents by occupation for first jobs and present jobs. The occupation "engineer" is defined in detail in the questionnaire in order to get as much uniformity in interpretation of the term as possible in the minds of respondents. (The respondents are told that they should classify themselves as engineers when "the main portion of your time is occupied with engineering, including such things as executive-administrative, sales requiring substantial engineering capabilities, teaching, design, production quality control, research and development, construction supervision, or consulting.") Fifty-six percent of the entire sample listed their occupation as engineer for the first job and 43 percent listed themselves as engineer for their present job.

It would be interesting to know precisely the proportion of alumni trained in engineering that are now working as engineers. Unfortunately our data are not complete enough to make a precise headcount. To start with, at least some of the respondents who classify themselves as engineers did not receive a degree in engineering. Further while we know what proportion of Tech bachelors majored in engineering, we cannot tell from responses to our questionnaire the exact number who received a bachelor's degree elsewhere, did graduate work at Tech in engineering, and should be added to Tech engineering bachelors to get the total of respondents with engineering training. While we cannot determine precisely the percent who majored in engineering and are now practicing as engineers, we can roughly approximate this figure by comparing the percent in the sample who received a bachelor's in engineering to the percent now employed as engineers. As we pointed out earlier, 64 percent of those receiving a Tech bachelor's degree majored in engineering. This figure can be contrasted with the 56 percent of the sample who listed themselves as

Table II-14. Number and Percent of Respondents By Occupation, First and Present Job, Entire Sample, Pre-1966 Group, Post-1966 Group, By Sex.

	Entire Sample[1]				Pre-1966				Post-1966							
	1st Job		Present Job		1st Job		Present Job		1st Job				Present Job			
									Male		Female		Male		Female	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Engineer	2455	56.5	1848	42.6	1501	60.3	994	40.0	899	52.7	55	37.2	803	47.1	51	34.5
Architect	99	2.3	98	2.3	59	2.4	59	2.4	37	2.2	3	2.0	38	2.2	1	.7
General Contractor	56	1.3	104	2.4	35	1.4	65	2.6	21	1.2	—	—	39	2.3	—	—
Manager	379	8.7	869	20.0	195	7.8	582	23.4	172	10.1	12	8.1	267	15.7	20	13.5
Sales & Marketing	378	8.7	434	10.0	248	10.0	266	10.7	116	6.8	14	9.5	158	9.3	10	6.8
Insurance	41	.9	64	1.5	25	1.0	46	1.8	15	.9	1	.7	16	.9	2	1.4
Securities Salesman	10	.2	15	.3	8	.3	11	.4	2	.1	—	—	4	.2	—	—
Real Estate	14	.3	55	1.3	10	.4	40	1.6	4	.2	—	—	13	.8	2	1.4
Accountant	72	1.7	63	1.5	35	1.4	20	.8	31	1.8	6	4.1	39	2.3	4	2.7
Computer programmer	125	2.9	133	3.1	26	1.0	31	1.2	85	5.0	14	9.5	81	4.7	21	14.2
Teacher	103	2.4	111	2.6	57	2.3	74	3.0	42	2.5	4	2.7	31	1.8	6	4.1
Other	408	9.4	515	11.9	231	9.3	279	11.2	153	9.0	24	16.2	205	12.0	31	20.9

[1] Two hundred and two respondents did not identify the occupation for their first job; 33 did not identify the occupation for their present job.

engineers in the first job and the 43 percent who listed themselves as engineers in their present jobs.

The proportion of respondents working as engineers on the first job in the pre-1966 group is larger than the proportion for post-1966 males (60 percent versus 53 percent). The proportion of respondents doing engineering on the present job in the pre-1966 group is lower than that for post-1966 males (40 percent versus 47 percent). This difference is probably explained by the fact that many engineers tend to drift out of engineering in their later job careers. The movement out of engineering had had more time to occur with the pre-1966 group than with post-1966 males.

The smaller proportion of post-1966 female respondents working as engineers compared to post-1966 males is not surprising since a smaller proportion of post-1966 females with bachelor's degrees majored in engineering than was the case for post-1966 males. In fact only 41 women among post-1966 females currently employed received bachelor's degrees in engineering whereas 51 women reported themselves as currently employed as engineers.

Survey Results: Employer Size, Job Moves, Number of Top Executives

Employer Size. Table II-15 shows a distribution of the sample by the size of the respondents' current employers. Twenty-one percent of the entire sample work for small firms employing less than 50 people. Forty-four percent work for large firms employing more than 5,000. Post-1966 males have some tendency to work for larger employers than the pre-1966 group. Eighteen percent of the post-1966 males work for the smallest size employers compared to 24 percent for the pre-1966 respondents. Forty-five percent of the post-1966 males work for the largest size employer compared to 42 percent for the pre-1966 group. The

Table II-15. Number and Percent of Respondents By Size of Firm Worked For, Present Job, Entire Sample, Pre-1966 Group, Post-1966 Group, By Sex.

Size of firm (number of employees)	Entire Sample [1]		Pre-1966		Post-1966			
					Male		Female	
	No	%	No	%	No	%	No	%
Less than 50	916	21.2	600	24.2	302	17.8	14	9.5
50 - 500	640	14.8	370	14.9	245	14.4	25	17.0
500 - 5,000	872	20.2	467	18.9	379	22.3	26	17.7
Over 5,000	1893	43.8	1038	41.9	773	45.5	82	55.8

[1] Twenty-one respondents did not identify the size of their firm.

post-1966 females have a stronger tendency than the post-1966 males to work for larger firms. Fifty-six percent of the post-1966 females work for firms employing more than 5,000 people.

Number of Firms Worked For. Table II-16 shows a distribution of the respondents by the number of firms for which they have worked. Two-thirds of the entire sample have worked for no more than two firms. Only 18 percent of the sample have worked for more than three employers. The pre-1966 group job-hopped more than the post-1966 group, in part because they have been in the job market longer. The women in the post-1966 group have moved less than the men. Sixty percent of the women have worked for only one employer compared to 50 percent of the men.

Number of Top Executives. Sixteen percent of the respondents reported that they are currently president, chairman of the board, or chief executive officer of their firm. Table II-17 shows the distribution of these respondents by the size of the firms of which they are one of the top officers. Eighteen percent of this group head up firms that are quite small, with less than $100,000 a year in sales. Forty-three percent are heads of firms with annual sales in excess of a million. Twenty-seven individuals, or 4 percent of the heads of firms, are top officials of companies with annual sales over $50,000,000. The specific size of the firms of which these 27 individuals are the heads is not known since the top size category listed in the questionnaire is open-ended. The firms have annual sales of at least $50,000,000 but how much larger they are cannot be answered from survey data. Even the minimum, $50 million, represents a good size firm, however. The bottom firm on Fortune's list of the nation's largest 1,000 industrial firms, as measured in terms of 1976 sales, had annual sales of just over $100 million. Annual sales of $50 million is almost enough

Table II-16. Number and Percent of Respondents By Number of Companies or Organizations Worked For, Entire Sample, Pre-1966 Group, Post-1966 Group, By Sex.

Number of firms	Entire Sample[1]		Pre-1966		Post-1966			
					Male		Female	
	No	%	No	%	No	%	No	%
1	1653	38.1	719	28.9	845	49.6	89	60.1
2	1225	28.3	679	27.3	507	29.8	39	26.4
3	680	15.7	457	18.4	210	12.3	13	8.8
4	364	8.4	266	10.7	93	5.5	5	3.4
5	232	5.4	198	8.0	32	1.9	2	1.4
More than 5	180	4.2	165	6.6	15	.1	—	—

[1] Eight respondents did not indicate the number of firms worked for.

Table II-17. Number and Percent of Respondents Who Are Currently President, Chairman of the Board, or Chief Executive Officer of Their Firms, By Size of Firm.

Size of firm (current annual sales)	Number	Percent
Under $100,000	120	17.6
$100,000 - $1,000,000	268	39.2
$1,000,000 - $50,000,000	268	39.2
Over $50,000,000	27	4.0
Total	683	100

to make the cutoff of the largest 200 Southern firms according to the latest available list reported by South Magazine.

The members of the sample were also asked in the questionnaire whether they had ever started a business of their own. Twenty-five percent of the sample indicated that they have started a business. One-fourth of those who said they have started a business did not indicate the present size of the firm. Presumably these firms are no longer in business. Table II-18 shows that about a third of the firms started by Tech alumni and still in business are relatively small, less than $100,000 a year in annual sales. Twenty-nine percent have annual sales in excess of one million dollars. Eleven respondents reported that they started a business with annual sales now in excess of $50 million.

Survey Results: Income

Respondents to the survey were asked to report their 1976 earned before-tax income. This income was precisely identified in the questionnaire as including salary, commissions, and bonuses or fees "but excluding that part of your income which has no relationship to your work; that is, interest, dividends, rents, capital gains, inheritances, etc."

The median incomes reported by the sample are plotted in Figure II-4 by year of graduation. The upper quartile and the lower quartile incomes - the cutoff points between the upper and lower 25 percent of the sample - are also shown. The data on which Figure II-4 is based are presented in Table II-19. The 1976 class is excluded since some members of the class worked only part of the year.

The overall median 1976 income for the entire sample was $24,400. That is, 50 percent of the sample had a 1976 income above that figure. As Table II-20 shows, 25 percent of the sample had income in excess of $34,000;

Table II-18. Number and Percent of Respondents Who Have Started a Business, By Size of Firm.

Size of firm (Current annual sales)	Number[1]	Percent
Under $100,000	257	32.2
$100,000 - $1,000,000	309	38.7
$1,000,000 - $50,000,000	221	27.7
Over $50,000,000	11	1.4
Total	718	100

[1] One thousand and fifty-three respondents indicated that they started a business. Two hundred and fifty-five did not indicate the size of the firm. Presumably these firms are no longer in existence.

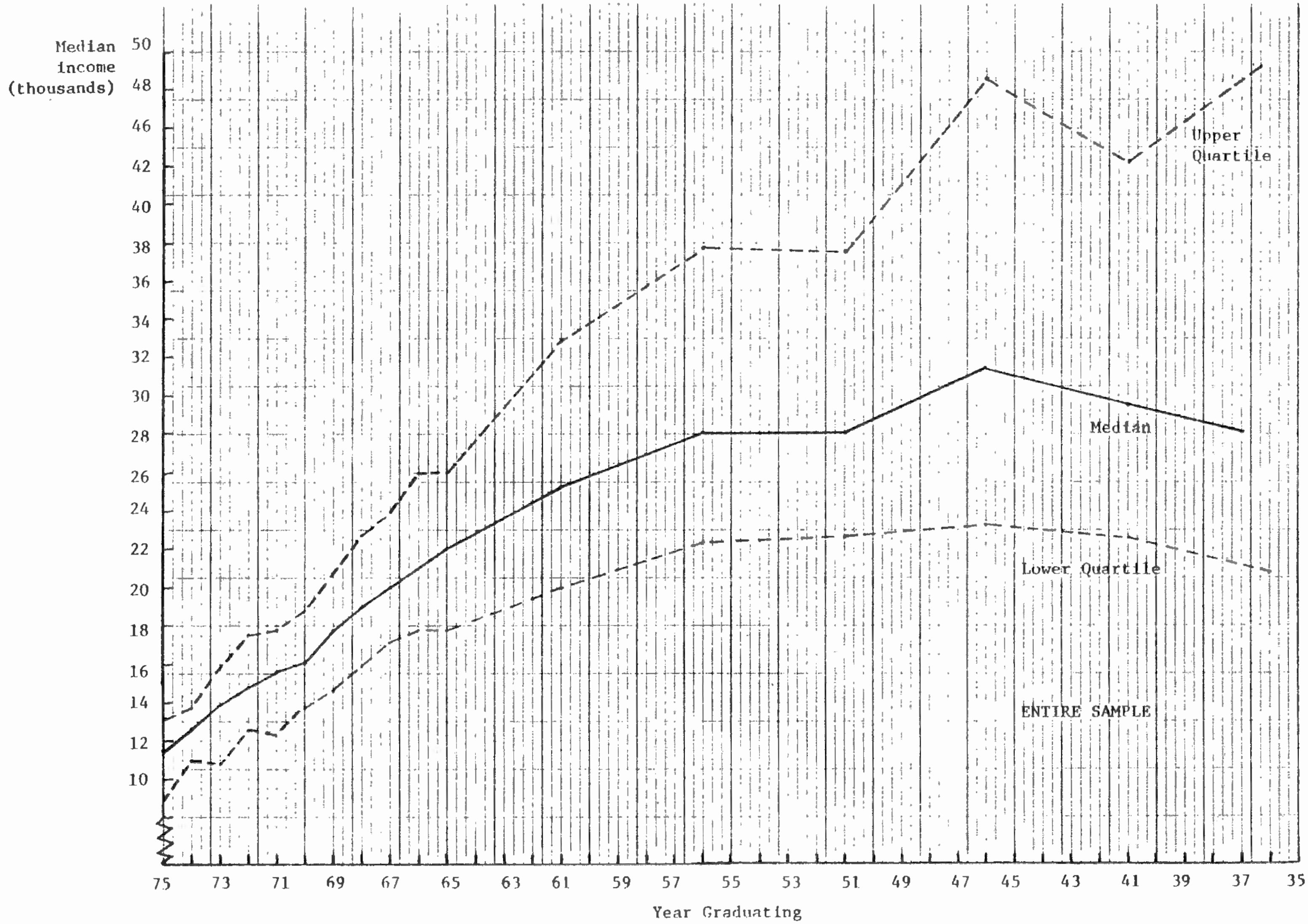


Figure II-4. Median and Quartile 1976 Incomes, Entire Sample, Georgia Tech Survey.

Source: Appendix, Table II-3.

Table II-19. Median and Quartile Income By Year of Graduation, Entire Sample.

Year of Graduation	Lower quartile	Median	Upper quartile
1936-1937	$22,750	$30,014	49,750
1941-1942	24,584	32,001	44,720
1946-1947	25,250	34,003	49,200
1951	24,600	30,002	40,000
1956	24,280	30,017	40,342
1961	22,000	27,100	35,400
1966	19,733	23,998	27,958
1967	19,000	22,008	26,000
1968	17,910	21,002	24,850
1969	16,667	19,997	22,800
1970	15,940	18,000	20,771
1971	14,250	17,503	19,814
1972	14,533	16,800	19,450
1973	12,960	15,994	17,770
1974	12,955	14,700	15,940
1975	11,000	13,504	15,300

10 percent had income above $50,000; 5 percent had income in excess of $70,000; and two percent had income in excess of $100,000. To put these numbers in perspective, a family income of $23,923 was sufficient to put a family in the upper 20 percent of American families in 1976. An income of $37,047 was sufficient to put a family in the upper 5 percent of American families.[2]

Survey Results: Engineers

As we saw earlier, 43 percent of the sample, 1,848 respondents, listed their current occupation as engineer. There is a fairly large concentration of young people, reflecting the larger graduating classes of recent years. As Figure II-5 shows, 38 percent of responding engineers have been out of Tech less than 10 years.

Engineers: Branch of Engineering and Work Performed. Table II-21 shows the breakdown of engineer respondents by the branches of engineering in which they are currently specializing. The respondents are most heavily concentrated in electrical and electronic engineering (21 percent of the sample) and mechanical engineering (18 percent). These large proportions are not unexpected since student enrollment in these programs has traditionally been large at Georgia Tech. Almost 12 percent are in civil engineering. The next groups are aeronautical and aerospace, chemical, and industrial, each with about 10 percent of the sample.

When the sample is broken down into the pre-1966 group and post-1966 males for purposes of comparison, the heaviest concentration of engineers is again found to be, for both groups, electrical and mechanical engineering,

Table II-20. Earned Income, 1976, Entire Sample, Median and Selected Percentiles.

Percentile	Income above
Upper 50 percent	$24,400
Upper 25 percent	$34,000
Upper 10 percent	$50,000
Upper 5 percent	$70,000
Upper 2 percent	$100,000

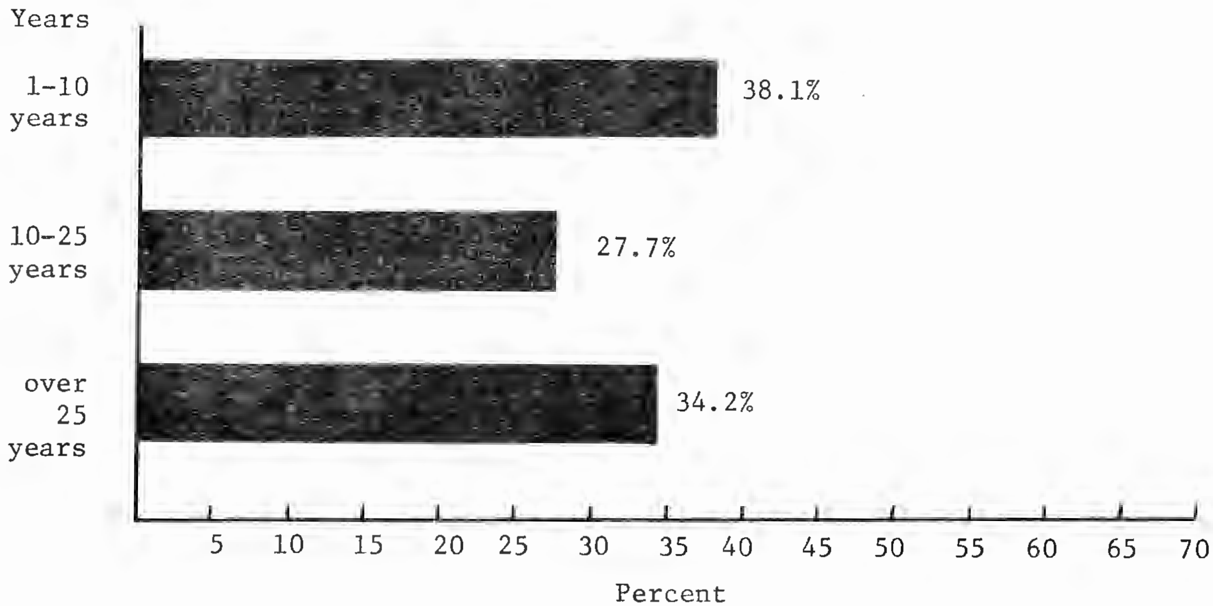


Figure II-5. Engineers, Number of Years Out, Georgia Tech Survey.

Table II-21. Number and Percent of Respondents Whose Present Occupation is Engineer, By Branch of Engineering, Entire Sample, Pre-1966 Group, Post-1966 Group, By Sex.

Branch of engineering	Entire Sample[1]		Pre-1966		Post-1966			
					Male		Female	
	No	%	No	%	No	%	No	%
Aeronautical & aerospace	179	9.7	131	13.2	47	5.9	1	2.0
Chemical	177	9.6	90	9.1	83	10.3	4	7.8
Civil	217	11.7	114	11.5	99	12.3	4	7.8
Electrical & electronic	381	20.6	208	20.9	169	21.0	4	7.8
Industrial	188	10.2	69	6.9	110	13.7	9	17.6
Mechanical	336	18.2	201	20.2	126	15.7	9	17.6
Metallurgical & materials	28	1.5	19	1.9	8	1.0	1	2.0
Petroleum and mining	29	1.6	15	1.5	11	1.4	3	5.9
Sanitary and environmental	64	3.5	28	2.8	33	4.1	3	5.9
Textile	39	2.1	16	1.6	18	2.2	5	9.8
Other	193	10.4	95	9.6	91	11.3	7	13.7

[1]Seventeen respondents did not identify their branch of engineering.

although a smaller proportion of post-1966 males specialize in mechanical engineering than is the case for the pre-1966 respondents. The biggest difference between the pre-1966 group and the post-1966 males is in aerospace and industrial engineering. The proportion of post-1966 males in aerospace engineering is less than half of the proportion for the pre-1966 group (5.9 percent versus 13.2 percent). The proportion of post-1966 males in industrial engineering is twice the proportion for the pre-1966 group (13.7 percent versus 6.9 percent).

Table II-22 shows the distribution of respondents whose present occupation is engineer by the type of work performed. Almost a fourth of the respondents listed themselves as involved in executive-administrative work. The next largest numbers reported themselves as working in design (almost 17 percent), research and development (16 percent), and production, quality control, and maintenance (14 percent). Almost 11 percent of the sample described themselves as involved in consulting.

A smaller proportion of post-1966 males are involved in executive-administrative work than is the case for the pre-1966 group (11 percent versus 35 percent). The difference is presumably due to the fact that executive-administrative responsibility in engineering comes with seniority. The larger proportion of post-1966 males involved in design work compared to the pre-1966 group (21 percent versus 13 percent) is also likely explained in terms of seniority considerations. Older engineers move out of design work and into management responsibility. The larger proportion of post-1966 males involved in production, quality control, and maintenance compared to the pre-1966 group is consistent with the earlier finding that a higher proportion of alumni of the last ten years

Table II-22. Number and Percent of Respondents Whose Present Occupation is Engineer, By Type of Work Performed, Entire Sample, Pre-1966 Group, Post-1966 Group, By Sex.

Type of Work Performed	Entire Sample[1]		Pre 1966		Post 1966			
					Male		Female	
	No	%	No	%	No	%	No	%
Executive-Administrative	438	23.7	348	35.0	87	10.8	3	5.9
Sales	113	6.1	58	5.8	53	6.6	2	3.9
Teaching	22	1.2	17	1.7	3	.0	2	3.9
Design	309	16.7	129	13.0	170	21.2	10	19.6
Production, quality control, maintenance	259	14.0	91	9.2	156	19.4	12	23.5
Research & development	295	16.0	167	16.8	121	15.1	7	13.7
Construction supervision	78	4.2	27	2.7	50	6.2	1	2.0
Consulting	196	10.6	96	9.7	93	11.6	7	13.7
Other	117	6.3	53	5.3	58	7.2	6	11.8

[1] Twenty-one respondents did not identify the type of work performed in their job.

are working as industrial engineers than is the case with pre-1966 respondents.

We saw earlier that 16 percent of the entire Georgia Tech sample is self-employed. Only 7 percent of the respondents whose current occupation is engineer is self-employed.

Engineers and Reported Income. The median income for engineers by year of graduation is shown in Figure II-6. The data on which the figure is based are presented in Table II-23. Median income for engineers as reported by the Engineering Manpower Commission are also presented in both the figure and the table for purposes of comparison. The two sets of data require further comment.

The Engineers Joint Council is a coalition of a large number of engineering and related societies. The Engineering Manpower Commission was organized in 1950 as part of Engineers Joint Council to serve as a focus for national technological manpower problems. The Commission has conducted salary surveys for engineers at two year intervals since 1953. The results of the 1976 survey, for selected years, are reported in Figure II-6 and Table II-23.

The Tech data and the Commission data differ in two respects. First, Commission income data are not obtained from individuals by questionnaire as were the Tech data. The data are reported by employers. A little over 900 establishments participated in 1976, including government agencies and educational institutions. Over 162,000 engineering graduates were included in the 1976 survey, "probably the most comprehensive in the United States from the point of view of engineers covered."[3] The Commission estimates that the survey includes about one quarter of the engineering graduates doing engineering or related work in the United States.

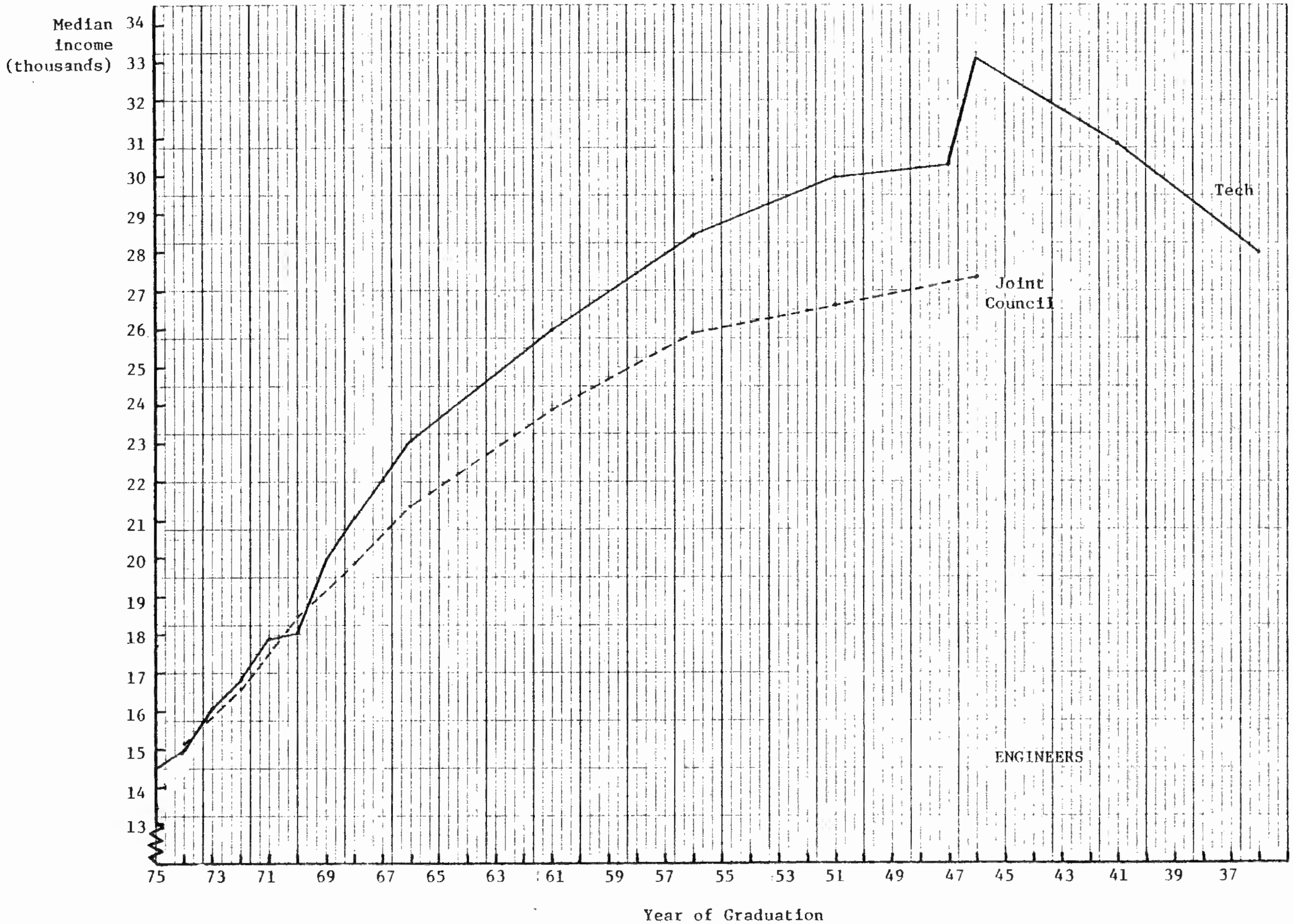


Figure II-6. Median Income for Engineers, Georgia Tech Survey and Engineers Joint Council Survey, 1976

Table II-23. Median Income for Engineers, Georgia Tech Survey and Engineers Joint Council Survey, 1976.

Year of graduation	Georgia Tech sample	Joint Council sample
1936-1937	$28,000	
1941-1942	30,987	
1946	33,214	27,350
1947	30,408	
1951	29,997	26,710
1956	28,500	25,800
1961	26,004	23,900
1966	23,106	21,350
1967	22,000	
1968	21,018	19,850
1969	20,000	
1970	18,002	18,450
1971	17,912	
1972	16,862	16,650
1973	16,019	
1974	15,016	15,200
1975	14,501	

Source: Georgia Tech Survey, 1976 and Engineers Joint Council Professional Income of Engineers, 1976, p. 13.

The second difference is in terms of the definition of income. In the Tech survey all income is reported including "commissions and bonuses or fees." Salaries reported by the Manpower Commission include "base salary and regular allowances, but not overtime or other unpredictable payments."[4] "Other unpredictable payments" apparently include such things as stock options and bonuses.

It seems likely that overtime payments are not a major factor in engineers' salaries. There does not seem to be a uniform practice in industry for overtime payment of engineers so it is difficult to say just how much overtime payment takes place. However, data on overtime payments for all professional and technical workers can be used as a type of benchmark. In mid-1976, 26 percent of full-time professional and technical workers worked 41 hours or more a week. Of this group, 16% received premium pay for the overtime work. This would mean that only 4 percent of all professional and technical workers were receiving premium pay in mid-1976.[5] Even if engineers matched this figure, the effect on median income would not be large.

Such things as stock options were most likely not included in Tech data because of the wording of the income question. Bonuses were included. The difference that bonuses would make is unknown.

Since overtime and bonuses are included in Tech data and not in Manpower Commission data, the comparison between the two series does not yield precise results. The comparison is, nevertheless, interesting. Tech engineering graduates out more than five years are above the Commission sample in median income. The extent to which the difference is due to differences in income definitions is unknown.

PART III

EDUCATION AND RESEARCH[1]

The two preceding parts of this report have dealt with the flow of money through Georgia Tech - and the economic impact of this flow on the economy of Georgia - and the flow of people that now make up the Georgia Tech alumni. This third part of the report deals with the flow of ideas through the Institute.

The Educational Program

The imparting of knowledge is, of course, the basic reason for the existence of an institution of higher learning. It is centered in the teaching process in which scholars in a wide range of fields train young men and women and prepare them to make their contribution in a variety of professions and occupations. Since Georgia Tech opened its doors, over 52,000 degrees have been conferred.

The Student Body. In the 1976-1977 academic year the average number of students enrolled per quarter was 8,880. Seventeen percent were graduate students. Tech students were studying in one of four "Colleges": the College of Architecture, with options in Architecture, Building Construction, Industrial Design, and City Planning; the College of Engineering, with options in ten engineering schools, Aerospace, Ceramic, Chemical, Civil, Electrical, Engineering Science and Mechanics, Industrial and Systems Engineering, Mechanical, Nuclear, and Textile, plus a program in Health Systems; the College of Industrial Management, with options in Industrial Management, Economics, and Management Science; and the College of Science and Liberal Studies, with degree options in Biology, Chemistry, Geophysical Sciences, Information and Computer Science, Mathematics, Physics, and Psychology and supporting departments of English, Military Science, Modern Language, Music, Physical Education, and Social Sciences.

The Tech student body majoring in these various fields has a broad geographic representation. There are students from every Georgia county and from every state in the Union and the District of Columbia. There are 400 students from 60 foreign countries.

In addition to formal recruiting, Tech reaches out in a number of programs to a broad range of students. There is, for example, a dual degree arrangement with 91 liberal arts colleges spread from Oregon to New England to Florida. Students enrolled in the program take three years at a participating college and two additional years at Georgia Tech and receive a degree from both schools. Eleven of the participating schools are traditionally black colleges and 21 are traditionally women's colleges. The dual degree program has contributed greatly to success in attracting an increasing number of minority-group students. Approximately 250 black engineering students were enrolled at Georgia Tech in the 1976-1977 academic year and over 350 additional black students were enrolled at the Atlanta University Center in the three-year pre-engineering phase of the dual degree program.

Tech also has a joint enrollment arrangement for high school students which is, in effect, an early admissions program. A limited number of gifted students take Tech freshman courses which count toward both their high school diploma and a Georgia Tech degree. The typical enrollment has been 40 to 50 students a year. At a school where freshmen have traditionally been known as "rats," it was inevitable that these students would become known as "mice."

There are a number of smaller programs. The Minority Introduction to Engineering (MITE), for example, is an orientation program conducted in the summer for rising senior high school students who live on campus for one week and are given an opportunity to learn of the challenge technology offers. In summer, 1977, the third year of the program, there were over 750 applicants for the 210 spaces available. Twenty-five percent of the first two MITE groups enrolled at Georgia Tech in their college freshman year and another 10 to 15 percent enrolled at cooperating Dual Degree Colleges. Participants came from all over the South.

The MITE program has also contributed, along with other efforts, to a rapidly increasing number of National Achievement Scholars enrolled at Tech, mostly in engineering. National Achievement Scholars are black students selected by the same national organization that selects National Merit Scholars. In the fall of 1977 Georgia Tech had more National Achievement Scholars enrolled than any other publicly supported college in the country.

The total number of black students enrolled at Tech at the beginning of the 1976-1977 academic year was 465. This is seven times as many as were enrolled four years before in 1972-1973.

During the 1976-1977 school year the headquarters for the Southeastern Consortium for Minorities in Engineering (SECME) was established at Georgia Tech with a full-time director. This organization, a cooperative effort of the Engineering units of seven colleges in five Southeastern states, is funded largely by a grant from the Sloan Foundation. The cooperating institutions are the Universities of Alabama, Florida, South Carolina, and Tennessee, Tennessee State University, Tuskegee Institute, and Georgia Tech. The major thrust of the SECME program is the introduction of teaching modules - centered on engineering - into high school science, mathematics and English courses. In the 1977-1978 school year, 33 school systems are introducing the material in their curricula. Five of them are in Georgia. To facilitate the introduction of these materials into Georgia high schools with high black enrollments, the Tech Engineering College has employed on a half-time basis a professional with long years of experience as a science coordinator in the Atlanta City Schools.

One of the most dramatic changes in the student body at Tech in recent years is in the number of women students. The first women entered Tech in the early fifties. For some time growth in the number of women students was small. Even by 1968 the total female enrollment was only 132 students. Recent growth has been rapid. In the 1976-1977 academic year the female enrollment was over 10 times the 1968 figure. Georgia Tech students of the past used to look to Agnes Scott for social companionship with women students. Georgia Tech now has twice as many women students as Agnes Scott. Forty-five percent of the 1,359 women enrolled in the 1976-1977 school year were majoring in engineering; 27 percent in the sciences; 17 percent in management; and 11 percent in architecture.

Tech Students and Jobs. The immediate goal of Tech students after graduation is, of course, a job. During the 1976-1977 academic year, almost 500 firms visited the Georgia Tech Placement Center recruiting Tech graduates. Representatives from about half of these firms visited more than once. Almost 14,000 interviews were conducted. The average monthly salary offer for Tech bachelor's degree engineering students was $1,296. By comparison, the average monthly salary offer for bachelor's degree engineers, as reported by the College Placement Council for 1976-1977 with the average based on reports submitted by a representative group of 160 colleges throughout the United States, was $1,283. The average monthly salary offer for Tech Industrial Management bachelors for the same period was $997. The average monthly offer reported by the College Placement Council for bachelors in Business Administration - the business degree closest to Industrial Management - was $915.[2]

In the "coop program" Tech students are exposed to industry prior to graduation. Since 1912 Tech has offered a cooperative plan for students who wish to combine practical experience with technical theory; a plan in which the student alternates quarters in residence at Georgia Tech with quarters working in a learning environment in industry. About 275 firms in the eastern half of the country, but with heavy concentration in the South Atlantic and Southeast, participate in the program. Thirteen hundred students are enrolled in the cooperative plan. To remain in the program academic performance must be above average; over half of the coop students are typically on the Dean's list. The jobs held by students are expected to provide an educational experience. The program is thought of as an enriched method of education in which an employer participates in the educational process. Representatives from Tech visit participating firms to meet with students and their supervisors during work quarters to insure that job assignments match the intent of the program.

Community Education Program. In addition to its instructional program for its resident students, the Institute also provides information and educational programs to the State and national community.

The Tech library, one of the best technical libraries in the South, for example, is available to the general public. Members of the National Alumni Association are entitled to free borrowing privileges, as are all employees of the State of Georgia. High school students who present a letter from their principals may also use the library. About 300-400 high school students a year use the Tech facilities. The library has reciprocity arrangements with other collegiate institutions and members of the general public with legitimate reasons to use the library may obtain a library card for a small fee.

The library has a reference department and information exchange center staffed by professionally trained persons. Information requiring a small investment of time is provided without charge. Information requiring more lengthy search time is provided for a fee. The library also makes available to industry on a subscription basis its card catalogue of the entire library holdings reproduced on micro-fiche. Participating local firms can order by telephone and have the book or publication delivered by library-operated van. The library also provides for subscribers a bibliographic computer search. In the vast majority of cases it can also provide the physical document identified in the search and deliver it to local users. Quite recently the library has acquired a microfilm information system of particular value to industry. This system, Visual Search Microfilm Files, provides a variety of information: vendor catalogue data, product specifications, performance data, drawings, test data, application information, "where to buy" information, and complete industry standards for a number of societies. The data are revised and updated as often as every 30 days.

The Department of Continuing Education was established in 1947 to act as an administrative and operational unit handling all non-credit continuing education programs of Georgia Tech. In the 1976-1977 academic year, the Department was responsible for the offering of approximately 145 short courses, conferences, seminars, and special service programs to a total of approximate

4,300 persons. Examples of courses offered are: Urban Drainage-Hydrology, Basic Statistical Methods, Estimation Analysis and Control of Engineering Costs, and Management for Engineers.

A recent example of how the Department of Continuing Education and the library combine efforts to serve industry and business is provided by the case of a Southern based retail chain with a large number of stores throughout the South. The firm wished to provide human relations type training for its store managers. The library did a bibliographical search for information on the availability of such specialized training materials. The Continuing Education Department did a search of training companies that could provide a program. If no suitable training company can be found in such cases, the Department can itself design and staff a training course on a contract basis. Georgia Tech staff can provide both consultation on industry training and provide education courses when requested.

Another example of Tech's involvement in education for the broader public is its participation in the Association for Media-based Continuing Education, Inc. (AMCEE). This association is a nationwide non-profit consortium of universities formed to increase the national effectiveness of continuing education for engineers. AMCEE has established, on a national level, a network of member institutions which are producers and distributors of media-based materials for the purpose of keeping career professionals up-to-date on the latest technological advances in their fields. Participating members include such schools as Auburn University, Case Western Reserve University, Massachusetts Institute of Technology, Purdue University, Stanford University, the University of Michigan, and the University of South Carolina. The national headquarters of AMCEE are located at Georgia Tech.

Under development at Tech is a television broadcast capability which could make an important contribution to the educational resources available to local industry. The system will consist initially of two classrooms on the Georgia Tech campus and one on the Southern Tech campus equipped with TV cameras. Lectures delivered in regularly scheduled classes will be taped and messenger delivered cassettes will be available to off-campus students. Both credit and non-credit courses can be offered in this way. Ultimately it is expected that live transmission will be possible. A transmitter and a microwave antenna installed on top of the 70-story Peachtree Plaza Hotel in downtown Atlanta will have the capacity to broadcast a radius of 35 miles, covering an area shown in Figure III-1. Through the medium of television students located at any number of private companies and private and public institutions throughout the area can participate in a class conducted on the Tech campus. Off-campus students will be able to communicate by voice transmission with the instructor and students in the originating classroom. The Tech program will be similar to programs that have been successfully operated at other schools, like Southern Methodist University and Stanford.

Research

A large part of the education process is the communication of existing knowledge in the basic instruction program. Another major part is participation by faculty and students in the discovery of new knowledge, an activity usually described as research.

Georgia Tech has been involved in research in a significant way for only a relatively short period of time. Research is more commonly associated with graduate education, particularly at the Ph.D. level. Prior to the war, and

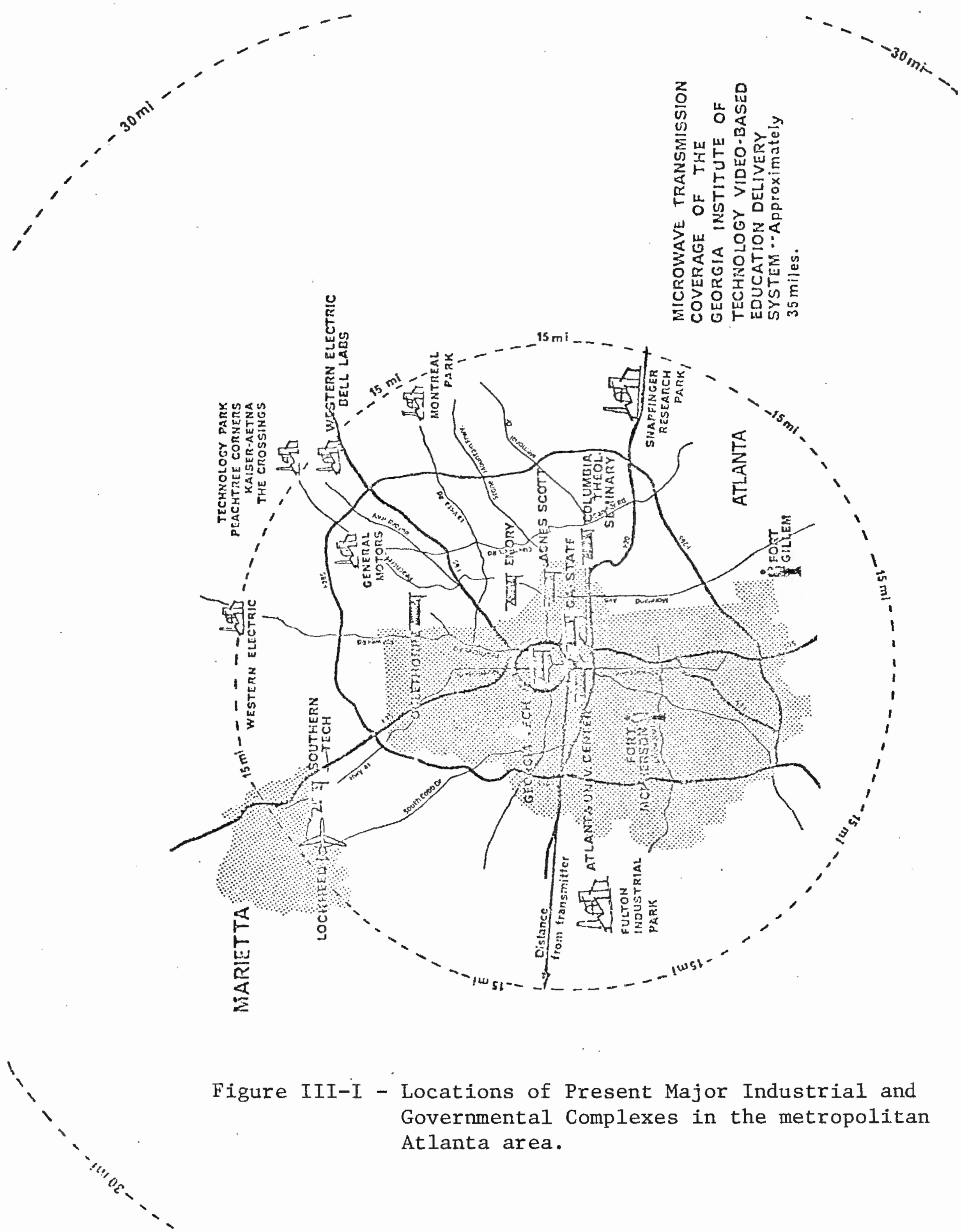


Figure III-I - Locations of Present Major Industrial and Governmental Complexes in the metropolitan Atlanta area.

for some time after it, Georgia Tech was known mainly as an institution which excelled at undergraduate training of engineers.

A small beginning in graduate education was made as far back as the 1920's. In 1922 the Board of Trustees of what was then the Georgia School of Technology authorized curricula leading to the Master's degree. The first Master's degrees were awarded in 1925. The degree of Doctor of Philosophy was authorized by the Board of Regents of the University System of Georgia in 1946. The first Ph.D. degree was granted in 1950. As Table III-1 shows graduate education has been an important part of the Institute's activities for only about the last twenty-five years. With the development of graduate education, research activity also increased on the Tech campus.

Today there are about 1,000 members of the Georgia Tech faculty, counting both teaching faculty and full-time research scientists and engineers. Roughly 700 of these are at least partially supported by research funds, the total dollars involved being equivalent to full-time support for about 400 faculty members.

There are two main centers of research at Georgia Tech, the academic units of the Institute and the Engineering Experiment Station. The academic units make up the four Colleges: Architecture, Engineering, Industrial Management, and Science and Liberal Studies. The Engineering Experiment Station is a unit exclusively devoted to research; a counterpart of the Agricultural Experiment Stations that exist at universities all over the country, including the University of Georgia. The Experiment Station was founded in 1919 by the General Assembly of Georgia for the promotion of engineering and industrial research in the interest of developing natural

Table III-1. Number of Master Degrees and Ph.D. Degrees Awarded at Georgia Tech, 1925-1977.

Academic Years	Master's Degree	Ph.D. Degree
1925-49	397	0
1949-50	128	1
1950-51	149	2
1951-52	74	5
1952-53	73	13
1953-54	102	8
1954-55	112	7
1955-56	116	7
1956-57	99	9
1957-58	116	4
1958-59	117	12
1959-60	143	12
1960-61	154	20
1961-62	172	13
1962-63	181	31
1963-64	212	27
1964-65	231	40
1965-66	250	45
1966-67	312	56
1967-68	381	52
1968-69	392	56
1969-70	343	63
1970-71	419	72
1971-72	456	64
1972-73	385	78
1973-74	518	74
1974-75	513	67
1975-76	500	53
1976-77	500	66
Total	7277	957

resources, industries, and commerce in the State. Funds were not provided for operation of the Station at the time of its creation. The unit was not activated until 1934. In 1960 the legislative charter was broadened to include industrial extension field offices. Under its present charter, the Engineering Experiment Station is charged with formulating and implementing "a program of research which will seek to enhance the economic and industrial development of the State of Georgia . . . (and) to render assistance to national programs of science, technology, and preparedness." (Georgia Code, Chapter 32-3.)

In the earlier period of the Station's development a director and small staff were supported by State funds and most of the research - with additional support from outside sponsors - was done by faculty members from the academic units who worked part-time at the Station. The Station played a central role, in its early days, in the development of a research atmosphere on the whole of the Institute campus.[3] The academic schools and departments did not even budget separately funds for research until fiscal year 1952-1953. A limited base of industrial and governmental support had been built by the time World War II ended and the Station then attracted major funding from Federal agencies. As graduate work developed in the academic units in this postwar period - and a need for a strong research program - it was natural for the faculty to continue its research through the Engineering Experiment Station, but gradually the Station and the Colleges became less interrelated.

The reasons for this separation are based in the differences in the objectives and the needs of the two groups, the Colleges and the Experiment Station. For one thing the highly applied contract research done at the

Experiment Station, and the timing problems connected with it, does not lend itself easily to the more basic research projects suitable for academic research and for Ph.D. dissertations. Further, the simple physical presence of research activities in the midst of the academic units is important in inducing good habits of thinking in students training to be scientists and engineers. From the viewpoint of the Station on the other hand, continuity in personnel is helpful in client-oriented research where publishing deadlines become critical. Further, large scale experimental work - particularly off-campus, field experiments - are not practical using part-time personnel drawn from the academic units. The teaching faculty tended, for these reasons, to develop its own research programs and the Experiment Station moved to a full-time staff and a looser affiliation with the activities of the Colleges. Up until 1963 the Engineering Experiment Station handled the administration of all sponsored research for the entire campus. In that year President Edwin Harrison moved the responsibility for research in the academic units back to the schools and colleges.

Today there is still a connection between the Station and the academic units. A rough estimate suggests that about ten percent of the 800 research programs currently under contract at Georgia Tech are jointly administered by academic units and the Engineering Experiment Station, with a significant contribution of personnel by both groups. Another ten percent of active research projects involve a trading of personnel. On the other hand as many as 50 people from the Engineering Experiment Station staff do some occasional teaching in the academic units. While contact with Ph.D. students is limited, for reasons explained above, the Station is one of the largest employers of undergraduate coop students, employing as many as 150 at a time.

But while the Station and the academic units do interact, it is probably accurate to say, as a 1972 self-study report did say, that the role of the Engineering Experiment Station at Georgia Tech, relative to the academic program, is "associative" rather than "supportive."

Total Georgia Tech expenditures for research for the last decade are shown in Figure III-2. In fiscal 1976-1977 a little over half of research activity, as measured by dollars expended, was at the Experiment Station. The other portion was in the colleges and specialized centers. Figure III-3 shows that only about one-third of the total funds expended for research at Georgia Tech in fiscal 1976-1977 came from the State of Georgia. The remainder came from research grants provided by the federal government, local government, and industry. For every one dollar contributed by the State, an additional two dollars is generated from outside sources.

Developing a support base is a constant challenge to Tech researchers. A sustained, high level of contract development activity is required to maintain the necessary research support for the various laboratories. Funded research over the entire campus requires the generation of a continuous stream of proposals submitted to funding agencies. Table III-2 shows, for example, a research funding summary for 1976 and 1977. In fiscal year 1976-1977, 1,178 proposals were submitted to funding agencies. A precise estimate of the number of hours of effort required simply to draft this many proposals is not available but this activity obviously involves an important commitment of resources. If each proposal took just 20 hours to prepare - a conservative estimate - the time required would be equivalent to twelve highly trained researchers, doing nothing but writing proposals eight hours a day for 50 weeks out of the year. The total dollar

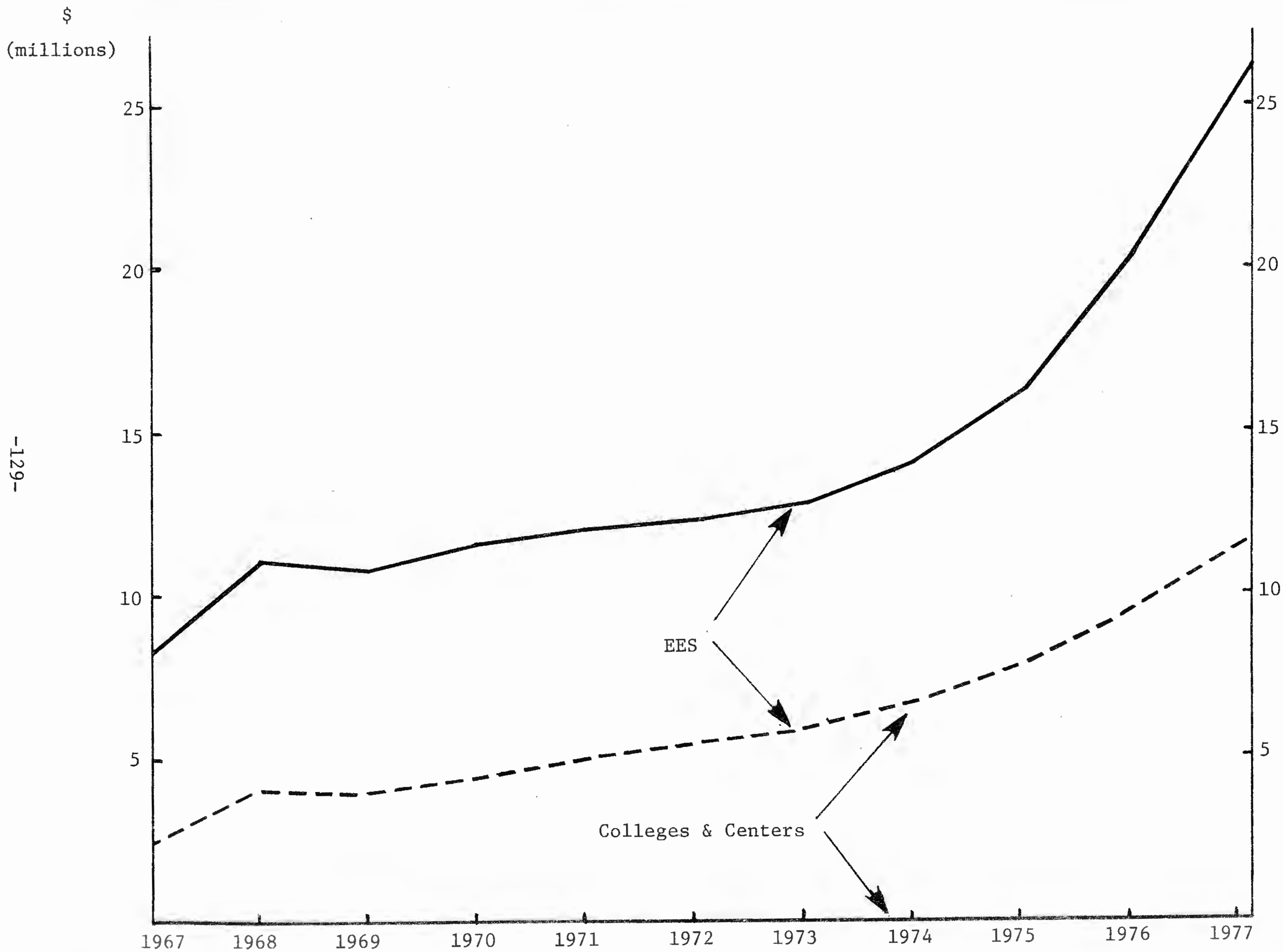


Figure III-2 - Total Georgia Tech Expenditures for Research, 1967 -1977.

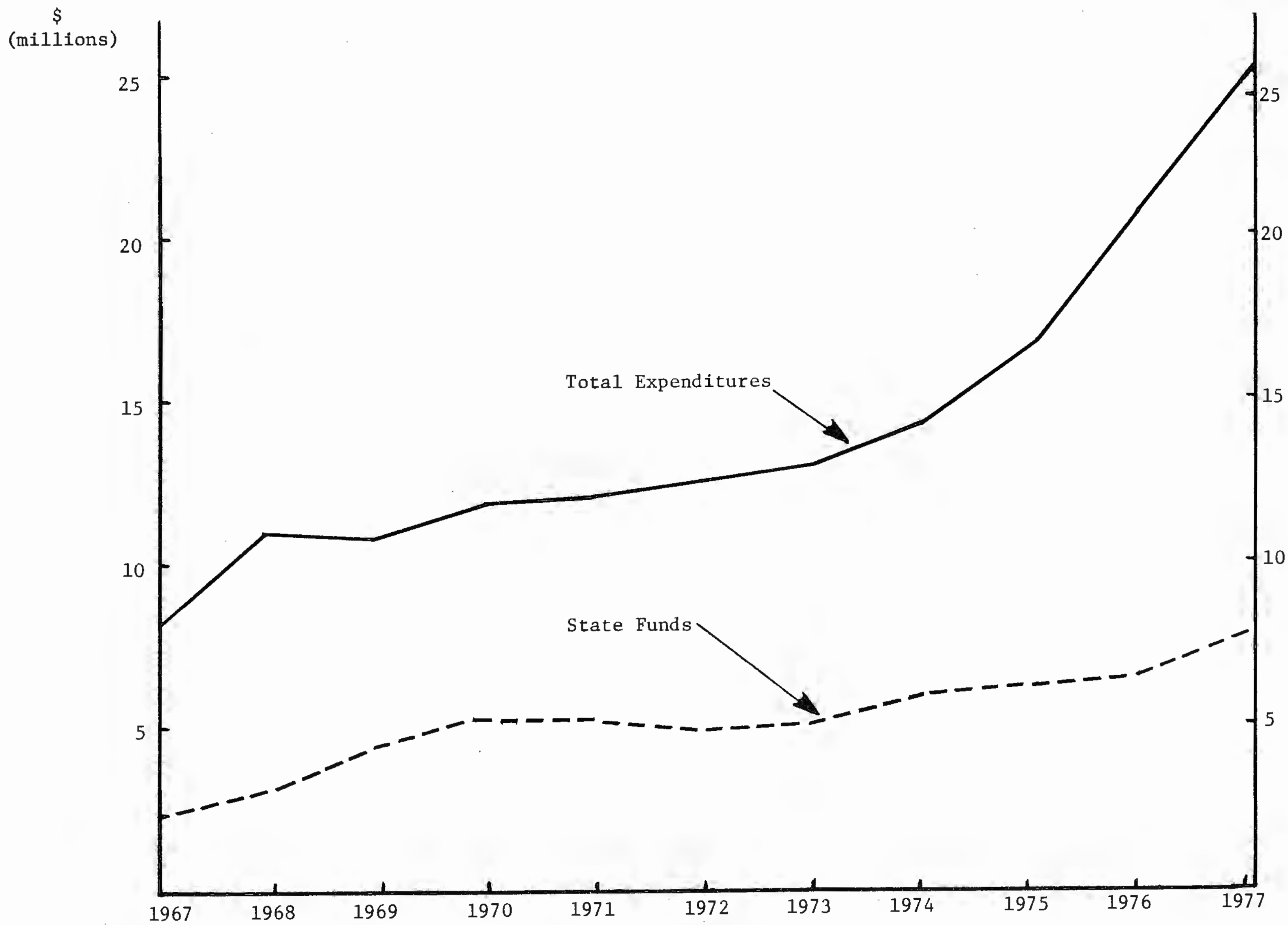


Figure III-3 - Total Georgia Tech Expenditures for Research Compared with State Funds, 1967-1977.

Table III-2. Research Funding Summary, Georgia Institute of Technology, Fiscal Years 1976 and 1977. (The dollar figures are in millions.)

Item	Fiscal Year 1976	Fiscal Year 1977	Change
Proposals Submitted	1,057	1,178	+11.4%
Dollar Value of Proposals	$62.9	$97.8	+55.4%
Dollar Value of Rejected Proposals	$40.3	$53.2	+32.0%
Proposals Under Consideration	$29.9	$49.2	+64.5%
Proposals Funded	600	719	+19.8%
Funds Received	$17.8	$24.6	+38.2%

value of the proposals was almost $98 million. About one-fourth of the proposals, in terms of dollar value, were funded, with some of them involving expenditure of funds over a several year period.

Dollar totals give an indication of the volume of research on campus. But to get a really good feel for the work done at Georgia Tech requires at least a brief description of specific research activities on campus.

Research in the Colleges

Describing the research programs in the academic units is not easy since they cover a bewildering variety of topics. They also range across a wide spectrum from basic and highly theoretical work, through research oriented toward application but strongly analytical in methodology, to mostly applied investigations. In a research summary, such as is attempted in this report, there is a tendency to emphasize applied work and neglect the more theoretical and basic since the main point of highly theoretical research frequently can be understood only by the initiated.

For example, one of the areas of research strength in the School of Physics is in dynamical systems. In much of this research, attention is centered on the nature of the solution to the mathematical equations governing certain types of physical phenomena. Several research projects now underway involve a cooperative effort with scientists from Italy, Japan, and the Soviet Union. An example of an eventual application that could result from this basic work is in the area of weather prediction.

A project in Industrial Management is related to the dynamics of price changes over time in speculative markets, like the stock market, where decision makers take action on the basis of expectations about the future market environment. The study involves notions of stability in various stochastic systems.

In both of these cases the work being done is important. The main point of the research, however, is difficult for most people to understand.

Realizing that we can cite only a fraction of current Tech research and that the more esoteric work will be underrepresented, we can nevertheless catch some of the excitement of current efforts on the Tech campus by a brief survey of research activities.

College of Engineering. Research in the Engineering College involves projects one would expect to see undertaken by engineers. In the School of Aerospace Engineering, for example, one finds research being done in aerodynamics, aeroelasticity, helicopters, and propulsion. Ceramic Engineering has concentrated on the development of new high-temperature materials and processing in space. Chemical Engineering has examined liquid metal properties, air and water pollution, new plastics and textiles, glucose utilization, and fertilizers. Civil Engineering has developed simulation models in the management of the construction industry, evaluated fatigue and rutting of asphalt concrete mixes, done dam hydraulic model studies, and carried out computer analysis of water drainage and traffic signal systems. The traffic signal system designed by Civil Engineering staff and installed on Northside Drive in Atlanta to provide for a smoother flow of traffic is estimated to save Atlanta motorists a considerable sum annually. Electrical Engineering is doing work in computers, laser systems, electric power, electronics, and communications. Engineering Science and Mechanics is doing research on minimum weight of fuselage stiffened cylindrical shells, the mechanics of tires, and the structural optimization of shallow arches. Industrial and Systems Engineering is doing research on energy systems and manufacturing productivity, an improved cotton handling system, and problems of urban transportation. Mechanical Engineering is doing work in lubrication, acoustics, combustion and flammability, and plasma research. Nuclear Engineering is working on reactor safety, new types of reactors, and the measurement of low level nuclear radiation. Textile Engineering has studied improvements in carpet processing techniques and ways for the textile industry to reduce water and energy requirements.

A catalogue listing of this type fails to convey, of course, the human component in these research efforts; the discipline in method of trained scientists at work, the commitment of those engrossed in finding a solution to a problem. To get the feeling of research in progress, one has to walk through the labs and talk to the people doing the work. One area of research that has been pursued on a continuous basis for a number of years in Mechanical Engineering, for example, is called tribology, a word derived from two Greek words meaning in combination "the study of rubbing;" that is, the study of the friction and wear involved in moving parts and the problems of reducing the friction through lubrication.

The tribology group is supported by the National Science Foundation and NASA with funds that make possible latitude in choice of area of investigation and permit research more fundamental and general in application. This basic research is related to highly loaded machine parts, gears, cams, and bearings. The pressure exerted on these parts is extremely high - equivalent to 15,000 to 50,000 atmospheres in some cases - since the force is concentrated on a very small space on the machine component. The research involves the study of the mechanics of the contact, the thickness of the lubricant film and the temperature at contact points, and the mechanical properties of the lubricant.

Additional support for this research comes from General Electric. The association with General Electric started with a problem involving gas turbine designs; specifically, a problem with the cooling of a large bearing, one component of a large turbine used to generate electric power. The bearing in question is located in a less accessible part of the turbine. The research isolates such a bearing in a lab and simulates conditions found in the turbine. A large space is required for the apparatus; an outer jacket, almost spherical in shape and six feet in diameter, to house the shaft and bearing and to hold the gas heat which duplicates the high temperature levels reached in an operating turbine. Bundles of wire lead to sensors in the interior of the apparatus that monitor temperatures and the behavior of the lubricant. The original bearing problem was solved and Tech researchers continue to work with General Electric on turbines of different sizes.

The tribology lab is also interested in traction drive units. Traction drive involves two things moving side-by-side with a film in between. Traction drive units could be used for automobile transmissions and have been studied as a substitute for the 3-speed gear system almost since the beginning of the auto industry. Traction drive units have the advantage of continuous variations in speed ratios which make it possible for the engine to run closer to peak efficiency with greater fuel economy. The rise in the price of gasoline has caused renewed interest in traction drive. The problem with it involves the durability of the unit; and this is where Tech researchers with expertise in lubrication problems come into the picture.

The tribology lab involves two Mechanical Engineering faculty members and a research engineer. A number of masters and doctoral students have done their research in this area and under-graduates have also been hired to work in the lab on a fairly continuous basis. Professors and students from Great Britain, Denmark, France, Germany, Japan, Kuwait, the Netherlands, and Venzuela have visited this Tech group, some for a few days, some for an academic quarter.

The work of the tribology lab involves rather straight forward engineering problems. One of the fascinating things about research on the Tech campus today is the way in which expertise developed to solve more traditional engineering problems is now being applied to a host of things far removed from what is usually thought of as the engineer's concern. A good example is the work being done in biomedical engineering.

One research project in Engineering Science and Mechanics involves an investigation into the mechanical properties of arteries. Arterial disease is one of the nation's major health problems. One matter of current interest is detecting the problem before the symptoms appear and it is too late to reverse the damage. After the symptoms become evident, examination of arteries with existing techniques is painful, expensive, and to some degree dangerous. Researchers at Tech are attempting to develop a method of early detection through analysis of the mechanical properties of the arteries. Research of this type could lead someday, if successful, to the capability of screening masses of people by examining arteries for such things as diameter changes, pulse contours, and wall thickness. The technique would involve use of ultra-sound, a method having the advantage of being both safe and inexpensive. With examination it could be determined whether a patient's arteries are statistically normal or not and whether trouble is likely to develop at some point in life.

Other faculty members at Tech are also involved in vascular research. A group in Aerospace Engineering is involved in a study of blood flows.

Aerospace engineers have always had an interest in flow problems, resistance, and turbulence, as in the case of air flows over an aircraft surface, and they have now turned their skills toward the problem of blood flows in the human body.

There are several such projects underway. One of these involves determining the degree of occlusion or blockage in a blood vessel by determining the degree and structure of turbulence in the blood flow. Another part of this research is to find a way to measure the turbulence. One possibility is ultra-sound. The advantage of a method like ultra-sound is that the measurement can be made in a non-invasive manner.

Another project involves the effects of polymer additives on turbulent blood flow. Certain polymers, elongated molecules, have the effect of reducing resistance to flows. Polymers can be added, for example, to firehoses to reduce the resistance , producing what is sometimes called "slippery water." Tech researchers are attempting to find out whether polymer additives would be helpful in reducing the blood flow turbulence in a patient with an occlusion long enough to permit a more permanent remedy like surgery. This research is still at a fundamental stage. Polymers, for example, cannot be introduced into the human body. If polymers are found to be useful, however, some other agent that acts like polymers and can be used with human beings might be substituted at some future time.

A number of research groups are at work on medical problems, from new methods of measuring the thickness of the cornea of the eye - eye malfunctions are closely correlated with cornea thickness - to work on inner ear acoustics. Georgia Tech is now represented on the board of the Georgia Heart Association. A professor from Industrial and Systems Engineering has been appointed to the

Advisory Committee to the National Food and Drug Administration on quality control standards in manufacture of medical devices.

These research interests in medical problems have found their way into classroom instruction. The introductory course in bioengineering taught each quarter in Engineering Science and Mechanics must limit the enrollment to 50 or 60 students to keep the class size down to manageable proportions. A pre-medical track is available to undergraduates majoring in Aerospace Engineering.

Another interesting facet of current Tech engineering research is the way in which expertise developed in one field of engineering is found to have application to problems usually thought of as related to a different field of engineering. A current research project in Aerospace Engineering, done jointly with Civil Engineering, is related to window and curtain wall performance in high rise buildings. The exposure of high rise buildings to strong winds is a type of phenomenon that is familiar to aerospace engineers. Windows and glass are now used in high rise buildings in new ways where the loading and response have not been well understood. The purpose of this joint project of Aerospace and Civil Engineering was to characterize the statistics of localized wind pressures on a building. Owners of a high rise in Atlanta cooperated with the research by allowing their building to be used as a laboratory. A model of the building was tested in a wind tunnel and measurements were also recorded on the building itself. Further experimentation involved simulation using a large apparatus set up in the Civil Engineering building.

As just one other example of the wide range of engineering applications, the expertise gained from rocket combustion studies in Aerospace Engineering is being applied to problems of fire safety. Asphyxiation, not burning, is what more frequently kills people. Researchers are investigating such things as the particle size and particle concentration of smoke to determine the damage of smoke from a given material. The ultimate objective is to reduce the amount of smoke and its toxicity.

Recognition of the contribution that can be made by a number of engineering specialties to a common problem has led to the development of a number of multidisciplinary program areas in which the resources of several schools are brought to bear. In addition to its degree programs, the College of Engineering provides opportunities for students to do specialized study in 17 multidisciplinary areas. Among these are acoustical engineering, energy engineering, environmental studies, and urban engineering.

It is also interesting to observe adaptation of engineering science on the Tech campus to areas of immediate national concern. Research related to energy conservation and the development of new energy sources is taking place in a number of laboratories. Transportation for the handicapped and the development of low-cost bicyle pavements are being studied in Civil Engineering. Industrial and systems engineers who have long applied statistical techniques to problems such as production quality control in industry are turning their attention to the design of modeling techniques for forecasting the incidence of person-to-person crimes in large cities. The ultimate purpose of this research sponsored by the U.S. Department of Justice is to develop methods to ascertain the effects of various types of intervention in the criminal system - for example, intensification of police effort - on the crime rate.

College of Science and Liberal Studies. The College of Science and Liberal Studies is the organizational home of schools and departments with specialties more diverse than those found in the College of Engineering. The College extends from Mathematics, Physics, and Chemistry to Philosophy, English, and Modern Languages. Research also covers a correspondingly wide range of topics.

As one would expect in an institution devoted primarily to engineering, the physical sciences, physics and chemistry, have a uniquely important place at Georgia Tech. Work in these areas is quite specialized so that research done by one professor may not be understood completely by colleagues. The research is also quite basic in the sense that it is done to advance the science, with whatever applications that the research findings might have being left to others to develop.

An example of basic research in the School of Chemistry is an investigation of the interaction of matter with physical surfaces. For materials in general, what is important is not the bulk of the material but the outer surface. The properties of aluminum, for example, vitally depend on what is going on on the outer layer. If you removed the outer layer of oxide from an aluminum block and prevented it from adhering, the block would be reduced to powder. Research on this subject at Tech is concerned with developing the fundamentals. Practical applications in which the basic findings of research might be useful to other researchers include such things as the absorption of pollutants by various types of charcoal in antipollution devices. The surface properties of the charcoal are critical to such absorption processes. But Tech researchers are not directly concerned with these applications. They are involved in trying to understand the chemistry of the problem. Much of the work in the School of Chemistry is of this basic type.

One does not have to be a chemist, however, to sense the excitement of the learning environment that exists in the chemistry labs. It is quite common in Chemistry for a lab to be made up of a senior professor and a half-dozen students. A senior professor visited in one lab works in organic chemistry which is the study of compounds containing carbon. Carbon is basic to the makeup of things. Not only is carbon basic to things found in nature; man can use carbon to put together new things, synthetics - important synthetics, such as plastics and drugs.

This particular professor has synthesized compounds called "crown ethers," synthetic molecules that are very large ring compounds containing carbon, hydrogen, and oxygen. The cavity size of these molecules can be made to vary, to fit various types of metals. They act as vehicles for transporting metal ions which are charged species. They have biological implications and are highly active physiologically. They are found, for example, to be anti-viral, though use on humans is far into the future, if at all.

A half-dozen students work in this lab: post-doctoral students who wish to do further work under a recognized scientist after receiving the doctoral degree; graduate students working for advanced degrees; and usually at least one undergraduate.

There were in the 1976-1977 academic year about 60 junior and senior chemistry majors. About a third of these students do a sequence of three courses involving a special research problem. Registration for these courses must be approved by a senior professor who evaluates the student's motivation and capacity to absorb in this learning environment. The student, when accepted, becomes a member of the research team, working side-by-side with the post-doctoral and doctoral students. Since the post-doctoral students and the graduate students come from a varied background of other undergraduate and graduate programs - indeed from all over the world - the undergraduate is exposed to a cosmopolitan scientific environment. Many of these undergraduates publish a paper with the senior professor, receiving credit as co-author. A number of these Tech chemistry majors go to medical school or to graduate school.

Although the research in this lab is at a rather theoretical level, the senior professor stays close to possible industrial applications by acting as a consultant for four companies. The consulting consists of interaction with the firm's chemists, in groups and on an individual basis, evaluating proposed lines of research and suggesting alternatives. While not all chemistry professors do consulting, this professor feels that the feedback from industry is beneficial to him and to his students.

One fascinating type of research in the School of Chemistry that the layman can more easily understand involves natural products. One project of this lab involves attempts to develop new products from plants that have medicinal value. This work is currently sponsored by the National Cancer Institute. Plants are obtained from all over the world, some of them known in the folklore of a region to have curative properties. An extract is made from the plant and forwarded to the National Cancer Institute. Should the extract have a positive effect in prolonging the life of rats or mice that have tumors or cause these tumors to disappear, the Tech lab then tries to identify the active compound that caused the favorable result.

As an interesting historical note, Tech researchers have recently worked with a plant found at Unicoi Gap called white snake root. This root causes the illness "milk sickness." It appears in humans who drink the milk of cows which have, in turn, eaten white snake root. The plant also grows in Illinois and Abraham Lincoln's mother died in the year 1818 from drinking such contaminated milk. A century and a half later, we still don't know the chemical in the plant which causes milk sickness.

Another problem being investigated by faculty and students working on natural products is why cows eat some grasses and not others. Agronomists have developed highly nutritious grasses for cattle. The trouble is the cows do not always find these grasses tasty. Even when they are made to look exactly like grasses the cows do eat, the cows still reject them. Apparently the cows can differentiate among grasses on the basis of odor. The research team is attempting to identify the causes of the different odors. If what is causing the cows to turn up their noses at one grass and not another can be identified, grasses which the cows now reject can be sprayed and made acceptable to the bovine taste.

One research instrument that is finding use all over the Tech campus is the laser. The word "laser" is an acronym formed from the first letters of the words "light amplification by stimulated emission of radiation." The laser may be a development ultimately as important as the transistor. The beam of this sensitive instrument has a flair for versatility based on three qualities: its ability to produce light on a single wavelength or a thin series of wavelenghts; its difference from an ordinary light source that spreads in travel; and its coherence which makes the laser a natural choice for use in communications. The four major types of lasers - gas, liquid, solid state and injection - insure a wide range of wavelengths, power levels and other characteristics so that if one brand of laser can't do a particular job, another one will. Some potential uses of lasers are far out. For example, light has energy and ultimately space travel via laser beam may be possible.

Lasers are not that far removed from the ordinary citizen. Bar codes for identification by optical scanning are now on practically all commercial products. The laser is as far away as one's supermarket.

At Georgia Tech the laser is finding a variety of uses in research. A professor in chemistry is applying lasers to the study of cataract formation in the human eye. A professor in physics is using lasers for basic research. Spectroscopy involves the use of an optical instrument for forming spectra, dispersion of color due to the breaking up of light into different wave lengths. By examining light emitted from a substance or scattered by it an investigator is able to deduce something about the properties of the material. The laser has advantages which other instruments used in spectroscopy do not have. The physics professor is using the laser to study the effect on light beams due to the activity of certain molecules.

The same professor can turn his attention to very practical problems when necessary. Lasers are now being used for visual displays by entertainers such as rock music groups. If used improperly, lasers can do damage to the human eye. The State of Georgia monitors such visual displays, though the agency involved has only advisory authority at the present time. The physics professor has served as a safety observer on at least one occasion. A former student now does this type of work regularly for the State.

Work with lasers on various parts of the campus has had its impact on undergraduate training. A elective course in lasers, team-taught by professors from the Schools of Physics and Electrical Engineering, attracts about 70 students, a large number for an elective. Lasers are also related to an entire program recently initiated in the School of Physics. Lasers have caused a revolution in the optical industry. Things that formerly were done electronically can now be done optically. An applied optics program is available to students at the undergraduate level.

The School of Biology, also in the College of Science and Liberal Studies, offers at the graduate level a Master's degree only. Although it does not offer a Ph.D., it participates in a number of collaborative research projects and joint seminars in the Ph.D. level life-sciences interdiciplinary program involving Biology, Chemistry, Physics, and Psychology.

Perhaps one of the most exciting research projects in the School of Biology, from both the viewpoint of the layman and the professional scientist, is the work related to the search for evidence of living organisms on the planet Mars. There were three life-on-Mars experiments carried in the Viking Mars probe. Each was developed by a team. A Tech Biology professor is one of the three senior scientists on one of the experiments. His two colleagues in the project are from Cal Tech. The experiment was designed to search for evidence of the chemistry of life on Mars, if life does, in fact, exist. The Tech researcher spent six months at the California site where the data were evaluated. The experiment found positive evidence of life on Mars. Another experiment, also part of the Viking probe, however, failed to reveal any evidence of chemical structures that would be expected of living organisms. Apparently the chemistry found is not the chemistry of life, but a chemistry perculiar to Mars. The Tech professor is currently involved in attempts to simulate the Martian environment in his laboratory with the support of the National Aeronautics and Space Administration.

A professor who has had a successful career in radiation biology and cancer immunology and who recently joined the faculty in the School of Biology has teamed up with an Atlanta medical doctor also doing cancer research. Their project involves antibodies and radionuclides which are radio-active chemical compounds. The human body has the potential to manufacture antibodies in response to an intrusion by a foreign substance. The general function of these antibodies is to defend the body, to remove the foreign substance. Antibodies react to certain types of malignant tumors like they do to foreign substances. This research involves the attempt to extract antibodies from the body, attach radionuclids, and reinsert them in the body so that antibodies may carry radioactive material directly to a malignant tumor and subject it to close range radiation by the attached radionuclides. The advantage of this approach is that the radiation can be directed toward the tumor with greater precision than in the case of cobalt radiation where there is a problem of controlling the scatter. If successful, this research would lead to another tool for the cancer specialist.

Two other members of the faculty in the School of Biology, along with a number of graduate students, have worked for several years studying the effects of channelization on the ecosystem within the Satilla River in southeastern Georgia. In addition to support from the federal Office of Water Resources, these researchers have recently received significant additional support from the State of Georgia.

Other schools and Departments in the College of Science and Liberal Studies are also heavily involved in research. Since its founding in 1963 the School of Information and Computer Science has had over four million dollars of total sponsored income for research awards. A very significant event for Information and Computer Science at Georgia Tech is the School's success in attracting to campus a major research agency. In spring, 1977, the U.S. Army Computer System Command (USACSC) announced the transfer of the Advanced Technology Directorate from Ft. Belvoir to the Georgia Institute of Technology. The new organization has been designated as the U.S. Army Institute for Research in Management Information and Computer Science. The new Institute, which is to be colocated with the School of Information and Computer Science, will plan, initiate, and direct the USACSC research and development program in support of the U.S. Army multicommand management information systems. In addition, it will conduct research and development in support of Department of Army combat service support data systems and oversee the Department of Army Integrated Software Research and Development Program.

During the academic year 1976-1977 the seven faculty members in the School of Geophysics obtained nearly half a million dollars in research grants. The School of Psychology has interacted with other Schools to an unusual degree. Over the last ten years, approximately three-fourths of the psychology faculty have engaged in collaboration with colleagues in other units in research-related efforts. During the 1976-1977 school year, about 60 percent of the faculty in the School of Mathematics had at least one professional publication submitted or accepted for publication or appearing in print.

The English Department does not grant degrees but rather provides the courses needed in the programs of undergraduate students. Despite the fact that members of the English Department have heavy teaching loads, the members of the faculty published during the 1976-1977 school year one book, 23 articles, 46 poems and book reviews, and made 25 presentations or readings at scholarly or professional conferences. This publication record surpasses that of many English departments which offer a major in the field.

The Social Science Department is the organizational home of four disciplines: history, philosophy and history of science, political science, and sociology. As in the case of English, majors are not offerred at Tech in these disciplines. As part of the Tech educational program, however, they perform the vital role of helping the student cultivate a critical awareness of issues that confront man, both as an individual and as a member of a complex social order.

The Social Science faculty has become quite productive in recent years. During the 1976-1977 school year, three books were published, two book manuscripts were accepted for publication, and one was republished in Japanese translation. Forty-six scholarly articles and nine reviews were published and 43 papers were presented at professional meetings. The Social Science department is the home base for a national journal, *Technology and Culture*.

Among the interesting projects recently undertaken by members of the Social Science Department is a feasibility study done for the Smithsonian Institution by one professor; an evaluation of the task of editing the papers of Thomas Edison. Should this massive editing job be undertaken, the Tech professor would almost certainly be involved. This task could take 20 to 25 years.

Another interesting project currently underway is a biography of Charles Herty. Charles Herty, who lived from 1867 to 1938, was born at Milledgeville. A Ph.D. in Chemistry from Johns Hopkins University, Herty was at one time President of the American Chemical Society. He made major contributions to the economy of Georgia by developing an improved technique for gathering turpentine and by proving that slash pine can be used for newsprint.

Colleges of Industrial Management and Architecture. The College of Engineering and the College of Science and Liberal Studies are subdivided into Schools, degree granting units, and Departments, non-degree granting units. The Colleges of Architecture and Industrial Management are not fragmented in this way although they do have degree options. These Colleges closely resemble the large Schools in terms of numbers of students and organizational arrangement.

The College of Architecture has gone through a period of rapid growth. It now has almost 1,000 students, with two-thirds majoring in Architecture. The remainder are in Building Construction, Industrial Design, and City Planning.

Generally speaking research has been given historically less emphasis in architectural programs in American universities than it has been in the sciences and engineering. Architects must deal with a number of factors in making design decisions: the human element, the technical and structural problems, economic considerations, environmental relationships, and aesthetic judgment. The architect is required to synthesize, to consider a number of variables, some of which cannot be measured. Because of the multiple factors involved in design decisions, architects have tended to be staunch generalists and to resist the specialization that research activities frequently require. The best schools of architecture now do research as a part of their overall programs and Georgia Tech's is now also developing a research base.

A fairly large project in which as many as eight faculty members have participated at various times, along with a number of students, involves the problem of providing for elderly and handicapped pedestrians in structural designs. Sponsored by the Federal Highway Administration, this project has been particularly useful for sensitizing faculty and students to the needs of these special groups and the requirements mandated by recent state and federal legislation.

The College has received a rather large grant from the National Science Foundation for studying the problem of technical assessment of man-made environments. Architects are now more aware of the fact that structures do not exist as individual entities but are a part of large physical environments. Buildings in an urban area, for example, make up a total complex. How the buildings relate to one another, and to supporting facilities such as the transportation system, and how the environment satisfies the needs of the people that use it should be looked at in a broader framework than that previously thought appropriate. The grant from the National Science Foundation will permit faculty members to examine the problem of global assessment of built environments.

Other research projects currently underway in the College of Architecture involve such things as an investigation of a computer-based building information system, a study of professional liability insurance among architects, an analysis of environmental noise, and a study of energy conservation for new and existing buildings.

In addition to formal research projects, the faculty and students of the College of Architecture undertake investigative studies as part of the instructional program. The College recently completed, for example, a feasibility study, along with some preliminary design work, of a new capital city for the State of Alaska. A project of this kind combines theoretical analysis with applied consulting. The College has done, as public service activities, a number of community redevelopment projects, including the cities of LaGrange and Newnan.

The faculty of the College of Industrial Management consists of professors from a number of specialities: accounting, behavioral science, economics, finance, management science, marketing, production management, and statistics. They have in common investigation of the problems of successful management of businesses and other organizations. The College has added to its research capabilities in the last decade and its scholarly interests are as broad and diverse as the backgrounds and training of the faculty.

Research projects recently completed or currently in process include investigations into the economic problems of the petroleum industry, taxation, capital investment in the energy industry, cost-benefit of space communications technology, decision modeling for setting hotel reservation policy, economic development in Latin America and Nigeria, computer-based decision models to enable companies to improve decision making in the cash management function, the effect on company value of dividend policy and capital structure, and methods of forecasting and control of accounts receivable.

Among the projects of particular interest is the input-output model for Georgia designed by one of the authors of this report and utilized in the first part of this study to trace the economic impact of Georgia Tech.

A current topic that has received a lot of attention in recent years and has been investigated by two Industrial Management professors is inflation accounting. The historically high rates of inflation experienced in the economy starting in 1974 have caused serious distortions in certain traditional and critical accounting measures, such as, depreciation. The entire accounting profession has been involved in a discussion of possible revisions in accounting practices to accomodate to inflationary price behavior. The Georgia Tech professors have produced, among other things, a book on the subject of inflation accounting.

Among the more hotly debated issues in economics today is the relative effectiveness of fiscal policy and monetary policy as stabilization tools in the economy. One school of thought emphasizes fiscal policy, the use of the government's budget - spending and tax decisions - to compensate for variations in private spending and thus moderate the effects of recession. Another school emphasizes variations in the money supply under the control of the Federal Reserve System as a stabilizing device. A young Tech faculty member is involved in econometric research related to measuring the relative effect of the two public policy approaches.

A behavioral scientist in the College of Industrial Management is investigating the characteristics of work and work organizations that permit people to find pride in their work and the effect of this feeling of accomplishment on performance. At the present time dental students at Emory Dental School are serving as a test group. A group of industrial workers will be studied later. This same professor and his students are currently attempting to develop techniques for evaluating the performance of juvenile probation counselors in one Georgia county.

Engineering Experiment Station

From its beginning in 1934 when it was activated with an original allotment of $5,000, the Engineering Experiment Station has developed into a high technology research unit specializing in doing contract research for the State and local governments of Georgia, the federal government, and private business. It is a client-oriented contract organization. Its research is mission directed; sophisticated analysis aimed at the solution of an existing problem.

The Station is one of a relatively small number of similar non-profit research groups in the United States. While it is small compared to such giants as Battelle Memorial Institute and Stanford Research Institute, it is one of the largest high technology employers in the State and among the largest in the South.

As Table III-3 shows, the Station employed 843 persons as of December 31, 1977, counting the full-time professional staff and support personnel. The professional personnel are classified by levels of ranking comparable to ranking in the academic units but more appropriate to a full-time research group. The lists of ranks at the Experiment Station compared to academic ranks is shown in Table III-4.

The growth in the volume of research dollars at the Engineering Experiment Station since 1940 is shown in Figure III-4. Like research at Georgia Tech as a whole, research at the Experiment Station has been largely self-supporting. State support has typically been in the neighborhood of twenty percent of the budget. The Station raises most of its funds through research projects sponsored by government agencies and private industry. For every dollar supplied by the State, four additional

Table III-3. Engineering Experiment Station Staff, December 31, 1977.

Regular		542
Professional	371	
Support	171	
Supplementary Staff		277
Professional	28	
Support	37	
Students	236	
		843

Table III-4. Comparison of Academic Rankings and Engineering Experiment Rankings, Georgia Tech, 1977.

Instructional Title	Research Title
Professor	Principal Research Engineer/ Scientist/Technologist
Associate Professor	Senior Research Engineer/ Scientist/Technologist
Assistant Professor	Research Engineer/Scientist/ Technologist
Instructor	Assistant Research Engineer/ Scientist/Technologist
Lecturer	Research Associate

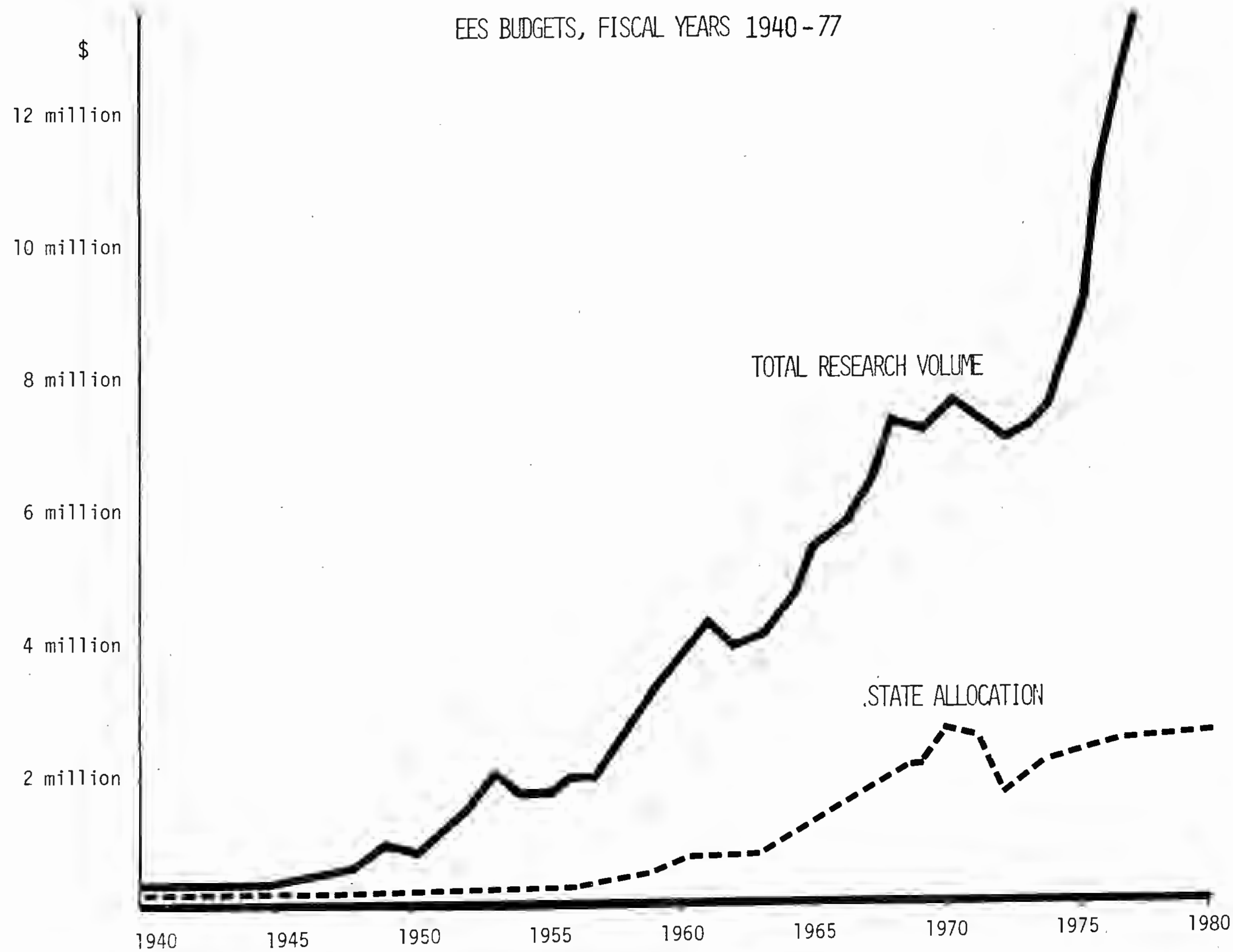


Figure III-4 EES Budgets, Fiscal Years 1940-77 dollars are generated by Station activity. The most important sponsor of Station research projects by far is the Federal Government. (The same is true of the academic units.) This suggests that the dollar pulling power of the Experiment Station is of a type that maximizes the net impact on the State; an attraction of funds that the State economy would not otherwise have gotten.

Table III-5 shows the various sources of sponsored personal services for fiscal year 1976-1977. "Sponsored personal services" is an accounting measure involving the contribution to specific projects of the value of time expended by Station personnel. It is the measure preferred by the Station administrators as the most accurate basis for judging the relative importance of contract sponsors and the internal allocation of resources. As a rough rule of thumb total contract value is typically twice the value of personal services. As can be seen from Table III-5, 87 percent of the funds from projects that represented sources of sponsored personal services came from the federal government. The heaviest concentration of these research contracts is with the Department of Defense, though NASA, DOE and other federal agencies are not unimportant as a source of contract research. The Station also does research for the State and local governments. Private industry contributes about 7 percent of the payments for sponsored personal services.

Research Programs. Arthur D. Little, Inc. is probably the largest profit-making consulting firm in the United States. The founder, Arthur D. Little, and a partner opened a small laboratory in Boston in 1886, two years before Dr. Isaac Hopkins was selected as Georgia Tech's first president by the Tech Board of Trustees. The lab was a commercial venture, offering "to undertake . . . investigations for the improvement of progress and the perfection of products." A part of the colorful history of the company is a

Table III-5. Sources of Sponsored Personal Services, Engineering Experiment Station, Georgia Institute of Technology, Fiscal Year 1976-1977.

Source	Percent of total dollars		
Federal government			87
Department of Defense		53	
Army	14		
Navy	18		
Air Force	21		
NASA		7	
DOE		9	
Other Federal		18	
State and local government			6
Industry and miscellaneous			7
Total			100

well known antic where Little, as a publicity gimmick and an effort to demonstrate the power of chemistry, made a silk purse out of a sow's ear. He stewed pounds of sow's ears, added chemical agents, drew the concoction into tiny, silky threads and had them woven into a "silk" purse. While there is no record of a Georgia Tech scientist or engineer making a silk purse from a sow's ear, they have engaged in a facinating variety of research projects.

The Engineering Experiment Station is divided into eight laboratories - about half of them with specialized "divisions" - according to the particular interest of the scientists and engineers that make up the separate units. As an aid in understanding the Station's areas of research strength, the organizational chart is of limited usefulness for the layman unfamiliar with the bewildering variety of modern day scientific and engineering research. The diagram in Figure III-5 shows, however, that the Station's research is heavily concentrated in electronics. Sixty-three percent of the Station's effort in fiscal year 1977, as measured in terms of personal services, was in this area of research.

The particular strength in electronics is partly explained - as is the identifying marks of most organizations - by historical happenstance. At a somewhat early stage in its history researchers at the Station developed a particular interest in the investigation of microwaves and the propagation of electromagnetic waves. Sophisticated electronic theory was combined with a particularly strong mechanical design capability which made it possible to go from theory to prototype in one continuous movement.

One of the most important applications of this strength in electronics is radar. Research projects have involved work on U.S. radar systems - design,

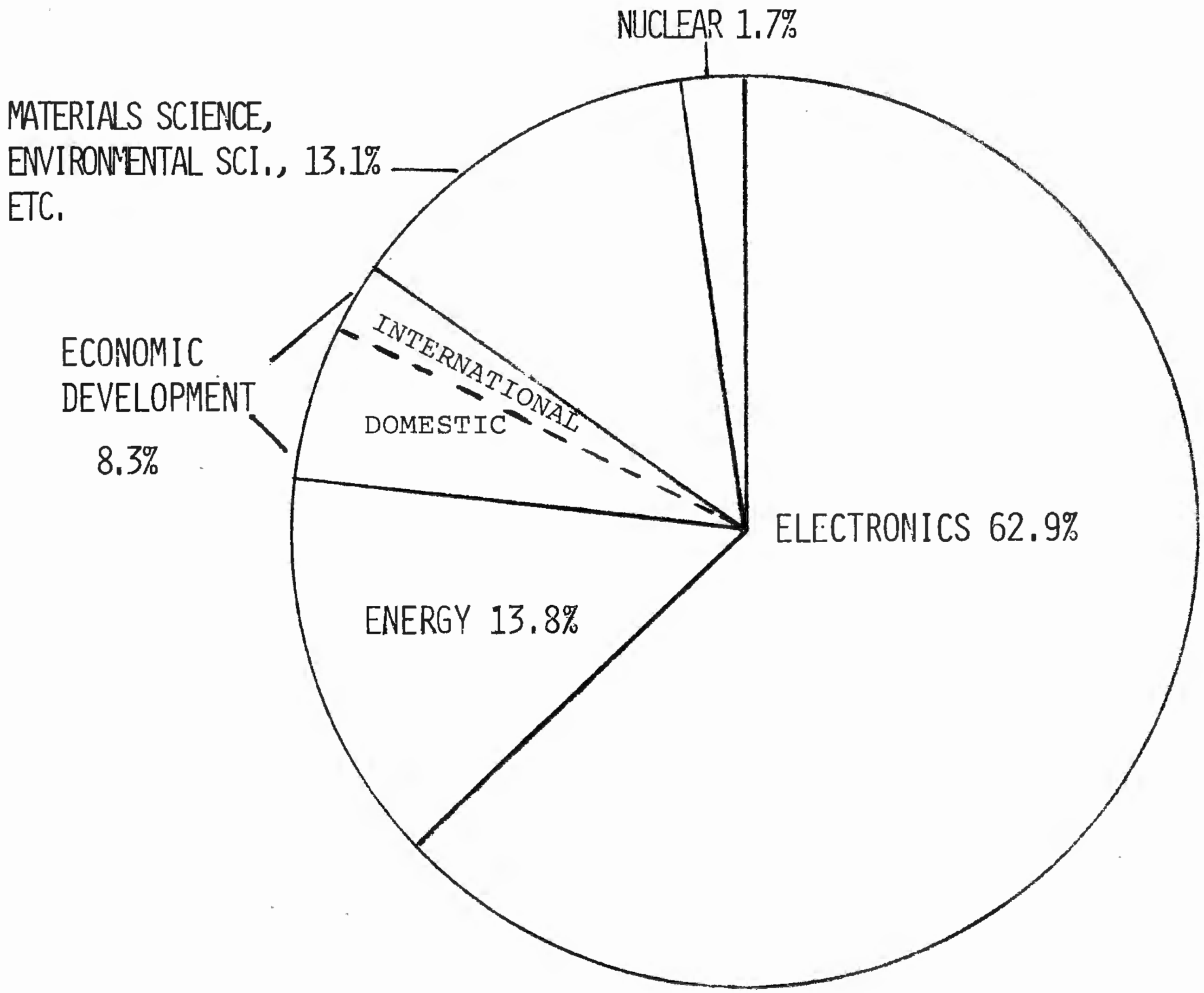


Figure III-5 - Personal Services in Broad Research Areas
Engineering Experiment Station, 1976-1977

performance, and assessment - for the Department of Defense as well as research on counter-measures with a heavy use of simulation techniques. As part of its work in radar, the Station recently acquired a twin engine, cargo type pressurized aircraft which serves as an airborne platform for testing complex electronic systems.

Researchers at the Station have done a lot of work on antennas used in connection with radar. This work tends to involve a highly sophisticated analysis involving such things as mathematical modeling to predict the effects that shipboard obstacles in the near-field of various antennas have on far-field performance.

Closely allied with radar as an application in electronics is communications, which, like radar, involves microwaves. This research applies to radio and television and to long-distance communications, such as, by satellite. Research scientists and engineers have performed, for example, feasibility and design studies for the NASA Goddard Space Flight Center on techniques for determining the electrical pointing accuracy of very-large ground-based satellite tracking antenna.

In addition to the obvious military applications of electronics, such as radar target detection, other military applications of electronics worked on by the Station have been quite varied. Two quite different problems involving specialized instrumentation serve as examples. The Army's Combat Development Experimentation Command operates a range where soldiers can be trained in a simulated battlefield environment that is realistic yet safe for participants. The Command wished to develop the capability of simulating the impact of projectiles from weapons such as howitzers. Station researchers tackled the problem of simulating the smoke cloud, flash, and bang of an impact in a manner that would be cheap, reliable, and safe for nearby soldiers. Numerous possible methods were evaluated experimentally, using specially developed photographic instrumentation to measure cloud size. The second problem involved development of a simple device that could be worn by a participant in combat exercises to sense his approximate posture and transmit that information to a central computer. The equipment developed uses mercury switches on trunk, thighs, and calves to sense the individual's orientation; a simple logic circuit receives the sensor outputs and determines which of five postures the soldier is in.

There are numerous peaceful applications of expertise developed in connection with defense work. One major weather problem is tornadoes to which the Southeastern portion of our country is particularly vulnerable. Efforts toward establishing a new methodology for early warning of tornadoes draws on existing radar capabilities and meteorological knowledge. The Station has assembled a small team of nationally known scholars in this area of research. The radar equipment used by this group is located on top of the library.

Other research involves experiments using satellites to rescue small boats and to locate and track wildlife. The small craft rescue project involves the development of antennas for use in locate and rescue emergencies. In the experiment, a small craft at sea will transmit a coded signal representing any one of several emergency situations. The signal will be received by a NASA satellite and related to an earth terminal. Within seconds an acknowledgement will be transmitted through the satellite to the craft. The Station's efforts were concerned with the development of an antenna suitable for mounting on a sailboat mast so that an actual satellite experiment could be conducted.

The program involving tracking wildlife via satellite was to study and design antenna devices that could be attached to a wide variety of wildlife including mammals, fish, reptiles, and birds. Wildlife resources are a complex and living form of national and international wealth that can be renewed or destroyed. They can be managed to meet the numerous needs of our society - including their role in maintenance of environmental health and quality. This program is a step in developing a key hardware component needed by wildlife biologists.

Research activities in the biomedical technical area stem from knowledge and experience developed in the Station in applied electromagnetics. Projects have involved engineering studies "to develop new and improved techniques for determining the in-vivo electrical properties of living tissues, electromagnetic techniques for thawing frozen white blood cells for transfusion in cancer therapy, electromagnetic techniques for thawing frozen kidneys for subsequent transplantation, and electromagnetic techniques for hyperthermia applications in the treatment of cancer. Support for these programs largely has been provided by the National Science Foundation, the Army Research Office and the National Institutes of Health. Several of these research activities involve joint programs that are being conducted in collaboration with medical personnel from the Medical College of Georgia and from the School of Medicine at Emory University."[4] The Station has also done, as industrial contracts, heart pace-maker evaluations for several manufacturers.

A part of the work in electronics is related to solid state research. For example, personnel have been involved in research on the use of diamonds as heat conductors and electrical insulators for high frequency microwave signal generators. The solid state world is a miniworld with things reduced to incredibly small proportions. "Some of these high frequency generators are so small that the power density within them exceeds that near the surface of the sun. Removing waste heat from these devices becomes one of the most difficult problems associated with them - that's where the diamonds come into play. Certain types of diamonds are better heat conductors than any other known material - between two and six times better than copper and silver."[5] Diamonds might seem like expensive material heat conductors. Actually they are cheap since thin diamond chips about thirty thousandths of an inch square are all that's needed.

The Station has a wide variety of research programs other than in the area of electronics. The Station has a large number of industrial analytical service programs with prime concentration and capabilities in the area of physical and materials science. This work involves materials testing and analysis using instruments such as the scanning electron microscope. The level of industrial support for this work is in large part a function of the overall economy. The same laboratory is doing X-ray and neutron diffraction studies on tooth enamel. A small program was supported by NASA for analysis of moon dust samples.

The nuclear reactor housed on the Georgia Tech campus is administered by the Experiment Station, though it is more intensively used by the academic units than by the Station. Station personnel have done work for "the Environmental Protection Agency to determine iodine in milk, with the Center for Disease Control to determine stable tracers in water . . . and with the Department of Interior to analyze tree cores for composition changes. The ERDA-funded Reactor Sharing Program is used by universities and colleges from diverse areas of the United States. Most of these schools are located in the Southern United States; however, the Program has aided schools in California, Massachusetts, Nebraska, New York and Texas . . . . Program participants (have) emphasized Neutron Activation Analysis Applications. Trace elements in such materials as blood, other biological materials, copper artifacts, rocks, and meteorites have been determined."[6]

The Station has become heavily involved in environmental and energy problems. Some of the research in this area has consisted in assessment and hardware studies. One project sponsored by the Federal Energy Administration involved the development of an industrial energy-conservation monitoring and reporting procedure, including extensive computer software for implementation of the system. Another, sponsored by Georgia's State Energy Office, involved the collection and documentation of a complete State energy-use audit and an analysis of potential new or auxiliary sources of energy for the State.

"Other programs are being conducted to study the combined siting and coupling of industrial and energy supply activities such that synergistic use of energy, raw materials, waste products, and land can be achieved. One of the programs is sponsored by the Appalachian Regional Commission for the investigation of 'synergistic co-siting' as a potentially beneficial new tool in regional industrial-development planning . . . . Another closely related program is being sponsored by the National Science Foundation for the study of power-system options for the Southeastern United States. This study considers the potential role of 'hybrid' power plants that use conventional fuel as well as waste products and solar-heated boilers to provide electrical energy, and examines the relative advantages of centralized versus decentralized power generation."[7]

A new research team has recently been added to the Station's staff to perform research in environmental chemistry, research expected to provide technical and scientific answers and guidance to environmental problems.

Research in Solar Energy. Station research scientists and engineers have a major interest in solar energy, as do also faculty members in a number of schools on campus. This interest evolved naturally from previous work in high temperature problems. It was in connection with this work that Tech scientists and engineers became in 1971 "the first U.S. scientific team to experiment with high temperature solar heat at the Centre National de la Recherche Scientifique (CNRS) Solar Furnace in Odeillo in Southern France. There they tested ceramics and metals exposed to heat fluxes which exceed temperatures of 6,000 degrees Fahrenheit."[8]

The CNRS furnace is currently the world's largest high temperature solar test facility. Sixty-three large mirrors collect the sun's rays which are then concentrated on a target area by a parabolic reflector. In materials development activities, "Georgia Tech engineers identified a military need which called for measurement of the radar transmission properties of material while they were subjected to high heat fluxes. Conventional heating methods either interfered with the radar measurements or were incapable of reaching the desired heat fluxes. The CNRS Solar Furnace offered the possibility of attaining very high heat fluxes using pure radiant energy which did not interfere with radar."[9] Because of this expertise developed in connection with high temperature materials problems, Georgia Tech is one of the more experienced organizations in the country in the conduct of research at large solar test installations. It has also become involved in solar energy research.

Interest in solar energy has developed in the United States and elsewhere because of the finite limit to gas and oil supplies. "Various future energy scenarios that have been presented by the U.S. Energy Research and Development Administration indicate that supplies of oil and gas will be approaching exhaustion in 40 to 60 years. Although our water and coal resources are vast, they have geographic and economic limitations as sources of inexpensive energy."[10] Solar energy is currently being explored, along with other alternatives, as an additional energy source. According to ERDA solar energy will provide about 25 percent of America's total energy needs by the year 2020.

There are a number of projects in solar energy in which Tech scientists and engineers have been active. Martin Marietta and Georgia Tech have collaborated on the designing, building, and testing of a bench model solar steam generator to acquire design information and operating data based on real experience. Sponsored first by the National Science Foundation and then taken over by ERDA when that agency was founded in 1975, the design of the model was made as close as possible to the design expected to be used in a commercial solar electric power generation plant. Testing of the model took place at the French CNRS solar furnace.

Georgia Tech is collaborating with Martin Marietta, Foster-Wheeler Energy Corporation, and Bechtel Corporation in a design program whose goal is to demonstrate the technical and economic feasibility of generating electric power by solar thermal conversion. The pilot plant that results from this effort of which Tech is a part will be the first constructed in the world. Tech is responsible for the thermal storage subsystem which stores heat for generation of steam during cloudy periods. This subsystem involves storage of heat in liquids. Georgia Power Company has cooperated with Tech by providing access to steam for the experiment at a site adjacent to a power plant located at Newnan.

Tech researchers are also experimenting with two types of solar collectors which have the potential for providing air conditioning and electric power for large buildings. "One utilizes a fixed mirror concentrator and is composed of long narrow flat mirrow facets arranged on a concave cylindrical surface . . . . The heat exchanger pipe is pivoted at the center of the reference cylindrical surface to remain at the focal point as sun direction changes . . . . The second system also utilizes a linear heat exchanger, but in this case it is illuminated by rotating facets. Each facet is oriented at the appropriate angle to reflect sunlight onto the heat exchanger pipe. As the sun moves a single bar rotates each facet the same amount so the sunlight remains focused on the heat exchanger."[11]

Tech has also been involved in a number of practical experiments in the use of solar energy systems for homes, offices, and public buildings. Tech researchers have been actively studying test data from solar collectors installed on the roof of the George A. Towns Elememtary School in Atlanta to provide solar heating and cooling. Instruments indicating performance levels of the system have been monitored by a team of engineers from the Schools of Electrical and Aeorspace Engineering. Tech was also awarded a contract by ERDA for the design and engineering of a solar community center in New Town, Shenandoah, 25 miles south of Atlanta. The center contains a complex of offices, an ice skating rink, gymnasium, theater, game rooms, and swimming pool. The system is expected to provide over 90 percent of the total energy required for winter heating and 60 percent of the total energy for summer cooling.

In a cooperative effort with the Georgia Poultry Federation and Wilson and Company, Tech also has developed and installed a low-cost system for heating a broiler house in Cumming, Georgia. The system was designed so most of the construction could be completed by the broiler house operator.

The collector consists of a layer of black polyethylene placed on the ground and covered with six inches of black-painted rocks. Covering the rocks are two layers of clear polyethylene glazing, separated by dead air space. Hot air is circulated into the grow-out house through concrete pipes. Tech staff members have measured rock temperatures of 145 to 185 degrees from the solar system.

Tech has also experimented with several types of collectors for improving methods of agricultural drying. "Even today, tobacco is often cured in crude wooden barns; forage is cut and left to dry in an open field, thus losing essential nutrients; and peanuts are still frequently field-dried subjecting them to wide temperatures and environmental conditions which can reduce or even ruin the quality of the crop. These techniques are still used because energy for agricultural drying is very expensive. On the other hand one of the least expensive ways to apply solar energy is in the collector designs that are applicable to agricultural drying."[12]

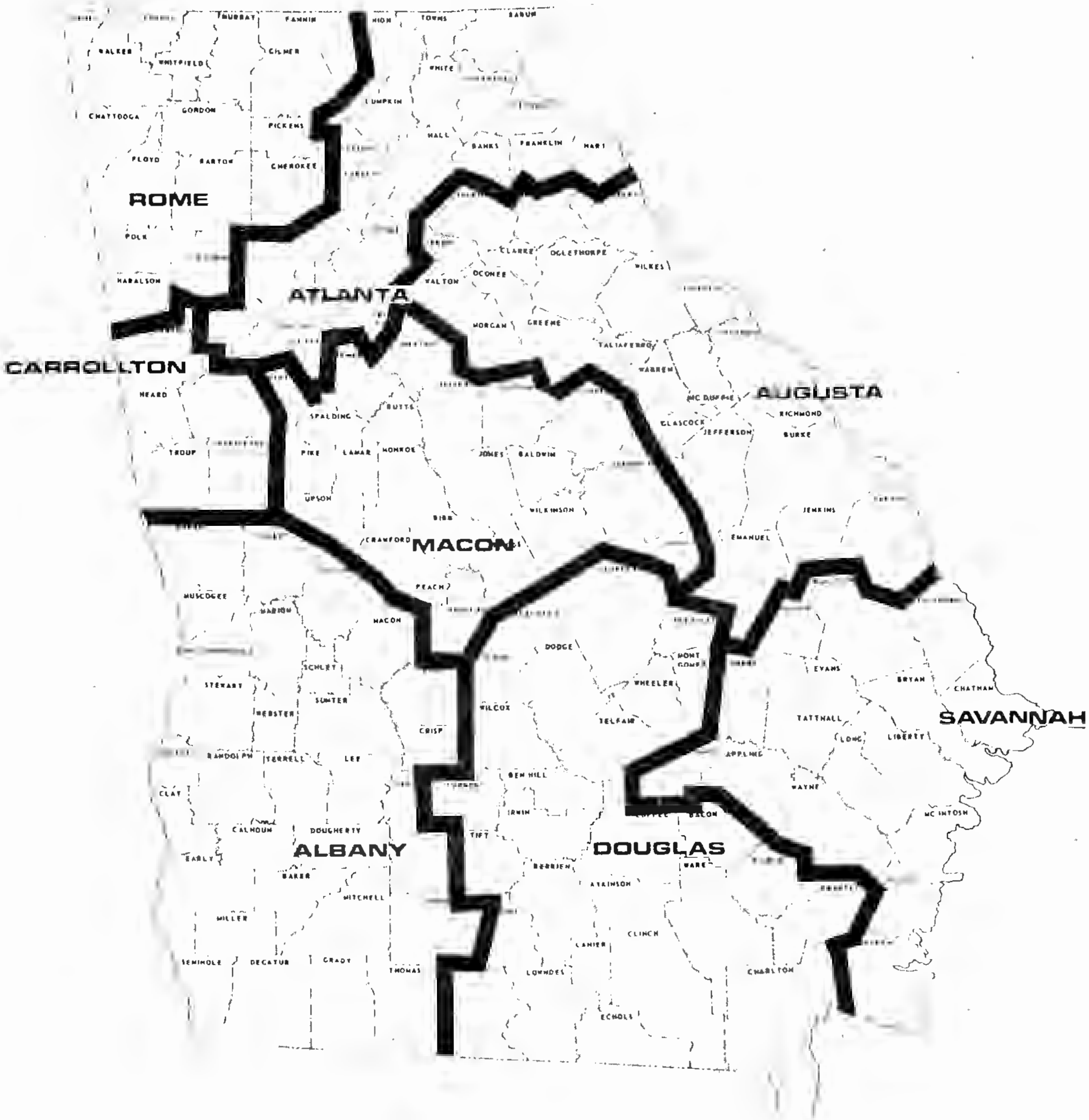
The most significant recent development in solar research on the Tech campus is the startup in the fall of 1977 of the new 400 Kilowatt Solar Test Facility, the third largest in the world. The Tech facility is modeled after a solar power steam generator developed at the University of Genoa. "The test facility operates with a series of 550 flat mirrors which track and direct the sun's rays onto a receiver or boiler suspended from an 85 foot tower in the center of the mirror field. The receiver converts water to superheated steam through a heat-exchange process. A throttling valve, located in the steam system, simulates a load on the system much like a steam turbine. This facility will be capable of providing the range of radiant thermal energy values needed to conduct a wide variety of solar-thermal experiments."[13] The test facility is owned by ERDA but will be managed by Tech.

Tech scientists, for both the Experiment Station and the School of Aerospace Engineering, have also done research on wind energy conversion systems. This work includes a cost-benefit study for NASA on the use of wind generators. The NASA study provided a basis for determining the relative merits of technological alternatives and for estimating the potential of wind power systems in the United States. The Research included a survey and analysis of climate factors, data on surface winds, and regional topographical features. Tech also participated in assessing wind potential in 13 New England regions under an ERDA contract. Tech now has its own windmill; an on-campus Grumman Windstream machine used in obtaining wind data statistics and investigating a variety of problems oriented to the eventual practical implementation of wind energy conversion systems.

Industrial Development Research. Perhaps the Experiment Station programs that are most obviously related to the economic well being of the State involve research in problems of industrial development. This type of research began in 1956. Station personnel started by surveying Georgia's industries and followed with a number of economic profiles in Georgia counties and municipalities. In 1960 the Legislature authorized the Engineering Experiment Station to provide an industrial extension service. The first field office was opened in Rome in 1961.

Today the Extension service maintains seven offices as described in Figure III-6. The Station has done economic and demographic surveys of each of the State's 159 counties. It has done detailed studies of over 75

Figure III-6 - Area Development Division
Economic Development Laboratory
Area Office Locations



Augusta Area Office, Augusta
Central Georgia Area Office, Macon
Northwest Georgia Area Office, Rome
Savannah Area Office, Savannah
Southeast Georgia Area Office, Douglas
Southwest Georgia Area Office, Albany
West Georgia Area Office, Carrollton

municipalities. It carries out economic research "for city and county governments, local development groups, area planning and development commissions, and private companies and associations. Typical services provided under these types of projects (include) professional guidance in evaluating local development potentials, identifying deterrents to economic growth, establishing and implementing development programs, servicing the needs of industrial prospects or other agencies through the preparation of special information and materials, establishing programs of promotion and coordination with statewide industrial development agencies, identifying and evaluating available and potential industrial sites, and analyzing and documenting basic location factors and local services and facilites."[14] It has also provided aid to minority businesses and is currently compiling a directory of minority enterprises in the State under the sponsorship of the U.S. Department of Commerce.

Station peronnel also conduct from time to time training programs throughout the State covering topics, such as, community development, human resource development, land use development, and energy cost-reduction techniques.

In cooperation with the Georgia Power Company the Station has conducted now for some years the Certified Cities Program designed to encourage and assist Georgia municipalities in all areas of community development. One of the most important accomplishments of this program is that it offers a reliable method for identifying civic improvements which are required to enhance the attraction of a community for any sort of business investment.

Tech also does special feasibility and plant location studies. For example, Georgia Tech economists recently published a study investigating the feasibility of utilizing commercially a new process in wood pulping technology called thermo-mechanical pulping. The process can use the abundance of surplus wood chips and other wood wastes generated by sawmills in Georgia and the region. The operation alleviates the problem of disposing of these residues and also provides a profitable use for these materials. The investigation made a survey of sawmill operators for estimates of the volume of raw material available for several specific locations, projected the capital needs and production costs, and conducted a survey to determine the size of the final markets for the output. Parly as a result of this study, a plant utilizing this process is now operating at Dublin, Georgia.

In another project, "a program of equipment development was conducted for the Gum Naval Stores industry with the purpose of improving working conditions and productivity. Two tools and a gum transporting vehicle were designed, fabricated and tested and have been made available to the Georgia Forestry Commission and American Turpentine Farmers Association for field testing and industry implementation."[15]

Engineering Experiment Station researchers are currently involved in a comprehensive study of energy conservation in the textile industry. The project, sponsored by ERDA, will be conducted in two phases. The first phase is devoted to identifying energy intensive processes which have potential for conservation modifications. The second part of the study will attempt to develop specific modifications on existing processes and equipment to achieve a reduction in energy use.

Poultry is one of the leading industries in Georgia. The State leads the nation in total production of eggs, broilers, and turkeys. One of the industry problems is disposing of almost 14,000 tons of manure per day. Tech researchers have designed an anaerobic digestor that will undergo extensive testing. The digestor will eventually produce marketable by-products including methane gas used to supply heat for broiler houses and to run a generator, while the fertilizer (sludge) has potential as a source of vitamin B Complex, and as cattle feed and soil supplement. Station researchers have also done work on an electro-magnetic system for hatching baby chicks and the mechanical problem of switching processed chickens from one conveyor belt to another.

In 1964 the Station became interested in the possibility of establishing an international program as a natural extension of its development work in Georgia port cities and adjacent costal areas, particularly in Savannah and Brunswick. This interest has developed into a major program. An Office of International Programs has recently been established within the Station to provide increased focus on international activities.

The staff "conducts a variety of projects and programs in cooperation with counterpart institutions in Brazil, Chile, Equador, Ghana, Guatemala, Indonesia, Kenya, Korea, Nigeria, the Philippines and Venezuela and has short term projects with other developing countries.

"The primary focus of these international activities is on the stimulation of small-scale industries in developing countries throughout the world, with special emphasis on rural and urban development, appropriate technology, alternate energy sources, technology transfer and training. In the fiscal year 1977, Georgia Tech's international team was active in eighteen developing countries."[16]

The Station compiles, edits, and publishes a quarterly international newsletter, Small Industry Development Network, under sponsorship of the U.S. Agency of International Development. The newsletter is now mailed each quarter to individuals and organizations in 41 states and the District of Columbia and in 103 countries throughout the world.

Undergraduate Research Projects

A report on Georgia Tech research would not be complete without a brief comment on research projects uniquely identified with undergraduates. Particularly important have been student contributions to SCORE (Student Competition on Relevant Engineering). SCORE is a national, non-profit, student-run corporation which provides realistic work experience for students by sponsoring competitions on solutions to contemporary engineering problems. This year Tech students traveled to Washington state for national competition on alternative energy sources. The four entries of GITSET (Georgia Institute of Technology Student Energy Team) were designed to produce all the electricity a home would need, approximately 20 kilowatt hours of electricity per day. The students developed four system designs for the competition employing wind, solar thermal, bioconversion (methane) and photovoltaics (solar cells). The students received donations of materials, supplies and support from over 50 organizations, companies, and individuals. The Tech team won first place in the solar division and in the organic fuels division. The solar entry also received a second place (no first place prize was awarded) for solar innovation.

Overall Status of Georgia Tech Research

We conclude this brief summary of Georgia Tech research by attempting an overall evaluation: Just how good, in general, is Georgia Tech research today?

We can, to start with, say that Georgia Tech has come a long way since the Institute, thirty short years ago, took its first hesitant steps, as one of the major units in the University System, to extend its mission beyond undergraudate education and to include as part of its work graduate training and research. The wide range of research activities described in this report shows that an impressive research program is now well established on the Tech campus.

In the memory of people who have been at Tech over the last decades and have witnessed the transition first-hand, the advances made have been genuinely impressive. One chemistry professor remembers coming to Tech as late as 1963 and being given as a combined office-lab an abandoned storeroom which he painted himself. Tech did not even keep an inventory of glassware normally used in labs. When a new flask was needed, it had to be ordered from a local supplier. Today the School of Chemistry is located in a modern building. Its instrumentation equipment compares favorably with good schools throughout the country. Its faculty is gradually building up national and international recognition and visibility. The professor who painted his own office when first coming to Tech has been to Europe for international conferences eight out of the last ten years, with the cost covered, incidentally, by outside sources. Two years ago a member of the faculty received the American Chemical Society award for creative work in synthetic organic chemistry, one of the top honors in American Chemistry.

Twenty-five years ago a chapter of the Society of the Sigma Xi - a research honorary society - was established on the Tech campus. At its first annual banquet in 1953, at which an award for the best research done on campus during the year was given, the papers published by the Tech faculty that year were listed in the dinner program. Thirty-eight publications were listed, including journal articles and special reports of all kinds. The list covered two pages. Two years ago the tradition of listing Tech publications in the annual dinner program was dropped because the program had turned into a good size booklet and became expensive to print. In the 1974-1975 school year program, the last program in which campus publications appeared, 453 journal articles, papers, reports, and books were itemized with the list covering 57 pages.

One cannot help but think in a moment of nostalgia of the pioneering efforts of dedicated administrators and faculty members who did the early development work on which a new generation of administrators and scholars now builds.

If one is looking for a more precise gage of the advances made in research, dollars allocated to this activity provide one such measure. There are limitations to the usefulness of this indicator, as there are to other global measures one can use. Dollars expended do not necessarily mean quality research. The dollar measure can be particularly deceptive when individual projects are compared with one another. The most significant research, measured in terms of contribution to knowledge, can also be, at times, the least costly. Albert Einstein worked mostly with a pencil and paper in what would be considered today a low-budget operation. The dollar measure also causes serious and healthy debate among dedicated faculties as to whether the search for financial support can distort the research goal in relation to the overall mission of academic institutions so that research projects are undertaken because funds are available rather than because of inherent scientific interest.

Despite the imperfections in the dollar measure, the size of the research budget can say a great deal about the performance of a research program. Research grants are made at least partly on the basis of peer review. Organizations that do not do quality research cannot sustain outside support over a prolonged period. The research budgets at the best universities in the world are large.

On the basis of funds expended, Tech research has grown rapidly over the last decade. Even when the dollar totals are adjusted to compensate for the inflationary rise in prices, total expenditures on research doubled over the last decade. In evaluating the overall research program at Georgia Tech, the first thing to be said is that we have come a long way.

The second thing to be said, however, is that we still have a long way to go in terms of graduate work and research when compared to other institutions of higher learning. Table III-6 shows some measures of productivity for leading engineering schools for the 1975-1976 school year the most recent year for which data are available. Column 8 shows the research expenditures for the various institutions. The dollar amounts include only dollars of research by the academic engineering units and exclude research expenditures on engineering problems by non-engineering units, such as physics and chemistry, and by research units such as Tech's Engineering Experiment Station. When Tech is compared to 26 leading engineering schools outside the Southeast, Georgia Tech is tenth in terms of total dollars expended (Column 8). In terms

Table III-6 Some Measures of Productivity for Leading Engineering Schools, 1975-1976.

Institution	(1) Under-grads	(2) Faculty[1]	(3) UG/F	(4) Grad[2]	(5) Ph.D's[3]	(6) Grad/F	(7) Ph.D's/F	(8) $R (000)[4]	(9) $R/F(000)
MIT	1,475	331	4.46	——	151			24,156	73.0
Berkley	2,241	201	11.14	1,571	173	7.81	0.86	12,603	62.7
Stanford	783	141	5.53	1,637	120	11.60	0.85	8,729	61.9
Illinois	4,137	369	11.21	1,508	137	4.10	0.37	19,139	51.9
Cal. Tech	484	79.5	6.13	299	47	3.76	0.59	4,529	57.0
Michigan	3,099	273	11.35	1,013	52	3.71	0.19	10,607	38.9
Purdue	4,999	297	16.83	1,255	107	4.23	0.36	12,018	40.5
Carnegie-Mellon	1,065	84	12.68	506	22	6.02	0.26	4,966	59.1
Cornell	2,269	218	10.41	643	76	2.95	0.35	8,132	37.3
Texas	3,041	177	17.19	832	64	4.70	0.36	8,701	49.2
Wisconsin	2,572	189	13.61	614	55	3.25	0.29	5,351	28.3
Minnesota	2,342	188	12.46	638	41	3.39	0.22	3,547	18.9
Ohio State	2,818	249	11.32	1,179	69	4.73	0.28	8,019	32.2
UCLA	1,385	133	10.41	984	64	7.40	0.48	6,990	52.6
Case Western	765	98	7.81	368	31	3.76	0.32	5,848	59.7
Northwestern	884	115	7.69	503	49	4.37	0.43	5,007	43.5
Penn	532	85	6.26	682	39	8.02	0.46	6,227	73.3
Rice	837	54	15.50	207	15	3.83	0.28	1,683	31.2
Wash (Seattle)	2,287	180	12.71	721	39	4.06	0.22	4,177	23.2
Columbia	767	88	8.72	754	35	8.57	0.40	3,653	41.5
Georgia Tech	4,051 (4)	263	15.41	780	35	2.97(23)	0.13	6,328 (10)	24.1(22)
Penn State	4,866	307	15.85	418	47	1.36	0.15	4,298	14.0
RPI	2,225	122	18.24	642	24	5.26	0.20	4,090	33.5
Iowa State	3,387	273	12.41	486	27	1.78	0.10	3,452	12.6
Southern Cal	996	125	7.97	1,282	54	10.26	0.43	5,286	42.3
Buffalo	1,409	79	17.84	347	24	4.39	0.30	2,514	31.8
PINY	1,368	153	8.94	2,071	52	13.50	0.34	2,866	18.7
Southeast:									
Alabama	858	87	9.86		2		0.02	479	5.7
Auburn	1,682	107	15.72	168	4	1.57	0.04	1,732	16.2
Clemson	1,216	134	9.07	231	12	1.72	0.09	2,310	17.2
Duke	590	45	13.1	104	14	2.31	0.31	1,119	24.9
Florida	1,508	190	7.94	559	43	2.94	0.23	7,169	37.7
LSU	1,807	101	17.89	168	5	1.66	0.05	1,318	13.0
N.C. State	3,087	145	21.29	514	36	3.54	0.25	4,884	33.7
S. Carolina	784	40	19.60	252	3	6.30	0.08	1,070	26.8
Tennessee	1,706	121	14.10	790	36	6.53	0.30	2,463	20.36
Tulane	648	43	15.07	212	10	4.93	0.23	673	15.7
Vanderbilt	858	63	13.62	148	13	2.35	0.21	885	14.0
Virginia	1,076	96	11.21	445	24	4.64	0.25	3,918	40.8
VPI	2,827	206	13.72	793	28	3.85	0.14	4,111	20.0

1. Total of full-time engineering faculty in the three professional ranks.
2. Includes masters, professional, and doctoral, Fall, 1976.
3. Ph.D's granted 1975-1976.
4. Research expenditures, 1975-1976, in engineering school units; excludes engineering research done in academic units outside engineering schools and in special research labs like the Engineering Experiment Station.

Source: Data on undergraduate enrollment from Engineering Education, October, 1976. Data on graduate enrollment, Ph.D's graduated and research expenditures from Engineering Education, March, 1977.

of thousands of dollars spent on research per faculty member, however, Tech is twenty-second out of the 26 schools (Column 9), When Georgia Tech is compared to 13 other engineering programs in the Southeast (see bottom of Table III-6), Tech is second in terms of total dollars spent. Tech is sixth in terms of thousands of dollars spent on research per faculty member, coming behind Virginia, Florida, North Carolina State, South Carolina, and Duke.

The data in Table III-6 also suggest that Tech retains its strong commitment to undergraduate education. Tech is fourth in the nation in terms of undergraduate enrollment behind Penn State, Purdue, and Illinois (Column 1). It is first among engineering schools in the Southeast. In terms of number of graduate students per faculty member Tech is twenty-third when compared to 26 engineering schools outside the Southeast. When compared to engineering schools in the Southeast, Tech is seventh among 14 schools.

The data in Table III-6 suggest that graduate education and research at Georgia Tech is still underfinanced when compared to other institutions. To look at the very best schools, for example, MIT has three times as many research dollars per faculty member as Georgia Tech, while Tech has three times the undergraduate load of MIT. Stanford has two-and-a-half times as many research dollars per faculty member as Georgia Tech, while Tech has almost three times as many undergraduates per faculty member as Stanford.

If one compares Tech to publicly supported schools, the result is not as striking but still shows Tech to be behind in terms of research support. Illinois, for example, has only three-fourths as large an undergraduate load per faculty member as Georgia Tech, but has over twice the research support. Michigan has three-fourths the Tech undergraduate load per faculty member and over one-and-a-half times the research funds. Purdue has a slightly higher undergraduate-to-faculty ratio than Tech but over one-and-a-half times the research support. Ohio State has three-fourths the undergraduates and one-and-a-third times the research support. Georgia Tech comes out looking better in terms of these comparisons than Minnesota, Penn State, and Iowa State when compared to schools outside the Southeast.

The number of undergraduates per faculty member is generally high among Southeastern engineering schools. Tech comes out significantly better in terms of research support and size of undergraduate load when compared to Alabama, Auburn, Louisiana State, Tennessee, Tulane, Vanderbilt, and VPI. It is rather close to Duke ratios. It has a considerably larger undergraduate load than Florida and Virginia, however, and a significantly smaller amount of research support.

One can form an overall general conclusion that Georgia Tech is distinguished as an institution for training undergraduate engineers. It has moved along rapidly in developing a graduate and research program and is gaining national visibility. But there is still a lot of work to be done in advancing Georgia Tech up the ladder of nationally ranked institutions.

FOOTNOTES, PART II

[1]All statements about the alumni population that are made, or implied, on the basis of sample evidence in this study have been checked statistically. Where possible these statements were examined in a hypothesis testing framework. Only those results that were significant at an alpha level of 5 percent or less were reported.

Many statements are made about the proportion of the population having a certain attribute or characteristic, based on the appropriate sample proportion. In each instance a 99 percent confidence interval for the true population was constructed. Seventy-eight percent of these 99 percent confidence intervals were no longer than .05. Loosely speaking, we can say that in these cases we are 99 percent confident that our estimate is within 2.5 percent of the true population proportion. For example, of the 3,738 undergraduate degree holders who responded, 925 hold master's degrees. As was stated in the body of the report, this is a sample proportion of .247 or roughly 25 percent. We are 99 percent sure that the proportion of the alumni population holding master's degrees does not differ from the sample proportion by more than 2.5 percentage points; that is, the proportion of the Tech alumni holding a master's degree is not less than 22.5 percent or more than 27.5 percent.

In the remaining 22 percent of the cases where proportion statements are made about the sample, 99 percent confidence intervals that apply to population proportions are somewhat larger. These cases tend to involve less important matters where the number of responses was relatively small.

[2]Statistical Abstract of the United States, 1977, Table 714, p. 443.

[3]Engineers Joint Council, Professional Income of Engineers, 1976, p. 7.

[4]Ibid., p. 6.

[5]Stephen J. Gallogly, "Workers on Long Hours and Premium Pay," Monthly Labor Review, May, 1977, pp. 42-45.

FOOTNOTES, PART III

[1]A number of Georgia Tech publications have been helpful in the writing of this section of the report. These include an assortment of school catalogues, official budget documents, official annual reports of the Institute and its separate divisions, other less formal reports and publications meant for external distribution, and self-study reports. Except in the case of lengthy quotations, the source of passages taken verbatim from the various documents have not been identified specifically lest the repeated use of quotation marks become distracting to the reader. A number of individuals on the Tech Campus were also interviewed in gathering background for this part of the report. The authors are grateful for the cooperation of these persons. Their names are listed in Appendix Table III-1.

[2]For a summary of 1976-1977 recruitment and placement activity, see Appendix Table III-1a and Table III-2a.

[3]See the letters of endorsement by President Blake R. Van Leer, and by Gerald A. Rosselot, Director of the Engineering Experiment Station, in _A Petition of the Establishment of a Chapter of the Society of the Sigma Xi at the Georgia Institute of Technology_. Atlanta, Georgia, October, 1952.

[4]_Annual Report of the Experiment Station, 1975-1976_, pp.27-28.

[5]_Engineering Experiment Station Report_, May, 1976, p. 4.

[6]_Annual Report of the Experiment Station, 1975-1976_, p. 86.

[7]_Ibid._, p.41

[8]_Solar Energy Research at Georgia Tech_, p. 1.

[9]_Ibid._, p. 3.

[10]_Ibid._, p. 1.

[11]_Ibid._, p. 17.

[12]_Ibid._, p. 19.

[13]_Whistle_, August 1, 1977, p. 1.

[14]_Annual Report of the Experiment Station, 1976-1977_, p. 54.

[15] *Ibid.*, p. 95.

[16] *Whistle*, July, 18, 1977, p. 1.

APPENDICES

Appendix I-1

TRACING SPENDING THROUGH THE GEORGIA INPUT-OUTPUT MODEL

We estimated the multiplier effect of expenditures related to Georgia Tech with the assistance of the Georgia Economic Model. This model is fully discussed in William A. Schaffer, *et al.*, *On the Use of Input-Output Models for Regional Planning* (Leiden: Martinus Nijhoff, 1976). Here we will simply describe it, outline mathematically the technique used in tracing the multiplier effect, present the direct requirements table essential to such tracing, and trace total expenditures due to Georgia Tech to supplement the calculations presented in Part I.

The Georgia Economic Model is a "regional input-output model" constructed for Georgia in 1970 in a project supported by the Georgia Department of Industry and Trade and the Office of Planning and Budget. It outlines in tabular form the sales by industries in Georgia to other industries and final consumers in Georgia and to purchasers outside Georgia. With sales by Georgia industries in rows of the table, each column necessarily represents the purchases by Georgia industries and consumers and by outsiders.

If we assume that purchase patterns remain constant over time, we can use a version of the table to trace the changes in industry outputs required to satisfy changes in final demands. This table portrays purchases by Georgia industries from other industries and from households, governments, and outside suppliers as proportional to industry outputs and is called a "direct-requirements table, or matrix" (Table I-1a). Symbolically, it may be

Table I-1a Direct Requirements per Dollar of Gross Output, Georgia Economic Model

	INDUSTRY	AGRICUL-TURE 1	MINING 2	CONTRACT CONSTRUC-TION 3	FOOD AND KINDRED PRODUCTS 4	TEXTILE MILL PRODUCTS 5	APPAREL & RELATED PRODUCTS 6	LUMBER AND WOOD PRODUCTS 7
1	AGRICULTURE (SIC 01, 07-9)	12.0951	0.0000	.2173	21.8378	.2397	.3227	6.0495
2	MINING (SIC 10-4)	.1107	1.2869	1.0109	.0195	.0010	0.0000	.0029
3	CONTRACT CONSTRUCTION (SIC 15-7)	.8333	.8259	.0353	.2151	.3061	.0510	.3784
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	7.1477	.0001	.0030	7.4595	.0009	.0001	.0025
5	TEXTILE MILL PROCUCTS (SIC 22)	.1598	.0025	.0483	.0905	14.3024	20.7810	.0281
6	APPAREL AND RELATED PRODLCTS (SIC 23)	.0368	.0000	.0205	.0766	.1281	3.0632	.0426
7	LUMBER AND WOOD PRODUCTS (SIC 24)	.1029	.0262	3.1782	.0283	.0002	.0460	15.2584
8	FURNITURE AND FIXTURES (SIC 25)	0.0000	0.0000	.2426	.0003	.0098	.0177	.1147
9	PAPER AND ALLIED PROCUCTS (SIC 26)	.1957	.0262	.2727	1.8386	.7504	.2989	.2667
10	PRINTING AND PUBLISHING (SIC 27)	.0063	.0015	.0013	.1704	.0017	.0020	.0052
11	CHEMICALS AND ALLIED PRCCUCTS (SIC 28)	.8649	.4644	.4967	.4819	1.2493	.0277	.2488
12	PETROLEUM REFINING (SIC 29)	.0023	.1464	.6497	.0005	.0003	.0001	.0031
13	RUBBER AND MISC. PLASTICS (SIC 30)	.0409	1.1932	.4044	.3227	.4408	.3789	.0413
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	.0037	.0002	.0003	.0006	.0011	.0538	.0055
15	STONE, CLAY AND GLASS FROD. (SIC 32)	.0265	1.8793	5.7808	1.3652	.0067	.0006	.0338
16	PRIMARY METAL INDUSTRIES (SIC 33)	.0001	.2576	.3881	.0000	.0001	.0119	.0636
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	.2085	.0761	3.9476	1.0056	.0080	.0138	.2959
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	.0976	.9225	.3209	.0342	.0833	.0042	.0645
19	ELECTRICAL MACHINERY & ECUIP. (SIC 36)	.0150	.0710	.6023	.0042	.0006	.0008	.0059
20	TRANSPORTATION EQUIPMENT (SIC 37)	.0071	.0699	.0065	.0017	.0002	.0004	.0111
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	.0007	.0006	.0611	.0067	.0316	.5141	.0285
22	TRANSPORTATION SERVICES (SIC 40-7)	.6911	.6679	1.6462	1.3723	.7110	.2297	1.1893
23	COMMUNICATIONS & UTILITIES (SIC 48-9)	.4892	3.6224	.5835	.7503	.9194	.4399	.9758
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	3.0691	3.5415	8.8970	3.4662	4.6548	2.8676	2.2092
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	2.4154	3.8746	1.0160	.8594	.7366	.9064	1.1294
26	SERVICES (SIC 70-9, 80-6, 89)	1.5251	2.7506	4.9221	2.2007	1.0983	.7674	1.4593
27	GOVERNMENT ENTERPRISES	.0163	.2314	.0842	.1035	.1122	.1661	.0771
28	UNALLOCATED INDUSTRIES	.1804	.7495	.5160	.2965	.3374	.3440	.3107
29	HOUSEHOLDS	36.4778	28.4807	26.3933	17.8801	22.3734	38.3985	27.7987
30	CITY AND COUNTY GOVERNMENT	3.0769	.9291	1.0242	.4451	.3614	.1439	1.4346
31	STATE GOVERNMENT	0.0000	.3389	.3683	.3340	.3092	.2700	2.2547
32	TOTAL	69.8970	52.4372	63.1394	62.6681	49.1759	70.1227	61.7896
33	CAPITAL RESIDUAL	11.4057	18.1265	4.1150	4.3411	4.1586	2.6623	5.8437
34	FEDERAL GOVERNMENT	0.0000	4.5437	4.0413	3.2095	2.8255	3.2393	3.6494
35	IMPORTS	18.6972	24.8927	28.7042	29.7813	43.8400	23.9757	28.7173
36	TOTAL PRIMARY INPUTS	30.1030	47.5628	36.8606	37.3319	50.8241	29.8773	38.2104
37	TOTAL PURCHASES	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000

Table I-1a Direct Requirements per Dollar of Gross Output, Georgia Economic Model (continued)

	INDUSTRY	FURNITURE AND FIXTURES 8	PAPER AND ALLIED PRODUCTS 9	PRINTING AND PUBLISHING 10	CHEMICALS AND ALLIED PRODUCTS 11	PETROLEUM REFINING 12	RUBBER AND MISC. PLASTICS 13	LEATHER & LEATHER PRODUCTS 14
1	AGRICULTURE (SIC 01, 07-9)	0.0000	0.0000	0.0000	.1252	0.0000	0.0000	0.0000
2	MINING (SIC 10-4)	0.0000	.5729	0.0000	.3709	5.5759	.0914	.0001
3	CONTRACT CONSTRUCTION (SIC 15-7)	.1319	.6692	.1524	.4066	.7844	.3289	.1211
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	.0000	.1197	.0766	1.8447	.0308	.0025	1.4943
5	TEXTILE MILL PRODUCTS (SIC 22)	3.1693	.1423	.0452	.0136	.0000	5.0065	1.9490
6	APPAREL AND RELATED PRODUCTS (SIC 23)	.0955	.0858	0.0000	.1113	.0278	.3372	1.0091
7	LUMBER AND WOOD PRODUCTS (SIC 24)	6.5087	3.7475	.1112	.2219	.0736	.3532	.4787
8	FURNITURE AND FIXTURES (SIC 25)	1.1356	.0012	.1670	.0003	0.0000	.0512	.0098
9	PAPER AND ALLIED PRODUCTS (SIC 26)	.8381	14.3591	11.3918	2.1707	4.8691	1.3039	.7154
10	PRINTING AND PUBLISHING (SIC 27)	.0049	.2919	2.2144	.0419	.0017	.0075	.0303
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	.4759	2.5199	1.5251	8.9672	3.5649	3.3310	.4575
12	PETROLEUM REFINING (SIC 29)	.0002	.0108	.0004	.1586	.1792	.0090	.0002
13	RUBBER AND MISC. PLASTICS (SIC 30)	3.1923	.3777	.2034	1.0250	.0278	.9336	2.8682
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	.0135	.0044	.0020	.0021	.0016	.0582	.6673
15	STONE, CLAY AND GLASS PROD. (SIC 32)	.1354	.0227	.0001	.6251	1.5126	.3612	.0026
16	PRIMARY METAL INDUSTRIES (SIC 33)	.4520	.1324	.0021	.0974	.0088	.1532	.0017
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	1.8476	.3341	.0367	1.5798	.8924	.3702	.0841
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	.1597	.0771	.0811	.0839	.0249	.1255	.0085
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	.0146	.0034	.0068	.0053	.0061	.0403	.0028
20	TRANSPORTATION EQUIPMENT (SIC 37)	.2121	.0042	.2543	.0090	.0030	.0322	.0025
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	.1118	.0347	.0764	.3617	.0044	.6326	1.2485
22	TRANSPORTATION SERVICES (SIC 40-7)	.8798	1.8358	.4370	1.2022	1.9827	.7970	.4270
23	COMMUNICATIONS & UTILITIES (SIC 48-9)	.8881	2.8748	1.1335	1.7095	4.2564	1.3447	.6087
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	4.4501	3.7110	2.1281	3.7114	6.3476	3.4191	2.8220
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	1.9819	1.0271	2.8794	1.1622	1.8735	1.1335	1.0247
26	SERVICES (SIC 70-9, 80-6, 89)	1.7951	1.8821	2.4583	3.5330	2.2080	2.2306	1.7631
27	GOVERNMENT ENTERPRISES	.1312	.1422	.7612	.1333	.0988	.1245	.2538
28	UNALLOCATED INDUSTRIES	.6020	1.9991	1.1919	.8389	.5553	.7906	.4836
29	HOUSEHOLDS	27.1860	21.8257	42.6772	19.4796	17.9714	30.0990	34.2335
30	CITY AND COUNTY GOVERNMENT	.5537	1.1024	.5793	1.0515	.5840	.9808	.4212
31	STATE GOVERNMENT	.2800	.5952	.5170	.6587	.1666	.6799	.6985
32	TOTAL	57.2471	60.5066	71.1099	51.7025	53.6336	55.1289	53.8877
33	CAPITAL RESIDUAL	5.3331	6.7881	7.3101	8.7331	4.2826	7.2443	7.3254
34	FEDERAL GOVERNMENT	3.7355	4.9918	4.0528	6.5004	1.5608	5.4553	6.0394
35	IMPORTS	33.6843	27.7136	17.5273	33.0639	40.5230	32.1716	32.7475
36	TOTAL PRIMARY INPUTS	42.7529	39.4934	28.8901	48.2975	46.3664	44.8711	46.1123
37	TOTAL PURCHASES	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000

Table I-1a Direct Requirements per Dollar of Gross Output, Georgia Economic Model (continued)

	INDUSTRY	STONE, CLAY AND GLASS PROD 15	PRIMARY METAL INDUSTRIES 16	FABRICATED METAL PRODUCTS 17	MACHINERY EXCEPT ELECTRICAL 18	ELECTRICAL MACHINERY & EQUIP. 19	TRANS-PORTATION EQUIPMENT 20	MISCELLA-NEOUS MAN-UFACTURING 21
1	AGRICULTURE (SIC 01, 07-9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.1278
2	MINING (SIC 10-4)	11.4454	.1246	.0027	.0016	.0007	.0010	.0140
3	CONTRACT CONSTRUCTION (SIC 15-7)	.7258	.3687	.1676	.1526	.1275	.1857	.2089
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	.0051	0.0000	.0027	.0957	0.0000	0.0000	.1277
5	TEXTILE MILL PRODUCTS (SIC 22)	.0139	.0533	.0460	.0508	.0688	.0915	.5783
6	APPAREL AND RELATED PRODUCTS (SIC 23)	.7584	.0205	.0430	.0328	.0238	.1213	.2494
7	LUMBER AND WOOD PRODUCTS (SIC 24)	.4360	.2249	.3282	1.3769	.1376	.9052	1.2053
8	FURNITURE AND FIXTURES (SIC 25)	.1317	.0066	.2481	.0423	.0769	.2959	.3380
9	PAPER AND ALLIED PRODUCTS (SIC 26)	.8680	.0895	.7500	.3044	.4118	.1394	2.2516
10	PRINTING AND PUBLISHING (SIC 27)	.0051	.0034	.1712	.0111	.0095	.0068	.3775
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	.7957	.2401	.7326	.8773	.4218	.1774	1.0653
12	PETROLEUM REFINING (SIC 29)	.0495	.0002	.0065	.0005	.0010	.0109	.0054
13	RUBBER AND MISC. PLASTICS (SIC 30)	.3530	.0407	.2862	.6944	1.3143	.3710	2.0620
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	.0048	.0032	.0030	.0228	.0024	.0006	.1440
15	STONE, CLAY AND GLASS PROD. (SIC 32)	2.8836	.0414	.5839	.1485	.2509	.0704	.1681
16	PRIMARY METAL INDUSTRIES (SIC 33)	.2090	2.0747	6.8459	1.7377	1.8567	1.5589	.7398
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	.2929	1.0782	2.5841	2.7178	1.8501	1.0278	1.7642
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	.1891	1.0739	1.3390	3.1081	1.1926	1.1564	.4365
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	.2414	.3605	.2626	1.0819	.9919	.6644	.5468
20	TRANSPORTATION EQUIPMENT (SIC 37)	.0870	1.2455	1.0326	2.4777	4.2896	1.1094	1.1350
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	.0275	.0734	.3672	.3991	.6559	.1112	1.4880
22	TRANSPORTATION SERVICES (SIC 40-7)	2.8719	1.3651	.7118	.4643	.4993	.4715	.4831
23	COMMUNICATIONS & UTILITIES (SIC 48-9)	4.0564	2.2290	1.0116	.7659	.8609	.8915	1.0002
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	2.7987	3.1769	2.8703	2.8914	3.2306	2.3577	4.2573
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	1.4782	1.0423	1.4117	1.3342	1.3523	.5734	1.3718
26	SERVICES (SIC 70-9, 80-6, 89)	2.6735	1.4946	1.6287	1.5200	1.6750	2.3355	3.0521
27	GOVERNMENT ENTERPRISES	.2262	.0931	.0900	.1182	.1087	.1298	.2113
28	UNALLOCATED INDUSTRIES	.8308	2.7242	.6418	.7109	.7750	.8030	.9922
29	HOUSEHOLDS	30.7323	25.3457	28.9427	29.8100	30.1680	23.1813	28.5278
30	CITY AND COUNTY GOVERNMENT	.7087	1.0107	.7823	.5054	.6767	.2756	.8921
31	STATE GOVERNMENT	.2544	.4422	.5170	.4694	.3853	.8288	.7180
32	TOTAL	66.1539	46.0471	54.4112	53.9237	53.4156	39.8531	56.5394
33	CAPITAL RESIDUAL	5.1195	4.4577	5.4800	6.8618	6.8774	8.0041	8.7580
34	FEDERAL GOVERNMENT	2.7473	2.8499	4.3284	4.4480	4.9692	5.7763	5.8516
35	IMPORTS	25.9793	46.6453	35.7804	34.7665	34.7378	46.3664	28.8510
36	TOTAL PRIMARY INPUTS	33.8461	53.9529	45.5888	46.0763	46.5844	60.1469	43.4606
37	TOTAL PURCHASES	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000

Table I-1a Direct Requirements per Dollar of Gross Output, Georgia Economic Model (continued)

	INDUSTRY	TRANSPORTATION SERVICES 22	COMMUNICATIONS AND UTILITIES 23	WHOLESALE AND RETAIL TRADE 24	FINANCE, INSURANCE, REAL EST. 25	SERVICES 26	GOVERNMENT ENTERPRISES 27	UNALLOCATED INDUSTRIES 28
1	AGRICULTURE (SIC 01, 07-9)	.0815	0.0000	.1176	1.5839	.0260	.0140	.6556
2	MINING (SIC 10-4)	.0000	.0012	.0084	.0336	.0030	.0004	0.0000
3	CONTRACT CONSTRUCTION (SIC 15-7)	2.2571	3.1691	.2855	2.5580	1.4926	12.0754	0.0000
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	.4344	.0014	.4620	.0846	.1705	0.0000	6.2497
5	TEXTILE MILL PRODUCTS (SIC 22)	.0121	.0247	.1521	.1358	.0212	.0267	.3997
6	APPAREL AND RELATED PRODUCTS (SIC 23)	.0079	.0058	.1105	.0354	.0909	.0364	.0349
7	LUMBER AND WOOD PRODUCTS (SIC 24)	.0025	.0074	.0889	.0311	0.0000	.0000	.0169
8	FURNITURE AND FIXTURES (SIC 25)	0.0000	.0001	.0288	.0065	0.0000	.0002	0.0000
9	PAPER AND ALLIED PRODUCTS (SIC 26)	.0187	.0767	.3061	.1702	.0474	.1641	.5195
10	PRINTING AND PUBLISHING (SIC 27)	.0342	.0028	.0654	.1361	3.6889	.0843	8.5732
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	.0366	.0571	.2495	.1856	.4612	.4099	.1290
12	PETROLEUM REFINING (SIC 29)	.0090	.0012	.0133	.0103	.0009	.0007	.0002
13	RUBBER AND MISC. PLASTICS (SIC 30)	.0954	.0084	.0866	.0318	.0714	.0260	.0756
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	.0000	.0001	.0064	.0022	.0028	.0010	.0550
15	STONE, CLAY AND GLASS PROD. (SIC 32)	.0026	.0030	.0955	.0284	.0760	.0006	.0049
16	PRIMARY METAL INDUSTRIES (SIC 33)	.0754	.0156	.0125	.0063	.0003	.0002	.7963
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	.0294	.0000	.0946	.0249	.0561	.0042	.3702
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	.0260	.0041	.0849	.0610	.1401	.0067	.3910
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	.1117	.0065	.0599	.0437	.1151	.0073	.0892
20	TRANSPORTATION EQUIPMENT (SIC 37)	1.2573	.0027	.2762	.0451	.0486	.0098	.3317
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	.0007	.0190	.0863	.0107	.2549	.0016	.5939
22	TRANSPORTATION SERVICES (SIC 40-7)	3.4308	.6214	.3719	.2205	.2066	2.9765	10.0775
23	COMMUNICATIONS & UTILITIES (SIC 48-9)	1.2647	8.1651	1.7477	1.4102	5.0294	2.5484	0.0000
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	3.2803	.6924	1.4918	1.4167	3.0916	.6351	4.0175
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	3.1018	1.3758	3.9853	16.0877	5.5617	1.8422	0.0000
26	SERVICES (SIC 70-9, 80-6, 89)	3.4894	3.3691	3.6895	4.4779	6.1491	2.8681	8.8903
27	GOVERNMENT ENTERPRISES	1.3185	6.3477	1.0544	1.4657	1.0638	.0708	0.0000
28	UNALLOCATED INDUSTRIES	.7023	.5223	.7344	.8829	1.7883	.5793	0.0000
29	HOUSEHOLDS	49.0481	26.8555	49.4785	45.5497	35.4330	45.0462	0.0000
30	CITY AND COUNTY GOVERNMENT	.6109	3.4026	1.3059	2.5094	2.4779	0.0000	0.0000
31	STATE GOVERNMENT	1.0673	.6729	12.9517	1.7401	1.1452	0.0000	0.0000
32	TOTAL	71.8065	55.4316	79.5020	80.9860	68.7150	69.4359	42.2720
33	CAPITAL RESIDUAL	6.7160	20.6631	7.8486	11.8907	12.9231	19.7230	0.0000
34	FEDERAL GOVERNMENT	3.2501	9.1968	6.2075	1.8893	6.4857	0.0000	0.0000
35	IMPORTS	18.2273	14.7085	6.4419	5.2340	11.8761	10.8411	57.7280
36	TOTAL PRIMARY INPUTS	28.1935	44.5684	20.4980	19.0140	31.2850	30.5641	57.7280
37	TOTAL PURCHASES	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000

Table I-1a Direct Requirements per Dollar of Gross Output, Georgia Economic Model (continued)

	INDUSTRY	PERSONAL CONSUMP-TION 30	LOCAL GOVERNMENT 32	STATE GOVERNMENT 33
1	AGRICULTURE (SIC 01, 07-9)	.6182	.0630	.0489
2	MINING (SIC 10-4)	.0026	.0004	.0004
3	CONTRACT CONSTRUCTION (SIC 15-7)	0.0000	20.8899	19.8271
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	4.9851	.4841	.3699
5	TEXTILE MILL PRODUCTS (SIC 22)	.2465	.0085	.0076
6	APPAREL AND RELATED PRODUCTS (SIC 23)	.6904	.0352	.0342
7	LUMBER AND WOOD PRODUCTS (SIC 24)	.0222	.0042	.0032
8	FURNITURE AND FIXTURES (SIC 25)	.2919	.1725	.0981
9	PAPER AND ALLIED PRODUCTS (SIC 26)	.0210	.0792	.0615
10	PRINTING AND PUBLISHING (SIC 27)	.2694	.2625	.1421
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	.3409	.3162	.2295
12	PETROLEUM REFINING (SIC 29)	.0023	.0008	.0005
13	RUBBER AND MISC. PLASTICS (SIC 30)	.0838	.0607	.0543
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	.1126	.0000	.0000
15	STONE, CLAY AND GLASS PROD. (SIC 32)	.0134	.0081	.0059
16	PRIMARY METAL INDUSTRIES (SIC 33)	.0003	.0003	.0002
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	.0308	.0143	.0070
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	.0169	.1612	.0868
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	.0355	.0249	.0193
20	TRANSPORTATION EQUIPMENT (SIC 37)	.8066	.0640	.0397
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	.0673	.0272	.0182
22	TRANSPORTATION SERVICES (SIC 40-7)	.7355	.5778	.3641
23	COMMUNICATIONS & UTILITIES (SIC 48-9)	2.4231	1.8674	1.1346
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	16.1564	.7954	.5577
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	11.6128	2.1088	1.3123
26	SERVICES (SIC 70-9, 80-6, 89)	11.8185	2.7063	2.4076
27	GOVERNMENT ENTERPRISES	.2744	.2325	.1923
28	UNALLOCATED INDUSTRIES	0.0000	.5192	.3973
29	HOUSEHOLDS	.6283	57.5198	35.7385
30	CITY AND COUNTY GOVERNMENT	2.3818	0.0000	28.2852
31	STATE GOVERNMENT	2.1549	1.5109	0.0000
32	TOTAL	56.8436	90.5152	91.4442
33	CAPITAL RESIDUAL	5.4933	0.0000	0.0000
34	FEDERAL GOVERNMENT	13.8525	0.0000	1.2098
35	IMPORTS	23.8106	9.4848	7.3460
36	TOTAL PRIMARY INPUTS	43.1564	9.4848	8.5558
37	TOTAL PURCHASES	100.0000	100.0000	100.0000

described as the matrix A, with each element a_{ij} in A representing purchases by industry i from industry j (x_{ij}) as a proportion of the output of industry j (x_j):

$$a_{ij} = \frac{x_{ij}}{x_j} \; .$$

Now let changes in final demands due to the presence of Georgia Tech be represented by the vector Y, where each element in Y, Y_j, is a purchase from industry j. The last column in Table I-2b is such a vector. The first round of expenditures due to Y is, of course, Y itself. We call it round 0 since it is represented by the product:

$$R_0 = A^0 \cdot Y$$

(A matrix raised to the 0^{th} power becomes the identify matrix in the same way that a number raised to the 0^{th} power becomes 1.)

Round 1, the first iteration of these expenditures through the economy, is found as:

$$R_1 = A^1 \cdot Y \; .$$

Each element r_{1i} in R_1 is the sum

$$r_{1i} = \sum_{j=1}^{n} a_{ij} \cdot Y_j$$

and represents the amount purchased from industry i in filling the final demands represented by Y.

Round 2 is found by tracing the results of round 1 through the system:

$$R_2 = A^1 \cdot R_1 \; .$$

This may be rewritten as:

$$R_2 = A^1 \cdot R_1 = A^1 \cdot A^1 \cdot Y = A^2 \cdot Y$$

and successive rounds may be traced as:

$$R_k = A^k \cdot Y,$$

with the total effect (E) of Y on the economy represented by the progression:

$$E = A^0 \cdot Y + A^1 \cdot Y + A^2 \cdot Y + A^3 \cdot Y + \ldots + A^m \cdot Y.$$

With $m = 12$ as in Table I-21, the results of our estimates are very close to their limit. As seen in Table I-21, the sum of round 12 is 0.3 percent of the total effect. In Table I-21, each of the first 13 columns represents a term on the right side of the above equation and the 14th column represents E, the total effect of expenditures.

The presence of Georgia Tech, as represented by the total expenditures associated with the Institute, is calculated using these procedures in Tables I-1b through I-1e, which parallel Tables I-19 through I-22.

Table I-1b Expenditures Related to Georgia Tech, Classified by Industry and Sector Receiving Funds, 1976-77

(thousands of dollars)

	INDUSTRY	RESIDENT INSTRUC-TION 1	ENG. EXPERIMENT STATION 2	ENG. EXTENSION DIVISION 3	AUXILIARY ENTER-PRISES 4	STUDENT IMPACT SPENDING 5	ATHLETIC EXPENDI-TURES 6	FOOTBALL FANS 7
1	AGRICULTURE (SIC 01, 07-9)	0.0	0.0	0.0	40.8	215.4	11.7	16.5
2	MINING (SIC 10-4)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	CONTRACT CONSTRUCTION (SIC 15-7)	641.8	34.9	0.0	0.0	0.0	54.9	0.0
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	0.0	0.0	0.0	571.6	3054.7	164.9	233.4
5	TEXTILE MILL PRODUCTS (SIC 22)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	APPAREL AND RELATED PRODUCTS (SIC 23)	0.0	0.0	0.0	0.0	845.3	0.0	26.8
7	LUMBER AND WOOD PRODUCTS (SIC 24)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	FURNITURE AND FIXTURES (SIC 25)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	PAPER AND ALLIED PRODUCTS (SIC 26)	0.0	0.0	0.0	0.0	32.5	1.0	0.0
10	PRINTING AND PUBLISHING (SIC 27)	1001.2	41.3	40.8	990.0	190.8	100.7	0.0
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	15.6	3.9	0.0	63.0	335.8	.3	10.5
12	PETROLEUM REFINING (SIC 29)	27.6	5.3	1.2	.0	669.3	.9	88.8
13	RUBBER AND MISC. PLASTICS (SIC 30)	0.0	0.0	0.0	0.0	162.6	0.0	.0
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	0.0	0.0	0.0	0.0	32.2	0.0	1.0
15	STONE, CLAY AND GLASS PROD. (SIC 32)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	PRIMARY METAL INDUSTRIES (SIC 33)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	2294.5	787.2	8.8	0.0	34.8	5.2	1.1
18	MACHINERY, EXCEPT ELECTRICAL(SIC 35)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	0.0	0.0	0.0	0.0	91.6	0.0	.7
20	TRANSPORTATION EQUIPMENT (SIC 37)	47.5	7.2	0.0	0.0	1540.4	10.1	0.0
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	0.0	0.0	0.0	117.4	195.2	70.2	5.9
22	TRANSPORTATION SERVICES (SIC 40-7)	249.5	367.1	1.2	47.5	2055.5	211.6	17.6
23	COMMUNICATION & UTILITIES (SIC 48-9)	2038.2	351.9	26.8	707.3	177.4	77.0	0.0
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	31.6	6.2	.8	145.5	7203.7	236.2	486.8
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	532.8	182.3	6.7	88.4	7139.8	233.2	.5
26	SERVICES (SIC 70-9, 80-6, 89)	1195.0	769.8	40.1	450.5	7315.8	138.4	780.4
27	GOVERNMENT ENTERPRISES	179.8	18.3	17.9	2.8	0.0	34.3	0.0
28	UNALLOCATED INDUSTRIES	1517.0	1140.0	59.5	182.2	0.0	153.5	0.0
29	HOUSEHOLDS	27442.6	9054.5	523.6	2330.6	0.0	927.0	0.0
30	CITY AND COUNTY GOVERNMENTS	0.0	0.0	0.0	0.0	0.0	1.3	0.0
31	STATE GOVERNMENT	302.6	373.5	.1	388.6	0.0	3.8	0.0
32	TOTAL PURCHASES	37517.3	13143.5	727.5	6125.2	31293.7	2436.3	1670.0

Table I-1b Expenditures Related to Georgia Tech, Classified by Industry and Sector Receiving Funds, 1976-77 (continued)

(thousands of dollars)

	INDUSTRY	CONTINUING EDUCATION STUDENTS 8	PLACEMENT VISITORS, OTHERS 9	TECH-RELATED DEMANDS 11
1	AGRICULTURE (SIC 01, 07-9)	3.9	.5	289.8
2	MINING (SIC 10-4)	0.0	0.0	0.0
3	CONTRACT CONSTRUCTION (SIC 15-7)	0.0	0.0	731.6
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	54.4	6.4	4085.3
5	TEXTILE MILL PRODUCTS (SIC 22)	0.0	0.0	0.0
6	APPAREL AND RELATED PRODUCTS (SIC 23)	10.2	0.0	882.3
7	LUMBER AND WOOD PRODUCTS (SIC 24)	0.0	0.0	0.0
8	FURNITURE AND FIXTURES (SIC 25)	0.0	0.0	0.0
9	PAPER AND ALLIED PRODUCTS (SIC 26)	0.0	0.0	33.5
10	PRINTING AND PUBLISHING (SIC 27)	0.0	0.0	2364.8
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	4.0	.0	433.0
12	PETROLEUM REFINING (SIC 29)	9.1	0.0	802.1
13	RUBBER AND MISC. PLASTICS (SIC 30)	.0	0.0	162.6
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	.4	0.0	33.7
15	STONE, CLAY AND GLASS PROD. (SIC 32)	0.0	0.0	0.0
16	PRIMARY METAL INDUSTRIES (SIC 33)	0.0	0.0	0.0
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	.4	0.0	3132.0
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	0.0	0.0	0.0
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	.3	0.0	92.6
20	TRANSPORTATION EQUIPMENT (SIC 37)	0.0	0.0	1605.2
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	2.2	0.0	390.9
22	TRANSPORTATION SERVICES (SIC 40-7)	3.2	17.0	2970.1
23	COMMUNICATION & UTILITIES (SIC 48-9)	0.0	0.0	3378.6
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	104.9	9.7	8225.4
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	.2	0.0	8184.0
26	SERVICES (SIC 70-9, 80-6, 89)	300.8	67.1	11057.9
27	GOVERNMENT ENTERPRISES	0.0	0.0	253.1
28	UNALLOCATED INDUSTRIES	0.0	0.0	3052.2
29	HOUSEHOLDS	0.0	0.0	40278.4
30	CITY AND COUNTY GOVERNMENTS	0.0	0.0	1.3
31	STATE GOVERNMENT	0.0	0.0	1068.6
32	TOTAL PURCHASES	493.9	100.7	93509.0

Table I-1c Final Demands Related to Georgia Tech, Local Purchase Coefficients, and Local Final Demands, 1976-77

(thousands of dollars)

	INDUSTRY	TECH-RELATED DEMANDS 1	LOCAL PURCHASE CO-EFFICIENT 2	LOCAL TECH DEMANDS 3
1	AGRICULTURE (SIC 01, 07-9)	289.8	56.9	164.8
2	MINING (SIC 10-4)	0.0	75.2	0.0
3	CONTRACT CONSTRUCTION (SIC 15-7)	731.6	91.3	668.2
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	4085.3	45.9	1877.0
5	TEXTILE MILL PRODUCTS (SIC 22)	0.0	52.2	0.0
6	APPAREL AND RELATED PRODUCTS (SIC 23)	882.3	29.6	261.3
7	LUMBER AND WOOD PRODUCTS (SIC 24)	0.0	53.2	0.0
8	FURNITURE AND FIXTURES (SIC 25)	0.0	49.6	0.0
9	PAPER AND ALLIED PRODUCTS (SIC 26)	33.5	47.5	15.9
10	PRINTING AND PUBLISHING (SIC 27)	2364.8	65.6	1552.3
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	433.0	25.3	109.5
12	PETROLEUM REFINING (SIC 29)	802.1	4.0	31.8
13	RUBBER AND MISC. PLASTICS (SIC 30)	162.6	38.4	62.5
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	33.7	17.4	5.9
15	STONE, CLAY AND GLASS PROD. (SIC 32)	0.0	57.5	0.0
16	PRIMARY METAL INDUSTRIES (SIC 33)	0.0	18.7	0.0
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	3132.0	34.9	1094.6
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	0.0	23.5	0.0
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	92.6	12.7	11.7
20	TRANSPORTATION EQUIPMENT (SIC 37)	1605.2	18.6	299.2
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	390.9	17.0	66.5
22	TRANSPORTATION SERVICES (SIC 40-7)	2970.1	46.7	1385.6
23	COMMUNICATION & UTILITIES (SIC 48-9)	3378.6	88.5	2989.5
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	8225.4	97.7	8033.7
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	8184.0	79.1	6475.0
26	SERVICES (SIC 70-9, 80-6, 89)	11057.9	82.1	9080.8
27	GOVERNMENT ENTERPRISES	253.1	97.8	247.5
28	UNALLOCATED INDUSTRIES	3052.2	69.3	2114.0
29	HOUSEHOLDS	40278.4	100.0	40278.4
30	CITY AND COUNTY GOVERNMENTS	1.3	100.0	1.3
31	STATE GOVERNMENT	1068.6	100.0	1068.6
32	TOTAL PURCHASES	93509.0	120.0	77895.4

Table I-1d Multiplier Effect of All Tech-Related Expenditures, 1976-77

(thousands of dollars)

	INDUSTRY	ROUND 0	ROUND 1	ROUND 2	ROUND 3	ROUND 4	ROUND 5	ROUND 6
1	AGRICULTURE (SIC 01, 07-9)	164.8	811.2	830.7	487.6	357.5	230.9	158.7
2	MINING (SIC 10-4)	0.0	13.9	26.3	30.1	25.2	17.5	11.5
3	CONTRACT CONSTRUCTION (SIC 15-7)	668.2	703.8	1295.0	880.5	574.5	381.4	258.5
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	1877.0	2363.4	1040.5	892.2	531.1	381.6	247.1
5	TEXTILE MILL PRODUCTS (SIC 22)	0.0	193.5	165.5	106.3	73.8	49.0	33.2
6	APPAREL AND RELATED PRODUCTS (SIC 23)	261.3	310.0	131.1	112.6	67.1	48.3	31.2
7	LUMBER AND WOOD PRODUCTS (SIC 24)	0.0	50.8	71.8	77.4	57.7	38.7	25.9
8	FURNITURE AND FIXTURES (SIC 25)	0.0	129.5	55.8	51.5	30.4	21.9	14.1
9	PAPER AND ALLIED PRODUCTS (SIC 26)	15.9	294.5	230.2	133.3	89.3	58.7	39.6
10	PRINTING AND PUBLISHING (SIC 27)	1552.3	680.9	348.9	200.7	140.5	92.0	62.6
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	109.5	280.0	199.5	142.5	94.7	64.2	42.9
12	PETROLEUM REFINING (SIC 29)	31.8	7.6	7.4	10.1	7.0	4.6	3.1
13	RUBBER AND MISC. PLASTICS (SIC 30)	62.5	73.8	58.1	40.0	28.1	18.7	12.6
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	5.9	47.8	17.7	16.6	9.5	7.0	4.4
15	STONE, CLAY AND GLASS PROD. (SIC 32)	0.0	94.5	96.0	103.6	75.3	48.7	32.8
16	PRIMARY METAL INDUSTRIES (SIC 33)	0.0	103.1	28.3	21.0	16.3	11.2	7.4
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	1094.6	116.3	93.0	87.6	62.8	40.9	27.5
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	0.0	62.9	44.2	28.7	20.9	13.7	9.3
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	11.7	45.9	31.7	24.1	16.9	11.2	7.5
20	TRANSPORTATION EQUIPMENT (SIC 37)	299.2	399.3	166.7	138.3	83.2	59.8	38.7
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	66.5	80.6	44.2	27.9	19.3	12.8	8.7
22	TRANSPORTATION SERVICES (SIC 40-7)	1385.6	707.2	343.0	264.0	168.6	116.6	76.9
23	COMMUNICATIONS & UTILITIES (SIC 48-9)	2989.5	2001.1	1205.1	801.3	534.8	360.7	241.6
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	8033.7	7379.2	3035.7	2730.9	1612.1	1163.6	750.3
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	6475.0	6742.1	3602.2	2644.3	1677.3	1160.6	766.1
26	SERVICES (SIC 70-9, 80-6, 89)	9080.8	6425.2	3049.9	2415.4	1493.0	1048.9	686.5
27	GOVERNMENT ENTERPRISES	247.5	613.6	440.8	250.3	178.1	115.7	79.1
28	UNALLOCATED INDUSTRIES	2114.0	350.4	307.4	162.4	123.1	77.6	53.9
29	HOUSEHOLDS	40278.4	14166.4	13932.8	7780.6	5795.9	3678.5	2548.2
30	CITY AND COUNTY GOVERNMENT	1.3	1906.1	1514.9	1069.2	652.4	462.5	302.5
31	STATE GOVERNMENT	1068.6	2187.5	1528.8	844.6	633.8	404.7	279.3
32	TOTAL	77895.4	49342.2	33943.4	22575.2	15249.9	10201.9	6861.8

Table I-1d Multiplier Effect of All Tech-Related Expenditures, 1976-77 (continued)

(thousands of dollars)

	INDUSTRY	ROUND 7	ROUND 8	ROUND 9	ROUND 10	ROUND 11	ROUND 12	TOTAL 13
1	AGRICULTURE (SIC 01, 07-9)	105.2	71.1	47.6	32.0	21.5	14.4	3333.1
2	MINING (SIC 10-4)	7.7	5.2	3.5	2.3	1.6	1.1	145.8
3	CONTRACT CONSTRUCTION (SIC 15-7)	172.8	116.2	77.9	52.4	35.1	23.6	5239.9
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	169.3	112.4	75.9	50.8	34.2	22.9	7798.3
5	TEXTILE MILL PRODUCTS (SIC 22)	22.2	14.9	10.0	6.7	4.5	3.0	682.7
6	APPAREL AND RELATED PRODUCTS (SIC 23)	21.4	14.2	9.6	6.4	4.3	2.9	1020.5
7	LUMBER AND WOOD PRODUCTS (SIC 24)	17.4	11.7	7.9	5.3	3.5	2.4	370.4
8	FURNITURE AND FIXTURES (SIC 25)	9.7	6.4	4.3	2.9	2.0	1.3	329.9
9	PAPER AND ALLIED PRODUCTS (SIC 26)	26.5	17.8	11.9	8.0	5.4	3.6	934.7
10	PRINTING AND PUBLISHING (SIC 27)	41.7	28.1	18.8	12.7	8.5	5.7	3193.2
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	28.9	19.3	13.0	8.7	5.9	3.9	1013.0
12	PETROLEUM REFINING (SIC 29)	2.1	1.4	.9	.6	.4	.3	77.3
13	RUBBER AND MISC. PLASTICS (SIC 30)	8.4	5.7	3.8	2.6	1.7	1.2	317.0
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	3.1	2.0	1.4	.9	.6	.4	117.3
15	STONE, CLAY AND GLASS PROD. (SIC 32)	22.0	14.8	9.9	6.7	4.5	3.0	511.7
16	PRIMARY METAL INDUSTRIES (SIC 33)	5.0	3.3	2.2	1.5	1.0	.7	201.1
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	18.5	12.4	8.3	5.6	3.8	2.5	1573.8
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	6.2	4.2	2.8	1.9	1.3	.9	197.1
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	5.0	3.4	2.3	1.5	1.0	.7	163.0
20	TRANSPORTATION EQUIPMENT (SIC 37)	26.5	17.6	11.9	8.0	5.3	3.6	1258.2
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	5.8	3.9	2.6	1.8	1.2	.8	276.0
22	TRANSPORTATION SERVICES (SIC 40-7)	52.1	34.8	23.4	15.7	10.6	7.1	3205.7
23	COMMUNICATIONS & UTILITIES (SIC 48-9)	162.3	108.9	73.1	49.1	33.0	22.1	8582.6
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	515.2	341.6	230.9	154.4	103.9	69.7	26121.0
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	519.1	346.7	233.4	156.4	105.1	70.5	24498.6
26	SERVICES (SIC 70-9, 80-6, 89)	467.4	311.3	209.9	140.6	94.5	63.4	25486.8
27	GOVERNMENT ENTERPRISES	52.5	35.5	23.7	16.0	10.7	7.2	2070.7
28	UNALLOCATED INDUSTRIES	35.5	24.1	16.1	10.8	7.3	4.9	3287.5
29	HOUSEHOLDS	1681.5	1139.6	761.0	512.4	343.4	230.7	92849.5
30	CITY AND COUNTY GOVERNMENT	206.0	137.2	92.5	61.9	41.6	27.9	6475.9
31	STATE GOVERNMENT	184.6	125.0	83.5	56.2	37.7	25.3	7459.7
32	TOTAL	4601.6	3090.9	2074.3	1392.8	934.9	627.6	228791.8

Table I-1e The Economic Impact of All Tech-Related Expenditures on Employment, Household Income, and Local and State Government Income, 1976-77

(thousands of dollars)

	INDUSTRY	NONAGRIC. EMPLOYMENT IMPACT 14	HOUSEHOLD INCOME IMPACT 15	LOCAL GOVERNMENT IMPACT 16	STATE GOVERNMENT IMPACT 17
1	AGRICULTURE (SIC 01, 07-9)	164.0	1215.8	102.6	0.0
2	MINING (SIC 10-4)	4.7	41.5	1.4	.5
3	CONTRACT CONSTRUCTION (SIC 15-7)	176.5	1383.0	53.7	19.3
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	158.9	1394.4	34.7	26.0
5	TEXTILE MILL PRODUCTS (SIC 22)	18.8	152.7	2.5	2.1
6	APPAREL AND RELATED PRODUCTS (SIC 23)	77.8	391.9	1.5	2.8
7	LUMBER AND WOOD PRODUCTS (SIC 24)	17.0	103.0	5.3	8.4
8	FURNITURE AND FIXTURES (SIC 25)	15.5	89.7	1.8	.9
9	PAPER AND ALLIED PRODUCTS (SIC 26)	19.1	204.0	10.3	5.6
10	PRINTING AND PUBLISHING (SIC 27)	132.6	1362.8	18.5	16.5
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	21.9	197.3	10.7	6.7
12	PETROLEUM REFINING (SIC 29)	1.6	13.9	.5	.1
13	RUBBER AND MISC. PLASTICS (SIC 30)	10.4	95.4	3.1	2.2
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	7.0	40.1	.5	.8
15	STONE, CLAY AND GLASS PROD. (SIC 32)	18.5	157.3	3.6	1.3
16	PRIMARY METAL INDUSTRIES (SIC 33)	4.7	51.0	2.0	.9
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	44.1	455.5	12.3	8.1
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	6.2	58.8	1.0	.9
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	5.1	49.2	1.1	.6
20	TRANSPORTATION EQUIPMENT (SIC 37)	25.1	291.7	3.5	10.4
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	13.4	78.7	2.5	2.0
22	TRANSPORTATION SERVICES (SIC 40-7)	192.9	1572.3	19.6	34.2
23	COMMUNICATIONS & UTILITIES (SIC 48-9)	252.8	2304.9	292.0	57.8
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	1846.5	12924.3	341.1	3383.1
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	433.7	11159.0	614.8	426.3
26	SERVICES (SIC 70-9, 80-6, 89)	1054.7	9030.8	631.5	291.9
27	GOVERNMENT ENTERPRISES	0.0	932.8	0.0	0.0
28	UNALLOCATED INDUSTRIES	0.0	0.0	0.0	0.0
29	HOUSEHOLDS	0.0	40861.8	2211.5	2000.8
30	CITY AND COUNTY GOVERNMENT	61.8	3724.9	1.3	97.8
31	STATE GOVERNMENT	207.1	2666.0	2110.0	1068.6
32	TOTAL	4992.6	93004.3	6494.7	7476.7

Appendix I-2

THE CHARACTERISTICS OF FOOTBALL FANS

Data for estimating the expenditures of football fans were obtained from interviews with fans at five games during the 1976 season. The sample is described in Table I-2a.

Since two games were missing from our sample, we recalculated the proportions of fans from Atlanta, the rest of Georgia, and outside of Georgia as shown in Table I-2b. The proportions were only slightly different from those obtained from the uncorrected sample, varying by less than two percent. While we used these corrected proportions with which to calculate fan expenditures in Appendix I-3, we used mean expenditures based on the uncorrected sample, confident that they closely represent the population as a whole.

A copy of the survey questionnaire itself follows Table I-2b. The data was gathered in a style developed in other sports studies (see, for example, William A. Schaffer and Lawrence S. Davidson, Economic Impact of the Falcons on Atlanta: 1972, Atlanta, the Atlanta Falcons, 1973). A team of 10-15 interviewers, primarily undergraduates at Georgia Tech, interviewed fans selected at random and scattered systematically throughout the non-student sections of the Stadium in accordance with a sampling plan based on expected attendance at each game, collected 791 responses distributed among the major stands as noted in Table I-2c.

Table I-2d tabulates responses for the entire season.

Table I-2a Sample of Football Fans

Opponent	Date	Number	Attendance
Clemson	Sept. 25	169	43,937
Virginia	Oct. 2	139	38,119
Tennessee	Oct. 9	210	55,631
Tulane	Oct. 23	138	31,214
Notre Dame	Nov. 6	141	50,079
Total		797	218,980

Table I-2b Calculation of Number of Nonstudent Fans from Metropolitan Atlanta, the Rest of Georgia, and Outside of Georgia

Date	Home opponent	Announced attendance	Nonstudent attendance	--Proportion from-- Metro Atlanta	Rest of Georgia	Outside Georgia	--Number from-- Metro Atlanta	Rest of Georgia	Outside Georgia
Sept. 11	South Carolina	38,923	37,327	.564[a]	.127[a]	.309[a]	21,052	4,741	11,534
Sept. 18	Pittsburgh	43,424	36,411	.507[b]	.207[b]	.286[b]	18,460	7,537	10,414
Sept. 25	Clemson	43,937	37,292	.564	.127	.309	21,033	4,736	11,523
Oct. 2	Virginia	38,119	32,121	.719	.180	.101	23,095	5,782	3,244
Oct. 9	Tennessee	55,631	48,345	.468	.144	.388	22,625	6,962	18,758
Oct. 23	Tulane	31,214	26,309	.660	.239	.101	17,364	6,288	2,657
Nov. 6	Notre Dame	50,079	43,564	.507	.207	.286	22,087	9,018	12,459
	Total	301,327	261,369	.558[c]	.172[c]	.270[c]	145,716	45,064	70,589
(Uncorrected sample values)[d]				(.574)[d]	(.173)[d]	(.253)[d]			

Column calculations:

(6) = (2) x (3)
(7) = (2) x (4)
(8) = (2) x (5)

Notes:

a/ Proportions for Clemson were used for South Carolina.

b/ Proportions for Notre Dame were used for Pittsburgh.

c/ Proportions calculated from summed estimates of nonstudent attendance by origin.

d/ Proportions and numbers for entire sample prior to adjustment for South Carolina and Pittsburgh games. Displayed only to show effects of adjustments a/ and b/.

FOOTBALL SURVEY

QUESTIONS FOR EVERYONE (section) ___ ___ ,

1. With whom did you come to the game?
   1- family only   3- friends and family   5- alone
   2- friends only   4- organization
2. How many are in your party (actual number, including yourself)?
3. How did you get to Grant Field?
   1- car, parked on campus   4- charter bus   6- taxi
   2- car to town, shuttle bus   5- city bus only   7- walked
   3- car to area, walked
4. Are you (yourself) a season-ticket holder?
   1- yes   2- no
5. Did you attend Georgia Tech?
   1- yes   3- no, attended visiting team's school
   2- no (just no)   4- no, attended ______________
6. Do you attend other football games in the area?
   1- Falcons regularly   3- University of Georgia   5- other
   2- Falcons occasionally   4- no
7. Which starting time do you like the most? the least? (M) ___ , (L) ___ ,
   1- 2:00   2- 4:30   3- 7:30
8. Would you prefer night games early in the season (when it's hot) and afternoon games late in the season?
   1- yes   2- no
9. Do you live in the metropolitan Atlanta area (seven-county area)?
   1- yes   2- no

QUESTIONS FOR RESIDENTS OF METROPOLITAN ATLANTA

10. How far do you live from Grant Field (approximate distance in miles)?
11. Where do you live?
    1- City   3- S. Fulton   5- Gwinnett   7- Douglas   9- Rockdale
    2- N. Fulton   4- DeKalb   6- Cobb   8- Clayton
12. If you live in the city, in which quadrant?
    1- NE   2- NW   3- SE   4- SW
13. Did you stop for food before the game, or do you expect to stop afterward?
    1- yes, on the way   3- yes, both
    2- yes, after only   4- no
14. If yes: How much does your party expect to spend on food outside Grant Field?
    1- $ 0-$ 5   4- $16-$20   6- more than $25
    2- $ 6-$10   5- $21-$25   (approximately $____)
    3- $11-$15
15. Would you be dining out anyway if there were no game today?
    1- yes   2- no

QUESTIONS FOR OUT-OF-TOWN RESIDENTS

16. Did you come to Atlanta specifically to see this game?
    1- yes   2- no
17. How far do you live from Atlanta (approximate distance in miles)?
18. In what state do you live?
    1- Ga.   3- S.C.   5- N.C.   7- Va.   9- Ind.
    2- Ala.   4- Tenn.   6- Fla.   8- La.   0 - ________
19. How did you travel to Atlanta?
    1- car   3- bus
    2- plane   4- train
20. For how many nights will you be in Atlanta?
21. Are you staying in:
    1- downtown hotel or motel   3- with friends or relatives
    2- suburban hotel or motel   4- other ______________

Please estimate how much you will spend for the following:

22. FOOD (outside stadium)	23. OTHER ENTERTAINMENT	24. SHOPPING	25. GASOLINE	26. LODGING
1- $ 0	1- $ 0	1- $ 0	1- $ 0	1- $0
2- $ 1- 5	2- $ 1- 5	2- $ 1- 5	2- $ 1- 3	2- $1- 9
3- $ 6-10	3- $ 6-10	3- $ 6-15	3- $ 4- 6	3- $10-15
4- $11-15	4- $11-20	4- $16-25	4- $ 7- 9	4- $16-20
5- $16-25	5- $21-30	5- over $25	5- $10-15	5- $21-30
6- $26-35	6- $31-50	($______)	6- over $15	6- $31-40
7- $36-$50	7- over $50	6- no est.	($______)	7-$41-50
8- over $50	($______)		7- no est.	8- $51-70
($______)	8- no est.			9- over $70
9- no est.				($______)
				0- no est.

Table I-2c Seating of Fans Classified by Geographic Origin

Stands	Atlanta	Rest of Ga.	Elsewhere	Total
	—	Origin —		
Lower West	139	40	15	194
Upper West	89	24	20	133
South	47	20	36	103
Lower East	56	19	45	120
Upper East	28	16	59	103
North	94	19	25	138
Total	453	138	200	791

Table I-2d. Tabulation of Results of Football Survey for 1976 Season

Tabulations are of percent of fans in categories. Note that the column heading denoting the geographic origins of fans is not repeated with each question.

Questions for everyone

	---Residence of fans---		
	Atlanta	Rest of Ga.	Elsewhere
1. With whom did you come to the game?			
1 family only	49.1	51.5	43.5
2 friends only	28.1	23.5	34.5
3 friends and family	16.8	19.1	20.0
4 organization	0.9	2.2	1.0
5 alone	5.1	3.7	1.0
Total	100.0	100.0	100.0
2. How many are in your party?			
One	5.7	3.7	1.0
Two	49.7	44.1	36.9
Three	7.9	11.0	8.1
Four	23.0	24.3	28.3
Five	3.8	5.9	8.1
Six	6.2	8.8	10.1
More than six	4.7	2.2	7.5
Total	100.0	100.0	100.0
3. How did you get to Grant Field?			
1 car, parked on campus	37.5	33.3	36.0
2 car, to town, bus	1.3	3.6	7.5
3 car to area, walked	54.7	59.4	39.0
4 charter bus	2.4	1.4	4.5
5 city bus only	0.7	1.4	2.5
6 taxi	0.9	0.0	6.0
7 walked	2.4	0.7	4.5
Total	100.0	100.0	100.0
4. Are you a season-ticket holder?			
1 yes	37.1	28.3	10.0
2 no	62.9	71.7	90.0
Total	100.0	100.0	100.0

5. Did you attend Georgia Tech?

1 yes	36.9	29.0	14.0
2 no (just no)	48.3	48.6	32.5
3 no, opposing school	3.1	2.9	40.5
4 no, other school	11.7	19.6	13.0
Total	100.0	100.0	100.0

6. Do you attend other football games in the area?

1 Falcons regularly	7.5	5.1	0.0
2 Falcons occasionally	38.6	24.1	11.1
3 University of Georgia	6.4	12.4	7.0
4 no	43.5	52.6	79.9
5 other	4.0	5.8	2.0
Total	100.0	100.0	100.0

7a. Which starting time do you like the most?

1 2:00	57.2	66.9	74.4
2 4:30	4.9	8.1	2.0
3 7:30	37.9	25.0	23.6
Total	100.0	100.0	100.0

7b. Which starting time do you like the least?

1 2:00	23.1	16.2	13.1
2 4:30	45.5	44.9	58.3
3 7:30	31.4	39.0	28.6
Total	100.0	100.0	100.0

8. Would you prefer night games early in the season and afternoon games late in the season?

1 yes	74.8	74.6	73.4
2 no	25.2	25.4	26.6
Total	100.0	100.0	100.0

9. Do you live in the metropolitan Atlanta area (7-county area)?

1 yes	100.0	0.0	0.0
2 no	0.0	100.0	100.0
Total	100.0	100.0	100.0

Questions for Residents of Metropolitan Atlanta

10. How far do you live from Grant Field?

1-5 miles	12.0
7-10 miles	20.5
11-15 miles	28.7
16-20 miles	24.5
more than 20 miles	14.3
Total	100.0
mean response	15 miles

11. Where do you live?

1 City	14.2
2 N. Fulton	14.6
3 S. Fulton	7.2
4 DeKalb	33.0
5 Gwinnett	5.6
6 Cobb	18.4
7 Douglas	1.1
8 Clayton	4.3
9 Rockdale	1.6
Total	100.0

12. If you live in the city, in which quadrant?

1 Northeast	43.1
2 Northwest	40.6
3 Southeast	7.5
4 Southwest	8.7
Total	100.0

13. Did you stop for food before the game, or do you expect to stop afterwards?

1 yes, on the way	36.9
2 yes, after only	24.5
3 yes, both	4.2
4 no	34.4
Total	100.0

14. If yes: How much does your party expect to spend on food outside Grant Field?

1 $ 0-5	49.8
2 $ 6-10	.3
3 $11-15	24.1
4 $16-20	11.8
5 $21-25	8.7
6 more than $25	5.3
Total	100.0
mean response	$7.25

15. Would you be driving out anyway if there were no game today?

1 yes	32.6
2 no	67.9
Total	100.0

Questions for Out-of-Town Residents

16. Did you come to Atlanta specifically to see this game?

1 yes	90.5	85.9
2 no	9.5	14.1
Total	100.0	100.0

17. How far do you live from Atlanta?

Less than 51 miles	27.0	0.0
51-100 miles	41.6	0.0
101-150 miles	19.0	27.1
151-200 miles	8.0	24.2
more than 200 miles	4.4	48.7
Total	100.0	100.0
mean response	95 miles	293 miles

18. In what state do you live?

1 Georgia	100.0	0.0
2 Alabama	0.0	4.5
3 South Carolina	0.0	24.5
4 Tennessee	0.0	43.5
5 North Carolina	0.0	5.5
6 Florida	0.0	6.5
7 Virginia	0.0	3.0
8 Louisiana	0.0	2.5
9 Indiana	0.0	1.0
10 Other	0.0	9.0
Total	100.0	100.0

19. How did you travel to Atlanta?

1 car	98.6	87.4
2 plane	0.0	7.5
3 bus	1.4	4.0
4 train	0.0	1.0
	100.0	100.0

20. For how many nights will you be in Atlanta?

0	61.6	27.0
1 night	27.5	23.5
2 nights	10.1	35.5
3 nights	0.7	11.0
more than 3 nights	0.0	3.0
	100.0	100.0

21. Are you staying in:

1 downtown hotel or motel	20.0	38.6
2 suburban hotel or motel	8.3	22.9
3 with friends or relatives	45.0	31.4
4 other	26.7	7.2
Total	100.0	100.0

Please estimate how much you will spend for the following:

22. Food (mean response)	$12.95	$20.68
23. Other entertainment (mean response)	$ 4.42	$10.31
24. Shopping (mean response)	$ 1.58	$ 3.72
25. Gasoline (mean response)	$ 5.79	$ 6.60
26. Lodging (mean response)	$ 5.33	$14.82

Appendix I-3

EXPENDITURES BY FOOTBALL FANS

The procedures used in estimating expenditures by football fans were as follows.

Expenditures by out-of-town fans

In calculating expenditures in Atlanta by football fans from outside Atlanta, we use the questionnaire responses of 338 of these fans. This number excludes all questionnaires for which the number in the party was greater than ten. These were divided into two groups: fans from the rest of Georgia and fans from outside of Georgia and separate calculations made for each group as outlined below.

First, we exclude the answers "over $X" (where X is the beginning of the open interval) and "no estimate" for the expenditure category being considered. These exclusions eliminate from the sample the large groups for which estimates are probably wild guesses, and they eliminate some fairly difficult problems in imputing values for the excluded categories. We feel that these exclusions improve the quality of the data substantially.

Second, we compute the mean expenditures per party by assigning midpoint values for the levels in each spending category and computing the mean value for the frequency distribution of fans in the category, subject to the exclusions above. Means were computed for fans classified as living in Atlanta, the rest of Georgia, and the rest of the world and are presented in Table I-3a.

Third, we compute mean expenditures per person by dividing mean expenditures per party by mean party size for each of the fan categories and

Table I-3a. Mean Expenditures by Football Fans, Classified by Type of Expenditure and Geographic Origin, 1976

Category	Mean group expenditure	Mean fan expenditure
	Atlanta fans	
Food, outside stadium	7.25	2.35
	Other Georgia fans	
Food, outside stadium	12.95	4.02
Other entertainment	4.42	1.37
Shopping	1.58	.49
Gasoline	5.79	1.80
Lodging	5.33	1.66
	Out-of-state fans	
Food, outside stadium	20.68	5.50
Other entertainment	10.31	2.74
Shopping	3.72	.99
Gasoline	6.60	1.76
Lodging	14.82	3.94

Notes:

Mean fan expenditures are calculated as the mean group expenditure divided by the mean group size for each grouping of fans. The mean group size is 3.08 for Atlanta fans, 3.22 for other Georgia fans, and 3.76 for out-of-state fans.

expenditure categories subject to the above exclusions, as shown in Table I-3a.

Fourth, we estimate total expenditures by fan category as the mean expenditure per person times the proportion of fans in the category times the number of persons in Atlanta specifically to attend games. This step resulted in Table I-8 in the text.

The number of fans from the rest of Georgia in Atlanta specifically to see a Georgia Tech game is estimated as total nonstudent attendance from the rest of Georgia (45,064) times the proportion in Atlanta specifically to see the game (.899). The number of fans from out of state is estimated similarly as 70,589 fans times .855.

<u>Expenditures by Atlanta fans</u>

Expenditures by Atlanta fans for food and gasoline are estimated as follows.

For food, the number of Atlanta fans (145,716) is multiplied by the mean food expenditure ($2.35).

For gasoline, the following formula is used:

$$\text{Gas expenditures by Atlantans} = \left[\text{Number of Atlanta fans} \times \text{Proportion by} \div \text{Average party size}\right]$$

$$\times \left[\text{Round trip distance} \times \text{Average gasoline price per gallon} \div \text{Average miles per gallon}\right]$$

$$= (145{,}716 \times .935 \div 3.08) \times \$.58 \div 16$$

$$= \$48{,}106$$

Appendix I-4

A SURVEY OF PARTICIPANTS IN CONTINUING EDUCATION COURSES

To form an estimate of expenditures by participants in continuing education programs, we conducted a survey of attendance at three sets of programs: a solar energy course for three days (55 responses), a course in industrial development for six days (43 responses), and a series of miscellaneous one-day programs (35 responses).

Of the 133 persons in the sample, 21 came from Atlanta, 17 from the rest of Georgia, and 95 from elsewhere in the United States. Even though this sample is small in terms of its statistical significance, it appears to be representative of the continuing education program and yields results which are within reason. As a consequence, we have used it without adjustment in estimating expenditures associated with continuing education at Georgia Tech.

The questionnaire follows this page and Table I-3a tabulates the results.

Using attendance figures from official records and mean expenditures by geographic origin we calculated expenditures for Table I-9 as follows:

For participants from Atlanta:

Food: Mean expenditure per person (=3.48) x 789 persons.

Gasoline: Proportion driving (=.9) x round trip distance (=25.8 miles) x cost per mile (= .0363) x 789 persons.

For participants from the rest of Georgia:

Mean expenditures per person x 597 persons.

For participants from outside of Georgia:

Mean expenditures per person x 1822 persons.

VISITORS ECONOMIC SURVEY

The Georgia Tech College of Industrial Management is conducting research on the economic impact of Tech on Atlanta. Part of this study includes the expenditures of people drawn to Tech by its programs and seminars. Would you please take a few minutes of your time and fill out our survey by putting the appropriate number in each blank? Thanks for your help.

1. How many similar programs have you participated in within the last two years:
   - at Tech ____
   - another college ____
   - your company ____
   - other ____

2. Did you attend Georgia Tech? ____
   1- yes 2- no 3- no, attended ____________________
3. How did you first hear about the program you are now attending? ____
   1- professional publication 4- company program
   2- from a friend 5- Tech brochure
   3- newspaper 6- other
4. How did you get to Tech today? ____
   1- car 3- city bus 5- walked
   2- charter bus 4- taxi
5. Which of the following best describes your line of work? ____
   1- government 3- industry 5- business 7- Other __________
   2- education 4- professional 6- unemployed

QUESTIONS FOR RESIDENTS OF METROPOLITAN ATLANTA

6. How far do you live from Tech (approximate miles)? ____
7. Where do you live? ____
   1- City 3- S. Fulton 5- Gwinnett 7- Douglas 9- Rockdale
   2- N. Fulton 4- DeKalb 6- Cobb 8- Clayton
8. If you live in the city, in which quadrant?
   1- NE 2- NW 3- SE 4- SW
9. Will you incur any expenses other than transportation and fees? ____
10. If yes: How much do you expect to spend? ____
    1- $0 - $ 5 3- $11 - $15 5- more than $20
    2- $6 - $10 4- $16 - $20 (approx. $_______)
11. And if yes; please describe: ____

QUESTIONS FOR OUT OF TOWN RESIDENTS

12. Did you bring your family with you? ____
    1- yes 2- no
13. How many are in your party (including yourself)? ____
14. Did you come to Atlanta specifically for this event? ____
    1- yes 2- no
15. How far do you live from Atlanta (approx. distance in miles)? ____
16. In what state do you live? ____
    1- Ga. 3- S. C. 5- N.C. 7- Va. 9- Ind.
    2- Ala. 4- Tenn. 6- Fla. 8- La. 0- ________
17. How did you travel to Atlanta? ____
    1- car 2- plane 3- bus 4- train
18. For how many nights will you be in Atlanta? ____
19. Are you staying in: ____
    1- downtown hotel or motel 3- with friends or relatives
    2- suburban hotel or motel 4- other ______________

Please estimate how much you will spend for the following:

20. FOOD	21. OTHER ENTERTAINMENT	22. SHOPPING	23. GASOLINE	24. LODGING
1- $ 0	1- $ 0	1- $ 0	1- $ 0	1- $ 0
2- $ 1- 5	2- $ 1- 5	2- $ 1- 5	2- $ 1- 3	2- $ 1- 9
3- $ 6-10	3- $ 6-10	3- $ 6-15	3- $ 4- 6	3- $10-15
4- $11-15	4- $11-20	4- $16-25	4- $ 7- 9	4- $16-20
5- $16-25	5- $21-30	5- over $25 ($_____)	5- $10-15	5- $21-30
6- $26-35	6- $31-50	6- no est.	6- over $15 ($_____)	6- $31-40
7- $36-50	7- over $50 ($_____)		7- no est.	7- $41-50
8- over $50 ($_____)	8- no est.			8- $51-70
9- no est.				9- over $70 ($_____)
				0- no est.

____ ____ ____ ____ ____

Table I-4a. Tabulation of Continuing Education Survey, 1977

Tabulations are of percent of fans in categories unless otherwise specified. Note that the column headings denoting the geographic origins of fans is not repeated with each question.

	--Residence of Participant--		
	Atlanta	Rest of Ga.	Elsewhere
1. How many similar programs have you participated in within the last two years (mean):			
at Tech	.35	.235	.126
at another college	.10	.412	.379
at your company	.15	.176	.326
other	.20	.471	.358
2. Did you attend Georgia Tech?			
1 yes	35.0	11.8	8.4
2 no	30.0	64.7	30.5
3 no, attended another college	35.0	23.5	61.1
Total	100.0	100.0	100.0
3. How did you first hear about the program you are now attending?			
1 professional publication	0.0	17.6	14.7
2 from a friend	25.0	23.5	9.5
3 newspaper	0.0	0.0	1.1
4 company program	20.0	11.8	13.7
5 Tech brochure	40.0	47.1	52.6
6 other	15.0	0.0	8.4
Total	100.0	100.0	100.0
4. How did you get to Tech today?			
1 car	90.0	58.8	57.9
2 charter bus	0.0	0.0	0.0
3 city bus	5.0	0.0	1.1
4 taxi	0.0	11.8	1.1
5 walked	5.0	29.4	40.0
Total	100.0	100.0	100.0

5. Which of the following best describes your line of work?

1	government	30.0	11.8	28.4
2	education	5.0	0.0	3.2
3	industry	5.0	17.6	22.1
4	professional	10.0	41.2	21.1
5	business	35.0	11.8	15.8
6	unemployed	0.0	5.9	0.0
7	other	15.0	11.8	9.5
	Total	100.0	100.0	100.0

Questions for Residents of Metropolitan Atlanta

6. How far do you live from Tech (approximate miles)?

mean response 12.9 miles

7. Where do you live?

1	City	15.0
2	N. Fulton	20.0
3.	S. Fulton	5.0
4	DeKalb	50.0
5	Gwinnett	5.0
6	Cobb	5.0
7	Douglas	0.0
8	Clayton	0.0
9	Rockdale	0.0
	Total	100.0

8. If you live in the city, in which quadrant?

1	Northeast	70.0
2	Northwest	10.0
3	Southeast	10.0
4	Southwest	10.0
	Total	100.0

9. Will you incur any expenses other than transportation and fees?

1	yes	40.0
2	no	60.0
	Total	100.0

10. If yes: How much do you expect to spend?

0	no	60.0
1	$ 0-5	15.0
2	$ 6-10	15.0
3	$11-15	5.0
4	$16-20	0.0
5	more than $20	5.0
	Total	100.0
	mean response	3.48

11. And if yes; please describe. (no tabulation)

Questions for Out-of-Town Residents

12. Did you bring your family with you?

1	yes	11.8	12.6
2	no	88.2	88.4
	Total	100.0	100.0

13. How many are in your party (including yourself)?

1	81.3	71.6
2	18.7	23.2
3	0.0	3.2
more than three	0.0	2.2
Total	100.0	100.0
mean response	1.9	1.4

14. Did you come to Atlanta specifically for this event?

1	yes	100.0	95.8
2	no		4.2
	Total	100.0	100.0

15. How far do you live from Atlanta (approximate distance in miles)?

mean response	126 miles	581 miles

16. In what state do you live?

1	Georgia	100.0	0.0
2	Alabama	0.0	2.1
3	South Carolina	0.0	7.4
4	Tennessee	0.0	9.5
5	North Carolina	0.0	7.4
6	Florida	0.0	17.9
7	Virginia	0.0	7.4
8	Louisiana	0.0	3.2
9	Indiana	0.0	2.1
10	Other	0.0	43.2
	Total	100.0	100.0

17. How did you travel to Atlanta?

1	car	82.4	45.3
2	plane	17.6	53.7
3	bus	0.0	0.0
4	train	0.0	1.1
	Total	100.0	100.0

18. For how many nights will you be in Atlanta?

none	29.4	1.1
1 night	0.0	0.0
2 nights	5.9	2.1
3 nights	23.5	25.3
4 nights	11.8	15.8
5 nights	29.4	45.3
more than 5 nights	0.0	10.5
	100.0	100.0

19. Are you staying in:

1 downtown hotel or motel	58.8	78.9
2 suburban hotel or motel	5.9	14.7
3 with friends or relatives	5.9	4.2
4 others	29.4	2.1

Please estimate how much you will spend for the following:

20.	Food (mean)	$45.79	$63.31
21.	Other entertainment (mean)	$11.82	$26.71
22.	Shopping	$ 8.56	$18.64
23.	Gasoline	$13.97	$ 8.89
24.	Lodging	$75.86	$100.53

Appendix I-5

Transformation of Purchases of Products to Purchases From Industries

The transformation matrix described in Part I (pp. 42-45) records the proportions by which a purchase associated with Georgia Tech is subdivided to show the industries which receive direct income from the transaction. These are primarily the margins associated with retail and wholesale trade, the transportation costs, and the payments received by producers of goods. Recorded in Table I-5a, our transformation matrix has been based on the detailed Georgia input-output data and on "Personal Consumption Expenditures in the 1963 Input-Output Study," Survey of Current Business I-1 (January 1971), 34-38.

Table I-5a Transformation of Purchases of Commodities Related to Georgia Tech to Purchases from Industries

	INDUSTRY	CONTRACT CONSTRUC-TION 1	FOOD AND KINDRED PRODUCTS 2	APPAREL, RELATED PRODUCTS 3	PRINTING AND PUBLISHING 4	CHEMICALS AND ALLIED PRODUCTS 5	PETROLEUM PRODUCTS 6	FABRICATED METAL PRODUCTS 7
1	AGRICULTURE (SIC 01, 07-9)	0.0000	.0593	0.0000	0.0000	0.0000	0.0000	0.0000
2	MINING (SIC 10-4)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	CONTRACT CONSTRUCTION (SIC 15-7)	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	0.0000	.8296	0.0000	0.0000	0.0000	0.0000	0.0000
5	TEXTILE MILL PRODUCTS (SIC 22)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6	APPAREL AND RELATED PRODUCTS (SIC 23)	0.0000	0.0000	.7900	0.0000	0.0000	0.0000	0.0000
7	LUMBER AND WOOD PRODUCTS (SIC 24)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	FURNITURE AND FIXTURES (SIC 25)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9	PAPER AND ALLIED PRODUCTS (SIC 26)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	PRINTING AND PUBLISHING (SIC 27)	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	0.0000	0.0000	0.0000	0.0000	.6536	0.0000	0.0000
12	PETROLEUM REFINING (SIC 29)	0.0000	0.0000	0.0000	0.0000	0.0000	.5886	0.0000
13	RUBBER AND MISC. PLASTICS (SIC 30)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	STONE, CLAY AND GLASS PROD. (SIC 32)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
16	PRIMARY METAL INDUSTRIES (SIC 33)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
18	MACHINERY, EXCEPT ELECTRICAL(SIC 35)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	TRANSPORTATION EQUIPMENT (SIC 37)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
22	TRANSPORTATION SERVICES (SIC 40-7)	0.0000	.0252	.0100	0.0000	.0196	.0400	0.0000
23	COMMUNICATION & UTILITIES (SIC 48-9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	0.0000	.0859	.2000	0.0000	.3268	.3714	0.0000
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	SERVICES (SIC 70-9, 80-6, 89)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	GOVERNMENT ENTERPRISES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28	UNALLOCATED INDUSTRIES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	HOUSEHOLDS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	CITY AND COUNTY GOVERNMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
31	STATE GOVERNMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
32	TOTAL PURCHASES	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table I-5a Transformation of Purchases of Commodities Related to Georgia Tech to Purchases from Industries (continued)

	INDUSTRY	TRANS-PORTATION EQUIPMENT 8	MISC. MANUFAC-TURING 9	TRANS-PORTATION SERVICES 10	COMMUNICA-TIONS AND UTILITIES 11	FINANCE, INSURANCE, REAL EST. 12	SERVICES 13	GOVERNMENT ENTER-PRISES 14
1	AGRICULTURE (SIC 01, 07-9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	MINING (SIC 10-4)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	CONTRACT CONSTRUCTION (SIC 15-7)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	TEXTILE MILL PRODUCTS (SIC 22)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6	APPAREL AND RELATED PRODUCTS (SIC 23)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7	LUMBER AND WOOD PRODUCTS (SIC 24)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	FURNITURE AND FIXTURES (SIC 25)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9	PAPER AND ALLIED PRODUCTS (SIC 26)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	PRINTING AND PUBLISHING (SIC 27)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
12	PETROLEUM REFINING (SIC 29)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
13	RUBBER AND MISC. PLASTICS (SIC 30)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	STONE, CLAY AND GLASS PROD. (SIC 32)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
16	PRIMARY METAL INDUSTRIES (SIC 33)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	TRANSPORTATION EQUIPMENT (SIC 37)	.8631	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	0.0000	.6688	0.0000	0.0000	0.0000	0.0000	0.0000
22	TRANSPORTATION SERVICES (SIC 40-7)	.0219	.0188	1.0000	0.0000	0.0000	0.0000	0.0000
23	COMMUNICATION & UTILITIES (SIC 48-9)	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	.1151	.3125	0.0000	0.0000	0.0000	0.0000	0.0000
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
26	SERVICES (SIC 70-9, 80-6, 89)	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
27	GOVERNMENT ENTERPRISES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
28	UNALLOCATED INDUSTRIES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	HOUSEHOLDS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	CITY AND COUNTY GOVERNMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
31	STATE GOVERNMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
32	TOTAL PURCHASES	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table I-5a Transformation of Purchases of Commodities Related to Georgia Tech to Purchases from Industries (continued)

	INDUSTRY	UNAL-LOCATED PURCHASES 15	SUPPLIES AND MATERIALS 16	PERSONAL SERVICES 17	STATE GOVERNMENT 18	FEDERAL GOVERNMENT 19	MEALS OFF-CAMPUS 20	MEALS, FRATERNITY 21
1	AGRICULTURE (SIC 01, 07-9)	0.0000	0.0000	0.0000	0.0000	0.0000	.0269	.0269
2	MINING (SIC 10-4)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	CONTRACT CONSTRUCTION (SIC 15-7)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	0.0000	0.0000	0.0000	0.0000	0.0000	.3794	.3794
5	TEXTILE MILL PRODUCTS (SIC 22)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6	APPAREL AND RELATED PRODUCTS (SIC 23)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7	LUMBER AND WOOD PRODUCTS (SIC 24)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	FURNITURE AND FIXTURES (SIC 25)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9	PAPER AND ALLIED PRODUCTS (SIC 26)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	PRINTING AND PUBLISHING (SIC 27)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	0.0000	0.0000	0.0000	0.0000	0.0000	.0002	.0002
12	PETROLEUM REFINING (SIC 29)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
13	RUBBER AND MISC. PLASTICS (SIC 30)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	STONE, CLAY AND GLASS PROD. (SIC 32)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
16	PRIMARY METAL INDUSTRIES (SIC 33)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
18	MACHINERY, EXCEPT ELECTRICAL(SIC 35)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	TRANSPORTATION EQUIPMENT (SIC 37)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
22	TRANSPORTATION SERVICES (SIC 40-7)	0.0000	0.0000	0.0000	0.0000	0.0000	.0129	.0129
23	COMMUNICATION & UTILITIES (SIC 48-9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	0.0000	0.0000	0.0000	0.0000	0.0000	.5806	.5806
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	SERVICES (SIC 70-9, 80-6, 89)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	GOVERNMENT ENTERPRISES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28	UNALLOCATED INDUSTRIES	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	HOUSEHOLDS	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000
30	CITY AND COUNTY GOVERNMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
31	STATE GOVERNMENT	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
32	TOTAL PURCHASES	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000

Table I-5a Transformation of Purchases of Commodities Related to Georgia Tech to Purchases from Industries (continued)

	INDUSTRY	CLOTHING, PERSONAL SUPPLIES 22	RECREATION AND ENTER-TAINMENT 23	AUTOMOBILE EXPENSES 24	HOUSING, OFF-CAMPUS 25	HOUSING, FRATERNITY 26	BOOKS AND SCHOOL SUPPLIES 27	OTHER STUDENT EXPENSES 28
1	AGRICULTURE (SIC 01, 07-9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	MINING (SIC 10-4)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	CONTRACT CONSTRUCTION (SIC 15-7)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	TEXTILE MILL PRODUCTS (SIC 22)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6	APPAREL AND RELATED PRODUCTS (SIC 23)	.2421	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7	LUMBER AND WOOD PRODUCTS (SIC 24)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	FURNITURE AND FIXTURES (SIC 25)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9	PAPER AND ALLIED PRODUCTS (SIC 26)	0.0000	0.0000	0.0000	0.0000	0.0000	.0855	0.0000
10	PRINTING AND PUBLISHING (SIC 27)	0.0000	0.0000	0.0000	0.0000	0.0000	.5019	0.0000
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	.0936	0.0000	0.0000	0.0000	0.0000	.0198	0.0000
12	PETROLEUM REFINING (SIC 29)	0.0000	0.0000	.0899	0.0000	0.0000	.0027	0.0000
13	RUBBER AND MISC. PLASTICS (SIC 30)	.0002	0.0000	.0218	0.0000	0.0000	0.0000	0.0000
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	.0092	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	STONE, CLAY AND GLASS PROD. (SIC 32)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
16	PRIMARY METAL INDUSTRIES (SIC 33)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	.0100	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
18	MACHINERY, EXCEPT ELECTRICAL (SIC 35)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	.0064	0.0000	.0093	0.0000	0.0000	0.0000	0.0000
20	TRANSPORTATION EQUIPMENT (SIC 37)	0.0000	0.0000	.2072	0.0000	0.0000	0.0000	0.0000
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	.0529	0.0000	0.0000	0.0000	0.0000	.0276	0.0000
22	TRANSPORTATION SERVICES (SIC 40-7)	.0113	0.0000	.0181	0.0000	0.0000	.0093	.9091
23	COMMUNICATION & UTILITIES (SIC 48-9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0909
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	.2703	0.0000	.1952	0.0000	0.0000	.3530	0.0000
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	.0041	0.0000	.2381	1.0000	1.0000	0.0000	0.0000
26	SERVICES (SIC 70-9, 80-6, 89)	.3000	1.0000	.2204	0.0000	0.0000	0.0000	0.0000
27	GOVERNMENT ENTERPRISES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28	UNALLOCATED INDUSTRIES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	HOUSEHOLDS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	CITY AND COUNTY GOVERNMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
31	STATE GOVERNMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
32	TOTAL PURCHASES	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table I-5a Transformation of Purchases of Commodities Related to Georgia Tech to Purchases from Industries (continued)

	INDUSTRY	ATHLETIC OFFICIALS 29	TICKET PROCESSING 30	GUARANTEES TO OPPONENTS 31	INTRAMURAL 32	ATLANTA SALES TAX 33	TUITION GRANTS, ATHLETES 34	HOUSING, ATHLETES 35
1	AGRICULTURE (SIC 01, 07-9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	MINING (SIC 10-4)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	CONTRACT CONSTRUCTION (SIC 15-7)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	TEXTILE MILL PRODUCTS (SIC 22)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6	APPAREL AND RELATED PRODUCTS (SIC 23)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7	LUMBER AND WOOD PRODUCTS (SIC 24)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	FURNITURE AND FIXTURES (SIC 25)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9	PAPER AND ALLIED PRODUCTS (SIC 26)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	PRINTING AND PUBLISHING (SIC 27)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
12	PETROLEUM REFINING (SIC 29)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
13	RUBBER AND MISC. PLASTICS (SIC 30)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	STONE, CLAY AND GLASS PROD. (SIC 32)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
16	PRIMARY METAL INDUSTRIES (SIC 33)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
18	MACHINERY, EXCEPT ELECTRICAL(SIC 35)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	TRANSPORTATION EQUIPMENT (SIC 37)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
22	TRANSPORTATION SERVICES (SIC 40-7)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
23	COMMUNICATION & UTILITIES (SIC 48-9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.4504
26	SERVICES (SIC 70-9, 80-6, 89)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	GOVERNMENT ENTERPRISES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28	UNALLOCATED INDUSTRIES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	HOUSEHOLDS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	CITY AND COUNTY GOVERNMENTS	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
31	STATE GOVERNMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
32	TOTAL PURCHASES	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	.4504

Table I-5a Transformation of Purchases of Commodities Related to Georgia Tech to Purchases from Industries (continued)

	INDUSTRY	GASOLINE, VISITORS 36
1	AGRICULTURE (SIC 01, 07-9)	0.0000
2	MINING (SIC 10-4)	0.0000
3	CONTRACT CONSTRUCTION (SIC 15-7)	0.0000
4	FOOD AND KINDRED PRODUCTS (SIC 20-1)	0.0000
5	TEXTILE MILL PRODUCTS (SIC 22)	0.0000
6	APPAREL AND RELATED PRODUCTS (SIC 23)	0.0000
7	LUMBER AND WOOD PRODUCTS (SIC 24)	0.0000
8	FURNITURE AND FIXTURES (SIC 25)	0.0000
9	PAPER AND ALLIED PRODUCTS (SIC 26)	0.0000
10	PRINTING AND PUBLISHING (SIC 27)	0.0000
11	CHEMICALS AND ALLIED PRODUCTS (SIC 28)	0.0000
12	PETROLEUM REFINING (SIC 29)	.4509
13	RUBBER AND MISC. PLASTICS (SIC 30)	0.0000
14	LEATHER AND LEATHER PRODUCTS (SIC 31)	0.0000
15	STONE, CLAY AND GLASS PROD. (SIC 32)	0.0000
16	PRIMARY METAL INDUSTRIES (SIC 33)	0.0000
17	FABRICATED METAL PRODUCTS (SIC 34, 19)	0.0000
18	MACHINERY, EXCEPT ELECTRICAL(SIC 35)	0.0000
19	ELECTRICAL MACHINERY & EQUIP. (SIC 36)	0.0000
20	TRANSPORTATION EQUIPMENT (SIC 37)	0.0000
21	MISCELLANEOUS MANUFACTURING (SIC 38-9)	0.0000
22	TRANSPORTATION SERVICES (SIC 40-7)	.0428
23	COMMUNICATION & UTILITIES (SIC 48-9)	0.0000
24	WHOLESALE AND RETAIL TRADE (SIC 50-9)	.5063
25	FINANCE, INS., REAL ESTATE (SIC 60-7)	0.0000
26	SERVICES (SIC 70-9, 80-6, 89)	0.0000
27	GOVERNMENT ENTERPRISES	0.0000
28	UNALLOCATED INDUSTRIES	0.0000
29	HOUSEHOLDS	0.0000
30	CITY AND COUNTY GOVERNMENTS	0.0000
31	STATE GOVERNMENT	0.0000
32	TOTAL PURCHASES	1.0000

Appendix I-6

SURVEY OF STUDENT SPENDING

To determine the expenditures of students, we conducted a survey of the student body during the winter quarter of 1977. A mail survey of 150 students selected at random from the student directory yielded only 35 responses. These were supplemented by returns from 12 different classes. Although the classes mostly involved courses taught by the College of Industrial Management, the number of students from outside the College enrolled for elective credit was substantial, making the sample representative. This representativeness is further demonstrated in Table I-6a.

In all, 414 completed questionnaires were received. Of these, 29 responses were incomplete or frivolous, yielding 385 good responses.

Since the more important information gathered in the survey appears in the text, we have not tabulated the responses here in detail (although it is available for inspection by interested parties). A copy of the questionnaire appears at the end of this appendix.

Table I-6a Comparison of the Student Population (Fall, 1976) and the Student Survey Sample, by Class Standing, Legal Residence, Housing, and Sex and Marital Status

Characteristics	Tech student population (percent)	Tech student survey sample (percent)
Class standing:		
Underclass	48	47
Upperclass	36	42
Graduate	17	11
Total	100	100
Legal residence:		
In-state	57*	65
Out-of-state	43*	35
Total	100	100
Housing:		
Tech housing	39	44
Fraternity	9	13
Off-campus, with parents	NA**	16
Off-campus, otherwise	NA**	27
Total	100	100
Sex:		
Male:		
Single	85	84
Married	15	16
Total	100	100
Female:		
Single	88	94
Married	12	6
Total	100	100
Male	86	79
Female	14	21
Total	100	100

*Based on fall, 1975 data. Fall, 1976 data not available at time data compiled.

**Not available.

STUDENT SURVEY DO NOT SIGN

As part of a major study of the economic impact of Georgia Tech, a set of statistics on student expenditures and income is being compiled. You are one of a small number of students selected at random for this survey. Since a high response rate is necessary to minimize costs, we would appreciate your completing the following questionnaire and returning it as quickly as possible in the enclosed envelope.

1. Please check the appropriate spaces:
   a. Marital status: (1) ___ single (2) ___ married
   b. Sex: (1) ___ male (2) ___ female
   c. Class standing:
      (1) ___ Freshman (3) ___ Junior (5) ___ Master's program
      (2) ___ Sophomore (4) ___ Senior (6) ___ Ph.D. program
   d. Do you pay out-of-state tuition? (1) ___ yes (2) ___ no
2. If you had not decided to attend Georgia Tech, would you have attended another college within the State of Georgia?
   (1) ___ yes (2) ___ no
3. Where do you live while attending Tech?
   (1) ___ Dormitory
   (2) ___ Fraternity house
   (3) ___ Married student housing
   (4) ___ Off-campus, with parents
   (5) ___ Off-campus, otherwise
4. What amount of your Annual income (total, including spouse's) is derived from each of the following sources? If you do not have exact dollar figures, please approximate them to the best of your ability. If you have not been here a full year, please estimate your income sources for your first 12 months.
   $ ________ Parents or relatives living in Georgia
   $ ________ Parents or relatives living outside of Georgia
   $ ________ Scholarship or tuition waiver from Georgia Tech
   $ ________ Scholarship or grant from other source in Georgia
   $ ________ Scholarship or grant from out-of-state source
   $ ________ Loan from or through Georgia Tech
   $ ________ Loan from Georgia bank
   $ ________ Loan from out-of-state bank
   $ ________ Work at Georgia Tech
   $ ________ Work in metropolitan Atlanta
   $ ________ Work elsewhere in Georgia
   $ ________ Work outside of Georgia
   $ ________ Other (describe)____
5. Please estimate your Quarterly expenditures (total, including spouse's) on the following items:
   $ ________ Tuition
   $ ________ Food, on campus
   $ ________ Food, off campus
   $ ________ Clothing and personal supplies
   $ ________ Recreation and entertainment
   $ ________ Automobile operating expense and payments
   $ ________ Housing
   $ ________ Books and school supplies, purchased at Campus Bookstore
   $ ________ Books and school supplies purchased elsewhere
   $ ________ Other items and unusual expenses (describe) ____________________
   ____

Thanks. Please return in campus mail in the self-addressed envelope enclosed.

GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA 30332

OFFICE OF THE PRESIDENT

March 4, 1977

Dear Georgia Tech Alumnus:

We are currently conducting a study of the economic impact of Georgia Tech as an institution through which people, ideas, and money flow out to our state, the region and the nation. We will use the results to help Tech in our dealings with state government and other constituencies.

As a part of the study we are conducting a survey of our alumni. We hope to obtain from the data provided by the survey a job profile of our graduates, including such things as their geographic location and movement, their industrial and occupational attachment, the size of the firms for which they work, the number of job movements, and their current earned income.

For purpose of the survey a sample of names has been drawn from our alumni roster. You have been selected for the sample. A short questionnaire is enclosed. Please fill it out and return it in the self-addressed envelope provided. To insure complete confidentiality you are asked not to sign your name.

The success of the survey depends on a high rate of response and we would appreciate your care in filling out the questionnaire as soon as possible. Please return it no later than April 4, 1977.

A summary of the results of the survey will be published in Tech Topics.

Sincerely,

J. M. Pettit
President

JMP/kt

Appendix II-1

Georgia Tech Alumni Survey — 1977

Form IM-1

1. Year of birth _______

2. Year Bachelor's degree received _______
(if non-graduate, year you left school)

3. Have you served in the Armed Forces? 1. Yes _____ 2. No _____
If "yes" what year did you enter? ____ What year did you leave? ____

4. Check degrees you now hold and school from which you obtained them.

	Tech	Other College or University
Less than Bachelors	1. ____	5. ____
Bachelors	2. ____	6. ____
Masters	3. ____	7. ____
Ph.D.	4. ____	8. ____
M.D., D.D.S., Law		9. ____

5. Check the field of study in which you obtained your degrees.

	Arch.	Eng.	Ind. Mngmt. (Bus.)	Science, Soc. Sci., Liberal Arts
Less than Bachelors	1. ___	5. ___	9. ___	13. ___
Bachelors	2. ___	6. ___	10. ___	14. ___
Masters	3. ___	7. ___	11. ___	15. ___
Ph.D.	4.	8. ___	12. ___	16. ___
M.D., D.D.S., Law 17. __				

6. Fill in the number identifying the geographic location of:

Your home on entering Tech	First civilian job held on leaving Tech	Present job (current residence if retired or unemployed)
_____	_____	_____

(If you have held only one job, indicate the appropriate job location under the "present job" category. If you travel across a number of states in your job, list your home base as your location.)

1. Metro Atlanta 2. Rest of Georgia 3. Outside U.S.A.

Rest of Southeast		Northeast		Great Lake States
4. Ala	10. N.C.	15. Conn.	21. N.H.	27. Ill.
5. Ark.	11. S.C.	16. Del.	22. N.J.	28. Ind.
6. Fla.	12. Tenn.	17. D.C.	23. N.Y.	29 Mich.
7. Ky.	13. Va.	18. Maine	24. Pa.	30. Ohio
8. La.	14. W. Va.	19. Md.	25. R.I.	31. Wis.
9. Miss.		20. Mass.	26. Vt.	

Plains States & Mt. States		Southwest	Far West
32. Colo.	38. Mont.	44. Ariz.	48. Alaska
33. Idaho	39. Neb.	45. N.M.	49. Calif.
34. Iowa	40. N.D.	46. Okla.	50. Hawaii
35. Kan.	41. S.D.	47. Tex.	51. Nev.
36. Minn.	42. Utah		52. Oregon
37. Mo.	43. Wyo.		53. Wash.

7. Fill in the number indicating the population of your city (metropolitan area) or town:

On entering Tech _____ First civilian job held on leaving Tech _____ Present job (current residence if retired or umemployed) _____

1. Under 2,500 2. 2,500 - 25,000 3. 25,000 - 250,000 4. 250,000 - 1,000,000 5. Qver 1,000,000

8. Check your current employment status (check one box only):

1. ____ Self-employed 3. ____ Retired 5. ____ Full-time student
2. ____ Employed (but not self-employed) 4. ____ Unemployed 6. ____ Armed forces

(If "retired," "unemployed," "full-time student," or in "armed forces," go to question No. 15.)

9. Fill in the number that best describes *the business of your employer* (your own business, if self-employed) for your first civilian job and your present job. If you have held only one job, use "present job" space below for your reply. (Please read all categories before selecting a choice.)

First job _____ Present job _____

1. Federal government
2. State & local government
3. Agriculture
4. Mining
5. Construction
6. Manufacturing
7. Transportation, communications, utilities

(Continued at top of next column)

8. Wholesale & retail
9. Finance (including banking)
10. Insurance
11. Real estate
12. Architecture
13. Engineering consulting or management consulting
14. Education
15. Professions (Medicine, Law, Religion)
6. Services (for example, hotels, auto repairs, recreation, etc.)
7. Other (specify: _______)

10. Fill in the number that best describes *your occupation* in your first civilian job and your present job (Please read all categories before selecting a choice.)

First job _____ Present job _____

1. Engineer (Where the main portion of your time is occupied with engineering, including such things as executive-administrative, sales requiring substantial engineering capabilities, teaching, design, production quality control, research and development, construction supervision, or consulting)
2. Architect
3. General contractor
4. Manager or administrator (but excluding supervision of activities primarily engineering)
5. Sales and marketing (including selling, sales management, and market research but excluding selling requiring substantial engineering capabilities)
6. Insurance agent or broker
7. Securities salesman
8. Real estate agent or broker
9. Accountant
10. Computer programmer, analyst, etc.
11. Teacher
12. Other (specify: _______)

10A. If you checked your present occupation in Question 10 as "Engineer," check the branch of engineering which best represents your current principal activity. If you did not check your occupation in Question 10 as "engineer," go on to Question 11.

1. ___ Aeronautical and aerospace
2. ___ Chemical
3. ___ Civil
4. ___ Electrical and electronic
5. ___ Industrial
6. ___ Mechanical
7. ___ Metallurgical and materials
8. ___ Petroleum and mining
9. ___ Sanitary and environmental
10. ___ Textile
11. ___ Other (specify: ______)

10B. If you checked your present occupation as "Engineer," check the type of work performed. (Check only one.)

1. ___ Executive-administrative
2. ___ Sales
3. ___ Teaching
4. ___ Design
5. ___ Production, quality control, maintenance
6. ___ Research and development
7. ___ Construction supervision
8. ___ Consulting
9. ___ Other (specify: ______)

11. Check the number of people working for the company or organization by which you are currently employed, including self-employment. (Use the parent company, or organization, not a division or plant for which you may work, when indicating the number of employees.)

1. ___ Less than 50
2. ___ 50 - 500
3. ___ 500 - 5,000
4. ___ over 5,000

12. Indicate your earned, before-tax, income for 1976 (including salary, commissions, and bonuses or fees but excluding that part of your income which has no relationship to your work; i.e., interest, dividends, rents, capital gains, inheritances, etc.) $ ________

13. For how many companies or organizations (but excluding armed forces) have your worked since leaving college or since receiving your last degree?

___ 1 ___ 2 ___ 3 ___ 4 ___ 5 ___ more than 5

14. Are you currently president, chairman of the board, or the chief executive officer of your firm? 1. ___ Yes 2. ___ No

If "yes" indicate the current annual sales of the firm.

1. ___ Under $100,000
2. ___ $100,000 - $1,000,000
3. ___ $1,000,000 - $50,000,000
4. ___ over $50,000,000

15. Did you ever start a business (by yourself or with associates)?

1. ___ Yes 2. ___ No

If "yes" and if the business is still in existence, what are the current annual sales?

1. ___ Under $100,000
2. ___ $100,000 - $1,000,000
3. ___ $1,000,000 - $50,000,000
4. ___ Over $50,000,000

Appendix II-1

Comments on the Design of the Questionnaire.

1. The responses provided in the questionnaire were completely confidential. There is no place on the questionnaire for the respondee's name. Confidentiality of the responses was emphasized in President Pettit's letter which accompanied the questionnaire in order to increase the response rate. The time allowed for return of the questionnaire, as stated in the accompanying letter, was about a month. It was thought that a longer interval would not increase the response rate much since it is unlikely that a questionnaire allowed to sit for more than a month would be returned anyway. The few questionnaires that filtered in for five weeks after the deadline stated in the letter were included, however, since final computations had not yet begun. The handful of returns received after this extended cutoff were not included.

2. The code in the upper right-hand corner of the questionnaire was used to separate the responses by race and sex. Questionnaires labeled "Form IM-1" were mailed to black females in the sample, Form "IM-2" to black males, "Form IM-3" to white females, and "Form IM-4" to white males. At the time of the survey 13 black females and 71 black males were on the alumni roll. Three black females and 22 black males responded, numbers considered too small for formal analysis. In the final tabulations the black and white females were combined, as were black and white males.

3. In the final analysis of survey data information obtained from Question 1 (year of birth) was not used. The question was included in the questionnaire

for backup information in case unexpected behavior patterns related to age should appear. As it turned out, age data were not needed. Question 2 (year Bachelor's degree received or year respondee left school, if non-graduate) provided the key information in dating the respondent. The year given in response to the question was interpreted as the job entry point for all members of the sample.

4. The data provided in responses to Question 3 (service in armed forces) were not used in the final report. The information may be analyzed at a later date.

5. The individual states were provided as choices in answering Question 6 to permit grouping of responses under several different definitions of regional geographic areas. Geographic regions are not defined uniformly in our country. The Bureau of the Census uses one definition, the Department of Commerce, other than for census purposes, uses another. The National Society of Professional Engineers which has collected survey data somewhat comparable to Georgia Tech data uses still another definition. In the interpretation of the Tech results the regional definitions provided in the questionnaire were used. If the data are used for further analysis at some time in the future, the definitions of the regions can be altered if necessary.

6. The population size choices given in Question 7 were based on intervals reported in the 1970 Census. The breakdown used in the questionnaire is not as fine as that used in the census on the basis that many respondees may not have a sufficiently informed estimate of their town/city population to choose accurately among smaller differences.

7. The industry choices in Question 9 were based on the standard industrial classifications but were modified to fit the unique characteristics of Tech graduates.

An undetected printing error appears in this section of the questionnaire. Both "manufacturing" and "services" are numbered "6" and both "transportation, communications, utilities" and "other" are numbered "7". The error in the second case (where "7" was used twice) caused no problem in tabulating results since the choice of "other" required the respondent to specify the industry. In the case of the repeated use of "6" a tabulation problem did exist. Careful examination of the entire questionnaire usually made it possible to determine the intended answer with a reasonable degree of certainty. A respondent who identified himself as an aeronautical engineer in response to Question 10A and as working in production in response to Question 10B, for example, clearly works in manufacturing and not in services. In those cases where the choice could not be inferred from the responses to other questions, the doubt was resolved in favor of "manufacturing" on the basis that the probability of this choice being correct is very high. In the final tabulation, "services" and "other" were then combined.

8. The categories in Questions 10A and 10B (branches of engineering and present occupation) are taken from the questionnaire used in the biannual survey of the National Society of Professional Engineers, but modified slightly to better suit Tech engineers.

9. The number of employee groupings used in Question 11 to describe sizes of firms are based on definitions used by the Engineering Manpower Commission

of the Engineers Joint Council in its <u>Professional Income of Engineers, 1974</u>. That publication classifies industrial employers as follows:

"small industrial employers"	fewer than 500 (manufacturing industries only)
"medium industrial employers"	500-5,000 (manufacturing industries only)
"large industrial employers"	5,000 or more employees.

While not all firms worked for by Tech alumni are industrial firms, those classifications nevertheless seemed useful in describing firm sizes. The size interval used in the Georgia Tech questionnaire break down "small industrial employers" into two groups to permit a finer distinction among small firms. This further breakdown makes the groupings more generally applicable to all types of firms, including non-industrial types where smaller size companies are more common.

10. The intervals used to measure company sales in Questions 14 and 15 are based on groupings used in census data, though the breakdown is finer in census reports than in the Tech questionnaire. The 200th largest Southern firm was reported in <u>South Magazine</u>, July-August, 1976, to have $56 million in annual sales. Because of this fact, $50 million and above in annual sales seems to be a good definition for "large firm" in our part of the country.

Appendix

Table II-1a. Percent of Those with Georgia Tech Bachelor's Degree Who Have Gone on For Master's Degree, By Field of Study at Bachelor's Level, Entire Sample, Pre-1966 Group, Post-1966 Group.

Sample group	Architecture	Engineering	Industrial Management	Science and Liberal Studies
Entire sample	11.7	25.6	14.9	34.7
Pre-1966	9.5	23.2	11.0	27.7
Post-1966	14.3	29.3	19.0	38.8

Table II-2a. Percent of Respondents in Cities and Towns of Each of Five Different Sizes, On Entering Tech, First Job, Present Job, Entire Sample.

Sample group	Under 2500		2500-25,000		25,000 - 250,000		250,000 - 1,000,000		over 1,000,000	
Home on Entering Tech	No	%	No	%	No	%	No	%	No	%
Entire Sample	362	8.3	957	22.0	1107	25.5	884	20.4	1003	23.1
Pre 1966	239	9.6	575	23.1	654	26.3	635	25.5	370	14.9
Post 1966	123	6.6	382	20.6	453	24.4	249	13.4	633	34.1
Male	114	6.7	368	21.6	423	24.8	224	13.1	563	33.0
Female	9	6.1	14	9.5	30	20.3	25	16.9	70	47.3
First Job:	No	%	No	%	No	%	No	%	No	%
Entire Sample	91	2.1	518	11.9	1205	27.8	969	22.3	1436	33.1
Pre 1966	59	2.4	336	13.5	733	29.5	691	27.8	622	25.0
Post 1966	32	1.7	182	9.8	472	25.5	278	15.0	814	43.9
Male	30	1.8	171	10.0	444	26.0	258	15.1	736	43.1
Female	2	1.4	11	7.5	28	18.9	20	13.5	78	52.7
Present Job:	No	%	No	%	No	%	No	%	No	%
Entire Sample	83	1.9	496	11.4	1161	26.7	713	16.4	1856	42.7
Pre 1966	41	1.6	303	12.2	690	27.7	425	17.1	1004	40.4
Post 1966	42	2.3	193	10.4	471	25.4	288	15.5	852	46.0
Male	40	2.3	184	10.8	437	25.6	268	15.7	769	45.1
Female	2	1.4	9	6.1	34	23.0	20	13.5	83	56.1

Table II-3a. Number and Percent of Respondents By Business of Employer, First and Present Job, Entire Sample.

Industry	First Job		Present Job	
	No.	%	No.	%
Federal Government	332	7.6	307	7.1
State and local Government	147	3.4	132	3.0
Agriculture	18	0.4	26	0.6
Mining	36	0.8	32	0.7
Construction	231	5.3	260	6.0
Manufacturing	1815	41.8	1451	33.4
Transportation, communications, utilities	486	11.2	467	10.8
Wholesale and retail	220	5.1	234	5.4
Finance (including banking)	96	2.2	123	2.8
Insurance	98	2.3	115	2.6
Real Estate	21	0.5	86	2.0
Architecture	103	2.4	102	2.3
Engineering consulting or Management consulting	259	6.0	357	8.2
Education	131	3.0	174	4.0
Professions (Medicine, Law, Religion)	82	1.9	127	2.9
Other	258	6.0	315	7.3

APPENDIX III-1

The following persons were interviewed in gathering background for Part III of the report. The contacts varied in length from a brief discussion to a prolonged interview.

Eugene C. Ashby, Professor of Chemistry
Milton R. Blood, Associate Professor, Industrial Management
Mary N. Carmichael, Associate Director, Placement Center
David S. Clifton, Economic Development Laboratory, Engineering Experiment Station
James I. Craig, Associate Professor, Aerospace Engineering
John W. Crenshaw, Director, Biology
James A. Donovan, Publications, Engineering Experiment Station
William H. Eberhardt, Professor, Chemistry
William L. Fash, Dean, Architecture
Joseph Ford, Professor, Physics
Don P. Giddens, Associate Professor, Aerospace Engineering
Donald J. Grace, Director, Engineering Experiment Station
Robin B. Gray, Associate Director, Aerospace Engineering
William W. Hines, Associate Director, Industrial and Systems Engineering
Patrick Kelly, Director, Social Sciences
Charles L. Liotta, Professor, Chemistry
Maurice W. Long, Retired
Earl W. McDanial, Professor, Physics
Donald C. O'Shea, Associate Professor, Physics
Germaine M. Reed, Associate Professor, Social Science
Edward Graham Roberts, Director, Library
Peter B. Sherry, Professor, Chemistry
Frederick W. Schutz, Jr., Associate Dean, Engineering
Thomas Stelson, Vice-President, Research
Bernell K. Stone, Professor, Industrial Management
Vernon Edward Unger, Associate Director, Industrial and Systems Engineering
Charles Vail, Associate Dean, Engineering
Raymond P. Vito, Associate Professor, Engineering Science and Mechanics
Virginia S. Watts, Assistant Dean, Science and Liberal Studies
Paul Weber, Retired
Richard Wiegand, Director, Continuing Education
Ward O. Winer, Professor, Mechanical Engineering
James G. Wohlford, Director, Coop Program
Rudolph L. Yobs, Director, Technology and Development Laboratory, Engineering Experiment Station
Leon H. Zalkow, Professor, Chemistry
Waldemar T. Ziegler, Professor, Chemical Engineering

Appendix Table III- 1a

Georgia Institute of Technology
Fred W. Ajax Placement Center

SUMMARY OF 1976 - 1977 RECRUITMENT
AND PLACEMENT ACTIVITY

I. RECRUITMENT

Number Of:	1972-73	1973-74	1974-75	1975-76	1976-77	%Change
Companies Visiting Campus	399	438	438	432	473	+ 9.5%
Company Visits	570	799	660	612	679	+10.9%
Interview Schedules	1,015	1,438	1,371	1,329	1,500	+12.9%
Interview Schedules Cancelled (due to lack of student response)		133	72	54	58	+ 7.4%
Interviews Conducted	11,118	11,397	11,306	12,297	13,742	+11.8%
Employment Offers Extended	593	934	519	565	857	+34.0%

II. PLACEMENT (GENERAL)

Graduates:	1972-73	1973-74	1974-75	1975-76	1976-77	%Change
Registered with Placement Center	1,370	1,330	1,539	1,311	1,418	+ 8.7%
Reporting Post-Graduation Plans	1,181	1,145	1,163	1,219	944	-22.5%
Employed (Total)	734	635	590	635	579	- 8.8%
Employed Outside of Georgia	370	421	343	275	347	+26.1%
Graduates Employed in Georgia	194	190	155	162	207	+27.7%
Entering Military	107	79	83	60	50	-16.6%
Enrolling Full-Time Graduate School	207	196	236	254	189	-25.5%
With Other Plans (travel, return home, homemaker, etc.)	7	47	82	126	56	-55.5%

III. PART-TIME AND SUMMER PLACEMENT

	1972-73	1973-74	1974-75	1975-76	1976-77	%Change
Part-Time and Full-Time (non-career related positions listed)	2,289	1,900	1,085	1,812	4,212	+132.5%
Organizations listing summer positions	233	310	145	227	175	- 22.9%
Positions filled by Georgia Tech Students	687	795	531	612	435	- 28.9%

Appendix Table III- 2a

Georgia Institute of Technology
Fred W. Ajax Placement Center

Summary of Offered and Accepted
Monthly Starting Salaries For
1976-1977 Georgia Tech Graduates

The average starting salary offers shown were computed from employer correspondence only. The average accepted salaries shown were computed from data supplied by June Graduates.

CURRICULUM	DEGREE	HIGH OFFER	LOW OFFER	AVERAGE OFFER/NO.	AVERAGE JUNE ACCEPTED/NO.
Aerospace Engineering	B	$1416	$1111	$1225/17	$1226/8
	M	1473	1230	1381/5	
	D	1095	1095	1095/1	1000/1
Applied Biology	B				$ 740/2
Building Construction	B	$1150	$1100	$1137/4	$1011/9
Architecture	B				$ 740/1
	M				958/2
Ceramic Engineering	M	$1333	$1333	$1333/1	$1458/1
	D				1800/1
Chemical Engineering	B	$1625	$1041	$1402/147	$1426/24
	M	1833	1321	1537/26	1605/3
	D	1600	1490	1561/6	1975/1
Chemistry	B	$1440	$1130	$1337/9	
	M	1458	1325	1391/2	
	D	1800	1642	1700/4	
City Planning	M	$1400	$1400	$1400/1	$1000/1
Civil Engineering	B	$1500	$ 979	$1195/75	$1218/29
	M	1550	1150	1310/9	1375/2
Electrical Engineering	B	$1517	$ 958	$1261/154	$1254/35
	M	1600	1140	1396/22	1410/8
	D	1550	1175	1362/2	
Engineering Economic Systems	B	$1170	$1170	$1170/1	$1250/1
Engineering Science	B	$1435	$1007	$1247/8	$1250/1
Engineering Science & Mechanics	M	$1525	$1175	$1400/3	$1525/1
Geophysical Sciences	M	$1300	$1300	$1300/1	
Health Systems	B				$1175/2

Appendix Table III-2a

CURRICULUM	DEGREE	HIGH OFFER	LOW OFFER	AVERAGE OFFER/NO.	AVERAGE JUNE ACCEPTED/NO.
Industrial & Systems Engineering	B	$1467	$1007	$1267/64	$1254/21
	M	1565	1163	1335/14	1416/2
Industrial Management	B	$1326	$ 750	$ 997/37	$1047/20
	M	1750	1283	1441/3	1394/31
Information & Computer Science	B	$1433	$1050	$1165/7	$1107/9
	M	1385	1385	1385/1	1393/4
Management Science	B				$1250/1
Mechanical Engineering	B	$1525	$1008	$1313/177	$1330/26
	M	1658	1291	1460/14	1463/5
Metallurgy	M	$1515	$1208	$1361/2	
Nuclear Engineering	B	$1400	$1088	$1203/18	$1226/7
	M	1450	1275	1366/8	1353/2
Physics	B	$1558	$1140	$1292/5	$1067/3
	M	1250	1250	1250/1	
	D	1550	1325	1437/2	
Psychology	B	$1283	$1283	$1283/1	
	D	1750	1750	1750/1	
Sanitary Engineering	M	$1417	$1417	$1417/1	
Textile Chemistry	B				$1170/1
Textiles	B				$1288/1
	M	$1350	$1041	$1172/3	

****

AVERAGE OFFERS FOR 1976-1977

		%Change
All BS Excluding Engineering	$1101/63	+3.87
All B/BS Degrees	$1279/724	+6.32
B. in Engineering	$1296/661	+6.75
BS/ Industrial Management	$ 997/37	-3.20
All M.S. Degrees	$1410/117	+8.29
M.S. in Engineering	$1413/108	+7.13
All Ph.D Degrees	$1537/16	-7.46

ARTHUR ANDERSEN & CO.

25 PARK PLACE, N. E.
ATLANTA, GEORGIA 30303
(404) 658-1776

March 31, 1978

Georgia Tech Foundation, Inc.
Georgia Institute of Technology
Atlanta, Georgia 30332

Gentlemen:

In accordance with our arrangement letter dated November 2, 1976, we have completed our assignment in connection with your research project to estimate the impact of the Georgia Institute of Technology ("Georgia Tech") on the Metropolitan Atlanta community and on the State of Georgia. The purpose of this letter is to summarize the objectives and nature of the research project, the scope of our review procedures (and their inherent limitations), and our conclusions.

Objectives of Project

The stated objective of the research project conducted by the College of Industrial Management of Georgia Tech was to quantitatively and qualitatively measure the following items relative to Metropolitan Atlanta and the State of Georgia:

. The direct economic effect of financial transactions associated with Georgia Tech, and the related indirect multiplier effect of such transactions;

. The impact of people associated with Georgia Tech and the ideas and innovation generated directly or indirectly by these people.

These objectives are more fully explained in the original "Proposal for Research" submitted to the Foundation by Dr. William A. Schaffer and Dr. W. Carl Biven during 1976.

Nature of Project

The following major tasks were undertaken by members of the Georgia Tech research team in connection with data-gathering aspects of the project:

. Evaluation and modernization of an existing State of Georgia economic input/output model for use in analysis of Georgia Tech financial transactions;

. Identification and classification of Georgia Tech financial transactions, and processing of these transactions through the updated input/output model;

. Design and conduct of Georgia Tech football game attendance survey in the fall of 1976, and tabulation and analysis of the results of the survey;

. Evaluation and analysis of estimated on-campus spending by visitors to Georgia Tech other than football game spectators;

. Design and conduct of a survey of Georgia Tech students, and tabulation and analysis of the survey returns;

. Design and conduct of a survey of Georgia Tech alumni, and tabulation and analysis of the survey returns.

Other procedures utilized by the research team in connection with the project included the following:

. Intensive verification and validation procedures were applied to the research data collected in surveys to enhance substantially the degree of accuracy and reliability of the results;

. The assumptions used in analyzing and interpreting the research data were comprehensively documented and evaluated as to reasonableness.

The details of the data validation process, statistical reliability levels achieved, and interpretive assumptions used are described in the final report prepared by the research team entitled "The Impact of Georgia Tech: Money, People and Ideas", and in other documentation maintained by the researchers.

Scope of Our Review

The objective of our participation on this project was to provide independent verification of the reasonableness of the procedures used to collect and validate the research data, and of the analytical methods applied to the data. In this connection the scope of our review was limited to the following:

- We maintained close contact with the primary researchers throughout the period of the project;

- We conducted periodic reviews of the research project documentation on a limited test basis;

- We considered alternative research techniques, where appropriate and we discussed these alternatives with the Georgia Tech research team;

- We provided general advice to the research team regarding project administration;

- We were prepared to report to the Foundation, on a timely basis, any corrective measures with respect to research procedures or techniques that we considered necessary in order for our firm to be associated with the project.

We did not attempt to independently audit the detail accuracy of the research data or the research results. Also, the research results are based on hypothetical assumptions and subjective judgments, and are subject to certain inaccuracies that are naturally inherent in any estimations. Accordingly, we cannot express any opinion with respect to the absolute validity of the research results.

Conclusions

In our opinion, based on our review, (1) the procedures used to collect and validate the research data were reasonable, and the intended application of these procedures was appropriate; (2) the assumptions used to interpret and analyze the research data were also reasonable and appropriate; and (3) the final report, entitled "The Impact of Georgia Tech: Money, People and Ideas", adequately describes the procedures used during the research project, and properly documents the assumptions upon which the report conclusions are based.

- - - - - - - - - - - -

If you have any further questions, we would be pleased to discuss them at your convenience. We appreciate the opportunity to have been of service to Georgia Tech on this important assignment, and we look forward to opportunities in which we may continue our close relationship.

Very truly yours,

Arthur Andersen & Co.