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ABSTRACT

This proposal contains a plan to alter the curriculum at Georgia Institute of Technology for the following reasons: to educate its students in Total Quality Management (TQM) approaches and practice, to develop a major research initiative designed to understand what TQM approaches work and why, to become a major center for the collection and dissemination of information from these research studies and from practitioners so as to accelerate the adoption of TQM principles, to completely revamp operations throughout the Institute, and to achieve these aims in an intensive collaboration with the business community. The plan calls for the creation of customer-driven processes in each of these areas to ensure that the school is continuously meeting or exceeding student expectations. The plan also includes a substantial financial and human resource commitment from Georgia Tech as well as a partnership with International Business Machines Corporation. Appendixes include a list of faculty members and others connected with Georgia Tech who have TQM expertise and interests, a table of course descriptions and documentation, an organization chart, a set of vitae of principal investigators, and a page of selected notes on the IBM-Georgia Tech relationship. (GLR)

A PROPOSAL FOR THE INTEGRATION OF TOTAL QUALITY MANAGEMENT INTO INSTITUTE CURRICULUM, RESEARCH, AND OPERATIONS

Submitted to

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A PROPOSAL FOR THE INTEGRATION OF TOTAL QUALITY MANAGEMENT INTO INSTITUTE CURRICULUM, RESEARCH, AND OPERATIONS

EXECUTIVE SUMMARY

Georgia Tech has recently completed the first cycle of a comprehensive strategic planning process. The principal conclusion from that effort is that Tech must transform its organizational culture from one that is focused internally to one that is dedicated to defining customers, ascertaining their needs, developing processes that meet those needs, and empowering faculty and staff to create, maintain and strengthen those processes, all in pursuit of continuous improvement. In order to transform our culture, we recognize that business as usual will not do and that a radical paradigm shift is required. Based on excellent results from initial efforts in several of its academic and support units, Georgia Tech is committed to achieving the transformation.

This proposal contains a plan to alter our curriculum radically to educate our students in TQM principles and practice, to develop a major research initiative to understand what TQM approaches work and why, to become a major center for the collection and dissemination of information from these research studies and from practitioners to accelerate the adoption of TQM principles, to completely revamp operations throughout the organization, and to achieve these aims in an intensive collaboration with the business community. The plan calls for the creation of customer-driven processes in each of these areas to ensure that we are continuously meeting or exceeding their expectations.

A comprehensive and well supported organizational structure is being created to implement this plan which is led by President John P. Crecine, driven by a Quality Council, guided and challenged by an external Visiting Committee, and supported by an Office for Continuous Improvement and Assessment. Curriculum development will be managed comprehensively by an Institute Continuous Improvement Curriculum Committee. Research, development and propagation activities will be accomplished through a newly created International Center for Continuous Improvement. The transformation of Tech's operations will be led by the Quality Council. An implementation schedule with milestones has been created to ensure the timely development and implementation of the plan.

The plan includes a substantial financial and human resource commitment from Georgia Tech as well. In budgetary terms alone, Tech's commitment matches IBM's two for one during the five year life of this project. In addition, Georgia Tech has received a commitment for a significant partnering relationship from Mr. W.T. (Tom) Smith, Vice President and Area General Manager for the Southern Area Office of IBM, USA.

Georgia Tech intends to become the leading higher education institution in the comprehensive implementation of the TQM paradigm--all in close partnership with business and other colleges and universities. In setting this ambitious goal, we recognize that implementing TQM in this fashion at a major research university is a massive undertaking and will require an incredible and sustained commitment from the top to the bottom of the organization. This commitment and a recognition of its far reaching ramifications are made without reservation.

A PROPOSAL FOR THE INTEGRATION OF TOTAL QUALITY MANAGEMENT INTO INSTITUTE CURRICULUM, RESEARCH, AND OPERATIONS

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1.0 INTRODUCTION

Georgia Tech's goal is to become the premier technological university of the 21st Century. We are completing the first cycle of a comprehensive strategic planning process which clearly indicates that we must transform our organizational culture, policies and processes from ones that largely are focused internally to ones that are dedicated to identifying customers,[1] ascertaining their needs, developing processes that meet those needs, defining realizable measurements of customer satisfaction, and empowering faculty and staff to create, maintain and strengthen those processes in pursuit of continuous improvement. While many of Tech's units, centers, and curricula have already incorporated Total Quality Management (TQM) principles, we recognize that a concerted, total shift in all of Institute operations to the TQM paradigm is necessary way to accomplish this organizational transformation.

With equal urgency, we recognize the need to implement TQM into our curriculum on a comprehensive basis to educate all of our students with regard to TQM principles and practice, to develop a major research initiative to understand what TQM approaches work and why, to become a major center for the collection and dissemination of information from these research studies and from practitioners to accelerate the adoption of TQM principles, and to achieve these aims in an intensive and positive collaboration with the business community. This need was expressed compellingly in an open letter from the Chairmen of the Boards of American Express, Ford, IBM, Motorola, Procter & Gamble and Xerox which stated in part:

> If the United States expects to improve its global competitive performance, business and academic leaders must close ranks behind an agenda that stresses the importance and value of TQM... Despite some successful collaboration between business and higher education in advancing total quality management, widespread adoption of TQM is moving too slowly to meet the challenge... Working together, companies and institutions of higher education *must* accelerate the application of total quality management on our campuses if our education system and economy are to maintain and enhance their global positions.[2]

Beyond these obvious imperatives for change, there are additional incentives for us to adopt the TQM paradigm on a comprehensive basis in our operations. Both the Regents of the University System of Georgia and our regional accrediting agency, the Southern Association of Colleges and Schools (SACS), are calling for comprehensive assessment at their member institutions. These calls stem from public questions about the

[1]We have struggled unsuccessfully to find a more appropriate term for "customer" in the higher education context. Use of the term here will denote the recipients of our value-added processes: first and foremost our students, and then their parents, business and industry which employs our graduates, the organizations which contract for our research, our alumni, and the people of the state of Georgia who support our activities.

[2]*Harvard Business Review*, "An Open Letter: TQM on the Campus," by Robinson, Poling, Akers, Galvin, Artzt, and Allaire (November/December 1991, pp. 94-5).

quality of higher education and from the resulting push in most states to require higher education to take the assessment challenge seriously. If Georgia Tech wants to determine the manner in which it will be assessed, it must install a sound, comprehensive assessment program as soon as possible. In discussions with staff at both the Regents Office and SACS, there is strong support for the idea that Georgia Tech may meet its assessment obligations by implementing TQM.

Given all of these reasons, we have set as our goal to become the leading research university in the comprehensive implementation of TQM in its curriculum, research initiatives, dissemination efforts, and operations--all in close partnership with business and other higher education institutions. In setting this ambitious goal, we recognize that implementing TQM on a comprehensive basis at a major research university is a massive undertaking and will require an incredible and sustained commitment from the top to the bottom of the organization. This commitment and a recognition of its far reaching ramifications are made without reservation.

Beyond this commitment to implement TQM on a truly comprehensive basis, there are significant reasons for IBM to support Georgia Tech with a TQM initiative grant:

1. Georgia Tech is committed to being the leader among major research universities in the transformation into an institution that is driven by meeting and exceeding the expectations of its customers.

2. We have a critical mass of talented leaders, starting with President Crecine, who are deeply committed to bringing TQM to Tech and some of whom are national leaders in the TQM movement.

3. Georgia Tech already has an extensive array of established academic programs, research centers, outreach efforts, and operating units in which the application of TQM has already begun.

4. The Institute is a major producer of highly talented engineers and managers whose TQM preparation will impact the nation, and due to our international programs, the the global marketplace.

5. Tech and IBM have a long history of successful collaboration on a wide range projects. Selected notes on these efforts appear in Appendix E.

6. Our proposed initiative has the ideas, resources, and management plan to implement TQM on a comprehensive basis at Georgia Tech and to transform completely our organizational culture.

The proposal which follows outlines our specific objectives and work plan to achieve our TQM goal. The following areas are addressed: (1) Georgia Tech's qualifications for this TQM initiative, (2) the comprehensive program we will undertake to transform Georgia Tech into the leading higher education TQM practitioner, educator, and research institution, (3) the resources and commitment Georgia Tech will bring to the table, (4) the major sources of external support we anticipate incorporating into this effort, and (5) the IBM partnership arrangements we anticipate for this undertaking.

2.0 QUALIFICATIONS OF GEORGIA TECH

Georgia Tech brings a unique combination of strengths to the proposed TQM project. These include our status as a major producer of engineering and management

graduates for the global marketplace, a strong foundation in TQM expertise, a wide variety of existing TQM curricula and research activities, and a strong record of application of TQM principles to Institute operations.

2.1 Georgia Tech: A National Engineering and Management Power

The Georgia Institute of Technology is a national engineering and management power. The sheer size of our engineering and management program enrollments at both the graduate and undergraduate levels enables us to have far reaching impact on the international workforce requirements for engineering and management students who understand and have the capability to practice TQM. As measured by the number of degrees granted, we are the second largest engineering program in the country. Last year we graduated 2,807 students, of whom 1,762 were engineers. We have a substantial array of international educational activities including a campus, GT-Lorraine, in Metz, France.

In addition, our undergraduate and graduate student bodies are of extremely high quality and bring with them considerable work experience. For example, the average SAT scores of our entering freshman class (1203) and their high school grade point average (3.6) indicate that we annually have among the best student bodies of all public universities in the country. **Indeed, based on the applicants we have accepted this spring, we anticipate enrolling the best freshman class of any public university in the nation this coming fall!** We rank number one in the number (90) of National Merit Scholars among public institutions and number three in terms of National Achievement Scholars (15). Additionally, valuable work experience is gained through required laboratory experiences and a cooperative education program with industry in which almost one third of our undergraduate and 11 per cent of our graduate students are enrolled. In addition, from a TQM perspective, a unique strength of our student body is their strong quantitative skills.

We are a major supplier of high quality engineering and management talent to the nation. (Over 700 of Tech's alumni work for IBM worldwide.) Graduates of our programs have become major executives in the elite industrial and business organizations around the nation. **In one year, the Baldrige and Deming awards were given to companies (Milliken and Florida Power and Light, respectively) run by Ga Tech alumni.** Our objective has been and will continue to be to produce outstanding graduates who can stay at the forefront of their field because they are have the capacity to recognize worthwhile ideas and seek new paradigms.

The 607 instructional and 973 research faculty at Georgia Tech combine strong academic and research accomplishments with a professional and industrial orientation. Approximately one third of the engineering faculty are registered professional engineers, and the average industrial experience is approximately four years. Last year we ranked third in dollar volume of sponsored research among all universities conducting engineering research, and fifth in the dollar volume of industrially supported research.

2.2 Strong TQM Foundation.

There are several important foundations upon which Georgia Tech builds its TQM effort. These include a growing commitment to serving customers, experienced people, established programs, and ongoing activities.

2.2.1 Growing Commitment to Customer Service. Georgia Tech is truly a fertile organization for the TQM seed. In 1990, in response to the changing demographics in our student customer base, we undertook a bold and sweeping reorganization of our academic program, which brought increased focus on the global economy, the management of

technology, public policy issues, computing, and effective communications for all of our graduates. In 1991, we completely reorganized our student services programs in response to student customer satisfaction surveys to create a responsive and "seamless" set of student support programs that will make the undergraduate experience at Tech less a matter of personal survival and more a matter of achieving academic success. In recent years we have had considerable success in attracting and graduating black Ph.D.'s in engineering because we have worked effectively with our suppliers, historically black colleges, through 3/2, 2/2 and other pipeline programs. Our Industrial and Systems Engineering School became number one in the nation in 1990 and 1992 in the U.S. News and World Report Survey of professional schools in part because it listened to its alumni customers and revised its curriculum in accord to survey results from that group. And we listen to our Georgia Tech Advisory Board, made up of our most accomplished graduates (W.T. (Tom) Smith, Jr., Vice President and General Manager for the Southern Area, IBM, USA is a member) and selected other leaders from business, academia and the public sector. This group has insisted that Georgia Tech focus on its customers (particularly students), commit to TQM and adopt strategic planning. To be sure, they will continue to press Tech to maintain its competitive edge into the 21st Century and we will continue to act on their advice.

2.2.2 **People.** A critical asset in Georgia Tech's efforts to incorporate TQM is the wealth of knowledge about and commitment to TQM many of our faculty and executives bring to the table. A summary listing of the persons who have chosen to participate in this initiative is provided in Appendix A.

A few of the national TQM leaders now at Georgia Tech should be noted. Dr. John A. White, recently appointed Dean of Engineering, provided national leadership in focusing attention on the need for TQM in academia when he was Acting Deputy Director of the National Science Foundation for Engineering. At the *First National Symposium on the Role of Academia in National Competiveness and TQM*, Dr. White gave the well-cited presentation "TQM: It's Time Academia." Recently, Dr. White was named to the Leadership Committee for the Total Quality Forum chaired by Procter & Gamble.

The interim Dean of the Ivan Allen College, which houses our School of Management, is Robert Cannon, an alumnus of Georgia Tech's mechanical engineering school. Mr. Cannon joined Georgia Tech following his retirement from Procter & Gamble, where he was the Senior Vice President in charge of P&G's quality programs. In that capacity, he participated in the planning for the *Third Total Quality Forum* and in the development of P&G's TQM program.

Additionally, considerable expertise exists among the faculty as shown in the listings in Appendix A. Much of our existing TQM instruction is provided in the School of Industrial and Systems Engineering (ISyE). ISyE has taught Quality Control (ISyE 4039) as a required course for over a decade, and as an elective course for more than 30 years. Students from many engineering and management disciplines take the course as an elective. Among the ISyE faculty who have taught ISyE 4039 are Dr. Harrison Wadsworth (one of the chief examiners of the Malcolm Baldrige Award), Dr. Jane C. Ammons (a protege' of Dr. W. Edwards Deming, who occasionally accompanies him on visits to corporations, universities, and seminars), and Dr. Russell G. Heikes (who has taught numerous courses for IBM on total quality and Six Sigma).

2.2.3 **Established Programs.** Georgia Tech has a substantial number of established programs and centers which provide support for its TQM efforts and the proposed project. These established activities are vital to the mission of Georgia Tech, and include academic programs, research centers, and quality focused programs. They are described below.

2.2.3.1 Academic Programs. Table 1 describes academic programs which support the TQM activities.

Table 1. Academic Programs Which Support TQM Activities

PROGRAM	RELATIONSHIP TO TQM
The Computer Integrated Manufacturing Systems Program (CIMS).	A highly visible and successful collaboration between the School of Management, the College of Engineering, and the College of Computing, the CIMS program is a Masters level *certificate* program. This interdisciplinary program was established in 1983 as a result of an IBM initiative. The program involves faculty from most engineering disciplines and management to prepare students for leadership in manufacturing environments. The CIMS program regularly enrolls over 150 masters students and is supported by corporate sponsorship from many North American companies, including IBM, Motorola, NCR, Northern Telecom, and Digital Equipment Corporation. (Appendix B describes the quality systems course, ISyE 6302, which was developed specifically for the CIMS program.)
The Management of Technology Program (MOT)	The MOT *certificate* program is another example of intercollegiate collaboration among the College of Engineering, the School of Management, and the College of Computing. Established in 1991, the purpose of this program is to prepare students with the interdisciplinary skills required to "link engineering science and management disciplines to plan, develop, and implement technological capabilities to shape and accomplish the strategic and operational objectives of an organization."[3] Students in this program are required to have a "technical background," usually satisfied by undergraduate or graduate level study in engineering, physical sciences, mathematics, or computer science. The MOT program is supported by a 26 member advisory board representing such corporations as IBM, AT&T, Coca-Cola Company, Delta, DEC, Hayes Microcomputer Products, Hewlett Packard, Kimberly-Clark. Lockheed Aeronautical Systems Company, NCR, Northern Telecom, Rockwell Corporation, and Russell Corporation. (Two of the quality courses described in Appendix B are included in the MOT Program.)
The Southeastern University and College Coalition for Engineering Education (SUCCEED)	A major innovative program begun this year to improve substantially the relevance and quality of undergraduate engineering degree programs in the 21st century, SUCCEED is a National Science Foundation-funded collaborative effort of nine universities: Clemson University, Florida A&M University, Florida State University, University of Florida, Georgia Institute of Technology, North Carolina A&T State University, North Carolina State University, University of North Carolina at Charlotte, and Virginia Polytechnic Institute and State University. A fundamental aim of the SUCCEED program is the integration of "the principles and practices of Total Quality Management (TQM) into the engineering curriculum, engineering management education , and engineering processes."[4] As home to one of the four centers within the SUCCEED program, Georgia Tech is expected to play a leadership role in this pioneering effort and will simultaneously be affected by its successes.

[3] *MoT Student Manual 1991-1992*, Georgia Institute of Technology, MoT Graduate Certificate Program, p. 3, citing *MANAGEMENT OF TECHNOLOGY: The Hidden Competitive Advantage*, published by the National Academy Press, Washington, DC, p. 9.

[4] *Southeastern University and College Coalition for Engineering Education (SUCCEED)*, Proposal to the National Science Foundation from nine Southeastern universities, 1991.

2.2.3.2 Research Centers. Georgia Tech has several research centers whose activities encompass research in related to quality. These centers are described in Table 2.

Table 2. Georgia Tech Research Centers Which Encompass Quality

RESEARCH CENTER	RELATIONSHIP TO TQM
Manufacturing Research Center	MaRC promotes interdisciplinary manufacturing-oriented research, development and educational projects to strengthen the national industrial base and meet the competitive demands of the Global Marketplace . It also fosters collaborative projects between industry, academia and government. A hallmark of the Center is the use of the team approach to problem solving, using TQM principles. Both its Director and Associate Director have been quality executives for major national corporations. The Center is located in a recently opened state-of-the-art 120,000 square foot facility. IBM is one of the major industrial supporters of MaRC.
Material Handling Research Center	MHRC was initially funded by NSF to strengthen American industry's productivity through a systems approach to improved material handling. The Center now has 30 member companies, whose funds are leveraged annually into $3 million for research into problems involving the movement, storage and control of material. A number of the Center's current projects address quality concerns and one of its current research thrusts involves extending TQM into material handling and logistics research. In recent years, Ga Tech has broadened its impact by enlarging MHRC to include four additional universities. IBM was a founding member of MHRC and has been a long term supporter.
Microelectronics Research Center	MiRC fosters interdisciplinary research in the integration of microelectronics, integrated optoelectronics, and microsensors and actuators. This research is conducted in a new 100,000 square foot state-of-the-art facility that provides the infrastructure and environment for interdisciplinary teams to work together successfully. One of the center members, Professor Hughes, developed a highly successful concurrent engineering course based on TQM/ Six Sigma, which was sponsored by Motorola.
The Center for Human-Machine Systems Research	The CHMSR is composed of an interdisciplinary group of senior staff and graduate students in engineering, computer science, and engineering psychology who pursue research on analysis, modeling and design of human-machine systems. The methodological emphasis incorporates a wide variety of mathematical modeling and experimental techniques, which can be applied to human decision making and problem solving. Examples of application areas for this research center include aircraft, ships, satellite control rooms, flexible manufacturing systems, and computer systems.
The Computational Optimization Center	The Center conducts research and educational programs in the development, implementation and application of optimization methods for large scale decision making applications in industry and the military. It is partially supported by contracts from IBM and one of its Co-Directors is Dr. Ellis Johnson, an IBM Fellow.

2.2.3.3 Quality Centers and Programs. In addition to academic programs and research centers, Georgia Tech has several centers and programs focused on quality. These are described in Table 3.

Table 3. Georgia Tech Quality Centers and Programs.

ACTIVITY	DESCRIPTION
Center for International Standards and Quality	The Center for International Standards and Quality was established in 1991 to provide standards information and fundamental quality control procedures for organizations that wish to expand their customer base to Europe. This Center works in liaison with the British Standards Institute to prepare firms for quality system certification and registration according to the requirements of ISO 9000 and BS5750. The Center has several corporate sponsors including Coca-Cola Company, Georgia Power Company, Kimberly-Clark, and C&S Sovran Corporation.
Georgia Productivity and Quality Center (GPQC)	Established by the Georgia State Legislature in 1975, the GPQC is a resource center whose primary mission is to assist Georgia business and industry in maintaining and strengthening its competitive market position through productivity and quality improvements. Housed in the Economic Development Laboratory of the Georgia Tech Research Institute, the GPQC conducts research and provides in-company consultation and quality audits as well as numerous seminars and training programs.
The TQM University Challenge	The TQM University Challenge is a faculty educational program sponsored by five companies: IBM, Milliken, Motorola, Procter & Gamble, and Xerox. During the late spring of 1992, each company will host up to 100 engineering and business faculty members from the seven universities selected as winning entrants in the competition. Georgia Tech was selected as one of the winning institutions in the TQM University Challenge. During the second week of May, 1992, Georgia Tech will be sending 50 of its engineering and management faculty to attend a one week intensive TQM educational program at Milliken headquarters in Spartanburg, South Carolina. It is anticipated that this exposure of a significant portion of our faculty to TQM concepts and implementation will stimulate rapid deployment of the TQM approach in all phases of Georgia Tech's curricula, research and operations.
The Electronic Group Decision Making Facility	Located in the School of ISyE is an electronic group decision making facility which includes networked computer terminals and requisite "groupware." At present the only facilities like this in Georgia include those at GA Tech, Bell South Training Center, and University of Georgia, although facilities are planned at the Carter Presidential Center and the State Board of Education. Georgia Tech is sharing this technology with the business community and uses it for ongoing research as described in Section 3.5.

These programs and centers form a strong foundation that will support Georgia Tech's proposed TQM initiative. In addition to these programs, Georgia Tech has participated in or sponsored other quality efforts. These include:

- Two years ago, 125 Georgia Tech faculty and staff attended an all day TQM program at Milliken in Spartanburg, South Carolina. Attendees included all Vice Presidents, Deans, most School Directors, all laboratory managers from the Georgia Tech Research Institute, individuals from the Athletic Association, heads of student recruiting, physical plant, the Georgia Tech Foundation, the Georgia Tech Alumni Association, registration, and financial aid.

- A similar program sponsored by Xerox was attended by the President of Georgia Tech and participants from the School of Management.

- Over 40 people from the Georgia Tech Research Institute attended the Deming seminar in Atlanta in September, 1991.

- Campus seminars on TQM-related topics have been given by several speakers including Mr. W.T. (Tom) Smith, Vice President and Area General Manager, Southern Area-IBM USA, Mr. Ben Bethell, Senior Vice President of Procter & Gamble, Mr John Johnson, Vice President for Manufacturing, Harris Corporation, and Mr. Ken Hall, Director of Quality, Star Enterprises (a joint venture of Texaco and Aramco).

- The Dean of Engineering and the Dean of the Ivan Allen College were active participants in the *Third Total Quality Forum* hosted by Procter & Gamble during the summer of 1991. The Institute's Executive Vice President also attended the meeting.

- During the Spring of 1990, Georgia Tech held a quality symposium and honored three of our alumni who led their companies to award winning quality efforts. These included Dr. Thomas Malone, President of Milliken, and Mr. Rhesa (Ray) Farmer, Executive Vice-President (now retired) of Motorola, whose companies won the Malcolm Baldrige Award, and Mr. John Hudiburg, CEO (now retired) of Florida Power and Light, which was the first non-Japanese company to win the Deming Prize.

- Georgia Tech has hosted satellite downlinks of national quality programs, including seminars by Dr. W. Edwards Deming.

- Georgia Tech hosts the monthly meetings of the Atlanta Deming Study Group, a nonprofit professional organization which focuses on the study of quality and total quality improvement principles of Dr. W. Edwards Deming. The three year old study group is composed of corporate executives, engineers, researchers, educators, military commanders, and academic faculty from the greater Atlanta area (100 mile circumference). Membership is approximately 100 people.

2.2.4. TQM in Operations. There is considerable TQM activity already underway at Georgia Tech operational units. Progress in the units is described in Table 4.

Table 4. Examples of TQM in Georgia Tech Operations

AREA	TQM ACTIVITY
The Division of Planning, Budget and Finance	The Division of Planning, Budget and Finance began its TQM efforts in the Summer of 1990. The division has just completed the first phase of its implementation process, which includes four steps: employee education, establishment of systems to develop a constancy of purpose with regard to TQM within the division, the achievement of improved results, and changing the division culture. The second phase of the process will involve development of a deeper and more qualitative understanding of basic administrative processes--to include benchmarking, more in-depth learning and practice about the "coaching leaders" and "empowered teams" concepts, and more accomplishments in terms of service, efficiency and reengineering.
Georgia Tech Research Institute (GTRI)	GTRI recently completed the first phase of its implementation process. A formal GTRI TQM policy and plan have been formulated and adopted. Pilot implementation programs have been undertaken in two labs and action teams for problem solving have been established at several levels. Second phase efforts include steps similar to those listed for the Planning, Budget and Finance Division.
Continuing Education	Under the leadership of Dr. Denney Freeston, Continuing Education has proceeded rapidly to the completion of the first phase of implementation of TQM. Education has been provided for all Continuing Education employees, a quality council has been formed, numerous improvement efforts have been undertaken, and noticeable changes to the department culture have been achieved. Plans are being laid for movement into the second phase of implementation.

Schools of Electrical, Industrial and Systems Engineering and Textiles and Fiber Engineering.	Units have begun to implement TQM within their organizations. ISyE's initial effort is focussed on the secretarial and support staff and Textile's and Electrical's deal with both faculty and support staff
The Ivan Allen College of Management, Policy, and International Affairs	This college has begun to assess its general education program in accord with the Board of Regents' Office guidelines. A college assessment committee has been formed. It has been directed 1) to define cognitive and attitudinal outcomes they believe a student should emerge with from the Ivan Allen College portion of the Institute's general education program, 2) to identify data and information already available on outcomes on campus with regard to the program, 3) to help develop focus group interviews for Tech seniors and alumni and a survey for alumni graduating five, ten and 20 years ago, and 4) to formulate plans for a retreat for all College faculty involved in general education to define overall objectives for the College program and to build a shared sense of purpose. This effort will be completed by the end of the spring quarter.
College of Sciences	Mounted a major initiative to improve mathematics, science and computing education at Georgia Tech through the creation of the Center for Education in Science, Mathematics and Computing (CEISMC). CEISMC is a comprehensive two pronged program. The first prong involves the development of pipeline programs to develop young scientists and engineers, improve the mathematical and scientific background of high school teachers in Georgia, and foster scientific literacy in all of K-12 students. Within the TQM framework, this activity explicitly acknowledges our responsibility to "work with our supplier" in order to improve the quality of our input streams. It is an obligation that Georgia Tech takes seriously and for which it now commits significant resources. The second prong includes a comprehensive assessment of the Institute's general education component in mathematics, science and computing and the development of detailed program for its continuous improvement.
Training	Several TQM "training" activities have been described above including visits by 125 Georgia Tech faculty and staff to Milliken, a similar visit by the President and College of Management faculty to Xerox, and the participation of 50 faculty from the Colleges of Engineering and Management in The TQM University Challenge, a week long program at Milliken. In addition, approximately 60 Georgia Tech administrators, faculty, researchers, and staff have attended the three credit hour academic course ISyE 4899, Special Topics in Total Quality Management. Their class assignments have been geared towards their Georgia Tech responsibilities. The demand for the course was so great in Spring Quarter 1992 that several administrators and faculty who wanted to take the course could not be enrolled, and will have to take it at the next offering.

Student SUCCESS Center	The Center will serve as the focal point for Tech's efforts to dramatically enhance its service to its student customers in several areas including recruitment, admissions, financial aid, academic advising, cooperative education and job placement. The Center is designed to implement President Crecine's "student life cycle" concept. Under this concept, Tech's relationship with its students is a lifetime contract. Contact with the student is made as early as possible in their K-12 careers through a variety of "pipeline" programs; intensifies in the college years, where not only the freshmen but the sophomore, junior and senior classes are recruited; and is sustained into adulthood where continuing education and alumni fellowship are provided. The Center will house all of these functions in a unique new dual-use facility where the interview rooms will be the skyboxes in the connected football stadium. A hallmark of the facility will be the use of the latest in Tech's multimedia capabilities to provide admissions, financial aid, academic advisement and placement information to students. The new facility, with an intensively trained, customer-oriented staff, will be opened in January, 1993.
Center for Enhanced Teaching and Learning (CETL)	Established to continuously improve the institute teaching and learning process. Many programs are provided by CETL, including courses on teaching skills for faculty and graduate teaching assistants, a monthly brown bag seminar for educational skill development, course evaluations and their monitoring and interpretation for faculty, and student development programs. CETL sponsors a "Visiting Professor Program" which pairs a set of industry guests with selected faculty, where the industry visitor meets with faculty, students, and may give an lecture to an appropriate class. Many of the visitors are president's or CEO's of their corporations. Approximately 100 of these industry guests will visit on May 7-8, which will promote high quality interaction with our customers so that we can better serve their educational needs. Perhaps the most innovative new program developed by CETL is planned for Fall 1992: the Faculty Friends Program. An Institutewide system of over 200 faculty advisors will be paired with small groups of incoming freshman in order to promote student retention.[5] This faculty-student pairing when the student arrives on campus is not for purposes of academic advising, which will continue to be done in the schools and departments. The goal is to create a very personal but systematic way to make sure every freshman hears, "We're glad you're here; we care about you as a person; and we'll help you any way we can to get your feet on the ground and then to be off and running."[6] In doing so, we will have less "waste" in lost students, and the interaction will allow the faculty a better chance to understand, meet, and exceed the true needs of our customer.

Our knowledge of the implementation of TQM into higher education operations suggests to us that this is the broadest-based effort to date of any major research university in the nation.[7] In making this statement, we are not indicating satisfaction with our efforts. In the

[5] Student-faculty informal interaction during the freshman year has been shown to be the most significant factor in student retention. Pascarella, Ernest and Patrick Terenzini, "Patterns of Student-Faculty Informal Interaction beyond the Classroon and Voluntary Freshman Attrition," *Journal of Higher Education*, Volume 48, pp. 540-52.

[6] "Frequent faculty-student contact in and out of class is the most important factor in student motivation and involvement. Faculty concern helps students get through the rough times and keep working." Chickering, A. W., and Z. F. Gamson, "Seven Principles for Good Practice in Undergraduate Education," *AAHE Bulletin*, Volume 39, Number 7, 1987, pp. 3-7.

[7] Seymour, Daniel T., "TQM on Campus: What the Pioneers are Finding," American Association for Higher

units that have implemented TQM, we have just begun the TQM Journey and there is much to be done. And, the majority of our academic and support units remain untouched by TQM principles. Also, we need to make a total organizational commitment to the principles of TQM and to create a concerted, comprehensive strategy and structure to make this happen. This strategy and the organization are described in the next section.

3.0 PROJECT DESCRIPTION

3.1 Introduction and Rationale

In this section, we propose a strategic plan and an organizational design that will make Georgia Tech the leading TQM practitioner among the major research universities in the United States. These efforts will include: 1) the incorporation of TQM principles into the entire curriculum , 2) an ambitious TQM research program, 3) the dissemination of our experience and the results of our research to other universities and to business and industry, and 4) the implementation of TQM into every aspect of our operations.

3.2 Vision and Anticipated Results

3.2.1 Vision. The vision for Georgia Tech is to become **the premier technological university in the Nation.**[8] An essential prerequisite for the achievement of this goal is the development of a premier Total Quality Management Program at Georgia Tech. By 1995, Total Quality Management (TQM) will focus our organizational efforts on the people we serve, empower our faculty and staff to assess the value added by the processes for which they are responsible, and promote a climate of innovation and continual improvement. The achievement of this goal will require a total commitment by the President and his key staff, its prioritization as the principal organizational development effort over the next several years, and a significant financial commitment by the Institute.

3.2.2 Anticipated Results. Our vision to become the premier technological university in the Nation implies the *development of processes* that continually improve our ability to meet our customers needs. Therefore, the principal result we anticipate from our focus on improved processes is better products and services for our customers. In doing so, we will *formulate and test an approach for the implementation of TQM into all aspects of the university's operations.* Furthermore, we anticipate the development of effective *processes for discovering and developing new TQM approaches and techniques and for sharing these developments* with other institutions and organizations. We anticipate the development of processes which are efficient in the sense that the "highest return on investment" is obtained by optimizing our combined efforts relative to our aim.. We anticipate striving for excellence in a culture of teamwork and innovation, driven by the desire to "understand, meet, and exceed the expectations of the customer."[9]

Education, November 1991. See also, Sanford University: Report on Commision on Colleges (on TQM), Southern Association of Colleges and Schools, July 1991.

[8] These statements are drawn directly from the 1992 Georgia Tech Strategic Plan for the implementation of TQM into its operations. Georgia Tech's fundamental strategy is continuous improvement, comprehensive and fully integrated among all institute functions.

[9] From the definition of TQM given at the Total Quality Forum, August, 1991.

3.3 Implementation Strategy and Organization

Georgia Tech has developed a strategic plan and an organizational framework for the implementation of its TQM program. Both are designed to bring about and maintain a total Institute commitment to TQM and to focus and coordinate the TQM efforts of all Institute units.

3.3.1 Strategic Objectives. The principal objectives of the Tech strategic plan for the implementation of TQM are provided below.

Objective I. **The President and the Georgia Tech executive leadership will establish constancy of purpose based on a commitment to Total Quality Management.**

Objective II. **Establish the necessary organizational structure to implement a comprehensive TQM program.**

Objective III. **Revise comprehensively the undergraduate, graduate and continuing education curricula so that they focus on the needs of students, expose each of them to TQM principles throughout the curriculum, assume a life-long learning perspective, and operate as a continuously improving system that enables students to flourish in their studies and their personal lives.**

Objective IV. **Create a customer-driven research program aimed at developing a "scientific" understanding of "what works in TQM, why it works, and what might work even better."**

Objective V. **Fully incorporate TQM principles into Institute operations by Summer 1995.**

Objective VI. **Develop partnering relationships with interested corporations which disseminate Tech's TQM knowledge and experience and bring financial support for these efforts.**

Objective VII. **Integrate the Institute TQM effort with the Strategic Planning Process and the Institute-wide Compensation and Classification Study.**

We fully recognize that these strategic objectives are extraordinarily ambitious and that a passionate and complete organizational commitment will be required to achieve them. We have made this commitment and believe that it is worthy of our best efforts.

3.3.2 Organizational Design. To support the achievement of these objectives, we will create a Quality Council, an Office for Continuous Improvement and Assessment, a Continuous Improvement Curriculum Committee, and International Center for Continuous Improvement (International Center). This structure is described below and is shown in Appendix C.

3.3.2.1 The Critical Role of the President. If we have learned anything from the corporate leaders who have successfully implemented TQM, it is that the chief executive officer must be totally committed to TQM for the long haul and play a central leadership role in bringing about its implementation. In keeping with this requirement, President Crecine will assume a central leadership role in the TQM process at Georgia Tech. He

will chair the quality council, drive the development of a Georgia Tech TQM strategy, oversee its implementation, and hold the Georgia Tech leadership accountable for progress on their indicators of continuous improvement.

3.3.2.2 **Quality Council.** The Quality Council will be chaired by President Crecine and will include the executive vice president, the vice president for planning, budget and finance, the vice president for information technology and executive assistant to the president, the vice president for the Georgia Tech Research Institute, the vice president for student services, the vice president for external affairs, the vice president for strategic planning, the dean of the College of Engineering, the dean of the School of Management; the director of athletics, the associate vice president for facilities, the associate vice president for human resources, the special assistant to the president for academic resources, the director of the International Center for Continuous Improvement; the chair of the faculty senate executive board, the president of the Student Government Association, and an Institute Professor to be designated. The Council will advise the president on the development of the Institute TQM strategy, which implements the priorities established in the Institute strategic plan, and issue an annual Institute Continuous Improvement Progress Report. The members of the Council who are line officers will also have responsibility for the implementation of TQM in their division and college operations. The vice president for strategic planning will serve as the executive director for the Council, assisting the president with the overall coordination of Institute TQM efforts. The Council would also be advised by the Continuous Improvement Visiting Committee.

3.3.2.3 **Continuous Improvement Visiting Committee.** The Continuous Improvement Visiting Committee will serve as an external advisory board to Georgia Tech's TQM efforts and will include CEO's and senior quality executives from corporations that have successfully practiced TQM. This Board will also provide input and advice with regard to the operations of Georgia Tech, the International Center and the development of the TQM curriculum and research programs.

3.3.2.4 **Office for Continuous Improvement and Assessment.** This office will be charged with providing staff and technical support to the President and the Institute Quality Council with regard to TQM and supporting unit continuous improvement efforts in the operations area. It will also have responsibility for coordination of the assessment and accreditation reports required by the Board of Regents and the Southern Association of Colleges and Schools. With regard to its continuous improvement responsibility, the office will facilitate unit continuous improvement training and implementation efforts, develop training materials, administer the campus continuous improvement awards program, work with the campus news bureau to develop an information campaign for the continuous improvement effort and staff the annual Institute Continuous Improvement Progress Report. The office director will report to the president on policy matters and to the vice president for strategic planning on operational issues. The office will be appropriately staffed and budgeted to carry out the responsibilities and will work closely with the International Center and the Institutional Research and Planning Office in its data collection and analysis efforts.

3.3.2.5 **Institute Continuous Improvement Curriculum Committee.** This committee will be charged with the development and maintenance of a "seamless" TQM curriculum that "touches every student" at the Institute in accord with the plans outlined in the section on curriculum below. The chair will be the dean of the College of Engineering, the vice chair will be the dean of the School of Management, the chairs of the Institute Undergraduate and Graduate Curriculum Committees, faculty members with an interest in TQM from all Institute Colleges and selected quality executives from corporations that

have successfully practiced TQM. College representation will be in proportion to its share of the total faculty. The Committee will report to the Institute Quality Council.

3.3.2.6 **The International Center for Continuous Improvement.** On the premise that there is a common need for sound information on the tools, methods and principles of TQM among the key high technology development and manufacturing companies and higher education institutions internationally, we will establish an international "quality center." The Center's mission will include: developing information on corporate and higher education successes to enhance state-of-the-art TQM capabilities and global competitiveness; bringing executives and managers at comparable levels together to share this information through conferences and short courses; holding forums with TQM guest speakers of the highest caliber; sharing training and resource material; serving as a "matchmaker" for companies and institutions to benchmark with comparable organizations; overseeing the Georgia Tech TQM research program, including the seed grants program; and providing the Institute Continuous Improvement Curriculum Committee with periodic reports regarding new developments that should be incorporated into the Institute TQM curriculum. The Center would be led by an individual with considerable experience in TQM, preferably a former corporate CEO or vice president for quality who is committed to carrying the banner for TQM internationally. The Continuous Improvement Visiting Committee described earlier will advise on the operation of the Center, and the Center will report to the Georgia Tech Quality Council.

3.4 Curriculum Development

The graduates of our undergraduate, graduate, and executive programs will play a vital role in the future competitiveness of the nation's businesses, educational institutions and government agencies. Thus, we have an absolute obligation to develop an *educational process* for TQM instruction, which is continuously improving and constantly exceeding our customer's anticipated needs. The following sections state our TQM curriculum development objectives and the steps required to achieve them, detail our existing curricula related to TQM and our curriculum development plans, and provide a timetable for achieving the proposed changes.

3.4.1 **Goals and Required Steps.** Our goal is to educate students so that they understand the TQM philosophy and attain the essential knowledge, skills, and practical experience in quality improvement required to make an immediate and effective contribution to the organization that hires them. We will strive to develop a curriculum that encourages a life time commitment to learning and instills the concept of "white collar productivity" as a "way of life" in all of our students.

Our goal is to develop **a continuous improvement process for TQM curriculum development** which features:

- a "market driven" approach for determining both content and delivery method
- an emphasis on "continual improvement" of faculty, materials, methods, and equipment
- the ability to perform "large-scale pilot studies" which test major proposals for change in the ways faculty teach and students learn to achieve large gains in the effectiveness of the educational program

- the integration of TQM material across the entire institute curricula, weaving the TQM philosophy into all courses, rather than requiring one or two "TQM courses" with business as usual everywhere else

- the assurance that students will get at least a minimum of exposure to TQM within every degree program by systematically targeting certain required courses for specific TQM knowledge and skill development

- the implementation of TQM principles into the operation of the curriculum and the associated support services to optimize student performance

- the development of "partnership" relationships with our suppliers, especially K-12 educational processes, and also with the "suppliers" of our curriculum accreditation requirements

These goals imply our objective to target not only WHAT we teach but HOW we teach it from the perspective of our customers' needs. This is a major departure from the traditional paradigm for university educational improvement efforts!

In creating a continual improvement process for our TQM curriculum development, we hope to challenge many of our conventional approaches. For example, we want to extend the short term focus of the learning experience. We need to examine 1) the impact of alternative evaluation and grading procedures, 2) the timing of material introduction, and 3) alternative delivery methods which explicitly recognize that different people learn in different ways. This will require "research" and experimental validation.[10]

We want to challenge the conventional university paradigm in the area directly related to our business and industry customers: we want to establish a program of "industry fellows" that will link them directly to the classroom. Although the concept is not a new one, its widespread adoption by Georgia Tech (and other research universities) has not been exploited on a systematic basis. One important benefit to Georgia Tech will be the "lateral diffusion of total quality management philosophy from industry into colleges."[11] There will be benefits from the interaction that the industry fellows channel back to their companies as well. For these reasons, this concept is gaining support for potential funding by government agencies.[12]

We also want to challenge the traditional approach of examining curricula by degree program only, and instead strive for interdisciplinary examination of courses. There are several curriculum innovation initiatives that provide an ideal opportunity for incorporating TQM concepts at Georgia Tech, using an interdisciplinary approach. These initiatives include the new ABET accreditation requirements for statistics in all engineering majors, the SUCCEED efforts mentioned earlier, the comprehensive review of the undergraduate program which is underway in the College of Engineering strategic planning process, and

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10 To illustrate, Dr. S. Manivannan, Assistant Professor in the School of Industrial and Systems Engineering, has recently submitted a proposal to the National Science Foundation for funding to examine the concept of "Just-in-Time Learning" in the undergraduate engineering curriculum.

11 *ASEE Prism*, "Bringing Corporate Know-how To Class," by Kovac and Augustine, April 1992, p. 26.

12 Establishment of an "Industry Fellows Program," with equal support from NSF, the university, and the company, is recommended in the *1992 Report of the Advisory Committee for the Division of Design and Manufacturing Systems*, Directorate for Engineering, National Science Foundation, Washington, D. C.

the exposure of 50 Georgia Tech faculty from all engineering disciplines and management to the week long instruction at Milliken as part of the TQM University Challenge.

As the following section documents, Georgia Tech has many of the building block courses in place to establish a premier TQM educational program. Before these building blocks can be properly assembled and supplemented with new courses, specific *processes* must be established. These processes are defined in Table 5.

Table 5. TQM Curricula Process Development Steps

PROCESS DEVELOPMENT STEPS	STRATEGIC PLAN	SPECIFIC MILESTONES
Step 1. Establish organization structure	Objective II	Establishment of Georgia Tech Quality Council, Visiting Committee , and Institute Continuous Improvement Curriculum Committee
Step 2. Develop "market driven" process for curriculum development	Objective III	Lead by the Institute Curriculum Committee
Step 2a. Develop a process and instruments to assess industry "needs" (external assessment)		Annual assessments based on surveys, interviews, site visits, alumni, etc. prepared;
Step 2b. Develop a process to assess how well our current students are prepared to meet industry needs (internal assessment)		Annual ssessments based on sampling of seniors, graduate students, and executives in continuing education courses prepared;
Step 2c. Develop a process to track what is being done in other programs and how effective it is		First benchmarking report prepared by the International Center; annually thereafter.
Step 2d. Develop a process which translates this knowledge into curriculum objectives, changes and innovation		Institute Curriculum Committee, with advice from the Visiting Committee, targets specific curriculum development efforts with resources;
Step 2e. Develop a process for continual improvement of faculty knowledge and skills		TQM University Challenge TQM Training Plan
Step 3. Develop an ongoing process to implement and evaluate TQM curricula	Objective III	Led by the Institute Curriculum Committe
Step 4. Develop process for studying and "learning" from the implementations as a basis for new trials	Objective III	Led by the Institute Curriculum Committe
Step 5. Develop process to share information and curricula developments with other universities	Objective II	Annual University Conference

The process creation steps listed in Table 5, vital to the development of a "continuously improving" curriculum, are scheduled in the implementation plan described in Section 3.8. Many of these functions are already in place within the institution; however, they are localized within degree programs and receive limited forms of systematic feedback at best. What we are proposing here is a global, interdisciplinary, customer-focused approach to designing, implementing, and continuously improving our TQM curriculum. The next section describes the solid foundation of courses on which we will build.

3.4.2 **Existing and Planned Curricula.** Georgia Tech has a long history and record in the quality area. Its faculty have written several texts in quality related areas,[13] and its curricula in the statistics and management areas are well developed to support key topics within TQM. Appendix B contains a listing of specific Georgia Tech courses which support TQM undergraduate and graduate education, and Table 7 lists continuing education. In addition, many other courses contain segments that provide and/or reinforce quality concepts such as communications, applications (e.g., ISyE 8101 Electronic Assembly Systems), and operations research courses.

The global impact of our education programs bears emphasis. Not only are we a large scale producer of engineers and managers for worldwide service, but the influence of our curricula is truly international. Our satellite uplink activites are global, and we manage AMCEE, the consortia of engineering colleges under which NTU falls. For example, this past quarter we had 19 course enrollments in France through the video based program. Due to the demand generated by the 1996 Summer Olympics, we teach a large scale English as a Second Language Program; last summer we taught English to 70 Japanese executives.

Careful examination of the curriculum at Georgia Tech reveals strengths and weaknesses in our existing programs with regard to the TQM philosophy and practice. Georgia Tech has an outstanding program covering the statistical aspects of quality, and a solid foundation in its managerial aspects. However, students within all of our degree programs need a better grounding in TQM philosophy(ies), strategies and tactics for implementing and developing TQM, and some need greater exposure to understanding and managing system variation using statistics. Given our current curriculum, we could achieve a reasonable level of TQM competency in our undergraduate and graduate students in engineering and management by requiring them to take ISyE 4899, Total Quality Management, and perhaps additional courses in team processes and statistics. But we want our students to have a much stronger grasp of TQM than this, and our proposed curriculum development activity is directed at this more ambitious goal. Because our curriculum development will be driven by the needs of our customers, our exact implementation is dependent upon the results of the customer surveys set in motion during planned Step Two described in Table 5. In general, however, we see the need for the following curriculum development activities.

3.4.2.1 Planned Undergraduate Curriculum Development. Vision. We plan for every undergraduate student to graduate from Georgia Tech with an understanding of the TQM philosophy and the essential knowledge, skills, and practical experience to make an immediate and positive contribution to the productive work of an organization. To accomplish this aim, our plan is to coordinate and augment the efforts of several undergraduate curriculum initiatives to target certain courses to assure specific TQM knowledge and skill development. Table 6 details the knowledge and skills we want to develop in our undergraduate students and suggests a potential focal point for this development within the undergraduate curriculum.

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[13] Georgia Tech faculty texts in the quality area include:
Principles of Quality Control, by Jerry Banks, John Wiley & Sons, New York, 1989.
Modern Methods for Quality Control and Improvement, by H. M. Wadsworth, K. S. Stephens, and A. B. Godfrey, John Wiley & Sons, New York, 1986.
Probability and Statistics in Engineering and Management Science, by W. H. Hines and D. C. Montgomery, John Wiley & Sons, New York, 1980.
Handbook of Statistical Methods for Engineers and Scientists, H. M. Wadsworth, Ed., McGraw-Hill, 1989.

Table 6. Curriculum Development Basis

PARALLEL CRITERIA FROM MALCOLM BALDRIGE NATIONAL QUALITY AWARD	KNOWLEDGE/ SKILL TO BE DEVELOPED	POTENTIAL LOCATION WITHIN THE CURRICULUM
Strategic Quality Planning	Strategic Planning Self Analysis	Initial Freshman course; application exercises tied to career planning and plan of study at Georgia Tech; "career" advising
Human Resource Development and Management	Working in Teams, group decision making	Introduction using team assignments given during the calculus series; refinement during interdisciplinary project team courses; electronic group decision making sessions using "groupware"
Leadership	Leadership	Initial Freshman course; refinement and practice during team assignments and group projects
The Quality Assurance System	Continuous improvement	Introduction during initial freshman course; reinforcement in most required courses; at least one improvement team participation experience before graduation
Information and Analysis	Measurement; understanding variation	Weave statistical methodology and application through the physics and chemistry laboratory experience; require statistical thinking during interdisciplinary group projects
Customer Focus and Satisfaction	Customer focus	Introduction in initial Freshman course; reinforcement in most required courses

The targeted knowledge/skills outlined in Table 6 exactly parallel the curriculum development effort projected for the SUCCEED program described above. Additionally, within the SUCCEED curriculum development initiative, fundamental changes are planned in the following curriculum components: Course Framework, Course Content, Instructional Environment, Evaluation and Grading, Advising, Tutoring and Mentoring, Professional and Clinical Practice, and Curriculum Administration.[14] Therefore, our TQM curriculum development activities for the College of Engineering will be achieved in the context of the SUCCEED program efforts. Additionally, we plan to require every student to participate in a Georgia Tech quality improvement team activity with other students, Georgia Tech staff, faculty, and administrators at least once before the student graduates.

Comparison of existing undergraduate curricula with planned curricula. As we develop the processes described in Table 5, we plan to alter our existing approach for teaching TQM. In particular, we plan to phase out our current method of teaching TQM in designated courses (ISyE 4899 and ISyE 4039), supplemented by our strength in the

[14] *Southeastern University and College Coalition for Engineering Education (SUCCEED),* Proposal to the National Science Foundation from nine Southeastern universities, 1991, page 9.

statistical aspects of quality. We will replace it with an integrated interdisciplinary approach that is driven by the needs of our industry customers and the total and TQM educational needs of our students. We plan to integrate this development effort within other current undergraduate curriculum restructuring activities to achieve far-reaching and synergistic change in our curriculum. Our approach builds on notions of "just in time" learning, requiring the students to a learn material as they require it for application.

3.4.2.2 Planned Graduate Curriculum Development. Vision. As with the undergraduates, all graduate students from Georgia Tech should have an appreciation for the TQM philosophy and the essential knowledge, skills, and practical experience to make an immediate and productive contribution within the company in which they go to work. In certain majors, we plan to accelerate our production of future national leaders in TQM and related fields.

For some majors we have several important courses in place, including ISyE 6301, Quality Systems; AE 8123, Concurrent Engineering and Quality Function Deployment; ME 6170 Engineering Design; ISyE 6400, Design of Experiments; etc. In addition to the Management of Technology and Computer Integrated Manufacturing Certificate Programs mentioned earlier, we are currently obtaining approval for a certificate program in Testing and Evaluation which will be jointly administered by Electrical Engineering and Industrial and Systems Engineering and funded by the Department of Defense.

However, when the Malcolm Baldrige National Quality Award criteria are reviewed in Table 6, it is clear that we have several knowledge/skill areas that should be incorporated into our graduate curriculum. Our curriculum development strategy for graduate programs will be to build the knowledge/skill areas into existing courses due to the limited time span covered by graduate programs of study. The knowledge and skills we incorporate will be derived from the information we obtain about customer needs from the process development efforts described in Table 5, and the undergraduate curriculum development efforts occurring within the SUCCEED program.

Comparison of existing graduate curricula with planned curricula. The course offerings for the programs of study in the existing graduate curricula may not be altered as drastically as the major restructuring planned for the undergraduate curriculum. However, what should change significantly is the focus, methods, emphasis, and procedures of every course taken by our graduate students as our faculty become more active in TQM understanding and practice. The first major change will be for the graduate students to be exposed to the philosophy of continuous improvement "as a way of life," which is applicable to all subjects and which includes an inherent customer focus. The second planned change will be in course structures, so that they develop leadership and teamwork skills in problem assignments and interdisciplinary projects. Third, we will attempt to weave throughout our graduate curriculum more exposure to applied statistical thinking and methodology.

3.4.2.3 Planned Continuing Education Development. Vision. Continuing education is the *new frontier* in higher education. Georgia Tech will make a commitment to its entering students to meet their professional educational needs throughout their life time. In so doing, we plan to become a leader in meeting life-long education needs in the areas of engineering, science, computing, and management. Each of these areas will have continuing education needs related to TQM. The Department of Continuing Education will offer programs in various formats and will utilize leading-edge technologies to deliver them. As a result of the continuous improvement of TQM education processes, which fulfill its customers' needs, Continuing Education will partner with the International Center to make Georgia Tech a *premier national center for executive TQM education.*

Again, our emphasis will be on a market driven process. We plan to meet and exceed our customers expectations for lifelong learning. Specific course development and evolution will be determined by the needs continuously identified by our customers. We are very active in working with our corporate customers to provide them with tailored, onsite instruction. (Last year we contracted with IBM for $500,000 worth of tailored instruction.) Georgia Tech has the capability and desire to produce many short courses, seminars, videotape courses, etc. in the area of TQM. Examples of topics which we will cover, depending on customer needs, are provided in the following table.

Table 7. Continuing Education Offerings

EXAMPLES OF CURRENT CONTINUING EDUCATION OFFERINGS	EXAMPLES OF FUTURE POTENTIAL OFFERINGS (DEVELOPMENT DEPENDENT UPON "MARKET DRIVEN" PROCESS)
Statistical Design of Experiments	Senior Management's Role in TQM
Sampling Methods and Statistical Analysis	Implementing TQM - an in-depth Overview for Managers
Quality Systems Standards for the 1990's	Employee Involvement
Strengthening Organizations through Individual Effectiveness	Implementing SPC in a TQM Environment
	Quality and Productivity Measurement Systems
	Designing and Implementing the Self-Management Team
	Implementing TQM - The Change Agents Road Map
	Facilitator Training for Quality Improvement Teams
	The Changing Role of the Supervisor in a TQM Environment
	Train the Trainer
	Designing the Quality Manual to Meet ISO 9000
	ISO 9000/MIL-Q-9858 Comparative Training
	Satellite Downlink of Various National Program
	Concurrent Engineering for Aerospace Design
	TQM Implementation for:
	Health Systems Management
	Textile Manfacturing
	Electronics Manufacturing
	Logistics
	Airplane Design and Manufacture
	University Operations
	Construction Management
	Research Operations
	K-12 Education Systems
	Benchmarking
	Group Decision Making and Advanced Communication Tools
	Software Quality Assurance
	Quality Forum for Area Colleges and Universities

Comparison of existing continuing education curricula with planned curricula. The differences between existing and projected courses for continuing education represent a

tremendous curriculum development opportunity. More important than the specific course titles, however, is the development of *processes* which support the continual improvement of continuing education curricula. These steps are indicated in Table 5 and are critical to the success of all curriculum development.

3.4.3 **Curriculum Development Timetable.** Based on the steps indicated in Table 5, the timetable for the development of continuous improvement *processes* for curriculum development is provided in Figure 2. These milestones are the foundation steps for all curriculum development. The planned undergraduate curriculum restructuring in synergy with the SUCCEED Project activity, which includes developing TQM, is planned for a five year time frame. For all of the planned curriculum development efforts, the initial year will be mainly spent educating faculty and developing the process steps as listed in Table 5. During this time we will develop baseline data measuring the "results" produced by our existing TQM programs. Years two through five will be spent in targeting specific knowledge areas/skills and developing curricula as determined by our "market driven" processes.

3.5 TQM Research Activities

3.5.1 **Objectives.** Our research goal is to develop a "scientific" understanding of "what works in TQM, why it works, and what might work even better." As with curriculum development, our research foci will be "market driven," with impact measured by results, and they will also reflect our strength as a technological university. Our research efforts are described in Table 8.

Table 8. Current and Future Research Activities

TOPIC	DESCRIPTION	CURRENT ACTIVITIES	FUTURE RESEARCH
"Basic Theory" *"What works"*	In this category is methodological and theoretical research. Specific topics include analytic statistical research, strategic planing, research on human motivation, developments in the theory of knowledge, optimization of large scale and complex systems, etc.	Numerous projects on statistical methodology including experimental design,[15] reliability, statistical process control, process characterization, operations research, human-machine systems.	Build on existing analytic programs and develop "people" side including psychology change.
Application of TQM *"How it works"*	For this area, research is directed at effective use and tailoring of TQM principles to specific industries or application fields.	Application of TQM to manufacturing, construction management, health systems, logistics systems,	Continuously improving "white collar productivity." New application areas include the academy, research organizations, and education systems.

[15] An example of this type of research is the National Science Foundation sponsored project by Professor Kwok Tsui on Experimental Design Techniques/Taguchi Methods. See Appendix A.

New TQM Methods *"How to do it better"*	Includes research in leadership development, alternative communication methods for turning data into information for decisions; alternative management systems such as self-managed work teams; organization theory, design, and effectiveness; new statistical procedures; and the development of evaluation/measurement systems for customer satisfaction.	Preliminary work in organization theory and design under the TQM paradigm; alternative evaluation/measurement approaches, and work on new statistical procedures.	Value centered leadership; large scale decision making, organizational design and effectiveness, including measurement theory
"Computer Aided/ Electronic TQM:" *"TQM and Technology"*	Technology has become an extraordinary aid for the presentation of information and facilitating decision making. To that end, Georgia Tech proposes a research component which builds upon our expertise in this area. [16]	Current projects include simulation "games" which teach TQM concepts and skills, methodologies for distributed group decision making based on preliminary work with groupware in our electronic decision making facility, and rapid prototyping methodologies such as virtual prototyping.[17]	Extension to the multimedia and graphics environments; pursuit of "virtual reality" tools for TQM training, group decision making, and product and process design.[18]

Future TQM research will be stimulated with a "seed money" funding program through a market driven process establish by the International Center. Specific milestones and the corresponding schedule are described in Section 3.8; interaction with IBM activities is described in Section 6.0.

3.5.2 Rationalization of research topics and their relationship to core courses. As with the planned undergraduate curricula, the four research areas described above can be mapped to specific Baldrige Award criteria. Within one or more of the research areas, topics can be found which relate to strategic quality planning, human resource utilization, leadership, continuous improvement, information and analysis, and customer satisfaction. Furthermore, these areas build on the existing research strengths within the institute and provide great opportunity to enhance current research programs with "market driven"

[16] Georgia Tech has developed world class capabilities in multimedia technology located in its College of Computing, the recently created Georgia Center for Advanced Telecommunications Technology, the Graphics Visualization Utilization Center and the Multi-Media Technology Laboratory. Tech's capabilities are best exemplified in its successful efforts to help attract the 1996 Summer Olympics to Atlanta through its creation of two highly sophisticated interactive multimedia models.

[17] Performed by Professor Richard Teach in the School of Business, Professor Mike McCracken in the College of Computing, and Professor Jane Ammons in the School of Industrial & Systems Engineering, respectively.

[18] A promising area of collaboration area with IBM researchers. See Section 6.0.

processes. Finally, the research areas provide needed input into the planned curriculum, particularly in the development examples, case studies, and new methodologies for requisite skill development outlined in Table 5.

3.6 Propagation to Other Universities.

We fully recognize that a transformation to TQM in higher education in this country is needed, and will not happen without cooperation and sharing of the best ideas and implementations among schools, business and industry. We plan to lead the transformation of higher education by example and by collaboration, sharing ideas and examples in mutually beneficial interactions. Not only will this exchange help us achieve our objectives, but we consider its execution a significant leadership responsibility.

As with other areas, we will develop market driven processes to capitalize on propagation opportunities. The International Center will provide the platform upon on which to establish propagation activities. Based on our university "customers" expectations, examples of the kinds of interactions that we anticipate include:

- After the awards are made in October 1992, we will convene the investigators from all the SUCCEED universities to share ideas from the each university's proposals, including successful and unsuccessful ones, in order to build on each others' best ideas.
- We will develop an electronic bulletin board which posts quality development activities for universities.
- We will host an annual international conference on TQM in universities.
- We will form a "Quality Forum for Education Institutions" with regional colleges and universities (including Emory University, Georgia State, Morehouse, Spellman, Southern Tech, Clark Atlanta, Georgia, Kennesaw, Georgia Southern, etc.) which will meet regularly to discuss TQM implementation in the university environment.
- We will explore ways to provide short courses on implementation of TQM in universities, both on site and through the NTU system.

Most of all, we take seriously the obligation to be not only *responsive* to the needs of our fellow institutions, but also to create processes which make us *proactive* at sharing and propagation. Figure 1 illustrates the schedule for development of the propagation processes.

3.7 Institute Operations

Tech's recent strategic planning effort revealed that many Georgia Tech operating units are not focusing on their customers. While the units that have already begun the implementation of TQM appear to be making excellent progress in improving their customer service, many more have not begun to address this issue. It is President Crecine's view that the best way to confront this problem is to implement TQM principles into all Institute operations. He has directed that a TQM strategy be developed for all Georgia Tech units and that implementation begin in Summer 1992. He has also directed that it be fully instituted by the Summer of 1995.

In implementing TQM at Georgia Tech, we will use the standard "cascade" approach. The first step will be to gain the commitment of Georgia Tech's executive

leadership to Total Quality Management. To accomplish this, we will hold a retreat for the Academic Council and Presidents Staff with the objective of orienting the group and establishing a covenant for TQM. This retreat will take place at the beginning of September 1992. The organizational structure described in 3.3 will be announced at the retreat and concurrently implemented. Immediately following the session, the Quality Council, with assistance from the Office of Continuous Improvement and Assessment, will begin developing a curriculum and a schedule for TQM training for Institute administrators, faculty and staff and for continual upgrading of their knowledge and skills in this area. This curriculum will be delivered in three phases to all units that have not previously received such training, beginning in the fall of each year. In the training sessions, the following major topics will be addressed:

1. Identification of customers.
2. Development of a process to identify and prioritize customer requirements.
3. Determination of a process to modify unit service procedures and outputs to meet customer true needs
4. Creation of measures to monitor effectiveness in meeting customer expectations
5. Development of data collection strategies.

In addition, to facilitate group working skills within each unit, training will be provided in areas relating to improving meeting effectiveness, enhancing group creativity and building group problem solving skills. Over the next three academic years, every Georgia Tech operating unit will be expected to participate in the TQM educational program, form a continuous improvement team, and begin the task of continuously improving the operations in their units, and where appropriate form cross-divisional continuous improvement teams.

The Quality Council, with the assistance of the Office of Continuous Improvement and Assessment, will develop a family of assessment tools and measures, focusing initially on "baseline" measures of customer satisfaction that will provide a thermometer (or thermometers) of the impact of TQM in the operations area; create a rewards and recognition system that is congruent with the goals of the Institute and promotes the desired culture of teamwork, innovation and continual improvement; develop an Institute public information program on TQM achievements for both internal and external customers in conjunction with the Vice President for External Affairs; and ensure the integration of the Institute TQM effort with the Strategic Planning Process and the Compensation and Classification Study. The Office of Continuous Improvement and Assessment will also consult with units on their continuous improvement efforts, with measurement assistance from Institutional Research and Planning, and to create and regularly update an Institute Continuous Improvement Resource Manual.

3.8 Implementation Schedule and Measurement Plan

3.8.1 Implementation Schedule. The project will be co-directed by Dr. Tim Gilmour, Vice President for Strategic Planning, and Dr. Jane Ammons, Associate Professor of Industrial and Systems Engineering. Their qualifications are indicated on the vitae enclosed in Appendix D.

Figure 1 provides a five year schedule for the activities related to Georgia Tech's TQM initiative. This schedule is likely to be superseded by experience and thus a "rolling

Figure 1
Georgia Tech
TQM Implementation Schedule

TASK	Academic Year 92-93 F	W	S	Academic Year 93-94 F	W	S	Academic Year 94-95 F	W	S	Academic Year 95-96 F	W	S	Academic Year 96-97 F	W	S
LEADERSHIP															
1. Executive Retreat (September 92)															
2. Establish Quality Council (September 92)															
3. Establish Continuous Improvement Visiting Committee	----	----	----	----	----	----	----	----	----	----	----	----	----	----	--->
CURRICULUM															
4. Develop "customer driven" process for continuous curriculum improvement with leadership of Institute Continuous Improvement Curriculum Committee	----	----	----	----	----	----	----	----	----	----	----	----	----	----	--->
4a. Develop process and instruments to assess student needs and baseline information on existing TQM courses	----	--•--	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•--	--->
4b. Develop process and instruments to assess industry needs annually	----	--•--	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•--	--->
4c. Develop a TQM curriculum benchmark process	----	--•--	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•--	--->
4d. Develop a process to translate this assessment information into curriculum innovations and change	----	----	--•--	----	----	--•	----	----	--•--	----	----	--•--	----	----	--•>
4e. Develop process for faculty continuous improvement (Beginning May 92 with TQM Challenge)	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•>
5. Develop process to evaluate TQM curricular innovations	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•>
6. Develop process to propagate curricular information to other institutions	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•>

Figure 1
Georgia Tech
TQM Implementation Schedule

TASK	Academic Year 92-93 F	W	S	Academic Year 93-94 F	W	S	Academic Year 94-95 F	W	S	Academic Year 95-96 F	W	S	Academic Year 96-97 F	W	S
RESEARCH AND PROPAGATION															
7. Establish International Center Continuous Improvement															
7a. Hire director	----	----													
7b. Create process for developing "customer driven" research	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•>
7c. Projects reviewed and supported	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•>
7d. Develop measures of extent customer expectations met	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•--	----	----	--•>
8. Implement Center dissemination program				----	----	----	----	----	----	----	----	----	----	----	--->
OPERATIONS															
9. Establish Office of Continuous Improvement and Assessment (September 92)															
10 Vice Presidents and Deans develop TQM training schedule for their units	Phase I	----		----	----	----	----	----	--->	--	--	--	--	--	--
				Phase II	----	----	----	----	--->	--	--	--	--	--	--
							Phase III	----	--->	--	--	--	--	--	--
11. Develop continuous improvement assessment measures, awards program, publicity, etc.		----	----	----	----	----	----	----	----	----	----	----	----	----	--->
12. Form cross-divisional continuous improvement teams				----	----	----	----	----	----	----	----	----	----	----	--->
REPORTING TO IBM															
13. Preparation and delivery of progress report for first two years					----	---•									
14. Preparation and delivery of project report														----	---•

five-year schedule" will be developed each year. It will be developed and coordinated by the Office of Continuous Improvement, reviewed by the Quality Council and approved by the President. The tasks detailed in the Figure 1are described in detail in other sections of this proposal. A heavy dashed line depicts activity in progress during the period with regard to a task and an arrow depicts completion of the task on the conclusion of the five-year schedule period. In the case of the operations tasks, a lighter dashed line is used for Academic Years 95-96 and 96-97, indicating that implementation of these tasks has been completed but that TQM activity continues in the area. The large dots on the activity lines indicate that an annual cycle of that process is to be completed at that time.

For the planned curriculum development efforts, the initial year will be spent educating faculty and implementing the first cycle of processes entailed in tasks seven through nine. During this time, baseline data on the "results" produced by our existing TQM courses and programs will be developed. Years two through five will be spent in targeting specific knowledge areas/skills and developing curricula as determined by our "market driven" processes.

For the research and propagation efforts, the first year will be focussed on the creation of the International Center, the creation of a process for the development of customer-driven research and allocating a few seed grants for research. In years two through five, ongoing research projects would be monitored and new research opportunities identified. During the same period, the International Center's dissemination and benchmarking role for business and higher education will be developed.

3.8.2 **Measurement Plan.** One of the greater challenges we will face in our efforts to bring TQM to Georgia Tech is the development and implementation of measures that effectively gauge our customers' perceptions of the extent to which we are meeting their expectations. This is because the relationship to our customers in both our instructional and research programs is more complex than most commercial transactions and because of a tradition in the academy against rigorous measures of the learning process. Despite these factors, Tech currently has students evaluate all of their courses, convenes focus groups to learn about their student services concerns and runs annual opinion surveys regarding dormitory conditions. Nevertheless, we are strongly committed to instituting a *comprehensive* program for measuring customer satisfaction and assessing the extent to which we are attaining our TQM goals.

Another significant challenge, which we understand most organizations face and in which we should have particular strength in our capacity as a technological institution, is the development of measures that are more precise and that fit into broader patterns that allow for the measurement of large segments of or entire processes in an organization. For example, while we measure student perceptions of their courses, we do not measure their perceptions of their majors or of many of the services they receive as student customers. In this TQM effort, we will measure these contributing dimensions and put them together into an overall measure of the extent to which we have met our student customers' expectations.

We will begin our measurement efforts with the development of a baseline measure of customer satisfaction. As complex as our program is and as sophisticated as our customers are, we do not anticipate developing a single measure. Nevertheless, we believe that we can develop a relatively simple "satisfaction thermometer" that can be used to gauge how well we are meeting our customers' expectations as TQM is implemented.

Beyond this baseline measure, we will need to develop strategies for measuring student learning progress and the impact of our research and public service programs. There are a variety of assessment strategies and techniques that, if converted to a customer

orientation, could be used in assessing these efforts. We see no major problems assessing support programs because many have analogous peer functions outside of the higher education, e.g., billing error rates. To identify their measures, each unit will be asked to determine who its customers are, their expectations, and the measures they will use to determine the extent which customer expectations are met. These measures will then be benchmarked with similar units in and outside of Tech. Finally, they will be instituted and units will gauge the extent they have met their customers' expectations.

Ownership of the measures will rest within the units responsible for their achievement. Small grants will be provided from the Office of Continuous Improvement and Accountability to develop measures where needed and technical assistance will come from that Office and from Institutional Research and Planning. It is anticipated that these measurements for continuous improvement will double as assessment information for the Board of Regents and the Southern Association of Colleges and Schools.

4.0 GEORGIA TECH RESOURCES AND COMMITMENT

Table 9 shows the budget for this project which includes both the Georgia Tech and IBM contributions. Over the five years of the grant, Georgia Tech would contribute from $382,000 to $453,000 annually in funds, which does not nearly capture Tech's total contribution to the TQM effort. Tech's funds would be supplemented by the IBM TQM initiative at $200,000 a year for the five year period. The IBM contribution is extremely important in that it will allow us to move the Tech TQM initiative forward on a much broader base considerably more rapidly. It will also permit us to initiate the International Center in the first year of the project and to have a full-time senior director from the start. It will also significantly increase our capacity to seed research through the five years of the project.

Table 9. Georgia Tech TQM Initiative Budget (in 000's)

Georgia Tech Funding	Year 1	Year 2	Year 3	Year 4	Year 5
Staff and Consultants*	332	348	366	384	403
Operating	25	25	25	25	25
Curriculum Develop.	25	25	25	25	25
TOTAL Ga TECH	382	398	416	434	453
IBM Funding					
Staff**	75	150	150	150	150
Curriculum Develop.	75				
Research Grants	50	50	50	50	50
TOTAL IBM	200	200	200	200	200
GRAND TOTAL	582	598	616	634	653

* Includes one fourth time of Vice President for Strategic Planning, Joseph Gilmour ($24K), summer salary for Professor Ammons ($17K), Director of Office of Continuous Improvement and Assessment ($60K), an institutional research analyst devoted to TQM measurement ($35K), benefits for these portions, and consultant time ($160K).

**Includes salary and secretary for International Center Director.

Projections of corporate sponsor fees are not included in the budget, but may total as much as $500,000 by year five of the project. These funds would be invested in customer-driven research, the creation of a sophisticated benchmarking facility for business and higher education and large-scale dissemination efforts.

5.0 EXTERNAL SUPPORT

Georgia Tech's TQM efforts and the proposed project will receive significant support through continued and new external funding of several established programs and centers (see Section 2.2.2.). For example, new corporate members of the CIMS program contribute $30,000 per annum (two-year minimum participation), and members of the Center for International Standards and Quality provide, at the top level, $50,000 per annum.

A new affiliate program will be created for business and industrial participation in the International Center for Continuous Improvement. In order to support, coordinate, and stimulate research activities in TQM and to propagate the results, this affiliate program will offer such benefits as:[19]

- A seat for the Continuous Improvement Visiting Committee
- Structured opportunities to meet with faculty, students, and administrators
- Invitations to on-campus TQM programs and research reporting meetings
- An annual visit to the corporate site to gain a better understanding of the member's particular needs and/or to make presentations
- Newsletter, research news releases, abstracts, articles, and theses
- Guaranteed seats and special discounts for Center-related short courses
- Affiliate recognition in the Georgia Tech Student Success Center

An annual membership fee of $25,000 is proposed for the Partnership level and $15,000 per annum for Associates. Other fee structures may be designed and added to provide for wide variations in company sizes. Membership recruitment is anticipated at the level of five to six companies annually for each membership category.

An early input of external support will be provided during May 1992, by Milliken & Company through the TQM Challenge Program.

Additional external support will likely take the form of named scholarships, fellowships, and seminar series related to TQM.

6.0 PARTNERSHIP RELATIONSHIP WITH IBM

Georgia Tech has asked for and received a commitment for a significant partnering relationship with the Southern Area Office of IBM, USA., headed by Mr. W. T. (Tom) Smith, Jr., Vice President and Area General Manager. Mr. Smith agreed to participate as an active member of the proposed External Advisory Board assisting with TQM curriculum development, research project selection, and implementation into operations, provided that we focus on the student as the customer in our instructional program. A wide variety of options for partnering were discussed with Mr. Smith and his staff including:

- Loan an executive to assist in the startup of the International Center

[19] The list of benefits will be modified based on surveys and focus group meetings with membership prospects.

- Loan "industrial fellows" for classroom interaction as defined during curriculum development

- Provide data and interaction for case study development for
  class presentation material
  class team projects
  student and faculty research projects

- Provide personnel, data, and access as needed to "team" as desired on specific TQM research projects

- Loan materials such as "groupware" and educational tools such as the "Quality or Else" videotape series

- Provide opportunities for student and faculty internships in the TQM area

- Provide training as needed to faculty and administrators in IBM's approach to TQM

- Participate in quality forums with other companies and universities to share what works, what does not, and why

- Partner in the development of research where we have common interests: e.g.,
  development of more precise TQM outcome and customer service measures,
  multimedia technology, software/hardware for distributed decision making,
  computer games/software for TQM skill development,
  investigation of computer games/software for TQM education at the K-12 level.

In our meetings, we concluded that we should commit to an intensive partnership based on the TQM paradigm. We agreed to establish an ongoing IBM/Georgia Tech team to continuously identify both organizations' TQM needs and then to develop programs to address those needs. While stating that he would assist Tech in partnering with the very best IBM unit he and his staff could identify for a particular problem, Mr. Smith indicated that the extent to which IBM's and Tech's expectations are met in each partnering effort must be measured and evaluated. We see this as an ongoing opportunity for continuous improvement. We are delighted with Mr. Smith's proposal and his strong commitment.

7.0 SUMMARY

Georgia Tech is honored to have this opportunity to compete for an IBM TQM grant. In this proposal we have attempted to convey our motivations for seeking the grant, to provide an overview of the qualifications we possess, to describe our plans for attaining the status of leading higher education TQM educator, researcher, and practitioner in the nation, to define the resources and commitment we will bring to this plan, and the IBM partnership arrangements we have jointly planned with the Southern Area Office of IBM, USA. We truly believe that we have a remarkable combination of strengths to bring to the table for this project, and an institutional heritage of getting the job done. We would be pleased to answer any questions the reviewer has on this project.

APPENDIX A

PEOPLE: OUR GREATEST ASSET

PERSON	TITLE	TQM EXPERTISE AND INTERESTS
Dr. John P. Crecine	President	Committed to vision of excellence and corresponding leadership responsibilities. Is leading the institute transformation.
Dr. Michael Thomas	Executive Vice President	Combines commitment to excellence with background in industrial engineering and its quality related fields. Two years ago lead 125 Georgia Tech faculty and staff for an all day TQM program at Milliken. Wrote successful proposal for which Georgia Tech was awarded participation in the TQM University Challenge.
Dr. Joseph E. Gilmour	Vice President for Strategic Planning	Directs strategic planning, quality assessment, and accreditation activities for the institute. Sought out TQM training in order to lead the implementation of the Continuous Improvement Plan. Has directed several major assessment studies in higher education and is an experienced marketing and survey researcher. Has extensive executive leadership experience.
Dr. Linda Martinson	Vice President for Planning, Budget & Finance	Academic background in the quantitative area of statistics. Leading the implementation of TQM in the business functions of Georgia Tech.
Dr. John A. White	Dean, College of Engineering	National TQM leadership in academia. Serves on Leadership Committee for the Total Quality Forum chaired by Procter & Gamble, ABET Ad Hoc Committee for Quality Assurance in Engineering Education. While Acting Deputy Director of the National Science Foundation, he addressed the *First National Symposium on the role of Academia in National Competitiveness and TQM* which resulted in the paper "TQM: It's Time Academia!"
Dr. Robert Cannon	Acting Dean, Ivan Allen College of Management, Policy and International Affairs	Former Senior Vice President of Procter & Gamble where he was responsible for quality programs. Planned the *Third Total Quality Forum*.

Dr. Robert Pierotti	Dean, College of Sciences	Leader of two TQM initiatives: 1) Mathematical and scientific literacy pipeline programs for K-12 ("working with the supplier"), and 2) comprehensive assessment of the Institute's general education programs in mathematics, science and computing
Dr. Peter Freeman	Dean, College of Computing	Designing TQM implementation for College of Computing. In curriculum, college is using database of quiz results to assess learning and make midcourse corrections in classes.
Dr. Donald J. Grace	Director, Georgia Tech Research Institute	Directs a staff of over 1300 involved in over 800 active research projects managed by seven research laboratories located on campus, 12 field offices throughout Georgia, and other sponsor sites. Since 1990, leading the implementation of TQM in the research environment.
Dr. Michael J. Kelly	Director, Manufacturing Research Center	Background includes 17 years with IBM, including an assignment as the Director of the Quality Institute, where he organized the program to educate and train all IBM employees on the principles of total quality. He also served as Manager of Quality Improvement and Professional Development programs for the IBM Systems Technology Division where he was directly responsible for influencing the establishment of quality programs in two IBM plants in the U.S. and two IBM plants in Canada.
Mr. Josiah C. Campbell	Associate Director, Manufacturing Research Center	Over 20 years of industrial experience, including working with Armand Fiegenbaum in the 1970's to implement total quality programs for the manufacture of reactor pressure vessels and steam generators for both Navy and commercial nuclear power programs. Currently active in implementation of TQM to the R & D environment.
Dr. W. Denney Freeston	Director, Continuing Education	Leading the adoption of TQM in the Office of Continuing Education, where initial successes have garnered enthusiasm from around campus. Former Associate Dean of Engineering.
Mr. H. T. Marshall	Director of Internal Auditing	Serves as chair of the Quality Council of the Business Office. Has taken course in TQM and read extensively from Deming, Juran, Crosby, and others. Plans to expand the role of the internal audit department to facilitate TQM, and would like to participate in the development of a Quality Manual for use in documenting Institute TQM culture and principles.

Dr. Bill Cummings	TQM Consultant to Business Office, Continuing Education, and Electrical Engineering	Former Vice President of Charter Medical Corporation, now active in advising universities and medical systems on the implementation of TQM. Especial interest in "empowerment" facilitation.
Mr. Orlando J. Feorene	Director, Office for Technology Integration	Former director of Management Services Division, Eastman Kodak Company, which included responsibility for development and implementation of quality management programs in R&D, engineering, manufacturing, marketing, and distribution organizations.
Mr. Edward P. Ellington	Director, Georgia Productivity & Quality Center	Active all over the state in assist Georgia business and industry in TQM. Past Chairman of the National Productivity Network, and currently serving on its executive committee.
Mr. Ken Charon	Senior Consultant, Georgia Productivity & Quality Center	Retired from IBM where he held positions of Vice President for Manufacturing and Quality IBM Europe, Vice President Administration and Information Systems IBM Europe, and Group Director of Operations for the Information Systems and Communications Group, IBM Corporation.
Mr. Fred L. Cain	Director, GTRI Total Quality Management	Director of TQM function within Georgia Tech's research unit since 1990. Various positions within GTRI since 1964; Principal Research Engineer since 1974. Leader in Atlanta Area Deming Study Group.
Dr. Harrison M. Wadsworth	Emeritus Professor, School of Industrial and Systems Engineering	Member, U.S. Technical Advisory Group, ISO/TC 69 on Statistics Methods and ISO/TC 176 on Quality Management and Quality Assurance. Chair, Subcommittee 1 of TC 69, and lead U.S. Delegate to SC 1 of TC 176. Chair, Standards Committee of ASQC where a new standard on TQM is being written. Co-founder of the Georgia Tech Center for International Standards and Quality. Author of 7 books or parts of books on quality and statistical topics. Senior Examiner, Malcolm Baldrige National Quality Award. Fellow of ASQC. Awarded Shewhart Medal by ASQC for Outstanding Leadership in the field of Modern Quality Control.
Dr. George Nemhauser	Chaired Professor, School of Industrial & Systems Engineering	Director of the Computational Optimization Center, a research center established with funding from IBM to address methodologies associated with large scale system optimization

Dr. Ellis Johnson	Coca-Cola Chair in Material Handling, School of Industrial & Systems Engineering, IBM Fellow	ISyE Faculty Member and researcher in the Computational Optimization Center on optimization methodology for large scale systems
Dr. Jane C. Ammons	Associate Professor, School of Industrial & Systems Engineering	Served for past 4 years as an aide to Dr. W. Edwards Deming. Interacts with numerous organizations on TQM. Developed TQM course for National Society of Professional Engineers. Established introductory TQM course for Ga Tech curriculum. Co-founder, Atlanta Deming Study Group.
Dr. Jerry Banks	Associate Professor, School of Industrial & Systems Engineering	Author of 15 books and parts of books on quality, statistics, and simulation and numerous publications. Co-Founder and Co-Director of the Center for International Standards and Quality.
Dr. Russell Heikes	Associate Professor, School of Industrial & Systems Engineering	Teaches and researches in the areas of quality systems, statistical process control and experimental design. Active in on-site IBM course delivery.
Dr. Kwok-Leung Tsui	Associate Professor, School of Industrial & Systems Engineering	Researches, teaches, consults, and develops courses in statistical methods for quality and productivity improvement. Interests include design of experiments and Taguchi methods, statistical process control, design and analysis of computer experiments. Winner of Quality Award at Quality Assurance Center, AT&T Bell Labs. Member, Panel on Statistical Quality Control, National Research Council, 1991-2. Secretary of American Statistical Association, Atlanta Chapter, 1992.
Dr. Justin A. Myrick	Associate Professor, Industrial & Systems Engineering and Director, Health Systems Program and Health Systems Research Center	Interests in the application of TQM to health care delivery systems including hospital organization, ambulatory care, emergency medical services, alternative delivery systems such as HMO's, rural health, international health, and health promotion. Serves as a unpaid volunteer for rural health care systems management assignments in Central America.
Dr. Paul Griffin	Assistant Professor, Industrial & Systems Engineering	Teaches and performs research in quality areas related to manufacturing. This summer will be working three weeks at industrial site to develop case studies for the classroom related to quality issues for printed circuit card manufacture.

Dr. Yih-Long Chang	Associate Professor, School of Management	Research and teaching interests in operations management and management of information systems with an emphasis on the application and integration of AI, expert systems, information systems, operations management, and operations research. Includes quality management, productivity, and operational integration.
Dr. Vinod Singhal	Assistant Professor, School of Management	Researches and teaches in the area of justification of new technologies, measuring and evaluating manufacturing performance, valuing flexibility, design of manufacturing systems, activity-based costing, management of quality, and the relation between quality improvements and firm performance. Co-author of recent paper "Quality Awards and the Market Value of the Firm: An Empirical Investigation."
Dr. Wayne J. Book	Professor, School of Mechanical Engineering	Founding Director of Georgia Tech's IBM sponsored Computer Integrated Manufacturing Systems Program. Actively involved in enhancement of value added in education process through reexamination of delivery and curriculum.
Dr. Steven Y. Liang	Assistant Professor, School of Mechanical Engineering	Research interests include in-process control of manufacturing process. Education interests in teaching concurrent engineering.
Dr. Joseph L. A. Hughes	Assistant Professor, School of Electrical Engineering	Coordinator of Computer Engineering Program. With sponsorship from Motorola and interaction with Motorola University, developed course in Concurrent Engineering for Electrical Engineers based on Six Sigma principles. Motorola is publishing course materials for course adoption at other universities.
Dr. Patrick Mahoney	Financial Management Associate, School of Electrical Engineering	Responsible for implementation of TQM in financial operations of the School of Electrical Engineering
Dr. Daniel P. Schrage	Professor, School of Aerospace Engineering	Director, Georgia Tech Center of Excellence for Rotary Wing Aircraft Technology (CERWAT) and Flight Simulation Laboratory (FLIGHT SIM), where his interests include the application of concurrent engineering and TQM to the design, analysis, and assessment of aerospace systems.

Dr. J. Lewis Dorrity	Associate Professor, School of Textile & Fiber Engineering	Former Vice President of Greenwood Mills, Inc. where he lead the adoption of TQM. Performs research in the development of real-time monitoring and control systems for textile processes. Interests include introduction of TQM to academic processes.
Dr. Shui-Nee Chow	Professor and Director, School of Mathematics	Active in the application of TQM principles to the teaching of mathematics.
Dr. Alfred D. Andrew	Associate Professor and Associate Director, School of Mathematics	Active in the application of TQM principles to the teaching of mathematics.
Mr. Wiley D. Holcombe, Jr.	Senior Research Engineer, Georgia Tech Research Institute	Combining technical research interests with the application of TQM. Taken TQM courses. Provides leadership to Atlanta Deming Study Group.

APPENDIX B

COURSE DESCRIPTIONS AND DOCUMENTATION

Table B1. Existing Georgia Tech Undergraduate Courses Related To TQM

EXISTING COURSE	TITLE	DESCRIPTION	COMMENTS
ISyE 3014	Systems and Productivity	Human contributions to productivity and interaction of technical advances with human performance. Examination of impact of individual needs, leadership styles, and organizational design.	Required for ISyE majors.
ISyE 3027	Applications of Probability	Engineering and science applications of probability.	Requires calculus
ISyE 3028	Engineering Statistics I	Introduction to statistical methodology	Requires ISyE 3027
ISyE 3029	Engineering Statistics II	Introduction to analysis of planned and unplanned experiments	Requires ISyE 3028
ISyE 3245	Creativity and Innovation in Engineering	Principles of innovation and invention with exercises and examples.	Requires junior standing
ISyE 4899	Total Quality Management	Introduction to the philosophy and application of TQM	Currently a special topics elective. Fall 1993 will be required for ISyE majors.
ISYE 4039	Quality Control	Design of quality control systems. Quantitative techniques for quality assurance.	Many majors have taken for 30 years. Required of ISyE students for 10 yrs.
Mgt 3300	Marketing I	Marketing's role in the productive process	Requires economics
Mgt 3325	Product Planning	New product development process	Requires organizational development and marketing
Mgt 4155	Fundamentals of World Business	Broad aspects of international business	Requires accounting and management theory
Mgt 4353	Manufacturing Strategy	Introductory exposure to manufacturing strategy	Requires operations management
AE 4353	Design for Life Cycle Cost	Project oriented course introducing robust design methodology (including Taguchi methods)	Senior AE elective
AE 4360	Computer aide design and computer aided manufacturing	Introduction to CAD and CAM	Senior AE elective
ME 4110	Manufacturing Engineering and Technology	Principles of manufacturing, including quality control and TQM	Required for ME majors
EE 4813	Concurrent engineering for Electrical and Computer Engineers	A design course based on Six Sigma principles	Developed with support by and collaboration with Motorola; Motorola is publishing course materials for adoption by other universities
TE 4420	Analysis of Textile Materials	Materials course includes testing and quality control	For Textile Engineering majors

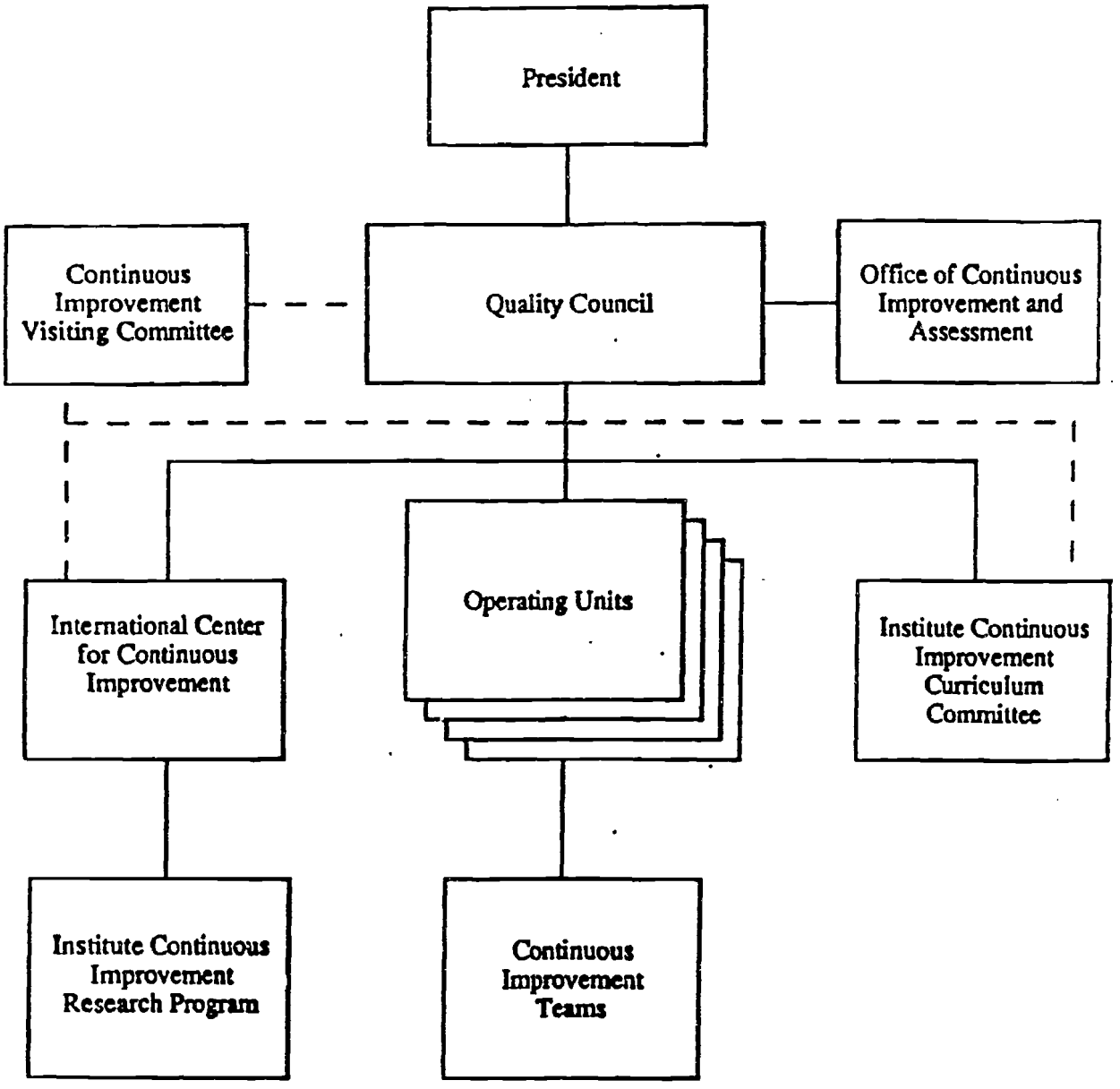
Table B2. Existing Georgia Tech Graduate Courses Related To TQM

EXISTING COURSE	TITLE	DESCRIPTION	COMMENTS
ISyE 6223	Understanding and Aiding Human Decision Making	Prescriptive and descriptive theories and presented within applications emphasis	Requires human-machines prerequisite
ISYE 6226	Replacement Analysis	Analytic methods to evaluate replacement and retirement options	Based on economic decision making
ISyE 6301	Quality Control Systems	Design of quality control systems. Requires ISyE 4039.	Graduate course required for several degree programs
ISyE 6302	Quality Control in Manufacturing Systems	Quality assurance methodology for manufacturing	Specifically for CIMS certificate program students
ISyE 6400	Design of Experiments I	Analysis and application of standard experimental designs	Taken in several masters programs; Requires ISyE 6739
ISyE 6401	Applied Regression Analysis I	Empirical model building	Requires ISyE 3028 or ISyE 6739
ISyE 6402	Time Series Analysis	Building empirical-stochastic models	Requires ISyE 3029
ISyE 6404	Nonparametric Statistics	Basic nonparametric statistics concepts	Requires ISyE 6739
ISyE 6405	Response Surfaces I	Introduction to response surface methodology	Requires ISyE 6400
ISyE 6406	Response Surfaces II	Continuation of ISyE 6405	Requires ISyE 6404
ISyE 6407	Sampling Techniques	Survey sampling techniques	Requires ISyE 3029 background
ISyE 6427	Applied Statistical Decision Theory	An intermediate-level course in statistical decision theory	Requires math probability background
ISyE 6450	Design of Experiments	Messy Multifactor Designs	Requires ISyE 6400
ISyE 6739	Experimental Statistics	Introduction to statistics	Requires calculus
ISyE 6781	Reliability Theory	Structural properties and reliability of coherent systems.	Requires math probability
ISyE 6799	Quasi-experimental Design	Extension of experimental design concepts to field settings that preclude ideal randomized experiments	Requires ISyE 6400
ISyE 7400	Design of Experiments II	Continuation of experimental design	Requires ISyE 7400
ISyE 7401	Applied Regression Analysis II	Continuation of multiple regression analysis	Requires ISyE 6401
ISyE 7441	Linear Statistical Models I	Introduction to full-rank linear statistical models	Requires math probability and ISyE 6400
ISyE 7442	Linear Statistical Models II	Continuation of ISyE 7441 emphasizing less than full rank	Requires ISyE 7441
Mgt 6023	Behavioral Aspects of Control	Relationships between control structures within an organization	Requires accounting and organization processes
Mgt 6100	Organization Processes	Behavioral issues in individual, group, and organizational performance	Introductory course
Mgt 6101	Human Resource Management	Manager's role	Requires Mgt 6101
Mgt 6102	Methodology in Human Resource Management	Use of statistics and methodology to make data-based decisions about human resources	Requires Mgt 6101
Mgt 6105	Individuals in Organizations	Individual behaviors in organizations	Requires Mgt 6100
Mgt 6106	Group Processes in Organizations	Managing group processes	Requires Mgt 6100
Mgt 6107	Organization Theory	Design of effective complex organizations	Requires Mgt 6100

Mgt 6140	Management Systems Analysis	Practice of management	Opportunity to improve TQM content
Mgt 6160	Management Theory	Principles of management theory	Opportunity to improve TQM content
Mgt 6350	Production and Operations Mgt I	Long term methods to improve productivity and quality	Requires operations management
Mgt 6351	Production and Operations Mgt II	Continuation of Mgt 6350	Requires Mgt 6350
Mgt 6771	Management of Technology	Focused on the external environment	Cross listed with ISyE
Mgt 6772	Management of Technology II	Managing Resources	Cross listed with ISyE
Mgt 6773	Management of Technology III	Strategic Issues	Cross listed with ISyE
Mgt 6774	Management of Technology Project	Multi-disciplinary team problem in real firm	Cross listed with ISyE
Mgt 7750	Seminar on Psychology and Management	Psychological complexities and individual behavior in an organization	Requires psychology and Mgt 6105
ME 6170	Engineering Design	Concurrent design methodology	Recommended for Design & Mfg Area students
AE 8123	Introduction to Concurrent Engineering	Introduction to the methodologies comprising concurrent engineering including Quality Function Deployment	Developed as part of the CIMS curriculum
AE 6350	Design Optimization	Numerical optimization of design	Complements the Taguchi methodology taught in companion course
AE 6351/2	Aerospace Systems Design I & II	Project Course on a specific industry problem	Required for design option in AE. Includes individual and team design activities.

APPENDIX C

Organization Chart



Appendix D Vitae of Principal Investigators

April 1992

JANE CHUMLEY AMMONS

Associate Professor
School of Industrial & Systems Engineering
Georgia Institute of Technology
Atlanta, GA 30332-0205

INTERESTS: Research and education in the design, analysis, and operation of production systems, including the application of total quality management. Serving for several years as an aide to Dr. W. Edwards Deming. Interacts with numerous organization on TQM. Developed TQM courses for the National Society of Professional Engineers and for interdisciplinary programs at Georgia Tech.

EDUCATIONAL BACKGROUND:

Ph.D.	1982	Georgia Institute of Technology	Industrial and Systems Engineering
M.S.	1976	University of Alabama	Industrial Engineering
B.S. *cum laude*	1975	University of Alabama	Industrial Engineering

EMPLOYMENT HISTORY:

Associate Professor	Georgia Institute of Technology	7/89-present
Assistant Professor	Georgia Institute of Technology	6/82-6/89
Visiting Assistant Professor	Georgia Institute of Technology	1/82-5/82
Assistant Professor	University of Alabama-Huntsville	12/79-2/80
Junior Engineer	Tennessee Eastman Company	1975

RESEARCH CONTRACTS:

"Impact of Terminal Conditions in Long Range Electric Generation Capacity Planning," National Science Foundation, $10,000, December 1981.

"Creativity in Engineering Award for Reginald D. Boswell,"National Science Foundation, $90,000, June 1988.

"Cut Order Planning," Defense Logistics Agency, J.C. Ammons and C. Jacobs-Blecha (Coprincipal Investigators) $157,461, April 1989.

"Configuring a PCB Workstation," Manufacturing Research Center, J. C. Ammons, L. F. McGinnis, and C. A. Tovey, April 1990, $28,000, Fall 1990-Summer 1991

"Printed Circuit Card Assembly Management," Material Handling Research Center, J. C. Ammons (Project director) with L. F. McGinnis and C. A. Tovey, $89,200 , Fall 1990-Summer 1991

"Course Development for CIMS: Electronic Assembly Systems," Georgia Tech Foundation, $12,000 June 1990

"Production Optimization for Circuit Card Assembly," National Science Foundation, J. C. Ammons, L. F. McGinnis, and C. A. Tovey,Amount Requested: $130,677 Result: Funded $66,000 Fall 1991 - Summer 1992

"Printed Circuit Card Assembly Management," Manufacturing Research Center, J. C. Ammons (Project director) with L. F. McGinnis and C. A. Tovey, $37,000, Fall 1991 - Summer 1992

"Printed Circuit Card Assembly Management," Material Handling Research Center, J. C. Ammons (Project director) with L. F. McGinnis and C. A. Tovey, $70,000, Fall 1991 - Summer 1992

"Printed Circuit Card Assembly Management," Manufacturing Research Center, J. C. Ammons (Project director) with L. F. McGinnis and C. A. Tovey, $37,000, February 1992 (Pending)

"Material Handling Research Center," National Science Foundation and 28 member companies, 1/2 time research in the Manufacturing Systems Program; including graduate students supervised, approximately $100,000 per year, 9/83-3/86;

PUBLICATIONS:

Ammons, J.C. and L.F. McGinnis, "Flexible Manufacturing Systems: An Overview for Management," Chapter 8.7 in The Production Handbook, (J.A. White, Ed.), New York: John Wiley & Sons (1987), pp 8-74 to 8-88.

Boswell, R. D., J.C. Ammons, and S. Manivannan, "Virtual Prototyping: Facilitating Design-For-Manufacture," Chapter in Advances in Manufacturing and Automation Systems, (C. T. Leondes, Ed.), San Diego: Academic Press (1991).

Ammons, J.C. and L.F. McGinnis, "An Optimization Model for Production Costing in Electric Utilities," Management Science, Vol. 29, No. 3, pp. 307-316, March 1983.

Ammons, J.C. and L.F. McGinnis, "A Generation Expansion Planning Model for Electric Utilities," Engineering Economist, Vol. 30, No. 3, pp. 205-226, Spring 1985.

Ammons, J.C., C.B. Lofgren, and L.F. McGinnis, "A Large Scale Machine Loading Problem in Flexible Assembly," special Flexible Manufacturing Systems edition of Annals of Operations Research, Vol. 3, pp. 319-332, 1985.

Platzman, L.K., J.C. Ammons, and J.J. Bartholdi, "A Simple and Efficient Algorithm to Compute Tail Probabilities from Transforms," Operations Research, Vol. 36, No. 1, pp. 137-143, 1988.

Ammons, J.C. and L.F. McGinnis, "Advanced Material Handling," Applied Mechanics Reviews, Vol. 39, No. 9, pp. 1350-1355, September 1986.

Ammons, J.C., T. Govindaraj and C.M. Mitchell, "A Supervisory Control Paradigm for Real Time Control of Flexible Manufacturing Systems," Special Flexible

Manufacturing Systems edition of Annals of Operations Research, Vol. 15, pp. 313-335, 1988.

Dunkler, O., C.M. Mitchell, T. Govindaraj, and J.C. Ammons, "The Effectiveness of Supervisory Control Strategies in Scheduling Flexible Manufacturing Systems," IEEE Transactions on Systems, Man, and Cybernetics, Vol. 18, No. 2, pp. 223-237, March/April 1988.

Ammons, J.C., T. Govindaraj, and C.M. Mitchell, "Decision Models for Aiding FMS Control," IEEE Transactions on Systems, Man, and Cybernetics, SMC-18, No. 5, 1988.

Snowdon, J., and J.C. Ammons, "A Survey of Queueing Network Model Packages for the Analysis of Manufacturing Systems," Manufacturing Review, Vol. 1, No. 1, March 1988.

Eben-Chaime, M., J.C. Ammons, J.L.A. Hughes, and C.A. Tovey, "Automated Circuit Partitioning Using Mathematical Programming," under revision.

Ammons, J.C. and L.F. McGinnis, "A Production Costing Model for Electric Utilities," ISyE Report Series No. J-79-22, Georgia Institute of Technology, August 1979.

Laliberte, A., J.C. Ammons, and L.F. McGinnis, "A Cost and Performance Analysis of Material Handling Systems for Flexible Manufacturing with Centralized Work-in-Process Storage," MHRC-TR-84-05, May 1984.

Ammons, J.C., C.B. Lofgren, and L.F. McGinnis, "A Workcenter Loading Problem in Flexible Manufacturing Systems," MHRC-TR-85-13, May 1985.

Snowdon, J., and J.C. Ammons, "A Survey of Queueing Network Model Packages for the Analysis of Manufacturing Systems," MHRC-TR-87-06, October 1987.

Ammons, J.C. and C. Jacobs-Blecha, "Cut Order Planning," Defense Logistics Agency, June 1991.

Ammons, J.C., "An Analytic Study of the Critical Terminal Conditions in Long Range Generation Expansion Planning for Electric Utilities," Proceedings of the ORSA Special Interest Group on Energy Applications: Analytic Techniques for Energy Planning, Washington, DC, June 1983.

Ammons, J.C., T. Govindaraj, and C.M. Mitchell, "Human Supervisory Control in Flexible Manufacturing Systems," Proceedings of the 24th IEEE Conference on Decision and Control. Fort Lauderdale, FL, December 1985.

Platzman, L.K., J.C. Ammons, and J.J. Bartholdi, "Integer Linear Programming Heuristics that Exploit a Relationship Between Computational Complexity and Bandwidth," Proceedings of the 24th IEEE Conference on Decision and Control, Fort Lauderdale, FL, December 1985.

Ammons, J.C., C.B. Lofgren, and L.F. McGinnis, "A Large Scale Work Station Loading Problem," Proceedings of the First ORSA/TIMS Special Interest Conference on Flexible Manufacturing Systems, The University of Michigan, August 1984.

Mitchell, C.M., T. Govindaraj, and J.C. Ammons, "Human Machine Interfaces in the

Control of Flexible Manufacturing Systems," Proceedings of the 1984 IEEE International Conference on Cybernetics and Society, Halifax, Nova Scotia, Fall -1984.

Ammons, J.C., "Scheduling Models for Real Time FMS Control," Proceedings of the 1985 IEEE International Conference on Systems, Man, and Cybernetics, Tucson, AZ, November 1985.

Ammons, J.C., T. Govindaraj, and C.M. Mitchell, "Human Aided Scheduling for FMS: A Paradigm for Human-Computer Interaction for Real Time Scheduling and Control," Proceedings of the Second ORSA/TIMS Conference on Flexible Manufacturing Systems, Ann Arbor, MI, August 1986.

Mitchell, C.M., T. Govindaraj, S.P. Krosner, O. Dunkler, J.C. Ammons, "Real Time Scheduling in FMS: A Supervisory Control Model of Cell Operator Function," Proceedings of the 1986 IEEE International Conference on Systems, Man, and Cybernetics, Atlanta, GA, October 1986.

Dunkler, O., C.M. Mitchell, T. Govindaraj, and J.C. Ammons, "An Empirical Evaluation of the Effectiveness of Supervisory Control in Flexible Manufacturing Systems," Proceedings of the 1987 IEEE International Conference on Systems, Man, and Cybernetics, Washington, DC, November 1987.

Ammons, J.C., L.F. McGinnis, F.A. Ramirez, and G.J. Thuesen, "New Methods for the Economic Evaluation of Capacity Expansion in Electric Utilities," Proceedings of the AIIE, Houston, TX, Fall 1979.

Ammons, J.C., and L.F. McGinnis, "An Optimization Model for Generation Expansion Planning in Electric Utilities," Proceedings of the Southeastern TIMS Meeting, Savannah, GA, October 1981.

Snowdon, J.L., J.C. Ammons, and L.F. McGinnis, "A Review of Queueing Network Packages for Manufacturing Systems Analysis," Proceedings of the IIE Integrated Systems Conference, Nashville, TN, November, 1987.

Boswell, R.D., J.C. Ammons, and S. Manivannan, "A Blackboard Architecture for the Design-For-Manufacture of Surface Mount Circuit Boards," Proceedings of the PCB EXPO '90/PRONIC, Paris, France, November 13-16, 199, Section 3.4.

Jacobs-Blecha, C., J.C. Ammons, W. Warden, "Cut Order Planning," Proceedings of Apparel Researchers Conference, Philadelphia, PA, February 1990.

Ammons, J.C., L.F. McGinnis, and C.A. Tovey, "Process Planning for Surface Mount, Proceedings of Surface Mount International Conference, San Jose, California, August 25-29, 1991.

Ammons, J.C., L.F. McGinnis, and C. A. Tovey, "Production Optimization for Circuit Card Assembly," Proceedings of the 1992 NSF Design and Manufacturing Systems Conference, Atlanta, GA January 8-10, 1992.

Ammons, J.C., and C. Jacobs-Blecha, "Cut Order Planning," Proceedings of the Third Academic Apparel Researchers Conference, Atlanta, GA, February, 1992.

CONFERENCE PRESENTATIONS:
47 presentations at National and International meetings.

AWARDS AND HONORS:

National Merit Scholar and Alumni Honors Scholar, University of Alabama, 1971-74.

Presidential Fellow, Georgia Institute of Technology, 1976.

Outstanding Young Women of America, 1978.

Outstanding Young Manufacturing Engineer Award, Society of Manufacturing Engineers, 1986. This is an *international* award given by the society to recognize and contribution to manufacturing research and education by young professionals.

Young Engineer of the Year, Metro Atlanta Engineering Societies, 1988.

Honor Society Memberships:
Tau Beta Pi, Engineering Honor Society
Alpha Pi Mu, Industrial Engineering Honor Society
Sigma Xi, Research Honor Society
Phi Kappa Phi, Academic Honor Society
Pi Mu Epsilon, Mathematics Honor Society
Mortar Board, Scholastic and Leadership Honor Society
Alpha Lambda Delta, Freshman Scholastic Honor Society

Research Awards:

Co-winner, Outstanding Industrial and Systems Engineering Dissertation Research Award, 1981-82, Georgia Institute of Technology.

Co-Advisor to Christopher Lofgren, Finalist in Operations Research Society of America Nicholson Student Paper Contest, 1985 and 1987 and Winner of the 1987 Wunch Award for the best material handling thesis in Industrial and Systems Engineering at Georgia Tech.

Co-Advisor to Moshe Eben-Chaime, whose thesis was awarded the 1991 Joseph Levy Prize by ORSIS (the Operations Research Society of Israel) for "outstanding work in Operations Research.

Teaching Awards:

Outstanding Faculty Member, 1984-5, Institute of Industrial Engineers, GeorgiaTech Chapter.

Outstanding Industrial Engineering Professor, 1984-5, elected from the Georgia Tech ISyE Senior Class and awarded by Alpha Pi Mu.

Outstanding Industrial Engineering Professor, 1987-88, elected from the Georgia Tech ISyE Senior Class and awarded by Alpha Pi Mu.

Outstanding Industrial Engineering Professor, 1988-89, elected from the Georgia Tech ISyE Senior Class and awarded by Alpha Pi Mu.

PROFESSIONAL ACTIVITIES:

Professional Society Memberships:
Institute of Industrial Engineers
Society of Manufacturing Engineers
Society of Women Engineers
Operations Research Society of America
The Institute of Management Science

American Society of Engineering Educators

Professional Society Service at the National Level:

Member, IIE National Task Force on the Formal Education Process, Sub- Task Force of Faculty Recruiting/Development, 1982-3.

Member, Organizing Committee for the 1985 Operations Research Society of America/The Institute of Management Science Joint National Meeting.

Instructor, IIE Continuing Education Course entitled "Professional Engineers Examination: A Review of IE Fundamentals," the "Facilities Planning" session, 1987.

Member, Society of Manufacturing Engineering Education Foundation, 1988, 1989, 1991.

Each year this committee reviews proposals from 65-90 universities and colleges, and grants 20-30 awards out of the approximately $500- 600,000 total awarded by all four committees of the foundation.

Member, National Quality Engineering Education Award Task Force, 1991.

Member, Pre-College Advisory Committee, Center for Education in Science, Mathematics, and Computer (CEISMC), Georgia Institute of Technology, 1991-present.

Vice-Chair, National Science Foundation Advisory Committee for the Division of Design and Manufacturing, 1992-3, Member 1991-92.

Planning Committee, Workshop on Electronics Manufacturing Research Sponsored by the National Science Foundation, College Station, Texas, February, 1992.

Professional Registration: Registered Professional Engineer, Georgia, #015654, 1986.

Editorial and Review Work for Technical Journals, Books, and Foundations:

Associate Editor, *Manufacturing Review*, American Society of Mechanical Engineers and Institute of Industrial Engineers, 1987-present.

Referee for *National Science Foundation*.

Referee for *Production Handbook*, J.A. White, Ed., New York: Wiley, 1987.
Referee for *Management Science*,
Institute of Industrial Engineering Transactions,
Computers and Industrial Engineering,

IEEE-Systems, Man, and Cybernetics Transactions, Operations Research.

Panel Member, National Science Foundation Review Panel for the Presidential Young Investigator Award, December, 1990.

Panel Member, National Science Foundation Review Panel for the Production Systems Program in the Division of Design and Manufacturing, May, 1991.

International;

Member, United States Economic Management Delegation to the Soviet Union, July 1990.

Invited Speaker, National Science Foundation, "Status of Scientific and Engineering Research in the Soviet Union," August 27, 1990.

CIVIC ACTIVITIES:

Member, Home Park Community Improvement Association, 1977-1985.

Member, Board of Directors of the Home Park Child Care Association, 1981-82.

Various positions including Vice-Chair of Administrative Board, Finance Chair, and Choir, Tenth Street United Methodist Church, 1981-present.

Member, Twin Lakes Community Center, 1985-present.

Member, Briarlake Elementary PTA, 1988-present. Recording secretary, 1991-2.

Member, Atlanta Lawn Tennis Association, 1987-present.

Appendix D Vitae of Principal Investigators

April 1992

VITA

Dr. Joseph E. (Tim) Gilmour, Jr.
Vice President for Strategic Planning
Georgia Institute of Technology
Atlanta, Georgia 30332-0325
(404) 894-9455

Home: 1944 Fields Pond Road
Marietta, GA 30068
(404) 640-6101

SUMMARY

Considerable executive level leadership experience in higher education; managed several large research projects including a national study of faculty governance structures; graduate study focused on organizational behavior; strongly committed to implementing TQM in higher education.

EXPERIENCE

Vice President for Strategic Planning , Office of the President, Georgia Institute of Technology, December 1989 to present.

Serve as one of three key members of the Office of the President including the President, the Executive Vice President and myself dealing with a wide variety of academic and administrative policy matters. Have responsibility for the Institute strategic planning process. Provide overall leadership for all campus facilities planning, design, maintenance and operations functions; included in these efforts are planning for $250 million in new facilities on campus for the 1996 Summer Olympics and the development of 20 year campus master plan. Responsible for Institute's assessment and TQM programs. Member of the Academic Council and the Institute Resource Allocation Advisory Committee. All facilities functions and Institutional Research and Planning report to me; budget responsibility totals $18 million.

Senior Research Fellow, National Center for Postsecondary Governance and Finance and Advisor to the President, University of Maryland, August 1988 to December 1989.

Led a national research project for the improvement of academic senate effectiveness funded by the Lilly Endowment and the NYNEX Foundation. Included were a national symposium and a national survey of academic senate organization and practice. Also completed a study of governance and operating practices in four major consolidated higher education systems for the president of the University of Maryland.

Executive Assistant to the President, University of Maryland at College Park, November 1981 to July 1988.

Served as chief of staff for campus administration, administrative officer for the Office of the President, the president's liaison to major campus committees, his principal advisor on policy matters, Board of Regents liaison, campus spokesperson on major issues, coordinator of governmental and community relations, and member of president's cabinet. Managed units reporting directly to the President's Office.

Associate Director of Academic Affairs, Council of State College and University Presidents for Washington State, 1978 to 1982.

Served as principal academic affairs staff member and liaison to the state coordinating board. Played role in all phases of state higher education master planning and budgeting processes. Developed cooperative programs for member institutions.

University Planning Specialist, Office of Budget and Planning, The Pennsylvania State University, 1971-78.

Served as senior academic planner, budget analyst and special studies officer for university system executives. Led several major research projects including a marketing study of the undergraduate admission and recruitment process.

ACADEMIC APPOINTMENTS

Assistant Professor, Higher Education and Associate Member, Graduate Faculty, University of Maryland, 1982 to 1989.

PROFESSIONAL ASSOCIATIONS

Association for Institutional Research, Presidential Assistants in Higher Education, and the American Association of Higher Education.

EDUCATION

Ph.D., Higher Education, University of Michigan, 1974.
M.Ed., Student Personnel, University of Delaware, 1970.
B.A., History, University of Delaware, 1966.

PERSONAL

Military Service: Honorable discharge, August 1968, first lieutenant.
Marital Status: Married, two children.
Community Service:
Member, Executive Committee, Prince Georges County Chamber of Commerce;
Vice President, Scarborough Condominium Board

PUBLICATIONS

"A Procedure for the Development of New Programs in Post-secondary Education," with Wayne A. Lee. Journal of Higher Education, May/June 1977, pp. 304-320.

"The Politics and Practicalities of Pricing in Academe," with J. Lloyd Suttle. In Issues in Pricing Undergraduate Education, Larry H. Litten, ed., San Francisco: Jossey-Bass, Inc., June 1984.

"Participative Governance Bodies in Higher Education: Report of a National Study," In Faculty in Governance: the Role of Senate and Joint Committees in Academic Decision Making. Robert Birnbaum, ed., San Francisco: Jossey-Bass, Inc., Fall 1991.

"Your Faculty Senate: More Effective than You Think?" Academe, September/October, 1991.

PRESENTATIONS

"Sources of Conflict between Institutional Researchers and Decision Makers." Paper presented to 1976 Association for Institutional Research (AIR) Annual Forum, Los Angeles, CA, May 3-6. Also in Forum Proceedings, pp. 97-100.

"A Model for the Review and Abandonment of Academic Programs in Post-secondary Education," with Leland Beik. Paper presented to 1977 AIR Annual Forum, Montreal, Canada, May 8-12. Also in Forum Proceedings, pp. 115-119.

"How Do High School Students Select a College?" Paper presented to 1978 AIR Annual Forum, Houston, TX, May 21-25. Also in ERIC (ED 308705).

"Developing and Implementing a Marketing Strategy for College Recruiting and Admission," with Mark D. Johnson. Paper presented to 1978 AIR Annual Forum, Houston, TX, May 21-25.

"Using Marketing to Incorporate Environmental Considerations into Program Processes." Paper presented to 1980 AIR Annual Forum, Atlanta, GA, April 27-May 1.

"The Role of Marketing in Presenting Better Information for Students." Paper presented to American Association of Higher Education Annual Meeting, Washington, D.C. April 16-18, 1982.

"Sustaining Institutional Vitality and Financial Strength through Portfolio Analysis," with Larry H. Litten. Paper presented to 1982 AIR Annual Forum, Denver, CO, May 16-19.

"Interstate Comparison of Financial Data." State Higher Education Executive Officers, panel presentation, Annapolis, MD, August 10, 1984.

"Study of a Crisis--the Len Bias Case." Paper presented to Colloquium on Intercollegiate Athletics at the Center for Higher Education, University of Michigan, April 11, 1987.

"Managing the Managers." Paper presented to North Carolina Association for Institutional Research, New Bern, NC, April 22, 1987.

"Ethics and Confidentiality in the President's Office." Panel member, Special Session for Presidential Assistants in Higher Education, 71st Annual Meeting, American Council on Education, January 18, 1989.

"Strategic Planning and Academic and Administrative Computing." Paper presented to the Educom Annual Meeting, October 17, 1990.

"A National Portrait of Academic Governance Models." Paper presented at Naples (FL) Institute conference "Forging New Partnerships: Effective Academic Governance for the 1990s," January 3, 1991.

"Academic Goverance Models for Comprehensive Universities." Presentation to Presidential Speaker Series, University of Texas at San Antonio, March 12,1992.

PROFESSIONAL ACTIVITIES

Consultant, Maryland State Board for Higher Education, Evaluation and Development Process, 1978.

Member, Advisory Board, Center for Helping Organizations Improve Choice in Education, University of Michigan, 1977-79.

Co-director, Association for Institutional Research Summer Workshop on Market Research for Colleges and Universities, Carleton College, July 23-26, 1979.

Member, 1982 Nominating Committee for Association for Institutional Research.

Association for Institutional Research Representative to National Center for Higher Education Management Systems National Advisory Council, 1985-1986.

Member, Presidential Assistants in Higher Education Program Planning Committee for 1988 and 1989 Annual Special Sessions.

Leader, Faculty Governance Assessment Team, University of Colorado System, November 1989.

Consultant to Eastern Michigan University on Overall Organization, CRESAP Consulting Group, August-November 1991.

APPENDIX E

Selected Notes on the IBM/Georgia Tech Relationship

IBM established the CIMS program with a $2 million grant in 1983. The program has grown to become the largest multidisciplinary program at Tech and probably the largest manufacturing engineering education program in the country.

IBM is a top recruiter and hirer of Georgia Tech students. Over 700 Tech alumni work in IBM's locations around the world. The company is also a major co-op employer and participant in the Georgia Tech Career Fairs.

IBM is a member of the Manufacturing Research Center (MaRC), contributing $1 million over five years. In conjunction with MaRC membership, IBM is also a member of the Materials Handling Research Center.

Last year IBM made a three-year, $750,000 commitment to support a research project in the College of Computing which will provide elementary school teachers with new teaching techniques using artificial intelligence. The Research Initiation Grant is titled "Making Science More Exciting: Using AI to Help Teachers."

Recent interactions have focused heavily on multimedia technologies. Tech's Corporate Relations office hosted 175 IBM employees for the Software Marketing Directorate Meeting. Our multimedia Olympic Model has been presented at numerous IBM sites. IBM has recently loaned important multimedia equipment to Tech and a number of initiatives are underway or pending.

IBM provides substantial continuing support to the College of Computing and the School of Electrical Engineering through IBM Department Grants, Faculty Development Awards, and Graduate Fellowship Awards.

IBM maintains a very strong pattern of research contract activity with the academic units and the Georgia Tech Research Institute.

Georgia Tech is deeply appreciative of IBM's significant and sustained support over the years and we are proud of the contributions our alumni have made to IBM's success.