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Project Unit ENGR COLL
Sponsor NORTH CAROLINA STATE UNIV/RALEIGH, NC
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Prime Contract Number EID-9109853

Title A BENCHMARK OF ENGINEERING EDUCATION RESEARCH ACTIVITIES
Effective Completion Date 30-SEP-1997 (Performance) 30-SEP-1997 (Reports)

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Annual Report
March 1, 1992 - February 28, 1993

An NSF Engineering Education Coalition
Clemson University • Florida A&M University • Florida State University
Georgia Institute of Technology • North Carolina A&T State University
North Carolina State University • University of Florida
University of North Carolina at Charlotte • Virginia Polytechnic Institute and State University
EXECUTIVE SUMMARY

The Southeastern University and College Coalition for Engineering Education (SUCCEED) is comprised of Clemson, FAMU/FSU, Florida, Georgia Tech, NC A&T, N. C. State, UNC-Charlotte, and Virginia Tech. The eight engineering schools at these institutions are jointly funded by the National Science Foundation as one of four existing university consortia which now comprise the NSF Engineering Education Coalitions Program.

The mission of SUCCEED is to conduct a program of educational and curricular research, development and implementation. The purpose of this activity is to establish the content, framework, instructional techniques, advising and mentoring mechanisms, learning environment, and evaluation procedures for a new undergraduate engineering curriculum model, CURRICULUM 21. The activities of SUCCEED will be directed toward achieving the following goals that focus on the changing needs and requirements of the engineering profession.

1. Develop effective mechanisms to increase participation of under-represented groups in engineering and to enhance their success in the university and subsequent professional careers.

2. Integrate continuous improvement principles and practices in the "engineering education process" and the "process of engineering".

3. Reduce or eliminate artificial boundaries at the transitional interfaces and within the academic environment which prevent students and faculty members from integrating course material and its application to engineering practice.

4. Incorporate concepts of global engineering practice in engineering curricula to promote our nation's competitiveness in the world market place.

5. Implement new communication and information technologies that enhances the effectiveness and efficiency of the learning process.

SUCCEED will achieve these goals by focusing its activity and effort on accomplishing the following specific objectives. These objectives represent the deliverables and outcomes to be produced by SUCCEED and by which the Coalition will be judged as having accomplished its mission.

1. Achieve a coalition-wide increase in the total number of female and under-represented minority students by 50% with an increase in student retention of at least 50%.

2. Develop a process for renewal of existing engineering curricular structures, including the faculty reward system, and apply this process to one (or more) traditional engineering curricula.

3. Develop a new Process Engineering degree program which is an integrated combination of traditional related engineering knowledge coupled with process engineering specific content.

4. Develop a new multi-disciplinary Bachelor of Science in Engineering Degree with no disciplinary designation to meet the growing technical/management generalist needs of industry.

5. Implement a (beta-site) demonstration of electronic connectivity for educational delivery and interaction between (a) SUCCEED institutions, and (b) SUCCEED campuses and appropriate community colleges.
6. Demonstrate technology insertion (such as multimedia) into teaching/learning situations comprised of four or more engineering courses and one or more pre-engineering courses.

SUCCEED's deliverables will focus the Coalition's efforts on the "process of engineering" and the "engineering education process". This will emphasize developing the means by which an orderly change can be affected in traditional engineering disciplines that stress individual and technical specialization. The focus will be on new and improved programs that emphasize a broader educational perspective centered on integrated multi-disciplinary thought processes and a team approach to product and process development in engineering.

The deliverables from SUCCEED's experimental research program and new curriculum model (CURRICULUM 21) will provide the prototypes and mechanisms to restructure existing curricula producing today's disciplinary specialists. SUCCEED will develop experimental multi-disciplinary curricula that educate a new breed of engineer who will serve industry as multi-functional technical generalists. These graduates will be prepared to serve the needs of the technical competitive environment of the twenty-first century.

The development of the specific deliverables will be achieved through the establishment of inter- and intra-institutional linkages among SUCCEED engineering schools and traditional discipline programs. Groups of institutions will be responsible for each deliverable and for integrating the diversity and unique strengths of each institution into the achievement of that specific objective. In addition, SUCCEED will engage in an outreach effort to extend the results of our curricular experiments beyond the boundaries of the participating institutions into other coalitions, engineering schools, and community colleges.

Special attention will be placed on the need to ensure broader participation and success for all students, especially among women and under-represented minorities. To accomplish this objective, SUCCEED will develop effective interfaces between its engineering programs, the new curriculum model, and the principal sources of supply of engineering students. Special emphasis will be directed to the K-12 education system, community colleges, and other alternate entry routes into engineering programs.

SUCCEED will also address the career advancement and success of engineering faculty who participate in the educational research and teaching scholarship that contributes to the development of the new curriculum model. Faculty participation and success issues will be addressed through the implementation of assessment and feedback mechanisms that provide meaningful input to the educational reward and evaluation system. This will be complemented by the development of an electronic computer based resource center to promote subject matter content, teaching methodology, and general instructional resource exchange between institutions and participating faculty.

To create an academic environment that can effectively address the continuous improvement of the "process of engineering" and the "engineering education process", SUCCEED will introduce the concepts and principles of modern quality management in the implementation of its strategic plan. This will provide the mechanisms and procedures for creating organization wide participation that will lead to the planning and implementation of continuous improvement procedures throughout the coalition. The effect will be to produce results that exceed the expectations of our customers, with the most important customer being our students. This will not only insure SUCCEED's effective realization of its unique mission, but will also provide a model for how these quality management principles can be successfully implemented in the revitalization of engineering education for the twenty-first century.
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1.0 INTRODUCTION

The Southeastern University and College Coalition For Engineering Education (SUCCEED) is comprised of eight major engineering schools and colleges from nine prominent universities, which are: Clemson University, Florida A&M University, Florida State University, 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. These institutions are jointly funded by the National Science Foundation as part of the NSF Engineering Education Coalitions Program. The SUCCEED coalition began officially on March 15, 1992 and has been in operation for almost one year.

During the first year of operation, SUCCEED has made substantial progress in developing and implementing its curriculum restructuring plan, the related strategic plan and management plan, and in initiating several important educational research projects. This report describes the progress made in each of these areas during the first year of operation and outlines our plans for the coming year. These plans include finalizing our strategic plan and initiating a more comprehensive set of projects which will carry SUCCEED to the time of the major third-year NSF review. As an introduction to the progress report, the following section first summarizes the mission and proposed deliverables of the SUCCEED coalition.

2.0 OVERALL MISSION AND COALITION DELIVERABLES

The mission of the SUCCEED Coalition is to carry out educational and curricular research, program development, and project management in order to establish the content, framework, instructional techniques, learning environment, advising and mentoring mechanisms, and evaluation procedures for a new undergraduate engineering curriculum model, CURRICULUM 21. This model was defined in the 1991 SUCCEED proposal, and a great deal of effort has been devoted this year to refining our original ideas and implementation plans. The approach now being used by the SUCCEED management team is based on five building blocks that represent departures from the present-day engineering education process and which address important issues related to the developing requirements of the engineering profession. During the first year of operation, SUCCEED has focused a substantial amount of effort toward clarifying and refining the problems and issues as they relate to these five building blocks, which provide our basic principles of operation. The five building blocks are:

- Incorporate new concepts of international engineering practice into the engineering curriculum to promote our nation's competitiveness in the emerging global economy
- Develop an organized system with structured mechanisms to increase enrollment of underrepresented groups in engineering and provide for the successful completion of their program of study and entry into the workforce
- Reduce or eliminate artificial boundaries in the academic environment which prevent students from relating subjects to each other and to the working world
- Integrate continuous improvement principles and practices in the engineering education process in order to respond effectively to the rapid changes and needs of the engineering profession
- Implement new technology that improves the learning process and provides access to the most current and extensive information base possible
As a result of applying our principles of operation, developing and implementing our new curriculum model, and interpreting the results from all the projects which will be conducted during the initial five-year period of operation of the coalition, SUCCEED will produce the following specific outcomes and deliverables:

1. Achieve a coalition-wide increase in the total number of female and under-represented minority students by 50% with an increase in student retention of at least 50%.

2. Develop a process for renewal of existing engineering curricular structures, including the faculty reward system, and apply this process to one (or more) traditional engineering curricula.

3. Develop a new Process Engineering degree program which is an integrated combination of traditional related engineering knowledge coupled with process engineering specific content.

4. Develop a new multi-disciplinary Bachelor of Science in Engineering Degree with no disciplinary designation to meet the growing technical/management generalist needs of industry.

5. Implement a (beta-site) demonstration of electronic connectivity for educational delivery and interaction between (a) SUCCEED institutions, and (b) SUCCEED campuses and appropriate community colleges.

6. Demonstrate technology insertion (such as multimedia) into teaching/learning situations comprised of four or more engineering courses and one or more pre-engineering courses.

Thus, SUCCEED's deliverables have been specified in order to focus our efforts on the process of engineering and the engineering education process. During the first year of operation, we have identified the area of process engineering as a key concept and critical curricular requirement to address the growing needs of industry for both specialist and generalist engineering graduates. Thus, based on the program we have developed during the first year, our plan is that we will build on existing, strong engineering disciplines and academic departments to design new curricula and educational infrastructure for the engineering college of the future. There will be an orderly transition from a current mindset with a graduate level emphasis and focus on individual accomplishment and disciplinary specialization to a broader perspective which also includes multi-disciplinary thought processes and a team approach to the product development process. In addition, we will address the needs for greater efficiency in the use of our educational resources and the increasing concerns by the public about the quality of undergraduate education. Thus, the deliverables from SUCCEED's new curriculum model (CURRICULUM 21) will augment (and not replace) the strong existing curricula which produce today's disciplinary specialists. This augmentation will produce a new "breed of engineer" whose education complements that of existing engineering graduates who now serve industry primarily as disciplinary specialists. In contrast, the new breed of engineer can be identified as a functional specialist. In addition, we will develop an experimental curriculum with no disciplinary designation which provides for another dimension of the new breed of engineer who will serve as either a functional specialist in engineering or a technical/management generalist to meet the expanding "integrator' needs of U. S. industry for the product development process. Thus, both types of engineers will be better prepared to perform in the competitive environment of the twenty-first century.

The development of these deliverables within the coalition will be achieved through the establishment and expansion of inter-institutional linkages among the SUCCEED engineering schools and colleges. Groups of institutions will be responsible for each deliverable and for integrating the diversity and unique missions of each institution into our overall strategic plan. In addition, we will complete a cohesive plan for extending the results of our curriculum experiments
beyond the boundaries of the SUCCEED institutions into other coalitions, engineering schools, and community colleges. Both of these efforts were initiated during the first year of operation.

SUCCEED remains committed to promoting participation of all students and impacting all segments of the educational process. Thus, during this first year, special attention has also been placed on the need for engineering education to insure broad participation and success for all students, especially among women and under-represented minorities. To accomplish this goal will require that SUCCEED develop effective interfaces between our engineering programs, the new curriculum model, and the principal supply sources of engineering students to all our institutions. Thus, special attention will be paid to the K-12 education system, community college system, and other alternate entry routes into engineering education. Also, we will address the career participation and success of our engineering faculty based on their educational research and teaching scholarship towards the development of our new curriculum model. The student and faculty participation and success issues can be addressed through the implementation of an assessment and feedback system into the educational process, through the development of a resource center which is an electronic, computer-based system to promote information and instructional exchange between institutions, and through the development of functional teams assigned to address the participation and success issues. Several of the projects which are already underway now address this important area of SUCCEED activity. During the coming year, we plan to start several additional projects in the area of student and faculty participation and success.

Also, SUCCEED remains committed to creating an academic environment which can address continuous improvement of the process of engineering and the engineering education process. Thus, during the first year, we have initiated projects which focus our initial efforts on the concept of Total Quality Management (TQM). TQM is an emerging structural system of both fundamental principles and practical tools for monitoring and improving a specific, well-defined process. Such a system is intrinsic to our focus on the process of engineering and the engineering education process. Thus, a TQM system provides mechanisms for creating organization-wide participation in planning and implementing continuous improvement that meets and indeed exceeds the expectations of the customer. Engineering educators realize that we do have many customers, the most important being our students. The essence of TQM is team study devoted to process improvement, which has application in both program and curriculum development. Thus, SUCCEED will execute the principles of TQM in all phases of the planning and implementation process to realize its distinctive vision, to cause continuous improvement in achieving its mission, and to implement the elements of its strategic plan. Specific TQM projects and evaluation methods have been started this year. During the next year of operation, we will explore new projects to refine the TQM concept and to evaluate its effectiveness in engineering education.

3.0 CURRICULUM RESTRUCTURING PLAN

Figure 1 shows a schematic of the CURRICULUM 21 model in the general context of the "engineering education pipeline". This figure is intended to convey the intention of SUCCEED's curriculum restructuring plan to address the major needs of engineering education within the university framework, while at the same time recognizing that changes in the curriculum within the university cannot be made without due consideration of the important interfaces between the university and its suppliers of students and the customers that hire our engineering graduates. Thus, as shown in Figure 1, SUCCEED will develop CURRICULUM 21 as part of an integrated plan which includes the K-12 interface, the community college and small college interface, and the interfaces with the primary customers of our undergraduate engineering programs which are the graduate school/academic sector and the commercial sector (which also includes the various national laboratories and government service). SUCCEED will pay special attention to our
interface with the community colleges since some of our institutions (e.g., Univ. of Florida and Virginia Tech) derive upwards of 50% of their B.S. level students from community colleges.

In Figure 1, CURRICULUM 21 is divided into three interconnected parts or Stages, which were chosen to represent three distinct emphases of our plan for curriculum reform. Thus, Stage I (the Integrated Engineering Core) covers about 40% of the curriculum, and is intended to emphasize the role of mathematics, physical and life sciences, and humanities as engineering subjects. In this Stage of CURRICULUM 21, all subjects will be integrated from the point of view of their impact on the engineering process and based on the content that they contribute to the engineering profession. Thus, engineering will serve as the integration point for learning. Stage II (the Engineering Design and Processes Core) also covers about 40% of the curriculum and is intended to emphasize that engineering is a process with design as a central theme. Thus, the focus here will be on the product development process, the interdisciplinary nature of engineering, and the importance of other professional areas, such as business and economics, in contributing to these concepts. Finally, Stage III (the Functional Engineering Core) covers about 20% of the curriculum and is intended to emphasize that there are important functional roles which engineers play in the product development process which are not addressed in most existing disciplinary curricula. For example, manufacturing is a function of engineering, as is research, marketing, and maintenance. Very little of these four components of the product development process are covered in existing curricula. These three Stages of CURRICULUM 21 are provided as general subject matter guides for the development of a new curriculum oriented toward process engineering. However, they also can be used to define incremental changes in existing curricula, and they can be used as a basis for considering other curricular frameworks. Thus, a five-year program as well as a four-year program could be developed within the context of these three Stages of the curriculum. This provides the flexibility for experimentation within the framework of either a four-year or five-year engineering program based on the outcomes of our experimental projects. Thus, CURRICULUM 21 is not confined to the four-year model for a baccalaureate engineering degree.

Figure 2 shows a general curriculum template for CURRICULUM 21 which we have developed during the first year of operation. The concepts imbedded in the template establish the next phase in the development of a model for curriculum reform, based on the general curriculum framework shown in Figure 1, and based on our key concept which places a major emphasis on process engineering, or the study of the product development process. This template will allow SUCCEED to further define the course content of its experimental curricula and to focus on the specific experiments required to achieve the curriculum deliverables specified in Section 1.0. This template conforms to the subject matter emphases for the three Stages of CURRICULUM 21 shown in Figure 1 as summarized in the preceding paragraph. The CURRICULUM 21 process engineering template is intended to represent an integrated curriculum in which the subjects are merged around broad topics rather than the current model for curriculum development that is formulated in terms of three-semester hour courses on very specific subjects, which are often only weakly linked to pre- or post-requisites within the existing disciplinary curricula. Thus, there are only three courses (or course modules) per semester instead of the usual six courses. However, the academic credits for these three courses would be the same as the traditional six courses per semester. These modules are taken over eight semesters and one summer session and they approximate the equivalent of a 125 semester-hour, four-year curriculum. Even then, through the use of team teaching techniques, it is also intended that these three courses be very closely coordinated with one another so that there are real connections between the subjects studied in each module. The students and faculty in these three modules will have specific activities and projects through which the cross-functional interactions will take place.

This process engineering template for CURRICULUM 21 is both calculus-based and statistics-based. There will be a great deal of emphasis throughout the curriculum on the use of the principles and tools of statistics, including the use of statistical process control concepts and the tools and methods used in the design of quality (e.g., TQM) within the product development
Figure 1. CURRICULUM 21 in the Engineering Education Process
Figure 2. SUCCEED Process Engineering Curriculum Template
There is considerable room for the merging of statistics-based engineering subjects with calculus-based engineering subjects, so that these two modules in Figure 2 could easily be merged into a single module, producing a more integrated curriculum template. In addition, the module which addresses the integration of arts, humanities, and culture with engineering will also address the communications skills, interpersonal relationship skills, and team building skills required for an engineer to contribute to the team-building approach which is used in the product development process of today's industry. Thus, there is room for additional curriculum integration within the general CURRICULUM 21 model.

An important centerpiece of the template shown in Figure 2 is the summer industry internship which will be required of all students and faculty who participate in the eventual implementation of CURRICULUM 21, based on the curriculum reform experiments and deliverables as discussed in Section 2.0. Thus, teams of students and faculty members will work in industry during the summer between the junior and senior years on industry problems in a team environment, along with engineers from industry. These problems will be interdisciplinary projects which focus on the product development process within an industrial environment. This will be an important learning experience for both students and faculty members, and should lead to more innovation within emerging CURRICULUM 21 model. During the summer of 1992, SUCCEED initiated a small pilot project for the summer industry internship. This important program will be expanded during the summer of 1993, based on plans which are now being finalized.

During the last two semesters of the process engineering template, or the traditional senior year, students will be able to spend time working together on a variety of functional aspects of the engineering profession. There will be a senior or "capstone" design project which will be implemented across departmental boundaries within an industrial/design setting. Students will be taught the principles of total quality engineering in the product development process, and they will be given a broad choice of experiences which will expose them to many of the non-traditional aspects of engineering, such as work experiences outside the U. S., and in new and emerging areas of cross-functional engineering (e.g., mechatronics, environmental aspects of engineering, manufacturing, etc.).

SUCCEED will use the curriculum template shown in Figure 2 to develop three specific curriculum deliverables, as described in Section 2.0. First, we will apply this curriculum template to an existing disciplinary curriculum such as electrical engineering. Thus, the process engineering core in Figure 2 would encompass several of the mainstream electrical engineering courses, although they would be offered within the context of a focus on the process as opposed to the product emphasis of existing electrical engineering courses. Then, with the functional emphasis of Stage III (Figure 1), and the total quality engineering, functional engineering, and senior process engineering modules shown in Figure 2, this experiment would produce an electrical engineering "functional specialist", as opposed to the "disciplinary specialist" now produced by the traditional electrical engineering curriculum. Next, the template will be applied to develop the plan for a new curriculum which is an interdisciplinary degree between two traditional degree programs (For example, two logical choices in the SUCCEED coalition might be Chemical Engineering and Industrial Engineering curricula, although these choices have not been finalized). However, we will not just pick a set of acceptable (accreditable) courses from the existing departmental catalogs. Instead, new course modules will be designed which conform to the template and provide for the education of a new type of "functional specialist" which is not now produced by either Chemical Engineering Departments or Industrial Engineering Departments. This is the next level of a breed of "new engineer". Finally, the template will be applied to develop a new Bachelor of Science in Engineering (B.S.E) with no disciplinary designation to meet the growing technical and management "generalist" needs of industry. These new degrees will be developed through an intense inter-institutional collaboration between SUCCEED engineering schools and colleges. Before the third-year NSF review, SUCCEED will have specific course content, framework, and instructional plans for each of the three curriculum deliverables, which are: (1) the existing
engineering curriculum, (2) the Process Engineering degree program which integrates two or more traditional engineering curricula, and (3) the new multi-disciplinary Bachelor of Science in Engineering Degree with no disciplinary designation.

4.0 SUCCEED MANAGEMENT PLAN

Figure 3 shows the diagram of SUCCEED's management plan as defined in the original proposal and as modified during the first year of operation. All parts of the management plan are now in operation, and the following sections provide a summary of the personnel involved and their major activities.

4.1 Director

During the period of March 15, 1992 through April 30, 1993, Dr. M. A. Littlejohn, Professor of Electrical and Computer Engineering at North Carolina State University served as the SUCCEED Director. On May 1, 1993, Dr. Carl F. Zorowski, Professor of Mechanical and Aerospace Engineering at N. C. State will assume this position. In addition, Dr. Robert J. Coleman, Professor of Electrical Engineering at the University of North Carolina at Charlotte serves as the Associate Director of SUCCEED and Ms. Shirley Baldwin is the Administrative Assistant to the Director and Associate Director. The office of the SUCCEED Director is located in 213 Page Hall on the N. C. State University campus which can be reached at (919) 515-6597. This office serves as the focal point for all information about SUCCEED, and provides the central administrative staff for coordinating the day-to-day activities of SUCCEED.

4.2 Council of Deans and Executive Committee

The eight Deans of the SUCCEED Colleges and Schools of Engineering make up the SUCCEED Council of Deans, with the SUCCEED Director as an ex officio Council member. The members of the Council of Deans are:

Dr. Ching-Jen Chen, FAMU/FSU Dean of Engineering
Dr. G. Wayne Clough, Virginia Tech Dean of Engineering
Dr. Thomas M. Keinath, Clemson Dean of Engineering
Dr. Harold L. Martin, NC A&T Dean of Engineering
Dr. Wilbur L. Meier Jr., N. C. State Dean of Engineering
Dr. Winfred M. Phillips, Florida Dean of Engineering
Dr. Robert D. Snyder, UNC-Charlotte Dean of Engineering
Dr. John A. White, Georgia Tech Dean of Engineering

During the first year of operation, Drs. Clough, Meier, Phillips, and White served as the Executive Committee of the Council of Deans for SUCCEED, with Dr. Phillips serving as the Chairman of both the Executive Committee and the Council of Deans. The four members comprising the Executive Committee were elected by the Council of Deans, and the membership of the Executive Committee will rotate by election each year. The Council of Deans serves as the basic policy-making board for SUCCEED which considers and approves all academic and management issues, including personnel for the offices and functions represented within the Management Plan shown in Figure 1. During the first year of operation, the Council of Deans met twice with the Director to review progress and plans for the coalition. In addition, the Executive Committee met two more times to address several policy issues related to the start-up phase of SUCCEED. The Director was present at each meeting.
Figure 3. SUCCEED Management Plan
4.3 The National Advisory Board and Technical Council

The SUCCEED National Advisory Board is a fourteen member group of industry, government, and academic leaders whose membership is shown in the following list.

Membership of SUCCEED National Advisory Board (NAB)

Dr. Robert L. Albright  
President  
Johnson C. Smith University  
Charlotte, NC 28216

Colonel Guion S. Bluford  
NASA Johnson Space Center  
CB/Astronaut Office  
Houston, TX 77058

Major General Charles D. Busey  
Army COE  
1812 Metzerott Road  
Adelphi, MD 20783

Mr. George Gourlay  
Senior VP for Technical Operations  
The Coca Cola Company  
Atlanta, GA 30301

Dr. Delon Hampton  
CEO and Chairman of the Board  
Delon Hampton Associates  
Washington, DC 20001

John T. Hartley, Jr.  
Chairman, President and CEO  
Harris Corporation  
Melbourne, FL 32919

Mrs. Janet Hemming  
Senior Vice President  
First Union National Bank  
Charlotte, NC 28288-0909

Mr. William E. Hogan  
VP, Corporate Operations and Quality  
Medtronic, Inc.  
Minneapolis, MN 55413

Ms. Mary Virginia Jones  
Director of Support Engineering  
Atlantic Research Corporation  
Gainesville, VA 26025

Dr. Edward J. Kfoury  
IBM VP and Pres. Industrial Sector Div.  
International Business Machines  
Milford, CT 06160

Dr. Jose F. Lluch  
Dean of Engineering  
University of Puerto Rico  
Mayaguez, Puerto Rico 00709-5000

Dr. Curtis J. Thompkins  
President, Michigan Technological University  
1400 Townsend Drive  
Houghton, MI 49931

Mr. Donald C. Vaughn  
President and CEO  
The M. W. Kellog Company  
Houston, TX 77210-4557

Mr. A. Thomas Young  
President and Chief Operating Officer  
Martin Marietta Corporation  
Bethesda, MD 20817

The primary function of this Board is to advise the SUCCEED Council of Deans and the Executive Committee on management, and policy issues, to offer industrial and practical input to academic issues, and to provide a broad range of inputs from a diverse representation of industry, government, and academic perspectives. All members of the National Advisory Board were nominated by the Council of Deans based on direct knowledge of their individual contributions to engineering at the national level. The Board will be used to critique the operation of SUCCEED
and to develop a constituent voice for SUCCEED at the national level in a variety of professional forums.

The SUCCEED Technical Council is a thirteen member group of industry and academic leaders whose membership is shown in the following list.

**Membership of SUCCEED Technical Council (TC)**

Mr. Richard Alexander  
Program Manager, Techn. Products/ACIS  
International Business Machines Corporation  
Milford, CT 06460

Dr. Gerard J. Canavan  
Vice President, Advanced Services Dev.  
Sprint Corporation  
Kansas City, MO 64114

Dr. Joseph Colsen  
Exec. Director, Switching Systems Perf. Div.  
AT&T Bell Laboratories  
Naperville, IL 60566

Dr. Robert L. Davis  
Dean of Engineering  
University of Missouri, Rolla  
Rolla, MO 65401

Mr. James L. Flanagan  
Director, CAIP  
The State University of NJ Rutgers  
Piscataway, NJ 08855-1390

Ms. Tricia Kellison  
Higher Education Marketing Manager  
Apple Computer, Inc.  
Cupertino, CA 95014

Dr. Richard A. Kenyon  
ECS/ABET  
Rochester Institute of Technology  
Rochester, NY 14614

Dr. John R. Lauritzen, Jr.  
VP, Administration and Business Dev.  
AT&T Federal Systems Division  
Greensboro, NC 27420-5000

Mr. David J. McClaskey  
Quality Manager Coordinator/Consultant  
Eastman Chemical Company  
Kingsport, TN 37622

Dr. Howard Phillips  
Semiconductor Research Corporation  
P.O. Box 12053  
Research Triangle Park, NC 27709

Mr. J. C. Phillips, PE  
Product Development Manager  
Weck Endoscopy  
Research Triangle Park, NC 27709

Mr. William C. Picott III  
Group Manager  
Digital Equipment Corporation  
Maynard, MA 01754-2571

Ms. Charity Robey  
Executive Editor for Engineering  
John Wiley and Sons, Publishers  
New York, NY 10158

The primary function of this Council is to provide program assessment and technical direction of the SUCCEED academic programs to the SUCCEED Director, the Program Committee, and the SUCCEED Advisory Committee. The Advisory Committee is an informal group from the Program Committee, who can be contacted by the Director to provide advice on important matters in a timely fashion when it is required without time for a called meeting of the Program Committee (See Section 4.4). The Technical Council represents a working group which will also oversee the activities of the four SUCCEED Centers and to the Center Directors.
The first joint meeting of the SUCCEED National Advisory Board and the SUCCEED Technical Council was held on December 14 - 15, 1992 in Research Triangle Park, NC. The purpose of this meeting was to inform the NAB and the TC of the emerging directions of the SUCCEED program, and to ask for guidance and input to the SUCCEED Strategic Plan. The members were given the opportunity to meet among themselves and with the SUCCEED management team in order to define specific directions and action items for the NAB and the TC. The next joint meeting is scheduled for May 18-19, 1993 in Atlanta, GA and another meeting of the Technical Council will be held in November, 1993.

4.4 Program Committee and Advisory Committee

The Program Committee was first organized as a group of institutional representatives who were involved in the development of the SUCCEED proposal. This group is now comprised of the SUCCEED Director and the co-principal investigators of the NSF Cooperative Agreement #EID 9109853. The members of the Program Committee are:

Dr. William B. Barlage, Professor, Clemson College of Engineering
Dr. Martha A. Centeno, Assistant Professor, FAMU/FSU College of Engineering
Dr. Robert J. Coleman, Associate Professor, UNC-Charlotte College of Engineering
Dr. M. A. Littlejohn, Professor, N. C. State College of Engineering
Dr. Jack R. Lohmann, Associate Professor, Georgia Tech College of Engineering
Dr. James F. Marchman, Professor, Virginia Tech College of Engineering
Dr. Kenneth H. Murray, Professor, NC A&T School of Engineering
Dr. M. Jack Ohanian, Professor, Florida College of Engineering
Dr. James B. O'Neal, Professor, N. C. State College of Engineering

In addition, Drs. Barlage, Coleman, Lohmann, and Ohanian function as an Advisory Committee to the SUCCEED Director. This Committee serves as a sounding board to the Director in day-to-day operational matters where quick-turnaround advice is needed for an action item when the full Program Committee is not available and cannot meet on a short notice.

The Program Committee and the Center Directors met together six times during the first year of funding, with the primary purpose of selecting the initial projects to be funded by SUCCEED. The results of these meetings and the project selection process is described in Section 5.0.

4.5 Evaluation Committee

The SUCCEED Evaluation Committee was established as an independent group whose primary function is to evaluate the results of the SUCCEED program and projects. During the first year, the Program Committee in conjunction with the Center Directors (Section 4.6) and the SUCCEED Director decided that this group would begin as a funded SUCCEED project. Thus, through a competitive process, a project was selected which had the objective to develop a SUCCEED Evaluation System. The title of that project is "Development of Evaluation Systems for Continuous Improvement in Undergraduate Engineering Education." The project is managed by Dr. Bala Ram at NC A&T, and involves other faculty members from Virginia Tech, Univ. of Florida, and N. C. State. The project was initiated on a relatively small scale for the period of August 17, 1992 - February 28, 1993, and it will be expanded substantially during the second year of SUCCEED operation. A project summary and brief status report for each educational research project funded by SUCCEED during the first year of operation is given in Appendix I. These project summaries will be up-dated each six-months and published in a separate project information directory.
4.6 Centers and Center Directors

All SUCCEED projects started during the first year of operation are managed through one of four centers which are shown in the management plan of Figure 3. These four centers provide the administrative mechanisms for defining and implementing the major thrusts and deliverables discussed in Section 1.0. Each center has a Director who is charged with administering the center technical responsibilities and coordinating all of the projects in his/her mission area. The following sections will summarize the center missions and identify the SUCCEED Center Director. The SUCCEED projects are summarized by Center in Appendix I. In addition, statements of accomplishment are given, even though most projects started but a few months ago.

4.6.1 Center For Curriculum Content and Integration
Dr. Timothy J. Anderson, Center Director, University of Florida
Telephone: 904-392-0881
FAX: 904-392-9513
Internet tim@nerdc.nervm.ufl.edu

The mission of the Center for Curriculum Content and Integration is to develop, test, implement, and evaluate innovative, efficient, relevant and adaptable curricula to prepare engineering students for a life long career in the next century.

In order to accomplish the Center’s mission, a better understanding of engineering education as a process will be sought. From this understanding, principles and practices that continually improve the educational process will be implemented. The Center will provide a multi-institutional, multi-disciplinary educational laboratory in which innovative curricular ideas can be tested. The experimental results will then be used to design a new engineering curriculum, termed CURRICULUM 21 (see Section 1.0). This educational research program will investigate models and methods which instill an understanding of the process of engineering, reduce course and infrastructure barriers, address the interface between K-12, community college and industry with the university, and create an environment that fosters innovation, leadership, teamwork and professionalism.

Within the Center for Curriculum Content and Integration, the education of engineers is viewed as a general process that includes learning, instructional, tutoring, advisory, mentoring, evaluative, and administrative subprocesses. The engineering education process incorporates systems that establish the needs for understanding the process of engineering and implements procedures that allow for continual improvement. The education process recognizes the diversity amongst students and faculty, the intellectual connectivity between subject matter, and the transitions that occur before and after the university experience. Students are active and life-long learners and participants in their own education. The focus of their educational experience is the process of engineering with insertion of the fundamental engineering sciences, engineering judgment, problem solving skills, design and synthesis, risk analysis, and leadership and communications skills, while recognizing the socio-political and international context of engineering practice.

During the first year of operation, eighteen projects were selected for funding within the Center for Curriculum Content and Integration. A list of these projects and the SUCCEED institutions involved in conducting them are:

* Development of Evaluation Systems For Continuous Improvement In Undergraduate Engineering Education
  North Carolina A&T State University, (North Carolina State University, University of Florida, and Virginia Polytechnic Institute and State University during the second year)
• Internationalizing Engineering Education Through Curriculum Revision and Experiential Learning
  University of North Carolina at Charlotte

• Integration Of Fundamental Principles and Key Concepts Throughout An Innovative Engineering Curriculum
  Clemson University

• Internationalizing The Engineering Curriculum
  Clemson University

• An Integrated Statistical Experience In Engineering Curricula
  Clemson University

• Longitudinal Study Of Alternative Approaches To Engineering Education
  North Carolina State University

• Math, Physics, and Engineering Introductory Course Integration
  North Carolina State University

• Introduction To Product and Process Engineering
  North Carolina State University

• Probability Theory For Engineers: A New Teaching Approach
  North Carolina State University

• Linking Fundamental Science Courses To The Engineering Curriculum Through Materials
  North Carolina State University, Virginia Polytechnic Institute and State University, and
  Clemson University

• Enhanced Community College Interface
  University of Florida

• Managing Engineering Academic Units Using Total Quality Management (TQM)
  Clemson University, University of Florida, and Florida A&M University

• Using The Continuous Improvement Process To Prepare Engineering Curricula For Century 21
  University of Florida and Florida State University

• Freshman Interdisciplinary Laboratory
  University of Florida

• Approximations And Methods Of Reasoning For Difficult, Interdisciplinary Engineering Problems
  University of Florida

• A Materials Certificate Program
  University of Florida

• Integration of Engineering Into Freshman/Sophomore Mathematics Courses
  University of Florida
• Teaching Modeling And Analysis Of Dynamic Systems From An Energy Balance Approach Using Multi-Media Tools
University of Florida

These projects were selected to address five basic objectives of the Center, and each project is summarized in Appendix I.

4.6.2 Center For Professional Success
Dr. Carolyn W. Meyers, Center Director, Georgia Institute of Technology
Telephone: 404-894-3264
FAX: 404-894-8336
Internet: carolyn.meyers@me.gatech.edu

The mission of the Center for Professional Success is to assist in the fulfillment of the human resources needs of CURRICULUM 21 through: (a) early and broad exposure to the engineering profession among pre-college students from all segments of the general population; (b) innovative support programs for engineering students at all levels in academe; (c) activities aimed at smoothing the career transitions of students and faculty within the engineering profession; (d) comprehensive programs to ensure the success of faculty in all ranks; and (e) the implementation of equitable faculty reward models reflective of the emphasis on excellence in undergraduate education in CURRICULUM 21.

The Center for Professional Success has the primary responsibility for achieving our goal of a 50% increase, coalition-wide, in the total numbers of female and underrepresented minority students, and an increase in student retention of at least 50%. In addition, other Center goals include increases in the four-year graduation rates and in the numbers of students pursuing graduate degrees; improvements in the interfaces between 4-year institutions and 2-year institutions and community colleges; enhanced mathematics and science education in K-12; establishment of a coalition-wide minority in engineering network, including faculty and students; establishment of a coalition-wide minority engineering student mentoring network; and development and implementation of alternative models for faculty reward and affirmation.

The Center for Professional Success is committed to the dissemination of information regarding the engineering profession to the academically able so that informed career choices can be made; to assisting in the academic preparation of pre-engineering students; to the recruitment and the retention of engineering students from all segments of the general population; to the support of gifted professionals as faculty members; and to fostering effective professional relations among students and faculty members in the SUCCEED Coalition.

During the first year of operation of SUCCEED, six educational research projects were started under the guidance and management of the Center for Professional Success. A list of these projects and the SUCCEED institutions involved in conducting them are:

• A Collaborative Learning Experience For Freshman Engineering Students
Clemson University

• Playing and Inventing (Experiencing Engineering Design)
Georgia Institute of Technology and Florida State University

• SUCCEED Under-Represented Research Engineering (SURE) Program
North Carolina State University
• Women and Minority Retention in U. S. Engineering Colleges  
  University of Florida

• Modular Design Projects For Jump-Starting Engineering Students  
  University of Florida

• Effects Of Group Study on Student Performance in Freshman Engineering Courses  
  Virginia Polytechnic Institute and State University

These projects are in the areas of freshman retention, high school enrichment, undergraduate research participation, and retention of women and minorities. In addition, a major effort which has been identified as the SUCCEED Women's Engineering Board (WEB) has been started representing a large group of female faculty members in all of the SUCCEED institutions. This group has met five times and is preparing to submit a major proposal for the sponsorship of a coalition-wide network to support female student and faculty participation in engineering. The prospects is that the WEB will grow into a major national force for women in engineering. A summary of all the projects within the Center for Professional Success is contained in Appendix I.

4.6.3 Center For Engineering Practice  
Dr. Carl F. Zorowski, Center Director, North Carolina State University  
Telephone: 919-515-2365  
FAX: 919-515-7968  
Internet: zorowski@eos.ncsu.edu

The mission of the Center for Engineering Practice is to support educational research projects and program activity that focuses on integrating engineering design and industrial practice throughout all stages of CURRICULUM 21, and to use engineering practice involvement to attract students to engineering and increase their retention and success. The Center for Engineering Practice intends to promote an academic environment and educational experience coupled with industry interaction through active partnerships that integrates knowledge and engineering practice in the development of the skills and abilities of engineering students and faculty to meet the technological needs of the twenty-first century.

In developing its programs during the first year of operation, the Center for Engineering Practice has established several objectives which must be met in order to carry out its mission. These objectives include: implementing horizontally-integrated, cross-disciplinary design courses in CURRICULUM 21; developing vertically-integrated project activity within the disciplines; establishing engineering project activity across SUCCEED institutions employing electronic connectivity; introducing early design involvement at community college and freshman levels; creating summer "engineering practice camps" for under-represented students; investigating new concepts in cooperative education and internships with industry; establishing an engineering practice "clinic" for university-industry interaction; and developing physical facilities that enhance engineering practice instruction and experience.

The Center for Engineering Practice will accomplish its mission by developing integrative, synthesis, innovative, and analysis skills of engineering students individually and in a team environment, introducing cross-disciplinary and intra-disciplinary activities involving students, faculty members, and industrialists, promoting engineering education and professional involvement as life long processes, creating engineering practice experiences for pre-college students, developing new concepts for cooperative education and other forms of industry interaction and partnerships, and developing strategies for continuous improvement of engineering practice curriculum elements.
During the first year of operation, six projects were initiated by the Center for Engineering Practice. A list of these projects and the institutions involved in conducting them are:

- Using Evolving Design Projects To Promote Active Learning
  Clemson University, N. C. State University, and the University of North Carolina at Charlotte

- Concurrent Engineering For UAV Engineering Practice and Curriculum Integration
  Clemson University, Georgia Institute of Technology, and North Carolina State University

- Bridging The Gap Between Theory and Application With A Competitive Multi-Level Design Experience
  North Carolina A&T State University and North Carolina State University

- Early Design Experience in the Engineering Curriculum
  North Carolina State University

- Computer-Aided Process Improvement Laboratory
  University of Florida

- Vertically Integrated Design
  Virginia Polytechnic Institute and State University

Abstracts for each project and summaries of the project status are provided in Appendix I.

4.6.4 Center For Technology and Communication

Dr. Joseph G. Tront, Center Director, Virginia Polytechnic Institute and State University
Telephone: 703-231-5067
FAX: 703-231-3362
Internet: jgtront@vtvm1.cc.vtedu

The mission of the Center for Technology and Communication is to support projects and programs that focus on the use of technology in the curriculum so as to better convey information, ideas, techniques, and knowledge to engineering students. The achievement of this mission will produce an academic environment enhanced through the use of advanced computer and communication technology wherein average students are motivated to perform beyond expectations, ill-prepared students are given the opportunity to learn at their own rate, advanced students are challenged to achieve their full potential, and where faculty members truly become guides in every student's quest for knowledge.

During the first year of operation, the Center for Technology and Communication has identified several objectives which will guide the Center's mission. These objectives are to: perform curricular experiments on the use of technology in the classroom to determine how these tools may be most effectively applied; establish a framework for the development of multimedia courseware within the coalition; develop and distribute multimedia interactive courseware as an integral part of CURRICULUM 21; provide electronic connectivity throughout the coalition and promote this technology as the educational delivery system of the future; develop a program for distant learning involving the coalition schools as well as community colleges; explore high speed communication technology for use in transmitting multimedia presentations; provide facilities and resources for the development of courseware including training faculty members and students on the use of multimedia tools; and investigate ways in which technology may be used to recruit and retain engineering students.
To accomplish its mission, the Center for Technology and Communication will fund the development of curricular experiments involving the integration of technology into the teaching/learning processes included in all of the three stages of CURRICULUM 21. Experiments judged to be most effective will become the paradigms for blending technology into the coalition's developed curriculum.

During the first year of operation, eight projects were initiated within the Center for Technology and Communication. A list of these projects and the institutions involved in conducting them includes:

- The Development and Implementation of Interactive Multimedia in Basic Engineering Education Courses
  Georgia Institute of Technology and Virginia Polytechnic Institute and State University
- Improving Student Performance and Retention in Basic Physics Courses
  Georgia Institute of Technology
- Multi-Media Engineering Introduction For High School Through Lower Level University Students
  Florida A&M University
- Emulated Flexible Manufacturing Facility
  University of Florida and Georgia Institute of Technology
- Development of Multimedia Teaching/Learning Environments in the Framework of SUCCEED's Integrated Engineering Core
  Virginia Polytechnic Institute and State University
- The Potential of Computer-Based Instruction For A Variety of Engineering Problems
  North Carolina State University and University of North Carolina at Charlotte
- Multimedia Enhancement of Introductory Physics For Engineering Students
  Virginia Polytechnic Institute and State University
- Development Of An Engineering Visual Data Base
  Virginia Polytechnic Institute and State University

Abstracts for each project and summaries of the project status are provided in Appendix I.

5.0 1992-1994 SUCCEED PROGRAM DEVELOPMENT PLAN

The SUCCEED Coalition was funded by the National Science Foundation beginning on March 15, 1992. During the period from March 15, 1992 until February 28, 1993 SUCCEED received $3,000,000 from the NSF in financial support for this first year of operation. This amount was matched by the participating institutions, based on the funding received at each campus.

The first six months was a start-up phase in which the overall management structure was put in place and a general technical program was defined. The initial technical program was broad and basically conformed to the objectives defined in the original proposal and the curriculum restructuring plan shown in Figure 2. A call for proposals was issued to each campus which indicated the criteria for selection based on these technical details. The first phase of the call for proposals asked for "white papers" which described the project ideas and the approach to
implementing and evaluating the educational and curricular concepts. The due date for these white papers was May 1, 1992. The Program Committee received a total of 203 white papers, with the institutional and center distributions listed in Table 1.

Table 1. Distribution of SUCCEED White Papers By Institution and By Center

<table>
<thead>
<tr>
<th>INSTITUTION</th>
<th>CENTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clemson University</td>
<td>Center For Curriculum Content and</td>
</tr>
<tr>
<td></td>
<td>Integration</td>
</tr>
<tr>
<td>Florida A&amp;M/Florida State University</td>
<td>79</td>
</tr>
<tr>
<td>University of Florida</td>
<td>Integration</td>
</tr>
<tr>
<td>Georgia Institute of Technology</td>
<td>Center For Professional Success</td>
</tr>
<tr>
<td>North Carolina A&amp;T State University</td>
<td>43</td>
</tr>
<tr>
<td>North Carolina State University</td>
<td>38</td>
</tr>
<tr>
<td>University of North Carolina-Charlotte</td>
<td>Center For Engineering Practice</td>
</tr>
<tr>
<td>Virginia Polytechnic Institute and State</td>
<td>25</td>
</tr>
<tr>
<td>University</td>
<td>Communication</td>
</tr>
</tbody>
</table>

**TOTALS** 203

The SUCCEED Program Committee reviewed these white papers in terms of their overall quality and potential for impact on the SUCCEED educational program. In particular, the criteria was strongly oriented toward three areas of impact: (1) women and under-represented minority representation, (2) curriculum integration, and (3) continuous improvement processes. From this group of white papers, approximately 100 were selected as being appropriate for the SUCCEED program. The faculty members were then asked to submit full proposals with complete budgets, from one to three years in duration. On July 1, 1992, the SUCCEED Program Committee received 86 Final Proposals in response to our request. These final proposals had the institutional and center distributions as listed in Table 2.

Table 2. Distribution of SUCCEED Final Proposals By Institution and By Center

<table>
<thead>
<tr>
<th>INSTITUTION</th>
<th>CENTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clemson University</td>
<td>Center For Curriculum Content and</td>
</tr>
<tr>
<td></td>
<td>Integration</td>
</tr>
<tr>
<td>Florida A&amp;M/Florida State University</td>
<td>34</td>
</tr>
<tr>
<td>University of Florida</td>
<td>Center For Professional Success</td>
</tr>
<tr>
<td>Georgia Institute of Technology</td>
<td>15</td>
</tr>
<tr>
<td>North Carolina A&amp;T State University</td>
<td>Center For Engineering Practice</td>
</tr>
<tr>
<td>North Carolina State University</td>
<td>12</td>
</tr>
<tr>
<td>University of North Carolina-Charlotte</td>
<td>Center For Technology and</td>
</tr>
<tr>
<td>Virginia Polytechnic Institute and State</td>
<td>25</td>
</tr>
<tr>
<td>University</td>
<td>Communication</td>
</tr>
</tbody>
</table>

**TOTALS** 86

During the white paper and proposal review process, there was a concerted effort to encourage inter-institutional collaboration and multi-university proposal submissions. The numbers provided in the listing of the distribution of white papers (Table 1) and the listing of final proposals (Table 2) reflect to some degree that process of consolidation and collaboration.
From this process and the 86 final proposals received by the Program Committee, the 38 projects listed in Sections 4.6.1, 4.6.2, 4.6.3, and 4.6.4 were selected for funding. These projects were selected to start on August 17, 1992, which was the beginning of the Fall terms for most of the SUCCEED institutions. The duration for the funding in this initial start-up phase of SUCCEED was eighteen months in most cases, covering the periods from August 17, 1992 through February 28, 1993 (approximately six months) and March 1, 1993 through August 16, 1994 (approximately 12 months). This funding cycle was intended to take the initial SUCCEED projects through a point for an evaluation which would allow us to determine which projects most contributed to the final objectives stated in the Strategic Plan. Also, it was determined by the Program Committee that prudent management of the funds required that we have a plan for building the program to the point of optimizing the prospects for a successful third-year NSF review, which is now scheduled to take place during the Fall of 1995. Thus, we did not spend all of the available funds during the first year, so that we might develop a comprehensive funding and project package that best met the needs of our overall strategic program. This resulted in a large amount of "carry-over" moneys for the first year of SUCCEED operation. Also, because of the large amount of travel and planning meetings which were involved in setting up the SUCCEED management plan and in communicating SUCCEED's goals and objectives to all the campuses, an inordinate amount of the first year funds were consumed as "administrative costs". Both the administrative costs and the funds for starting up new projects early in the second year were adjusted by planning for a more balanced two-year funding cycle, covering the period from March 15, 1992 through February 28, 1994.

6.0 1992-94 SUCCEED BUDGET PLAN

The list shown in Table 3 indicates the project expenditures and the budget plan for the first year of funding for the SUCCEED Coalition.

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>TOTAL FIRST YEAR FUNDING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutional Administrative Budgets</td>
<td>$618,670</td>
</tr>
<tr>
<td>Center For Professional Success Projects</td>
<td>$167,134</td>
</tr>
<tr>
<td>Center For Engineering Practice Projects</td>
<td>$334,638</td>
</tr>
<tr>
<td>Center For Technology and Communication Projects</td>
<td>$280,131</td>
</tr>
<tr>
<td>Center For Curriculum Content and Integration Projects</td>
<td>$595,234</td>
</tr>
<tr>
<td>Reserve Fund For New Projects</td>
<td>$1,004,173</td>
</tr>
</tbody>
</table>

TOTAL FIRST YEAR SUCCEED (NSF) BUDGET $3,000,000

[12 mos. (3/15/92 - 2/28/93) administrative funds and 6 mos. (8/17/92 - 2/28/93) project funds]

The project funds listed in the above tabulation under Center Projects requires continuation support of $2,203,451 for the period of March 1, 1993 through February 28, 1994. The Program Committee decided to plan for a substantial cut in administrative costs during the second year of funding. Thus, the projected amount of administrative funds for the second year of funding was $472,339 (SUCCEED Director and Administrative Budgets combined). This provides an additional amount of $324,210 for new projects during the second year of funding. Thus the
The projected SUCCEED budget for the period of March 1, 1993 through February 28, 1994 is listed in Table 4.

**Table 4. Projected NSF Allocations For 3/1/93 - 2/28/94**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>TOTAL FIRST YEAR FUNDING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Administration</td>
<td>$472,339</td>
</tr>
<tr>
<td>Continuation Funding For Existing SUCCEED Projects</td>
<td>$2,203,451</td>
</tr>
<tr>
<td>Center Funding For New Projects From 2nd Year Funding</td>
<td>$324,210</td>
</tr>
<tr>
<td><strong>TOTAL SECOND YEAR SUCCEED (NSF) BUDGET</strong></td>
<td><strong>$3,000,000</strong></td>
</tr>
<tr>
<td>[12 mos. administrative funds and 12 mos. project funds (3/1/93 - 2/28/94)]</td>
<td></td>
</tr>
</tbody>
</table>

In effect, because of delays in getting the projects started and because of changes in the NSF emphases for the coalitions program, SUCCEED did not introduce any additional new projects during the period after August 17, 1993 (as initially intended). At the end of the first year of operation, there was slightly more than $1M in un-expended or "carry-over" funds. These carry-over funds came from the $1,004,173 in reserve funds and from about $50,000 in unspent administrative funds shown in the first year budget list above, of which both amounts were not spent during 3/15/92 - 2/28/93. Thus, based on the actual expenditures to date and the projected expenditures for the second year of funding, the following list shown in Table 5 lists the projected two-year SUCCEED (start-up phase) budget with funds from the National Science Foundation.

**Table 5. Projected NSF Allocations For 3/15/92 - 2/28/94**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>TOTAL FUNDING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial (First Round) Center Project Funding</td>
<td>$3,580,608 (60%)</td>
</tr>
<tr>
<td>New (Second Round) Center Project Funding</td>
<td>$1,328,383 (22%)</td>
</tr>
<tr>
<td>SUCCEED Administration</td>
<td>$1,091,009 (18%)</td>
</tr>
<tr>
<td><strong>TOTAL FIRST PLUS SECOND YEAR SUCCEED (NSF) BUDGET</strong></td>
<td><strong>$6,000,000 (100%)</strong></td>
</tr>
</tbody>
</table>

Of course, the budget amounts shown in Table 5 will be matched by the SUCCEED institutions, based on the amount of funding received on each campus and based on the matching fund agreement that is explicitly stated in the Cooperative Agreement #EID 9109853. Thus, based on these budget projections, the amount of NSF funds spent on administration will be approximately 18% and the amount spent on support of projects will be 82% after SUCCEED has been in operation for two years. We anticipate requesting $3,000,000 from NSF for the third year of funding, and by the end of three years of operation, we hope to have the administrative portion to be less than 15% of the total budgeted and expended NSF funds.
7.0 1993-1994 BUDGET REQUEST

The budget request for the next funding year (3/1/93 - 2/28/94) totals $3,000,000 as listed in Table 4. Table 6 summarizes the categories for this budget request in terms of the NSF general budget categories. A detailed NSF budget is shown on the following page.

Table 6. NSF Budget Request For 3/1/93 - 2/28/94

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>TOTAL FIRST YEAR FUNDING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Personnel</td>
<td>$993,000</td>
</tr>
<tr>
<td>Other Personnel</td>
<td>$597,000</td>
</tr>
<tr>
<td>Fringe Benefits</td>
<td>$238,500</td>
</tr>
<tr>
<td>Permanent Equipment</td>
<td>$60,000</td>
</tr>
<tr>
<td>Travel</td>
<td>$39,000</td>
</tr>
<tr>
<td>Other Direct Costs</td>
<td>$99,550</td>
</tr>
<tr>
<td>Indirect Costs</td>
<td>$972,950</td>
</tr>
</tbody>
</table>

TOTAL SECOND YEAR SUCCEED (NSF) BUDGET $3,000,000
[12 mos. administrative funds and 12 mos. project funds (3/1/93 - 2/28/94)]

8.0 DEVELOPMENT OF STRATEGIC PLAN

A substantial effort has been devoted to the development of a strategic plan by the SUCCEED management team during the first year of operation. The first version of the plan was submitted to the NSF for critique in April, 1992. The SUCCEED Director visited NSF in May and June of 1992 to discuss the important ingredients and changes for the strategic plan. The SUCCEED management team held a planning retreat in July, 1992 and formulated the outline of a strategic plan, including the idea of a process engineering emphasis for our curriculum restructuring plan. A revised version of the strategic plan was submitted in October, 1992. Additional feedback and discussion occurred during other visits to NSF and during the Frontiers in Education (FIE) meeting in November, 1992. As a result of these interactions, another version of the strategic plan has been prepared. This version is shown in Appendix II. However, this version is not complete since the detailed strategies for the latter years of the operation of SUCCEED require additional planning based on the selection of new projects to address the deliverables described in Section 2.0. The refinement of SUCCEED's strategic plan is continuing, and a final version will be reached in collaboration between the SUCCEED management team and NSF personnel.

9.0 SUMMARY AND CONCLUSIONS

This first annual report has surveyed the operation and progress of the SUCCEED NSF Engineering Education Coalition. The focus of SUCCEED is on the development of a new model of the engineering curriculum for the twenty-first century. We call this model CURRICULUM 21. The focus of CURRICULUM 21 is on process engineering which we believe to be the correct emphasis to educate engineers who can contribute to the issues of global competitiveness and the improvement of the product development process in U. S. industry. This new model is both calculus and statistics based, and emphasizes engineering practice and the cross-disciplinary and functional aspects of engineering. The management and operations plan has been discussed, and
this plan will allow SUCCEED to implement and evaluate significant curriculum experiments which will lead to this new curriculum. The additional focus of SUCCEED on the engineering education process will allow us to contribute to student and faculty participation and success, and we believe that we will be especially successful in improving the participation of women and underrepresented minorities in engineering education.
APPENDICES

<table>
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<th>Section</th>
<th>SUCCEED PROJECT DESCRIPTIONS</th>
<th>Page No.</th>
</tr>
</thead>
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<td>Center for Professional Success</td>
<td>A39 - A50</td>
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<tr>
<td></td>
<td>Center for Engineering Practice</td>
<td>A51 - A62</td>
</tr>
<tr>
<td></td>
<td>Center for Technology &amp; Communication</td>
<td>A63 - A76</td>
</tr>
<tr>
<td>APPENDIX B.</td>
<td>PERSONNEL DIRECTORY</td>
<td>B1 - B11</td>
</tr>
</tbody>
</table>
Project Title: Development of Evaluation Systems for Continuous Improvement in Undergraduate Engineering Education

Project Number: AT 002 CI 92

Project Duration: 8/17/92-2/28/94

Project Abstract:

This project will address the following objectives:

(i) To help develop evaluation plans for individual NSF-SUCCEED sponsored projects; these plans will include identifying evaluation measures and selecting an experimental design.

(ii) To develop a plan to evaluate the impact of the overall NSF-SUCCEED coalition program at the individual institutions.

(iii) To develop and test an evaluation system to measure the quality of students that receive education and graduate from SUCCEED coalition institutions, and to design a feedback mechanism to integrate information from the evaluation system into curriculum development actions.

(iv) To develop and test an evaluation system to measure the quality of instruction given by engineering faculty at SUCCEED coalition institutions, and to design a curriculum-based teaching incentive/reward system.

The involvement of three SUCCEED coalition institutions in (ii) and (iii) above, will ensure some portability of the results to other institutions.
Project Status:

The accomplishments are stated below relative to the objectives stated in the Abstract.

(i) Four workshops on the subject of "evaluation" were held at NCSU, VPI, Clemson, and Univ. of Florida for the benefit of SUCCEED project directors and principal investigators. Dr. Neff Walker (Department of Psychology, Georgia Tech) conducted the workshops. The workshops included an information session on "evaluation" and discussions with individual SUCCEED project personnel to help formulate evaluation plans for projects. Dr. Walker also had similar discussions with Project Directors at Georgia Tech. Each of these Project Directors have been provided a reference book on evaluation and a sample Evaluation Plan. The Project Directors were asked to mail their draft Evaluation Plans to Dr. Walker for review. Seven of the forty projects have submitted evaluation plans to Dr. Walker. Some lessons learned from this exercise are detailed below:

(a) The workshops helped the Project Directors better focus their projects and understand evaluation issues.

(b) It may be worthwhile for each Project Director to have an activity that pays attention to: (i) institutionalizing a project (look into making the effort a regular part of education) if some success is indicated by short-term evaluation and (ii) replication of project at other coalition institutions. Such an activity could translate small successes into a larger impact on engineering education in the coalition.

(c) Also, some projects while having a potential for educational impact (for example, some multimedia projects) seem expensive to implement. Projects that show good short term evaluation, should address the issue of cost of implementation at a later date.

(ii) Three other NSF Engineering Education coalitions have been contacted, briefly, about their activities in this regard. The only major input here is the efforts of SYNTHESIS, provided by Dr. M. A. Littlejohn. Dr. R. Serow of Department of Education Psychology at NSCU has consented to serve as a consultant/facilitator for this effort.

(iii) A detailed literature review on the following topics has been completed: (i) student quality evaluation methods, and (ii) customer needs of engineering graduates.

(iv) Work relative to this will commence in March 1993.
**Project Title:** "Internationalizing Engineering Education Through Curriculum Revision and Experiential Learning"

**Project Duration:** August 1992 - August 1996

**Project Abstract:**

This project seeks to internationalize the Engineering curriculum through course revision and experiential learning. It will accomplish its goals 1) by designing and developing an integrated "package" of courses that will simultaneously fulfill the ABET and University general education requirements while providing students with a coherent introduction to the study of foreign languages and international studies; and 2) by developing for those students who have completed the above program and wish to enhance their language skills and global competence an intensive summer program and a variety of overseas internships and study abroad option specifically tailored for engineering majors.

The project will provide engineering students with foreign language skills and an enhanced international awareness, which will assist them in coping with the demands of the emerging global economy. It will help them to comprehend the global context within which new technologies are developed and implemented. By so doing, it will enable them to apply their engineering expertise more effectively and productively.

**Project Status:**

It has become generally recognized and accepted that the need to learn about other cultures, languages, and customs is now essential to the practice of Engineering and that the seeds to this global awareness are planted in the college education. UNC Charlotte proposes to respond to this need by designing a general education curriculum for Engineering majors that is international in content and design and by providing a variety of opportunities for Engineering majors to work and study abroad in order to enhance their international competence.
Because this project is composed of two separate stages, we have organized its implementation into separate components. The project team is currently working on Stage I, which involves developing a "package" of courses that will internationalize the general education curriculum for engineering students. During the first six months of the grant, faculty members in English, Religious Studies, and Sociology will revise general education courses to include a substantial amount of international content. During the next year additional courses will be revised and developed in English, Art, Economics, and Philosophy. These new and revised courses will be introduced into the curriculum beginning in the Fall, 1994 semester and it is expected that Stage I will be fully implemented by the 1994-95 academic year.

Stage II of the project seeks to provide engineering students with an international experience that will enhance their competence in both language and the knowledge of a particular foreign country or region. In order to prepare students for this international experience, an intensive summer program consisting of language immersion and area studies will be designed. Planning for the first summer institute and for overseas opportunities for our engineering students will take place during 1993-94, with implementation in the summer of 1994. The first overseas internships and study abroad opportunities will be made available in the 1994-95 academic year. During the following year additional summer institutes and overseas experiences will be made available.

Evaluation and fine-tuning will continue throughout the project and gradually other institutions within the SUCCEED coalition will be invited to participate in the summer institutes and overseas experiences.
SUCCEED Center: Center for Curriculum Content and Integration
Project Title: Integration of Fundamental Principles and Key Concepts Throughout an Innovative Engineering Curriculum
Project Number: CM-001-CI-92 Project Duration: 8-17-92 to 2-28-94

Project Directors
Project Director: Donald E. Beasley
University: Clemson University

Project Abstract:
The continuing evolution of engineering as a profession and of engineering education necessitates broadening and refining the undergraduate experience, with increasing emphasis on engineering fundamentals, originality of thought, communication skills, and preparation for lifelong learning. Specifically, this project seeks to address the issues of continual improvement in the curriculum, as well as the identification of those fundamental principles and techniques which should be taught to engineering students. Curriculum 21 goals include devising mechanisms to assure continual curriculum renewal, and identifying those fundamental principles and key concepts which should receive greatest emphasis in the curriculum. The primary goals of the efforts proposed here directly support Curriculum 21 objectives. These goals include examining in detail the existing engineering curriculum by tracing the development of selected fundamental principles and key concepts, and analytical techniques through the curriculum. Two instruments will be used to accomplish this objective. One will be the further development of a scale to be used in describing expectations for learning at the topical level. Another will be the construction of a detailed course syllabus for every engineering course in the curriculum. This syllabus will define the topical coverage in a conventional way but will also define the linkage, topic by topic, as appropriate to other courses in the curriculum. Concurrent goals include assessing and controlling the topical density of the curriculum, matching expectations to student cognitive styles and levels of intellectual development, integrating topics across courses and years, and integrating design throughout the curriculum. Clearly, it is not possible to develop a universal engineering curriculum; rather this project is attempting to develop a means for assessing existing curricula, focusing the topical coverage, and integrating topics and themes across courses and years. This project does not address single course development.
Project Status:

An innovative means has been developed for assessing and revising engineering curricula, and significant progress made in developing the instruments necessary to accomplish such a review. The structure of the present curriculum and mechanisms for improving that curriculum are limited. Typically, a course syllabus is established by considering:

- historical precedent and available textbooks,
- topics deemed essential by faculty whose primary interest lies in the course area,
- computer utilization, and design and communications content, and,
- grading schemes and course administration.

Realistically, structuring course syllabi in isolation from the rest of the curriculum, and by a small group of faculty who may not be as cognizant as they could be of the relationship of the particular course to engineering practice or the overall curriculum, leads to a much higher probability of overburdening of the course with topical coverage, leaving insufficient time for mastery of fundamental concepts. Evidence for this trend can be observed since even when syllabi are structured carefully to include the absolute maximum amount of new topical material, many faculty still have a strong sense that essential topics are missing.

An approach to establishing a rational integration of topical coverage across courses and years is currently being implemented to review the Mechanical Engineering Curriculum at Clemson. In addition, these initial ideas are being distributed within the SUCCEED coalition to initiate interaction with other schools and departments. The approach, as it currently exists, consists of examining an existing curriculum and:

- Identifying a list of Fundamental Principles and Key Concepts which are timeless
- Tracing the development of Fundamental Principles and Key Concepts throughout the curriculum.
- Developing a learning scale to address the level of mastery a student is expected to achieve for each occurrence of a particular topic in the curriculum
- Tracing the development of broader aspects of students' professional development, such as oral and written communication skills and computer skills through the curriculum.
- Providing a framework in which to structure design activities which develop through the curriculum.

The recognition of the curriculum as a dynamic entity, requiring continual safeguarding and improvement, along with appropriate up-dating, requires an underlying educational philosophy. Without this philosophy the curriculum focus becomes one of topical coverage rather than education in the truest sense of the word. The underlying philosophy for such an examination of an existing curriculum is to provide a structure for the selection of areas of emphasis rather than simply a topical approach. In other words, topics would be selected which fulfill specific goals in the structure of the curriculum. The focus will become the curriculum rather than the courses. A newly proposed General Engineering Design Criteria from the Engineering Accreditation Board states,

*The public... should be able to discern the goals of a program and the logic of the selection of the engineering topics in the program. In particular, the institution must describe how the design experience is developed and integrated throughout the curriculum, show that it is consistent with the objectives of the program... and identify the major, meaningful design experiences in the curriculum.*
The curriculum and course issues described above can be achieved through a variety of curriculum structures. It is proposed to examine means to achieve these goals within the existing basic structure of the curriculum. The efforts described here are not program specific, especially in the development of appropriate scales to assess and ensure learning. The concepts described here also are appropriate for further development in association with Total Quality Management concepts.
**SUCCEED Project Information Directory**

**SUCCEED Center:** Curriculum Development  
**Project Title:** Internationalization of the Engineering Curriculum  
**Project Number:** CM 005 CI 92  
**Project Duration:** 5 years

### Project Directors

**Name:** Stephen S. Melsheimer  
**University:** Clemson University

### Project Abstract:

With the increasing globalization of the world economy, the need for American engineering education to prepare graduates for the world marketplace is of growing importance. For example, at a March, 1992, NSF Workshop on US-German interaction in engineering education, industry representatives emphasized their need for U.S. engineers prepared for the international environment. Requirements cited included language proficiency and engineering work/study experience in a foreign culture.

This project responds to this need by developing an international option that can be integrated into almost any engineering curriculum. The following principles underlie this program, termed **EPIC - the Engineering Program for International Careers:**

- To be meaningful, the program must produce graduates in significant numbers.
- Prior language skills cannot be a prerequisite to entry.
- To be attractive to potential students, the program must be incorporated into the existing educational schedule without major increases in cost or graduation requirements.
- Ultimately, the graduate is an engineer. Thus, all accreditation requirements must be met, and the technical content of the program must not be compromised.
- The graduates must leave the program with a foreign language proficiency adequate to function effectively in the engineering/industrial environment of the relevant country(s).
- The program must include engineering work/study experience in the foreign environment.

EPIC meets these objectives by building the program around an industrial internship in the foreign environment. Depth in language study is provided with three years of college level study of the foreign language. Other features include:

- "Immersion" language training prior to the internship to ensure language competency
- Continued exposure to the language in the period following the overseas experience.
- An optional semester-abroad taking courses creditable toward the engineering degree.

To be successful, the program must be structured so as to meet the actual needs of the companies that will be providing the Internships and hiring the graduates. Thus, an Industrial Advisory Board will guide the development, evaluation, and operation of the program is a critical feature.
Project Status: The initial meeting of the EPIC Industrial Advisory Board was held on December 9, 1992. Charter members represented included BASF Corporation, Michelin Tire Company, Hoechst-Celanese Corporation, Miles, Inc. (U.S. subsidiary of Bayer AG), and the Square D Company (US subsidiary of Schneider SA). Subsequently, BMW has also agreed to participate in EPIC. Recruiting efforts are continuing actively with the goal of increasing the number of industrial partners in EPIC to at least 10-12 by the end of the 1992-93 academic year.

At its first meeting, the EPIC Board reviewed the proposed program structure and suggested revisions. As a result, the EPIC program as currently planned has the following key features:

* Entry will require completion of all Freshman requirements with a grade point ratio $\geq 3.2$, and registration in first year (or higher) language courses.
* Students who qualify as noted above will be interviewed by EPIC companies, with selection/matching guided by the EPIC program staff.
* EPIC students will work as an engineering intern at least one semester or summer with the sponsoring company at a domestic location prior to the overseas internship.
* The overseas internship will be scheduled so that students will have completed engineering coursework through at least the mid-junior level before the internship.
* Language options will be limited initially to French, German, and Japanese.

A "typical" EPIC curriculum schedule incorporating the key program features is shown below. Italics highlight variations from standard (non-EPIC) engineering curricula.

<table>
<thead>
<tr>
<th>Freshman Year</th>
<th>- standard freshman sequence ........................................... ~35 cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sophomore Year</td>
<td>- Two semesters foreign language (first-year) .......................... 8 cr</td>
</tr>
<tr>
<td></td>
<td>- Balance of &quot;normal&quot; sophomore courses ................................~28 cr</td>
</tr>
<tr>
<td>Third Year</td>
<td>- industrial internship period in U.S.</td>
</tr>
<tr>
<td>Fall</td>
<td>- third semester of language ................................................3 cr</td>
</tr>
<tr>
<td>Spring</td>
<td>- balance of &quot;normal&quot; first-semester junior classes .....................~15 cr</td>
</tr>
<tr>
<td>Summer</td>
<td>- &quot;nominal&quot; junior classes ..................................................6 cr</td>
</tr>
<tr>
<td></td>
<td>- intensive summer language course ........................................6 cr</td>
</tr>
<tr>
<td>Fourth Year</td>
<td>- International Internship (4 months)</td>
</tr>
<tr>
<td>Fall</td>
<td>- International social science elective ...................................3 cr</td>
</tr>
<tr>
<td>Spring</td>
<td>- &quot;normal&quot; second-semester junior courses ................................~15 cr</td>
</tr>
<tr>
<td></td>
<td>(optionally, Spring semester abroad at a foreign institution)</td>
</tr>
<tr>
<td>Fifth Year</td>
<td>- upper division language course ...........................................3 cr</td>
</tr>
<tr>
<td></td>
<td>- International social science elective ...................................3 cr</td>
</tr>
<tr>
<td></td>
<td>- balance of &quot;normal&quot; senior year sequence ...............................~30 cr</td>
</tr>
</tbody>
</table>
Many of the 20 foreign language credits shown will qualify as electives within the base curriculum. Clemson curricula, for example, include 10 "free" elective credits, plus 16 credits of humanities and social sciences. At least 14 language credits would fit within these elective groups. EPIC thus requires about 6 "excess" credits, equivalent to the immersion language course. The two social science courses shown satisfy ABET social science requirements.

The EPIC program requirements (e.g., the 3.2 GPR admission criterion) and structure will be reviewed and revised as part of the project evaluation program. For example, it is anticipated that as the program grows, alternative schedules with the international internship in the Spring semester will be developed, along with coordinated immersion language course offerings.

Now that the program structure has been established, recruitment of students is beginning. The first group will be mostly current freshmen who will go on their overseas internship in 1995. However, upperclassmen currently enrolled in language courses will be identified to provide a group ready for the first offering of the intensive language course, and internship, in 1994. During this first year, recruitment will be limited to Clemson students, but subsequently the program will include students from other SUCCEED schools. Thus, the first graduates should be produced in 1995, with larger numbers graduating from 1996 onward.
Project Title: An Integrated Statistical Experience in Engineering Curricula

Project Number: CM-006-CI-92

Project Duration: 8/17/92 - 2/28/94

Project Abstract:

The importance of statistical training of engineers is now widely recognized, so much so that ABET has included the AY 1992-3 requirement that "Students must demonstrate knowledge of the application of statistics to engineering problems" for all engineering curricula. The object of this proposal is to create a statistical experience for engineering students that integrates statistical training into laboratories and courses. If statistical thinking and practice are not reinforced after an introductory statistics course, students will not retain their statistical skills or be able to exploit them in engineering practice. Thus, we propose to introduce statistical techniques where engineers first encounter real data which, in most curricula, is the engineering labs. Experience gained from collaboration with engineering professors will serve as a basis for developing an introductory course in statistics for engineers. Our goal is to create a course that engineering faculty will want their students to take, one that prepares students for what will be required of them in their labs, courses, and future employment. Also, since faculty are naturally reluctant to introduce material they are not comfortable with themselves, another goal of the project is to provide seminars/short courses in statistics for faculty development. The key aspect of our approach is to view the statistical education of engineers as a PROCESS: The CUSTOMER (industry and government) is asked what they want in the PRODUCT (the student). Those involved in PRODUCTION (cognizant engineering and statistics faculty and professionals) must work together to effect the desired change.

Project Status:

The project to develop "An Integrated Statistical Experience in Engineering Curricula" is on schedule. First year proposed tasks are:

1. Conduct industry survey
2. Statisticians become engineering oriented
   a. Learn purposes, procedures, and how engineering labs are conducted by working with instructors and students in the actual lab setting.
   b. Collect and process sample experiments and problems for lab workbook.
   c. Point out elements of variability/design to engineering instructors.
1. Design of the survey instrument is underway. Target industries have been identified. One of the investigators (Wallenius) visited Westinghouse Commercial Nuclear Fuels Division in Columbia, S.C., winner of the Malcomb Baldridge Award for Quality. An extensive in-house statistical training program is in effect there. Westinghouse CNFD will be included in the survey. Several distinguished industrial statisticians have been brought in at no expense to the SUCCEED NSF funds. We have gained insight into industrial applications of statistics and in-house statistical training as a result of these visits.

2. Engineering orientation of statisticians started even before the grant was awarded and is partly described on page 2 of the proposal. In addition, the process of three engineers and three statisticians meeting to define problems, set objectives and generate a proposal was in itself an "orienting" activity for all involved. The engineering investigators (Barron and Burati) conducted tours of chemical engineering and civil engineering laboratory facilities to orient project statisticians and graduate assistants to laboratory equipment, procedures, and documentation. Lab manuals with minimal statistical content (which we deem insufficient) were obtained and studied. Two of the statisticians (Senter and Wallenius) were invited participants at a week long NSF-sponsored "Quality Engineering Workshop" January 4-8 at the University of Arizona in Tucson.

2a. "Learn processes ... in lab setting". Statistics graduate assistants participated as observers and consultants in engineering laboratories. The immediate impact has been surprisingly dramatic, beyond expectations. The engineering professor (Barron) who graded the chemical engineering lab reports states that the quality of statistical analysis of data has improved "an order of magnitude in one semester".

2b. "... process sample experiments ... " Statisticians (Nelson and Wallenius) have examined some good and poor student lab reports. One such report, a B+ warrants comment. In reporting results on the Chicago Heat Exchanger experiment to measure various heat transfer coefficients, one group of students' analysis resulted in a negative estimate of a coefficient that cannot be negative. The students conjectured that the spurious result might have been caused by an internal leak in one of the fluid transporter tubes. Upon checking their statistical analysis, we discovered that in calibrating the flow rate as a function of pressure differential, they had forced the regression through the origin. (zero pressure differential implies zero flow!) This statistical blunder caused a systematic error in recorded flow rate. When this was explained in an engineering lecture conducted by a statistician to some 60+ engineering students, the lab instructor exclaimed "I've always known its not good statistical practice but never knew why before!"

2c. "... elements of variability/design ..." The heat exchanger experiment is an ideal vehicle to demonstrate the effect of selecting flow rates to increase the precision of coefficient estimates. The lab-manual simply advises students to select "a few" levels, usually about 8-10, at which to run the heat transfer experiment. Since a particular relationship is known to be linear after transformations, a two-point design can be found to optimize information used to calculate an estimate of the outside film coefficient. This was explained to students and demonstrated using a high-resolution interactive statistical graphics and analyses package.
SUCCEED Project Information Directory

SUCCEED Center: Curriculum Content and Integration
Project Title: Managing Engineering Academic Units Using TQM
Project Number: UF-007-CI/FS-006-CI
Project Duration: 8/17/92 - 2/28/94

Project Directors

Name: S. A. Awoniyi D. J. Elzinga M.S. Leonard
University: FAMU/FSU U of Florida Clemson

Project Abstract:

The objective of this project is to manage three engineering academic units using Total Quality Management (TQM) principles. The hypothesis under test is that these engineering departments can be improved and made more effective by adopting, and managing with, TQM principles and practices. In the conduct of the project, the investigators will develop, document, and disseminate management processes that lead to significant enhancements in academic unit performance and more effective utilization of resources. Methodologies, processes, and facilitation skills used in manufacturing and service organizations will be adapted to the university academic department environment. The consequences of process changes will be measured in terms of meeting customer (e.g., alumni and employers of graduates) needs, and in organizational (instruction, research, and service support) effectiveness and efficiency. Anticipated outcomes of this project are tied to the SUCCEED program objectives of enhancing the long-term professional success and enriching the quality of professional life in engineering academia, and to improvements in engineering curricula and course work.

Project Status

The basic structure for this project among the three participating industrial engineering (IE) academic departments includes the following five steps: (1) document current academic unit key processes, (2) identify opportunities for improvements in customer satisfaction and unit effectiveness and efficiency, (3) make process changes and measure responses, (4) communicate findings to other academic departments, and (5) prepare materials that will assist other academic units in the adoption of TQM principles and practices. A brief description of progress to date in each of the three academic units is presented.
FAMU/FSU: Project activities are designed to (1) identify the IE Department's customers, and customer needs and expectations, (2) translate customer needs and expectations into feasible subprograms and projects along with implementation details, and (3) present subprograms and projects to the IE Department for implementation following Curriculum Committee approvals. Accordingly, the following are some of the results obtained to date:

(a) The faculty have agreed to adopt the results of this TQM program, after such results have been passed through the Curriculum Committee of the IE Department.

(b) The project has identified IE Department current customers to be students, the Florida Board of Regents (BOR), industrial organizations, society (through ABET), the Florida A & M University (FAMU), the Florida State University (FSU), the FAMU/FSU College of Engineering, and the IE Department faculty as a generic group.

(c) The project has done work on some customer related subprograms as shown in the table below:

<table>
<thead>
<tr>
<th>Projects</th>
<th>Customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Process Scheduling Project</td>
<td>Students, Faculty</td>
</tr>
<tr>
<td>Industry Relations Project</td>
<td>Industry, Society</td>
</tr>
<tr>
<td>Student Learning Process Project</td>
<td>Students, BOR, FAMU, FSU</td>
</tr>
<tr>
<td>Course Bases Project (Planned)</td>
<td>BOR, FAMU, FSU, Faculty</td>
</tr>
</tbody>
</table>

(d) Further details on work done are as follows:

**Instructional Process Scheduling:** Basic computer software will be produced for scheduling classes, classrooms, homework deadlines, project deadlines, and examinations and tests. The goal is to minimize work overload and idle times for students and faculty. Classroom utilization may also be improved. Rudimentary forms of this software have been produced. Development work will continue for the next year. Testing will require an additional year.

**Industrial Relations:** A mechanism will be designed to continually provide the IE Department with information and evaluations from industry. This mechanism has been initiated. It consists of two parts, periodic four-question questionnaires and continuous literature reviews. Further work will involve the use of a suitable database (such as Q & A) for processing information obtained from questionnaires and literature reviews.

**Student Learning Process:** Computer-implemented tutorials will be developed to aid mastery learning. A format has been selected for these tutorials. Further work will involve the use of multimedia for implementing a prototype tutorial.

FLORIDA: The efforts on this project in the Department of Industrial and Systems Engineering are focused on STRATEGIC PLANNING and IMPROVEMENT OPPORTUNITIES that emerge from the strategic planning process. The entire faculty met with David McClaskey of Eastman Chemical Company on Friday, September 11, 1992, for two hours of training in Quality Management. It was decided that the first step of Quality Management would be the development of a strategic plan for the Department. Teams were formed to address various aspects of a departmental self-study. On Friday, October 23, 1992, the faculty attended an all-day retreat devoted to strategic planning facilitated by David McClaskey. A second all-day retreat was held on Saturday, November 23, 1992, to continue the strategic planning efforts. The results of the two retreats are: a departmental mission statement, critical success factors, goals, objectives, and quality measures. Three improvement opportunities were identified and work is proceeding on them.
Undergraduate curriculum revision: Student input has been gathered through the efforts of a Student Advisory Council, formed in response to this improvement opportunity. Surveys have been designed for employers and alumni. They have been sent to 150 employers and 300 alumni. A faculty team is assembling this information and assimilating it with its own work. A session with a newly-formed visiting committee is planned for later this spring.

Ph.D. curriculum revision: A faculty team is investigating industrial and societal needs in the areas that the Department specializes in. New ideas on Ph.D. subject areas and program structure are being developed and circulated among the faculty.

Graduate student recruitment: A faculty team is investigating new ideas for attracting Master's and Ph.D. students to the Industrial and Systems Engineering programs.

**CLEMSON:** Current project activities are directed toward the accomplishment of three Major Improvement Commitments (MICs): (1) Departmental Focus, (2) Efficient Execution, and (3) Scholarship. These MICs were selected to yield demonstrable performance improvements within the next academic year. Specific quality management activities related to the SUCCEED project are described in the material below:

(a) The faculty have agreed to share non-confidential departmental performance data as a participating academic unit in this SUCCEED project.

(b) Overview-level flow charts have been developed to describe important IE Department processes such as course documentation materials preparation, lecture/laboratory session preparations, and the conduct of student course evaluations.

(c) The IE faculty have identified national recognition for performance in quality engineering with time-phased introductions to excellence in design and ergonomics as the department’s strategic focus. Appropriate integration of this focus into academic and research efforts is the objective of the Departmental Focus MIC. Clemson IE alumni who graduated at least four years ago and employers of three or more Clemson IE graduates have been selected as the department’s two key customer groups in addressing strategic focus integration. Questionnaires are near completion for soliciting input from these two customer groups.

(d) Activities related to the Efficient Execution MIC have centered on the preparation of instructional materials. Lecture materials (visual aids and example parts) have been prepared for the department's undergraduate manufacturing processes course. A training course for teaching assistants is also being developed. This course will cover topics such as grading homework and laboratory assignments, and the use of library resources.

(e) For the Scholarship MIC, an Editor has been selected for the IE Department working paper series, and editorial policies for this set of publications are being developed. The department's Undergraduate Committee has proposed a new teaching evaluation system that solicits input from several sources in its assessment of teaching effectiveness. The IE faculty are currently evaluating this proposed system. Finally, a new three-tiered faculty evaluation system is being developed. This new approach to evaluation may be used for yearly performance reviews as well as Promotion, Tenure, and Reappointment evaluations.
Project Title: "Longitudinal Study of Alternative Approaches to Engineering Educations"
Project Number: NS 009 CI 92
Project Duration: 8/16/92-2/28/94

Project Abstract:
A cohort of students has been instructed by the principal investigator in five chemical engineering courses taught on successive semesters, beginning with the introductory course in the first semester of the sophomore year. The courses incorporated a number of methods that have been shown by educational research to promote effective learning, including cooperative (team-based) learning and frequent assignment of open-ended problems and problem creation exercises in class and homework. Two groups are being studied and compared—an experimental group consisting of students who experience the proposed approach for three or more semesters, and a comparison group containing students who proceed through the curriculum as normally taught. The experiments have been designed and data analyses performed by an interdisciplinary team of investigators from the Departments of Chemical Engineering, Psychology, Counselor Education, and Statistics. The objective of the research is to demonstrate that the systematic and repeated use of the specified methods can have a significant beneficial effect on academic performance, retention, problem-solving ability and creativity, and attitude toward chemical engineering as a curriculum and career choice.

Project Status:
The experimental sequence of courses began in the Fall of 1990. All five courses have now been taught. Of the 123 students in the original data base, 57 progressed through the complete sequence; the others either failed a course or entered the co-op program and dropped out of the sequence.

Background data have been collected for all students in the experimental cohort, including demographic statistics, high school and freshman year academic records, Myers-Briggs Type Indicator profiles, Learning and Study Strategies Inventory scores, and Learning Environment Preference assessment scores, and responses to a variety of questions regarding attitudes and levels of confidence. We have so far done an extensive analysis of the introductory chemical engineering course; the results are contained in a paper in the Journal of Engineering Education. A second paper on differences between rural and urban students has been submitted to that journal. The comparison group began the curriculum in the Fall of 1992; analyses of background and course performance data for that group (which contains 190 students) has only just begun.

In addition to general compilation and analysis of the data on the experimental group, we are performing several research studies on specific topics suggested by the results of our preliminary analyses. These topics include.
1. Assessment of ability of various pre-engineering performance measures, including SAT scores, admission index, freshman year GPA, and grades in selected freshman courses, to predict performance in engineering courses.

2. Assessment of ability of different instruments (MBTI, LASSI, LEP) to predict performance in engineering courses.

3. Comparison of performance of students who began their engineering programs at N.C. State with that of students who transferred from pre-engineering programs.

4. Comparison of male and female performance in and attitudes toward engineering courses.

5. Effects of group composition on functioning of cooperative learning groups, progression of attitudes toward cooperative learning.
Project Title: "Math, Physics, and Engineering Introductory Course Integration"
Project Number: NS 012 CI 92
Project Duration: 8/16/92-2/28/94

Project Abstract:
The project addresses critical issues in the restructuring of the undergraduate engineering curriculum, and proposes a new experimental model for undergraduate engineering education. A new model is proposed for integrating mathematics, physics, and introductory engineering courses in the crucial freshman year which will immediately expose students to engineering, and emphasize the common knowledge base of math, physics and engineering. Innovative features of the integrated course include (1) a flexible allotment of instructional time between math, physics, and engineering, (2) implementation of "just-in-time" learning between the three subject areas, and (3) a common computer-based laboratory which will feature cross-disciplinary projects.

Project Status:
The first students of the Math, Physics and Engineering Introductory Course Integration project will meet in the fall semester of 1993. Recent milestones of the project include:
- A proposal to the National Science Foundation Instrumentation and Laboratory Improvement program was submitted in November, 1993. A federal grant, matched by a gift from IBM and funds from North Carolina State University, would provide the essential equipment for creating a computer-based laboratory for experiments in physics and data acquisition. The computers would also serve as platforms for symbolic algebra systems used in all three disciplines.
- Dr John Gastineau was hired in November, 1992, to design and teach the physics elements of the project.
- A detailed outline of the fall semester of the course has been completed. A feature of the plan is the weekly assignment of cross-disciplinary projects that will make use of concepts from all three disciplines. Through such projects students will see the application of physics and mathematics topics to engineering, and so avoid the common trap of compartmentalized learning. Another element is the early and complete treatment of the statistics of measurements. Introduced in the mathematics component of the course, knowledge of the measurement statistics will allow students to fully comprehend what their physics experiments mean, and what their engineering measurement and control systems are capable of doing. The physics component will be taught in a workshop physics style, with few lectures and many hands-on experiences. This calculus will be taught using the Maple symbolic algebra system, and the engineering will emphasize computer measurement and control.
**SUCCEED Center:** Center for Curriculum and Instruction  
**Project Title:** "Introduction to Product and Process Engineering"  
**Project Number:** NS 021 CI 92  
**Project Duration:** 8/16/92-2/28/94

<table>
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<tr>
<th>Name:</th>
<th>David F. Ollis</th>
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<td>NCSU</td>
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**Project Directors**

**Project Abstract:**
A freshman engineering lab experience titled Product and Process Engineering will be developed and implemented. Six recent technologies (photocopy machine, bar code scanner w/inventory system, videocamera, compact disc player, ultraviolet water purifier, and fiber optic sensor) will each be represented by an intact, operating product or process. The student will learn about the engineering is such products by a series of hands-on exercises, each requiring a deeper technical understanding vs. the prior exercise. The student will successively play the roles of product user, product assembler, product repairman, and engineer analyst. The premise motivating course development is that such a holistic, overall product or process introduction will stimulate student interest in engineering careers, and that such an experimental approach will also stimulate curiosity, confidence and a feeling for competence about the technical world.

**Project Status:**
Individual chapters concerning the six topics (photocopy machine, videocamera, compact disc player, optical fiber sensor, ultraviolet water purifier, and bar code scanner) were written by graduate students in Professor Ollis' Photochemical Engineering graduate course during the Fall of 1992. A draft version of the laboratory manual is being assembled from these chapters. This spring of 1993, a dozen seniors also revising the chapters in light of experience with each device or process. The first offering of the new laboratory for incoming freshmen will take place in June of 1993 at NCSU.
Traditional methods of teaching probability theory have left engineering students with an inadequate understanding of random phenomena, their modeling and their applications to engineering systems. The objective of this project is to explore, implement and evaluate new methodologies for teaching probability theory to undergraduate engineering students. If successful, students will: a) be able to appreciate the power of the theory as a modeling tool, and b) have had the opportunity to apply the theory already in a field of their own interest. We hope to achieve this goal by: a) introducing all basic probability concepts through engineering experiments/computer simulations, and b) motivating/guiding the students to discover/apply probabilistic laws and thinking in engineering areas of his/her own interest. We shall give particular emphasis in horizontal integration with other engineering courses. The possibility for integrating with community college/high school curricula will also be explored.

The first set of experiments (covering random variables, histograms/density functions and the Strong Law of Large Numbers) has been designed.

Dr. Viniotis will teach a graduate and an undergraduate course in Probability theory, in the Fall 93 semester. Another teacher from the Math Department will teach a third section, using the "conventional" approach.

Dr. Viniotis has met with Drs. B. Ram of N.C.A&T and N. Walker of GA Tech. and discussed an Evaluation Plan for this project.
SUCCEED Project Information Directory

SUCCEED Center: Center for Curriculum and Instruction
Project Title: "Linking Fundamental Science courses to the Engineering Curriculum Through Materials"
Project Number: NS 040 CI 92
Project Duration:

Project Directors

Name: John C. Russ
University: NCSU

Project Abstract:

In order to provide a link between fundamental science courses (Chemistry, Math, Physics, etc.) and the various Engineering disciplines, a common thread based on the properties of engineering materials is being developed. This draws naturally on the basic science principles and provides a consistent and necessary basis for all of the engineering curricula. The implementation to this approach will take several different forms, according the differing needs and resources of various institutions. We plan to develop, introduce and evaluate the following modular and complementary teaching tools: a new course in Materials Chemistry; and interdisciplinary Introduction to Materials course; and teaching modules which utilize computer-aided technology including simulation, digital video and database management. These will be used as "multimedia" presentations for lectures, as interactive self-paced tutorials for student use, and to bring a "virtual laboratory" to lecture classes who would otherwise have little direct laboratory experience in their courses. Portions of the work will be performed at NCSU, VPI and Clemson, with communications, collaboration and sharing of results. Some testing at community college and UNC-Asheville will also be used. Evaluation will include the effect of these new tools on student selection of engineering majors, their subsequent performance, and retention in the program.

Project Status:

Work at all campuses has been proceeding with design of course and module contents, surveys of student responses and needs, and finding student talent to undertake the design and execution of the components of the program.
Project Title: Enhanced Community College Interface
Project Number: UF 003 CI 92
Project Duration: 8/17/92 - 2/28/94

Project Directors
Name: Crane, Carl D. III  Smith, Scott  Abbitt, John  Carroll, Bruce
University: University of Florida

Project Abstract:

More and more, the Community College is the access point for many in higher education. Statistics show that (1) more than half of all degree seeking students start their degree at the Community College, (2) almost half of all minority students enrolled in higher education are found in the Community College, and (3) that over half of the women that are in higher education are in the Community College.

A large percentage (approx. 50%) of upper division engineering students at the University of Florida have matriculated from two year Community College programs. Thus the Community College represents a very significant source of students which will assist the SUCCEED Coalition in achieving its goal of increasing engineering student enrollments. An improved interface with this important entry point to engineering education will support the stated SUCCEED objectives of:

1) Achieving a 50% increase Coalition-wide in the number of women and under-represented minority engineering students, and

2) Promoting improvements in the interactions with community colleges and 4-year institutions.

As indicated, an important goal will be to increase the number of women and under-represented minority students who pursue an engineering education.
Project Status:

The key features of the program can be divided into the four areas of database management, advising system, community college, faculty development, and curriculum. Each of these is briefly described.

Database: The objective of this section is to track and monitor the project's progress via a series of performance measures. For example, GPA and course completion data will be maintained on all program participants while at the Community College and then while at UF.

Advising: Program success depends on establishing strong contacts between University advisers and Community College advisers and faculty. Annual advising symposiums will be coupled with campus visits and regular liaison meetings.

Community College Faculty Development: An important goal is to work with Community College faculty in order to increase their knowledge of the engineering field. This will be accomplished via a summer school sabbatical program for Community College faculty and an Instructional Development Symposium to be held at UF during the summer.

Curriculum: An increased interest in engineering among undergraduate students may best be achieved by modifying the curriculum so that students see direct application of their course work at an early stage of their education. As such, improvement to the engineering curriculum is one of the most important areas of the project. The UF faculty and staff involved in the project hope to work with Community College counterparts to implement innovative and effective curriculum improvements.

The first year of the program focuses on establishing ties with three State of Florida Community Colleges. The schools chosen to participate are Santa Fe Community College, Florida Community College, and Miami-Dade Community College. Projects which are being organized with these schools are as follows:

1) Apprentice Engineer Program. Forty Community College students will be brought to the UF campus and will interact with engineering senior design teams. This will be followed by tours of selected engineering facilities. (to be implemented in April)

2) Faculty Sabbatical Program. Three Community College faculty members will be invited to work in UF engineering research labs for a period of four weeks in the summer semester.

3) Summer Honors Symposium. Seventy five Community College students will be invited to participate in a two week hands-on summer symposium dealing with Civil Engineering, Aerospace Engineering, and Engineering Education. The objective of the symposium is to excite students into pursuing engineering and education careers.

4) Curriculum Development Workshop. Faculty from UF and the three selected Community Colleges will define the current curriculum, identify current problems, and propose curriculum improvements during a one week workshop to be held at UF during the summer semester.
Engineering Preview. The University provides information to new incoming students to ease their transition. The current program will be augmented to provide specific information to engineering students who are transferring from Community Colleges.
SUCCEED Center: Curriculum Content and Integration

Project Title: Using the Continuous Improvement Process to Prepare Engineering Curricula for Century 21

Project Number: UF 008 CI 92

Project Duration: 8/17/92 - 2/28/94

Project Directors

Name: Elzinga, D. J. Crummer, A. A. Gailbraith, L. Leavenworth, R.
University: Univ. of Fla. Univ. of Fla. Florida State Univ. of Fla.
Name: Mahoney, J.F. McClaskey, D. J. Rogers, Hugh K.
University: Univ. of Fla. Eastman Chem. Valencia College

Project Abstract:

This project coordinates five approaches to applying the continuous improvement process to engineering education. Improving the Content and Conduct of Engineering Courses is devoted to developing processes and methodologies for marshaling TQM principles and practices into existing and new engineering offerings.

Total Quality Management involves course development for both upper and lower level education. An upper level TQM course has been developed for experimental teaching in the Spring of 1993. This course was developed in modules which may be expanded or contracted for insertion in other courses.

Immersion Education in Quality builds on the course developed above to provide a fast-paced training and hands-on experience in TQM for engineering undergraduates selected to participate during a Summer Program. It involves TQM training and visits to plants and to other business enterprises in which TQM is the management mode.

Life Cycle Engineering of TQM involves the development of a new integrative approach to engineering practice and education in cooperation with community colleges.

Team-Based Engineering and Problem Solving involves the development of special courses which emphasize teamwork, practical exercises, and strong interactions with other disciplines.
Project Status:

Improving the content and conduct of Engineering Courses emphasized the use of TQM principles, notably the focus on "customer" and continuous improvement, to improve the conduct and content of existing and new engineering courses.

A methodology for improvement of course content has been developed in which the customers of the target course are students who have taken the course and are applying the knowledge attained in it in a subsequent (so-called "post requisite") course. The post requisite course and its instructor are also considered to be customers of the target course. This approach testing during Spring Semester uses Statics as the target course.

A methodology for improvement of course conduct has been developed in which the customers of the target course are the students taking the course. A mechanism for student feedback via surveys has been formulated and is being tested during Spring Semester using computer Programming for Engineers as the target course. Dr. John F. Mahoney of the Department of Industrial and Systems Engineering, University of Florida, is the Co-Principal Investigator for this aspect of the project.

Total Quality Management Education has developed a new course, "Total Quality Management," based on the criteria for the Malcolm Baldridge National Quality Award and on the advice and input of a panel of industrial practitioners. The course is being taught during Spring Semester to 48 students from various engineering disciplines, including some graduate students. The course will be used as the basis for Immersion Education in Quality this summer. Dr. Richard S. Leavenworth of the Department of Industrial and Systems Engineering of the University of Florida is the Co-Principal Investigator of the aspect of the project. Dr. Leavenworth has served as a Baldrige Award examiner and is currently an examiner for Florida's quality award, the Sterling Award.

Immersion Education in Quality is an innovative approach to engineering education consisting of an intensive six-week program to be offered during the Summer Semester 1993. It will comprise three weeks of on-campus lectures and workshops followed by two weeks of plant trips to see how quality principles are employed in industry and culminate with a final on campus week of testing and report writing. The TQM course development in Total Quality Management Education will serve as the basis for the on-campus portions.

A promotional brochure has been developed and sent to the deans and department chairs of all the SUCCEED colleges of engineering. Arrangements for the plant visits and for industrial participation in the on-campus portions are nearly finalized. Dr. D. Jack Elzinga of the Department of Industrial and Systems Engineering of the University of Florida and Principal Investigator of this project leads this effort.

Life Cycle Engineering for TQM is developing a course which seeks to optimize the integration of design, performance, manufacture ability, reliability, maintainability and other product function measures to reduce design time and improve overall production effectiveness. The course will feature industrial interactions, including plant tours, and will be offered during the Summer Semester 1993 at FAMU/FSU to a group of ethnically and gender diverse students. The course will also be piloted at Valencia Community College in Orlando, FL with a focus on student disabilities. Dr. Lissa Galbraith of the Department of Industrial Engineering of Florida
Agricultural and Mechanical University/Florida State University is the Co-Principal Investigator of this aspect of the project. Dr. Hugh Roger coordinates the activities at Valencia Community College.

Team-Based Engineering and Problem solving is based on the hypothesis that an early experience in team-based engineering increases the ability of engineering graduates to function effectively in the group activities common to engineering graduates practice. This aspect of the project addresses three key areas: effective functioning as teams; critical skills in reading and writing technical documents; and presentation skills and technologies for communicating technical ideas. Approaches for effecting this were piloted during the Fall Semester 1992 and are being tested during Spring Semester 1993. In each area METHOD, a NUMERICAL MEASURE, AND an INSTRUMENT have been developed. The numerical measures are being established. New survey instruments have been formulated to establish the three numerical measures: Maturity Index for Team Techniques, Index of Perceived Ability in Technical Communication, and Index of Perceived Presentation Skills. Dr. Arthur Crammer of the Department of Computer and Information Sciences of the University of Florida is the Co-Principal Investigator for this aspect of the project.
Project Abstract: A Freshman Interdisciplinary Laboratory class is being taught as an experimental curriculum to help attract students to engineering. This class is intended to replace the standard one hour introductory freshman lecture. The proposed class rotates 4 groups of 10 students each through weekly three hour laboratory sessions in 11 engineering disciplines. Each discipline's lab exposes the students to hands on experiments representing concepts related to the discipline's specialty. Two additional periods are used for teaching word processing and spreadsheets, with one session for each. The project will continue for 18 months. The first year is to set up the experiments and teach the course on a limited single section basis. The final six months will be used to evaluate and modify the course. The final six months will also be used to expand the class to include all freshman considering entering engineering.

Project Status: The first four months of the project were used to devise and set up the individual projects. These were prepared and made ready to be used during the Spring 93 term. During the Spring 93 term, a limited four group (40 student) trial of the course is taking place. We are currently half way through that limited trial. Up to this point all the groups have had both the word processing and spreadsheet classes. In addition they have been to four different laboratories. So far the response has been excellent. The students have thoroughly enjoyed the different labs. They have commented that they never knew "X" discipline entailed so much. Many have said the labs have caused them to choose a particular discipline to enter. A survey form was given to both the lab class and the original lecture class. The survey form is being analyzed and the results will be compiled with the end of the term survey. An initial report will be prepared during the summer term.
SUCCEED Project Information Directory

SUCCEED Center: Curriculum Content and Integration

Project Title: Approximations and Methods of Reasoning for Difficult, Interdisciplinary Engineering Problems

Project Number: UF 014 CI 92

Project Duration: 8/17/92 - 2/28/94

Project Directors

Name: Lindholm, Frederik
University: University of Florida

Jenkins, David

Hatfield, Kirk

Project Abstract:

This research deals with developing and teaching methods to solve difficult, interdisciplinary engineering problems. To teach these methods to undergraduates, we will use a case-study approach. In this approach, students learn by confronting specific practical problems (cases) for which traditional classroom teaching and assigned readings have left them unprepared. Through such case studies, students learn to invent approaches to treat hard problems. In engineering, these approaches consist of the reasoning methods and of the physical and mathematical approximations that one finds repeatedly useful for a wide range of diverse problems. In concluding each case study, the instructor reviews the approximations and methods of reasoning developed previously. As the next case is examined, the class explores whether these approximations and methods apply or whether new ones are needed. In this way, a methodology emerges that has proved valuable for a wide range of difficult engineering problems. All the approximations and methods of reasoning have this in common: They extract useful information when a full solution is unfeasible.

There are two main hypotheses of this research program. The first is that the students will highly value their newly developed problem solving skills. The second is that the problem solving skills we teach will markedly increase the success that undergraduates have in approaching problems, especially difficult problems. The first hypothesis will be assessed by questionnaires. The second hypothesis is more challenging to assess. Developing and using good evaluation methods to assess this second hypothesis is a main objective of this research program.
**Project Status:**
During this period, the research has focused on particular elements included in the proposal and the work statement.

I. Development of Students' Problem Solving Skills
As a main objective, this research program seeks to develop students' ability to deal with engineering problems of such difficulty that they defy exact solution. To address such problems, the student will need to devise methods of approximation, visualization and reasoning. In this way, the student will learn to define new problems, related to the problem under study, but simpler than that problem. Solution of these related problems, or models, constitutes an approximate solution of the original problem.

It is a hypothesis of this research program that there exists a general set of problem solving skills essential to the solution of difficult engineering problems. By general, we mean in this context that this set of skills remains productive for a wide range of disciplines. This hypothesis contends not only that this set applies to all engineering disciplines—electrical, mechanical, aerospace, etc.—but also to disciplines outside engineering. Defining, explaining and illustrating this set of problem solving skills constitute main objectives of this program.

To meet these objectives, our investigators (Drs. Jenkins, Hatfield and I) are pursuing two approaches. First, we are culling from our own experiences those methods that we can describe in terms not specific to our own disciplines. Second, we are reviewing pertinent literature on problem solving. Much of relevance appears in the works of psychologist, Wayne Wicklegren, (How to Solve Problems), of the inventor, Edward de Bono, (Lateral Thinking and New Think), of the engineer, Stephen Kline, (Similitude and Approximation Theory), and of the mathematician, George Polya, (How to Solve It and Mathematical Discovery: On understanding, learning, and teaching problem solving). Engineering educators are largely unacquainted with the ideas presented by these researches in problem solving.

Using this two-pronged approach, we anticipate producing reports, journal papers, and audio and video tapes to transfer understanding of these problem solving skills both to all participants in the SUCCEED coalition and to the wider engineering community.

II. Evaluation Methods
During this period, we developed preliminary evaluation methods. The hypothesis that undergraduates will highly value the problem solving skills we taught can be assessed by simple questionnaires. We have developed a preliminary questionnaire form. It is more difficult to assess how successfully undergraduates can apply the newly acquired problem solving skills to difficult problems they have not seen before. We have made progress in developing an evaluation method and devising suitable control and experimental groups. In January, we had a highly productive meeting with Dr. Neff Walker of the Department of Psychology at Georgia Tech. Since then, we have communicated with Dr. Walker by phone and have sent him our preliminary evaluation methods for his comments.

III. Course Development
During this period, we have made good progress developing a case study that can be introduced in the Fall of 1993 to approximately 250 undergraduates. We are working on developing a course that focuses entirely on engineering problem solving skills.
The goal of this program is to establish a set of integrated materials courses specifically designed to engineers and scientists who do not have a formal education in materials in order to increase their marketable skills and to develop a cross-disciplinary approach to problem solving. The program will emphasize horizontally integrated foundation courses in materials, their performance, selection and design for various applications. These applications include mechanical, electrical, chemical, biomaterial, environmental and aerospace. As such, the participants will come from a variety of disciplines including physics and chemistry. As part of this program we plan to have access to students from the start of their undergraduate years so that they may pursue the certificate program concurrently with their formal degree program. Their progress will be monitored using course evaluations and program appraisals which need to be developed. An additional group will be those students who would like to pursue a graduate degree in materials but do not have the necessary formal training in materials. Thus, some of the courses will be designed to also count toward graduate degree credit. It will be possible for the students who have graduate credit to potentially complete a Master’s degree with an additional year or two depending on the specific program.

A further goal of this program is to make available the courses established in the Materials Certificate Program to other southeastern universities which do not have a Materials program. This will be accomplished by videotaping the established and newly developed courses. The certificate program will also be offered to engineering industries through established videotaped programs such as the Florida Engineering Educational Delivery System (FEEDS) program.

Finally, as part of the strategy in the program, it is planned to develop a Materials Clinic to be offered to personnel from industry. The goal is to make available to engineers working in a material related field with no formal training an opportunity to get formal training in a relatively short time. Thus, the same curriculum that is developed for the Materials Certificate Program will be offered in the summers but in a short course format.
Project Status:

A proposed program was established with tentative approval of the Materials Science and Engineering Department faculty. This program is to be kept broad so that the student, along with his or her advisor, selects the courses most appropriate for his or her background and goals. The only required course in the program is "Introduction to Materials Science". The certificate will require at least 15 credits to be taken in materials related courses.

The Materials Certificate Program was critiqued for its evaluation process as part of another SUCCEED program during the "Workshop on Evaluation Component in SUCCEED Projects." It was determined that the evaluation of the certificate program is relatively easy. Course evaluations will be used for each course. Questionnaires of students that have completed the program will be given and the results evaluated. The Materials Research Society will be asked to formally recognize the Materials Certificate Program; thus, the program will be externally evaluated and, if successful, will be nationally recognized. The industrial participants will be asked to evaluate the program using verbal and written formats.

A Materials Certificate workshop was held on February 5, 1993, at the Holiday Inn/University Center in Gainesville, FL, as part of the SUCCEED program. Representatives from other UF departments and industries around the state of Florida attended. Although other southeastern university representatives were invited, none attended. Presentations were made concerning the SUCCEED program, the Materials Science and Engineering (MSE) Department and the Materials Certificate Program. These were discussed by the attendees. Many useful suggestions and questions resulted in the interaction. Overall, there were many favorable comments concerning the Materials Certificate Program. Many of the suggestions centered around expanding the program to include graduate work as well as undergraduate credit. The following is a summary of the issues that need to be addressed before the program can be activated.

One of the critical questions that was addressed was: what are the admission requirements? They are clear for students attending UF and enrolled in the engineering program. What about students who are working and not enrolled at UF? Some provision for enrollment must be made. What about the problem of prerequisites or equivalency? Do the participants have to be four year college graduates? Do they have to be engineers? It was thought that the equivalent of two years community college should be enough, i.e., two equivalent college credit for mathematics, chemistry, and physics. It was decided that individual requests can be decided on a case by case basis and handled by special petition. However, for the certificate to be awarded, a grade of "C" or better must be obtained in the course.

There appeared to be a clear suggestion that we allow the course curricula to include one or two selected courses from other departments. For example, the Agriculture Engineering and Chemical Engineering Departments both offer materials related courses. (Professor Teixeira presented the course that he developed for biological materials). The Civil Engineering Department addresses concrete and asphalt more than other materials because of credit limitations, but would like to have their students be exposed to other materials. Can these courses be included in the program? It was tentatively decided that courses such as these could be included, if they are appropriate for the student, with prior approval of the MSE Department and approval of faculty advisors from the home department.
There appeared to be a strong desire to include as many 5000 level courses as possible in the Certificate program. This resulted from the fact that there are limited undergraduate credits permitted to be used for graduate credit in a non-materials major. For example, the suggested course, Engineering Materials Design could be a 5000 level course and thus be used as either undergraduate or graduate credits. Can we make some of the 4000 level courses into 5000 level courses? Many questions from industry centered around whether or not the certificate could count towards a Master's degree program. Several scenarios of certificate courses plus additional work leading to a non-thesis Master's degree in various engineering departments were discussed. Another suggestion focused on a graduate equivalent of the Materials Certificate program, especially if courses were offered with equipment operation such as FTIR, SEM, TEM, etc. Can we include these courses in the FEEDS system? There is a plan in the future years of the program to include the courses on the FEEDS network so that they may be available to other universities without materials programs and to industries.

It was noted, especially by the industrial representatives, that there were no Total Quality Management (TQM) or Quality Control (QC) courses suggested in the curriculum. They would like to see courses like this added to the curriculum. It was noted, however, that QC is taught within the framework of materials processing, properties and application courses and a TQM course is being taught (in the Industrial Engineering Department) as part of the SUCCEED program.

Can we obtain national recognition for the program? For example, will the Materials Research Society formally recognize the certificate? It was generally agreed that we would attempt this recognition. If the Materials certificate is approved by the College of Engineering Curriculum Committee and the UF Curriculum Committee, then the University will recognize the certificate and be responsible for the administrative records.

The workshop resulted in many useful suggestions which will be implemented whenever possible. The suggestions will be formulated into a formal package for consideration by the MSE faculty. Once the faculty agrees on the forms of the Materials Certificate program, the formal announcement will be sent to all interested departments, schools and companies.
Project Title: Implementation of Engineering Into Freshman/Sophomore Mathematics Courses
Project Number: UF 022 CI 92
Project Duration: 8/17/92 - 2/28/94

Project Abstract:
The objective of this research project is to introduce engineering/design problems into initial freshman/sophomore mathematics courses; specifically Pre Calculus, and Calculus I, with the intent to introduce and excite entry level students towards a career in engineering during this critical early academic experience. We propose to: (a) establish problem "banks", (b) survey students' career choices to evaluate project effectiveness, and (c) develop engineering/science oriented sections within these courses.

Project Status:
We have conducted student career interest (business, engineering, etc.) and career selection (this mathematics course, other personal experience, etc.) surveys, and obtained student population characteristics (SAT score, male/female, etc.) for the Fall '92 & Spring '93 Pre Calculus and Calculus I courses. These surveys will serve as our "null" set.

We are developing a "problem bank" of engineering oriented projects pertinent for Pre Calculus and Calculus lectures in coordination with engineering core course (statics, dynamics, materials, etc.).

We are presently teaching two "engineering oriented" sections of Calculus I, which utilize graphing calculators. Appropriate surveys are being conducted.

"Engineering oriented" sections have been designated for Fall '93.
Project Abstract:

The goal of this undergraduate education research program is to improve the level of understanding engineering students have concerning the modeling and analysis of dynamic systems. A second equally important objective is to develop and set a global systems framework that students can use to enhance their understanding of interdisciplinary engineering problems. The goal is to develop a comprehensive and horizontally integrated systems modeling and analysis course which is based on energy methods (systems approach). The program proposed here is based on three hypotheses:

*Hypothesis I:* Students' comprehension of the behavior of dynamic systems is improved if students can visualize dynamic motion.

*Hypothesis II:* Students' level of education and ability to look beyond traditional department boundaries is improved if they learn that many dynamic systems can be modeled using energy methods, and these systems can be analyzed using a common set of mathematical tools.

*Hypothesis III:* Students' level of interest in a course is improved if they have some form of interactive learning experiences.

The presentation of the material will be enhanced by using multi-media visualization techniques which provide for better student understanding, comprehension and motivation. Interactive instructional modules will also be developed to give students a better "feel" for dynamic system characteristics. Visualization techniques are addressed from two-tiers (i) Tier I: low-level interaction (playback) using ToolBook and (ii) Tier II: high-level interaction using "calculation-based" software (MATLAB/SIMULINK).
Project Status:

Modeling and analysis of dynamic systems represents a generic core course in many current engineering curriculums. For example, students may study dynamics associated with vibrating systems, rigid-body particles, electrical circuits, as well as chemical processes. However, experience indicates that students have difficulty in comprehending dynamic phenomena. More so, students see little "connection" between dynamic systems studied in various disciplinary courses. This may be caused by several factors. First, the typical engineering student probably has not been exposed to mechanical and/or electrical repair and experimentation (as consumer items have developed into unrepairable items). second, dynamic phenomena are difficult to present in-class using a static display (i.e. the chalkboard).

We are currently developing a single semester course, Eventually intended to be taken in the junior year, which approaches modeling and analysis of dynamic phenomena from an energy, or systems, approach. in addition, we are developing "multi-media" tools to aide in both the classroom presentation of the material, as well as out-of -class interactive tools. The class will first be offered Fall 1993 at the University of Florida. The course, with some changes reflecting "lessons learned" will then be offered Spring 1994 at VPI&SU. This alternating offering between University of Florida and VPI&SU will allow for immediate feedback and implementation/evaluation.

To improve the level of comprehension students have about how dynamic systems behave, a two-tiered visualization process is employed. The first tier relies on canned demonstrations which allow a relatively low amount of interaction using Tool-Book based software. The development of Tool-Book based software will also tie in to another SUCCEED project which is creating a "CD-ROM library" of engineering phenomena. The second tier visualization makes use of a "real-time calculation platform" to allow for a high level of interaction. Our current approach is based on the software package MATLAB/SIMULINK, as shown in Figure 1.

As a specific example, Figure 1 shows a software module which will be used to aide in the presentation of the concepts of dynamic vibration absorbers. The key concept in dynamic vibration absorbers is that main-mass vibration can be minimizing by properly "tuning" the absorber mass. Although not apparent from Figure 1, the function generator (which acts as a forcing disturbance to the main mass) has "slider-bars" which allow the instructor/student to vary the forcing frequency in real-time. The corresponding dynamic response of the main-mass, absorber-mass, and relative position between the main and absorber masses are displayed in real-time on oscilloscope-like displays. Also not apparent from the figure is that the vibration absorber parameters (mass and stiffness) can be varied to evaluate various designs. This module will be used in the classroom to present key concepts of vibration absorber analysis. This will then be followed with out-of-classroom use as a vibration absorber design project.

Students who learn an energy based approach to modeling of dynamic elements will be less constrained by department boundaries. It is our view that the partial breaking down of departmental boundaries is required in order to prepare students for the interdisciplinary, team-oriented engineering job market (both current and future). Additionally, by incorporating visualization techniques in the classroom, students will have an increased comprehension of how dynamic motion occurs and how that motion is characterized-this increased comprehension will be accompanied by an increase in interest. We believe the influence of this course will cause
students to develop a better understanding of their upper-level courses, thus increasing the graduation rate of Curriculum-21.
Figure 1 – MATLAB/SIMULINK Dynamic Vibration Absorber Demonstration
**SUCCEED Project Information Directory**  
**March 10, 1993**

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<tr>
<th>SUCCEED Center:</th>
<th>Center for Professional Success</th>
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<tbody>
<tr>
<td><strong>Project Title:</strong></td>
<td>A Collaborative Learning Experience in Calculus for Freshman Engineering Students</td>
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| **Project Number:** | CM007PS92  
| **Project Duration:** | 8/17/92 - 2/28/93  
|                    | 3/1/93 - 8/16/93 |

| Name:          | Robert W. Snelsire  
| University:    | Clemson University  
| Susan J.S. Lasser  
| University:    | Clemson University  

| **Project Abstract:** |

Research conducted at the University of California at Berkeley indicated that a lack of experience with the process of group study (collaborative learning) is a major factor in African American students' tendency to be less successful in technical disciplines. According to researcher Dr. Uri Treisman, African American students who are successful in high school are very likely to study in isolation, getting together with peers solely for social activities. Since group study is a crucial factor in aiding comprehension of technical material, African American students are at a significant disadvantage in the engineering and science majors.

A collaborative learning math workshop, based on Clemson University's successful Math Excellence Workshop, is being offered at Clemson during the 1993 spring semester for engineering students concurrently enrolled in second-semester calculus.

At the beginning of the weekly three hour period, each student is given a worksheet containing three or four realistic engineering problems keyed to the calculus syllabus. These problems are difficult enough that no student is able to solve them without becoming part of a team and working collaboratively. As the students attempt to solve the problems, they find that they must draw on material learned in the previous calculus and pre-calculus classes, as well as on current material. This emphasizes that they are acquiring skills they will need in later engineering classes and for their engineering careers, not just memorizing for current math class tests.

The collaborative learning experience will help the students develop a clear understanding of the calculus course content. In addition, it will give them some insight into the way that professional engineers work together on the job. Finally, it will effectively demonstrate to them the value of collaborative learning and encourage them to form study groups for their other classes.
Project Status:

The course, called "Engineering 110: Collaborative Calculus for Engineers," is currently being offered at Clemson. It meets once a week for three hours. Enrollment was solicited through direct mail to the minority students and by posters in all the engineering and science buildings.

The workshop is facilitated by an engineering professor, Dr. William Park, assisted by Mr. Kevin Barnett, a Ph.D. candidate with collaborative learning experience. Problems for the daily worksheets are being created by a committee of four engineering professors from different disciplines. These problems are edited and revised by Dr. Park, based on his perception of student readiness. Topics for the worksheets have included: flow rate in a canal; building settlement in saturated clay; inventory control; power dissipation in resistors with sinusoidal inputs; the velocity profile of air moving over a plate; and analysis of learning curves.

There are 17 students enrolled, 5 Black males, 3 Black females, and 9 white males.

If results of the first course prove satisfactory, the course will be offered at University of North Carolina - Charlotte, and at Virginia Tech.
SUCCEED Center: Professional Success
Project Title: Playing and Inventing! (Experiencing Engineering Design)
Project Number: GT 009 PS 92
Project Duration: 02/28/93 - 02/28/94

Project Directors

Name: W.E. Rodríguez R. Quiñones M. Centeno R. Gerhart

Project Abstract:

This project will provide a targeted group of 9th-graders the opportunity to discover the exciting part of engineering: Playing and Inventing! During five consecutive summers they will be able to design new products using engineering principles and tools. The project will provide a unique set of experiences to apply math/science and design methodology in solving simple problems. Students will conduct real-world research (using their peers as "clients"); propose alternative solutions to problems; build and test their designs; and write and present their inventions to their "clients". They will also learn the "College application process" -- ranging from SAT strategies to obtaining scholarships. The project will also help high school teachers improve their offerings by incorporating a similar approach in their courses and in organizing unique design laboratories that will benefit minority as well as non-minority students at those schools. A team of professors and practicing engineers (mentor-pairs) will develop the summer sensory-oriented exercises (in contrast with theoretical) in coordination with the student/teacher participants. The program will focus on improving teacher preparation and student involvement in their own educational process. The overriding objective is to motivate and prepare underrepresented students for professional success in engineering careers.
Project Status:

Georgia Tech faculty (in collaboration with two volunteer practicing engineers, and consultants at FAMU/FSU) are developing a non-traditional (real-life and simulated) engineering design/computer workshop to motivate talented under-represented pre-college students to pursue engineering careers. The first workshop, to be offered on July 26-30 in Aguadilla, Puerto Rico, will pair students and math/science teachers at predominantly Hispanic-American secondary schools with pre-eminent minority engineering faculty and practicing engineers in the U.S and P.R. The PIs will advise teachers and administrators at those schools about implementing new pre-engineering and advanced placement courses as well as the planning of computer laboratories. Two practicing engineers are helping to match design problems with student/teacher interest and abilities. It is anticipated that 100 participants (80 students and 20 teachers) from targeted secondary schools would benefit from the project. The workshop will incorporate a simplified model for concurrent engineering, design/manufacturing/construction principles, CAD modeling tools, and friendly visual simulation techniques. PRELECT, a network of under-represented engineering faculty and graduate students, will be used to match pairs and facilitate the implementation of the workshop. The workshop is being designed as a set of cross-disciplinary and horizontally-integrated projects involving industry participation. For instance, students, teachers, and the PIs are proposing problems, such as "designing a better mouse that uses no poison, glue or springs" (see Figure 1 - extracted from W. Rodriguez's book The Modeling of Design Ideas (McGraw-Hill, 1992), a design problem to avoid the glare on car dashboards, and so on.

Figure 1. Designing a Better Mouse Trap

Each developed problem is incorporating the use of math and computer tools and some science fundamentals as well as use of optimal materials, cost considerations, and so forth based on David Macaulay's *The Way Things Work: A Visual Guide to the World of Machines* (Houghton Mifflin, Boston, 1988).

Other planned activities will include some basic "workplace know-how" skills based on the Labor Department's Secretary report titled "Learning a Living," as modified below:

* Problem solving and design: How to define a problem, including its functional requirements; and how to generate, model and evaluate alternative solutions.

* Basic resource allocation: How to allocate time, money, materials, space and staff for the designed product.

* Information: How to select equipment and tools and apply technology to the design problem, and how to acquire, evaluate, organize, interpret and communicate design solutions, including computers to process information.

* Interpersonal skills: How to work with design teams, teach others, serve customers, lead, negotiate and work with people (students/teachers) from culturally diverse backgrounds.

List of Tasks Pending (Planning Phase):

A. Prepare list of predominantly minority High Schools that have not had access to pre-engineering workshops in their area.

B. Announce all potential H.S. (Call-for-application to participate in this program.)

C. Develop criteria and select students and teachers.

D. Reserve space and lab resources for week-long workshop that will include morning orientation and SAT test-taking strategies and afternoon design sessions and computer laboratories for 80 students and 20 H.S. teachers.

E. Recruit lab staff that will help in lab experiences. Reserved equipment for design/computer labs with CAD modeling software, as well as space for making real cardboard models.

F. Develop the logistics for the Summer design camp and accommodation of the participants.
**SUCCEED Project Information Directory**  
**February 12, 1993**

**SUCCEED Center:** Center for Engineering Design and Processes  
**Project Title:** "SUCCEED Under-represented Research Engineering Program (SURE)"  
**Project Number:** NS 011 PS 92  
**Project Duration:** 8/15/92-8/14/94

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<th><strong>Project Directors</strong></th>
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| **Name:** Christine S. Grant  
**University:** NCSU |

**Project Abstract:**

A number of under-represented minority engineering and computer science undergraduates are interested in an academic or a research career. However, they often lack the proper information necessary to pursue these career choices. This program will provide under-represented minority students with the tools needed to successfully complete their undergraduate program and effectively negotiate admission to graduate school. There are three phases to the proposed program: (1) the identification of sophomore and junior level minority undergraduate students in engineering and computer science curricula who show the potential for successful graduate careers; (2) award of undergraduate research (SURE) assistantships to qualified minority undergraduate candidates to work under the supervision of faculty members (3) organization of a seminar series in which the undergraduate research assistants are both speakers and participants. The principal investigators associated with this proposal are from five different departments in the College of Engineering at North Carolina State University. Interactions with graduate students will provide an additional opportunity for these undergraduates to become exposed to individuals who are currently pursuing advanced degrees.

**Project Status:**

This is a planning grant. The proposal for the work in the abstract is under preparation.
**Project Abstract:** To improve retention among women and minorities in engineering colleges, we will utilize an advising system known as "the bubble" to stimulate and enhance students' academic experience. We will admit women and minorities as freshmen into the College of Engineering and we will create an environment in which the bubble students receive consistent advising to identify and solve problems. We will give them an opportunity to assimilate with others of similar backgrounds through shared classroom experiences. We will reinforce students' goals by providing minority and women role models and maintain student interest through a hands-on project, Habitat for Humanity, to supplement theoretical classroom lectures. The project will strengthen the bond created inside the classroom and teach students team-work and cooperation—skills necessary to succeed in industry. The Design and Build course offers a unique, holistic, total systems approach to engineering. Its emphasis is on the creative aspects of engineering, and its purpose is to envelop students in the wonders of conceiving and making products while introducing the fundamental principals that underlie all engineering disciplines. The students provide a service to the community through the course which involves working on a house for Habitat for Humanity, a non-profit organization that builds low-cost housing and provides it to homeowners with an interest-free mortgage.

**Project Status:** We have selected three bubbles of seven participants each. The women and minority students have been admitted into the College of Engineering two years prior to the standard junior admission. Members of each bubble have been pre-registering for classes together and, since Spring'93, have been taking their engineering courses as a group so that they will have peer support in their first two years of college. This is the time period in which most minority and women students drop out of engineering. Each bubble has an advisor with specialized experience as a minority mentor or who is him or herself a minority. Students have been meeting with their mentors for personal and career counseling.

Since January, students have been attending the course, "Design and Build I". Students meet on Thursdays for lectures and hands-on projects and on Saturdays at a Habitat for Humanity construction site to complement the classroom experience. Student bubbles have developed design specifications and have presented them to a Habitat review board, which has critiqued and offered recommendations for building improvement. The review was similar to one that an engineer would face when presenting a new concept or product to industry. Presentations included sketches, competitive benchmarks, concern for quality management, realistic cost estimates, and market studies. Some of the course has been filmed. A one-page class evaluation has been created to obtain feedback from students on the course.
SUCCEED Project Information Directory    February 12, 1993

SUCCEED Center: Center for Professional Success
Project Title: Modular Design Projects for Jump-Starting Engineering Students
Project Number: UF 017 PS 92    Project Duration: 8/17/92 - 2/28/94

Project Directors

Name: G. E. Nevill, Jr.
University: University of Florida

Project Abstract:

The project objective is to provide an effective mechanism for university, community college, and high school students, particularly women, blacks, and Hispanics, to be:

1. convinced of the fun, excitement, challenges, and rewards of engineering,
2. motivated to choose or continue in engineering careers,
3. started toward mastery of modern design practices and TQM methods.

This objective will be accomplished by creating, testing, demonstrating, and disseminating a coordinated collection of self-contained modules which provide early student involvement in realistic and informative engineering design experiences. The impact will be enhanced by a network of mutually supportive representatives of SUCCEED Universities, community colleges, high schools, and industry. This project will create more positive perceptions of engineering careers among students and increase the ability and motivation of teachers to guide promising students into engineering.

Project Status:

This project is based on the observation that one of the best approaches for attracting and retaining engineering students is to provide early involvement in creative design experiences. Therefore the principal thrust of the project is the development of a flexible collection of modular design tasks which can be used by students at different academic levels (from early high school through university sophomore) and in different settings (as part of a course, as the basis of an entire course, or in extracurricular/club activities).
One of the early project activities was to clarify the desired impacts of design task involvement on students and instructor. It was agreed that students should gain an improved image of the engineering profession and engineering careers, should become more likely to choose engineering as a career, and should feel more confident they can succeed in engineering careers. The principal impacts desired for instructors are that they will want to use the design tasks in their classes, they will gain an improved image of the engineering profession and engineering careers, and that they will be more likely to recommend engineering as a career to a wide range of students. An extensive listing of the design task attributes believed to lead to the desired outcomes was also developed. These are serving as the basis for the development of initial tasks and will be tested as the project proceeds.

The main focus of project activities to date has been the development and testing of a number of design modules, including written materials describing the tasks for both the students and for the instructor. These task modules generally involve the design, fabrication, and testing of a simple system using a common, readily available set of materials. Further, each task seeks to be clearly related to an important real world engineering problem. For example, one of the tasks, related to the real world need for more efficient cookers to conserve the forest in third world countries, involves designing and fabricating a "fuel stingy cooker" using only tin cans, bricks, wire, and aluminum foil. The goal is to boil a cup of water with a minimum of fuel.

Creation of a Student Support Team has been a vital factor in the development and testing of the design task modules. This team consists of a dozen students ranging from high school sophomores to college sophomores with strong representation of women, black, and Hispanic students. Team members, individually and in small groups, test design tasks and provide feedback both regarding ways to improve the tasks and their impact.

Development of an Instructor network, involving representatives of local high schools, community colleges, and SUCCEED institutions is also underway. Testing and feedback on design task modules has been initially limited to the Student Support Team and to classes at the University of Florida. This testing will be expanded to other local settings and to SUCCEED institutions as a significant number of reasonable complete design tasks becomes available.

In order to provide meaningful quantitative evaluation of the design task modules under development, we have also developed four evaluation instruments. These are intended to provide feedback on improving the design task modules and on the impact of involvement in the design experience, both for students and instructors.

Student response to the design task modules developed thus far indicates that participation in design experiences is an effective means of improving student perceptions of engineering and student interest in engineering as a career. This project is well started toward developing a coordinated set of design task modules to achieve the stated objectives.
Traditionally, most students accomplish their homework and study for tests on an individual basis. While studying alone may be very successful for many students, being able to study with other classmates, especially in problem-oriented courses, may be highly beneficial. In the California State University system, a program of collaborative learning has successfully enhanced the academic success of minority engineering students for the past twelve years. In this project, four 30-student sections of the Introduction to Engineering freshman sequence are being evaluated to determine the effects of unstructured or voluntary collaborative learning. Three of the remaining 36 sections will serve as control. In the test sections, students will be assigned to groups of three. Both the test and control sections have been adjusted on the basis of high school class standing, math aptitude, and SAT scores to provide for comparable academic potential. Two faculty each have two test sections. Students in the test sections are encouraged to work with their group in accomplishing homework requirements and in preparation for tests. Control sections were instructed that homework is to be accomplished in accordance with the University Honor Code which specifies that all work submitted for a grade must be accomplished individually. Evaluation is being accomplished using the following criteria: (10) Average student grades, (2) student retention, and (3) student views based upon input from completed questionnaires.
**Project Status:**

Test and control sections with an average enrollment of 28 students each in Engineering Fundamentals 1005 were established prior to beginning of Fall Semester 1992 with Instructor A having two test sections and one for control. Instructor B was assigned two test and two control sections. Test sections were divided into groups of either three or four students and instructed that they should make full use of the opportunity to study homework together. They were also advised and encouraged to collaborate while studying for quizzes, departmental tests, and the final examination. A total of students participated in the four test sections. At the end of one semester, evaluation of preliminary grade data and information from student questionnaires was conducted. Average course grades did not reveal any difference between test and control sections. Eighty nine percent of the test sections students indicated that they participated in group study. Less than five percent specified that they studied with their group nearly all of the time. Many discussed homework with group members only when they had difficulty with the assignment. Overall, the students were pleased with the opportunity to study together. During Spring Semester, students in test and control sections are enrolled in the same sections as for Fall with exception of those who failed EF 1005. Essentially the same guidelines regarding collaborative study will prevail during EF 1006. Instructors have allowed students to join groups of their choice now that they are familiar with their classmates. Another questionnaire will be prepared for administration at the end of Spring Semester. Lessons learned during the first semester will be applied during the refinement of the evaluation process for this project. After one academic year, we expect that sufficient data will have been accumulated upon which conclusions may be based.
Project Title: "Recruiting and Retention of Women in Engineering"
Project Number: GT 019 PS 92
Project Duration: 8/16/92-5/31/93

Project Directors
Name: Donna Llewellyn
University: Georgia Tech.

Name: Sarah Rajala
University: NCSU

Project Abstract:
The purpose of this project is to provide planning money for a coalition wide effort to define programs to support women in engineering. The goal is to establish programs to promote the success of faculty of all ranks, to recruit and encourage graduate students to consider academic careers and to provide the tools for their success, to facilitate the dissemination of information about engineering careers, and to increase the visibility of women in engineering.

Project Status:
A Women in Engineering Board (WEB) has been established to coordinate and promote the proposed activities. WEB consists of all women faculty of the SUCCEED schools, as well as two women graduate students from each school. These members support all WEB activities and bring relevant issues to the attention of the executive board. The Executive Board of WEB initiates, plans, carries out and evaluates all WEB activities. It consists of one women faculty representative from each SUCCEED school and two women graduate students from among the SUCCEED schools. Ex-officio members include the director of SUCCEED and the chair of the SUCCEED Council of Deans.

Issues of concern include: (1) Faculty success, including gender parity, start-up packages, spouse relocation, salaries, family leave and care, professional development, and recruitment. (2) Networking, including mentoring and a directory. This is a concern both at the faculty and graduate student level. (3) Student recruitment and encouragement, including gender parity, financial and physical support, family care, and job opportunities. (4) Sensitivity training. This is of concern both for graduate students and faculty. (5) Dissemination and visibility of women within engineering, and visibility of engineering within the general public.

A number of activities have been identified to address the aforementioned issues. They include: a statement of gender neutral language for all official publications and public relations information; a semi-annual retreat; directories for both faculty and graduate students; a sensitivity training workshop; data collection and recommended policies; and dissemination and visibility programs.

The effort to date has primarily focussed on defining appropriate programs and preparing a four year proposal to request funds in support of these programs. In addition, the first faculty directory is being developed and the first retreat is being planned.
Project Title: Using Evolving Design Projects to Promote Active Learning
Project Number: CM-004-EP-92
Project Duration: 8/17/92 - 2/28/94

Project Abstract:

One of the complaints heard most often from engineering undergraduates is that they do not see anything practical until late in the curriculum. Typically, engineering students take a variety of courses that contain heavy doses of theory, and the students become disillusioned because they cannot see how that theory can be applied to real-life situations. To the students, it becomes a seemingly endless stream of apparently useless equations and concepts. To make engineering education more interesting for students we must show the connection between science and practice in more concrete and realistic ways than are currently being offered. Learning an idea today that one may need some time in the unforeseeable future normally results in forgetting that idea right after final examination, if not earlier. Researchers at Clemson University, UNCC, and N. C. State University have teamed up to try to revitalize the undergraduate design experience. We propose to alleviate some of the learning difficulties by giving the students a design project (case study) in the early stages of their academic careers and have them work on that project as they proceed through a portion of the curriculum. The objectives of this research are to create a more active learning environment and to try to decompartmentalize the subject matter by showing students how the pieces interact. The coalition is important in this effort because it provides a framework in which several institutions can attempt curricular experiments and disseminate the experimental results in a structured fashion.

Project Status:

Activities have begun to involve students in evolving design projects. At Clemson, sophomores began a project in Fall 1992 dealing with the production of ethanol from a fermentation process. Working in groups of three or four, they prepared a detailed flow sheet from a written description of the process, and they then performed material and energy balances around certain pieces of equipment. In Spring 1993, these same students are now studying, in a thermodynamics course, the fermentation reaction in more detail. Another design project, production of formaldehyde, has been initiated with a second group of sophomores in the Spring 1993 semester. These processes were selected because they contain the important pieces of equipment that we would like to emphasize, namely pumps, heat exchangers, reactors, and separation columns. The first group of students has already indicated that this design project has been an excellent experience, despite the extra work.
At UNCC, eight undergraduates, split evenly between computer science, mechanical engineering, electrical engineering, and civil engineering, have become involved in the design experience. These students (a mix of freshmen, sophomores, and juniors) are now working on projects ranging from electro-optic sensors to the space station. The projects are experimental in nature or have a mix of experimental and theoretical work. The students in each discipline are presently working on different aspects of a particular project, depending on their expertise. For example, in the case of the electro-optic sensor, a sophomore is now involved with electronic signal processing and system analyses for the sensor. A junior is studying the change in field distribution due to introduction of various materials in the field region. The investigation of dielectric properties and their effect on the field distribution or the nature of the electric and magnetic field will be determined. This requires a detailed understanding of a large portion of physics and chemistry. Each of these steps can be arranged so that they overlap with the course of undergraduate studies. In this design approach, lower-level students can learn from upper-level students, and the upper-level students get the opportunity to be mentors, which can also be a valuable learning experience.

At N. C. State University, the first in a series of courses, Structural Evaluation I, is now being offered in the Spring 1993 semester to a group of nine undergraduate students. The other courses, Structural Evaluation II and Structural Evaluation III, will be offered in the Fall 1993 and Spring 1994 semesters, respectively, to this initial group of students. These three courses will attempt to integrate the structural engineering design practice into the civil engineering undergraduate curriculum. The demonstration structure selected for this initial group of students is Reynolds Coliseum on the NCSU campus. This structure offers the opportunity to bring into the classroom different types of structural systems, materials, and construction techniques. The architectural and structural drawings were obtained with the help of Mr. Don Iding, Architect at the NCSU physical plant. In this first course, an outline of a log book has been developed and the students are using this log book to keep a record of their activity and progress. The first few weeks of the semester have been spent introducing the students to the Reynolds Coliseum through the use of the architectural and structural drawings. Mr. Iding has been the guest lecturer for this portion of the course. In addition, the students have visited the structure to become familiar with the actual construction and to identify the structural members. During this semester, several design engineers will be invited to interact with the students. The class now meets for three hours per week and it is envisioned that, as the semester progresses, the contact time may be reduced to encourage the students to develop skills for independent work and design judgement.

The evolving design projects at Clemson, UNC-Charlotte, and N. C. State are designed to revitalize undergraduate engineering education, and to be instructional models that could be implemented in most existing curricula. We know that when students work on "real life" problems, they are much more excited about learning and they undoubtedly learn more by applying concepts to problems that they feel represent reality. This type of active-learning environment will increase the retention of students because it will allow them to use and develop their engineering skills and creativity earlier in their education. The students will be able to see how changing one part of a design may radically affect another part. More importantly, our students may become more successful engineers because they will be able to develop the integrative skills necessary to complete a successful design.
SUCCEED Project Information Directory

February 12, 1993

SUCCEED Center: Engineering Practice
Project Title: Concurrent Engineering For UAV Engineering Practice and Curriculum Integration
Project Number: GT 012 EP 92

Project Abstract:

For manufacturing systems TQM is defined as an integrated strategy to make quality a driving consideration at each step of a product's life cycle. Concurrent Engineering (CE) has been called the implementation mechanism for TQM and is defined as a systematic approach to the integrated, concurrent design of products and their related processes, including manufacturing and support. The proposed project is to apply the ten key characteristics of CE and the interaction of the four key elements of CE to unmanned aerial vehicle (UAV) pilot projects. The proposed project will involve the horizontal integration of six disciplines (AE, CE, CS, EE, IE, and ME) representing three coalition institutions. Proposed objectives are to integrate CE, hence engineering design and practice, throughout all stages of Curriculum 21, through the use of student involvement in engineering practice associated with the design and development of UAVs. This project is proposed as a student self-led project where graduate students (engineers) are the lead engineers, undergraduate students (apprentices) are assistant engineers, and summer interns (pre-college) are the technicians. Plans are to use capstone design courses, existing functional courses, and new courses to implement this project. Other activities include summer design camps and entry in AUVS international aerial robotics competitions. UAVs have been chosen for the pilot projects due to the need for horizontal integration of disciplines in these systems, the existing expertise at NCSU and GIT, the support of a professional society (AUVS), government and industrial support, as well as student interest.
**Project Status:**

The project consists of four sub-projects, as illustrated in Figure 1. Dr. D. P. Schrage serves as the overall Project Director, and is the PI for the sub-project: CE Methodology Development and Pilot Projects. All four sub-projects, along with the corresponding PIs, are illustrated in Figure 1 as well. An implementation plan was developed during the fall semester. This implementation plan details activities, including metrics, and discusses how the four sub-projects and three universities will interact to accomplish the specific objectives set forth in the proposal.

The project objectives consist of establishing the integrated cross disciplinary courses that involve projects emphasizing engineering practice, including manufacturing and support; create summer design camps that involve under-represented pre-college student with engineering practice and interest them in pursuing a formal engineering education; and create a physical environment that enhances undergraduate and graduate engineering practice instruction through hands-on lab, shop, and field activity.

The way that the project envisions accomplishing these objectives is through the application of a CE Methodology that will provide a horizontal integration of engineering disciplines and a vertical integration of courses. At the kickoff meeting on September 4, 1992, a framework for the implementation in the form of six activities was discussed. These activities are illustrated in Figure 2, and are scheduled throughout the project as outlined in the implementation plan. There have already been several courses taught which were centered around UAV pilot projects, and the schedule for the remaining courses is set out in the implementation plan. The implementation plan was finalized during the December 2 meeting, which coincided with student project presentations for GIT's Introduction To Concurrent Engineering. The implementation plan, based upon inputs from all PIs and Co-PIs, puts forth a precise schedule of courses, UAV competition and demonstrations, and summer design camps.
CE For UAV Engineering Practice and Curriculum Integration
Six Activity Approach

Figure 1

Activity 1
Concurrent Engineering Methodology and Process Definition

Activity 2
CE Pilot Project Identification for UAVs

Activity 3
CE Introduction into UG Courses

Activity 4
CE Pilot Project Competitions and Demonstrations

Activity 5
CE Skills Development in Summer Design Camps

Activity 6
Documentation of Lessons Learned and Continuous Improvement

* 18 Month Budget including NSF and Equal Cost Sharing

Figure 2
**SUCCEED Center:** Center for Engineering Design and Processes  
**Project Title:** "Bridging the Gap Between Theory and Application With a Competitive Multilevel Design Experience"  
**Project Number:** NS 017 EP 92  
**Project Duration:** 8/15/92-2/28/94

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<th>Name</th>
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<tr>
<td>V.C. Matzen</td>
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<td>K.H. Murray</td>
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**Project Abstract:**
Design competitions motivate students to obtain the knowledge and techniques that can improve their design. The engineering process can also attract students typically repulsed by the deductive style of teaching engineering science. In the first year 16 sophomore students recruited during the fall will divide into four teams to participate in a 1 unit semester long design competition developed and coordinated by a panel of faculty working with practicing engineers. Then 16 sophomores will be added each following year unit by the third year 16 sophomores, 16 juniors, and 16 seniors will work in teams for four or five including at least one senior, one junior, and one sophomore. It is hoped that upper-class students can help coordinate the team's activities by drawing upon previous years' experiences and that faculty can supervise less with each semester. In the first year only teams at NCSU will participate while in years two and three teams at NCA&T will also participate. This project will focus on the mechanics based fields of civil engineering including a physical scale model as part of the overall design. Practicing engineers and faculty will evaluate each team based upon an oral presentation, written report, and physical test of the scale model.

**Project Status:**
We recruited a class of 24 Civil Engineering sophomores and administered a learning styles test to the class. One education team member, John Park, divided the class into 3 person groups based upon the test results. Our class meets weekly during a 3 hours time slot. Each class has been about half lecture and half working time.

We selected an NCDOT bridge replacement of Caswell County as our real life design problem. A senior level NCDOT structural engineer provided the problem, gave us background information, and then lectured during the second class period. In class he responded to questions and issues highlighted during a class brainstorming session performed on the first class meeting.

Following our consultant's lecture students have investigated three design alternatives:
1. Replacing the bridge at the same site and detouring traffic over existing toads;
2. Building the replacement bridge next to the current bridge and using the current bridge as a detour;
3. Replacing the bridge at the current site and building a detour next door. Students are spending the first half of the semester evaluating these three general schemes, calculating costs, and then selecting the best alternative. At mid semester the design teams will present their recommendations and provide supporting documentation. Several invited practicing engineers will help the instructors critique student presentations.
After selecting a general design alternative students will spend the semesters remaining half on the detailed structural design. They will fabricate a 1/25th scale concrete model to be tested on the second to last class meeting. We will evaluate students on their design process as documented in a group journal, an oral presentation of their design, and the performance of their model bridge during a loading competition.
We propose two complimentary approaches to extending the type of design experience which is customarily available only for seniors to underclassmen. The first will team seniors and sophomores (and computer-literate freshmen) on industry sponsored software design projects through the UDC. The sophomores and qualified freshmen would participate in a two semester sequence, the first semester being a hands-on introduction to software engineering and the second being the actual design project. The seniors will serve as project leaders while the underclassmen participate as "design assistants."

In the second approach, a course would be established in which the students participate in a mock "company" in which they conceive, design, develop and manufacture a product. Underclassmen may register to participate in the company for one credit hour per semester. Seniors will serve as the company's leaders and may register for up to three credit hours. Students will advance in "corporate rank" and be given a higher level of responsibility in the product design process each successive semester in which they participate in the company.

The project is currently in its first semester of operation. There are 30 students participating, including freshmen, sophomores, juniors and seniors. Three sections of an experimental course, ECE 492E, have been set up. Underclassmen have registered for one credit hour of ECE 492E, while seniors have registered for four credit hours of capstone design course credit, ECE 480/481. Drs. Tom Miller, Troy Nagle and Dave Van den Bout are each responsible for one section.

The two proposed approaches have been combined into a unified framework which we call the "ECE Entrepreneurs Program." This theme was chosen for two reasons: First, the concept of entrepreneurism and a "small company" mentality is clearly an important model for the engineer of the 90's. New job opportunities over the next decade are predicted by nearly all leading economists to come from the small business sector, so this theme is highly relevant to our engineering students. Second, we expected that the entrepreneurial theme would attract a few students with strong leadership traits, and that these students would take charge on the design teams, serving as peer role models for the underclassmen.

Each section of ECE 492E has its own project theme. For the Spring 93 semester, one section is in the business of hand-held electronic instruments, one is in high-tech medical devices, and the third is in software consulting. Each group currently has its product defined and is in the development state. The software consulting group's "customer" is IBM. IBM has dedicated one person full-time and another part-time in support of this project. The other two groups are identifying potential customers and markets for their products.
The three sections of ECE 492E meet jointly once per week, during which time a seminar is held. The seminar speakers are individuals from RTP area involved directly or indirectly in entrepreneurial activity. This includes founders and CEOs of high-tech start-up companies, venture capitalists, attorneys specializing in start-up companies, and management consultants. Each group also has a regularly scheduled meeting time at least once per week. These meetings serve as planning sessions, design reviews, etc. The senior students are the team leaders and conduct these sessions. The faculty member serves not as the session leader, but as an advisor and facilitator. The seniors assign tasks to the underclassmen, commensurate with their abilities.

Our experience so far has been that the students display a high level of enthusiasm, and the team concept appears to be working well. The seminar sessions have been highly interactive, with approximately 40% of the time consumed by questions and answers. The seniors, some of whom were apprehensive at first about managing a group (as opposed to the "normal" senior design project model, in which the seniors work together in small groups and manage no one) have gotten accustomed to delegating responsibility to team members. We are finding that the seniors often pair themselves with the freshmen to work on a particular task.
Project Title: Computer-Aided Process Improvement Laboratory
Project Number: UF 010 EP 92  Project Duration: 8/17/92 - 2/28/94

Project Abstract:

Process improvement concepts and advanced information technology are being integrated into the engineering curriculum as both objects of study and as a basis for continuous improvement of the engineering education delivery system. Envisioned is a continuing curriculum improvement program that synergistically seeks solutions to the problems of strengthening industrial and economic competitiveness as a basis for achieving essential engineering education delivery system reforms. A three pronged approach is being taken:

(1) Create a computer-integrated decision support laboratory to provide an open instructional/learning environment for the formulation and solution of process improvement concepts. The laboratory will include networked engineering workstations supporting advanced decision support tools with interfaces to on-campus utilities to provide academic access to real world process data. Students will be given individualized hands-on experiences with databases, computer-aided engineering tools, statistical analysis, data visualization and data reconciliation as applied to the operation, analysis, design and improvement of industrial processes.

(2) Develop educational modules to infuse curricula with activities and exercises that require students to formulate meaningful questions and find appropriate answers. Challenging interdisciplinary team projects will be developed based on relevant campus utility system problems. Integrated use of these information technology based instruction modules and projects throughout the curriculum is expected to leverage student efforts in understanding scientific/engineering principles and hone their creative skills for solving complex problems.

(3) Transfer, disseminate, and share the laboratory resources and instruction modules as an integral component of the development effort.

The on-campus utility system basis of the Laboratory is highly relevant—attention is focused on problem areas of national technical and economic importance (provides examples of total quality management principles) and environmental concerns are addressed (emphasizes efficient energy and water management). The Laboratory will be widely applicable and readily reproducible as most industries and campuses have utility systems.
The curriculum improvement effort is being directed towards three primary areas: leveraging, learning and instruction effectiveness/efficiency through use of computer information technology; integrating instruction of related engineering fundamentals; and, integrating presentation of data based analysis and modeling with the presentation of theoretical concepts.

LABORATORY DEVELOPMENT

Central to the project is the development of a Computer-Integrated Decision Support Laboratory that provides a vision of future engineering practice through real world process examples based on campus utility systems.

Instrumentation interfaces are being developed with on-campus utility systems to transmit real-time operating data to database servers which will maintain databases of all pertinent operating parameters. The initial utility/instrumentation interfaces are currently being developed and connected to existing on-campus chilled water systems. Academic interface develop are also being coordinated with current construction of a cogeneration plant and a wastewater treatment plant.

Students will interactively use workstations to retrieve operating data from the utility system databases and apply software tools to analyze the data, develop process models, simulate the processes and critically evaluate results. Previously donated engineering workstations have been upgraded during the first six months of the project to provide the necessary computer capability to support this project.

USER INTERFACE DEVELOPMENT

Graphical User Interfaces (GUI)s are being developed to facilitate student access to the databases and software tools. Two types of student/user environments are under development - process monitoring and process simulation.

In the process monitoring environment, students are being provided workstation interfaces to real process data acquisition systems connected to on-campus utility operations. Utility process changes are displayed in real-time giving the students experience with real time factors and subsystem interactions. Built-in interfaces will provide easy access to the data acquisition system databases for exporting process data to analysis and modeling software tools.

In the simulation environment, students are being provided an emulation of physical plants with their associated instrumentation. The user interfaces being developed are replicas of the real monitoring environments described above. Students will have the perception of being able to operate a real system. They can see the instruments, the process flow diagrams, and equipment schematics on the workstation monitor screen. They can make arbitrary manipulations on the model system (opening and closing valves, changing set points, applying forces, etc.) and receive immediate feedback on the effect of their manipulations as a function of time (as indicated by the virtual chart recording and plotting devices).
Project Title: Vertically Integrated Design

Project Number: VP-11-EP-92

Project Duration: 8/17/92 - 2/28/94

Name: William H. Mason
University: Virginia Tech

N.S. Eiss, Jr.
University: Virginia Tech

Robert H. Pusey
University: Virginia Tech

Project Abstract:

This project is intended to involve freshman in a valid engineering design experience through a senior-freshman integrated design program. In doing this we expect to increase their interest in engineering, provide motivation for the engineering science courses, and improve retention rates. The senior design courses provide the best opportunity to have freshmen participate in design, and selected freshmen are working with the senior design teams. This also adds a new dimension to those design courses. Through interviews with the students and the subsequent academic performance of the freshman we will be able to determine the value of this approach as a way of improving design education and student motivation, performance in engineering science classes, and retention rate.

Project Status:

In the Fall of 1992 we selected control groups with similar backgrounds. One group is now working with seniors, one group is not. Twenty students were selected for participation in the Mechanical Engineering Design Program, and eight are in the Aerospace Aircraft Design Program. The Aerospace Design Program is a two semester program, and freshman participating in Aerospace Design attended the final Fall Semester design presentations by the senior design groups on Dec. 1-3, 1992.

Starting with the Spring 1993 semester, the freshman working with the seniors are replacing their normal engineering fundamentals class project in the freshman Introduction to Engineering Course with a project from their work with the senior design teams. Twenty students were placed on ME design teams at the beginning of spring semester, one per design team. The freshmen are participating in brainstorming and other idea generating exercises as well as providing drafting help in the later stages of the projects. They will participate in oral progress reports during the semester and the final presentation as appropriate. In Aerospace Design we have two freshman on each of the four teams. The two design projects are the AIAA global range transport and the USRA Vehicle based system to replenish the ozone layer. They can join AIAA and be part of the AIAA design competition. The grade on their work will count as the grade for their project in the freshman course. Their projects will be due April 28, 1993, and interviews with program participants will occur shortly thereafter.
SUCCEED Center: Center for Information and Technology
Project Title: Multi-Media Engineering Introduction for High School Through Lower Level University Students
Project Number: FS 002 TC 92

Project Directors
Name: Patrick Hollis, Nur Yazdani
University: FAMU/FSU College of Engineering

Project Abstract:
The objectives of the proposed research is to develop a computer based multi-media software set suitable for use in high schools, community colleges and the universities. This software will motivate students to choose engineering as a career, to choose an engineering discipline, and to reinforce their basic science and math skills through the use of engineering problems requiring many skills and involving many of the engineering disciplines. Because the software will be aimed at high school and community college students, it will also show what skills will be required of them to pursue engineering, what engineering as a career will mean, and at the same time help in bringing practical problems to their basic science and math courses. The impact of the developed software will be evaluated through survey of students and their eventual numbers pursuing engineering careers. Several predominantly minority school will be included in the survey. The end products will be disseminated through distribution to target institutions within and associated with the Coalition, and through workshops.

Project Status:
SUCCEED Center: Center for Information and Technology
Project Title: The Development and Implementation of Interactive Multimedia in Basic Engineering Education Course
Project Number: GT 001 TC 92

Project Directors

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<th>Name</th>
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<tbody>
<tr>
<td>Kurt Grammoll</td>
<td>Georgia Tech</td>
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<tr>
<td>Ron Kriz</td>
<td>Virginia Tech</td>
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<td>Jim Craig</td>
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Project Abstract:

The basic goal of the proposed work is to investigate methods and identify pedagogical issues for using interactive multimedia in engineering education. This includes the development of multimedia computer programs and databases that incorporates visual, audio, hypertext and graphics into a dynamic, interactive computer environment to enhance the learning process of current engineering students and future engineering students in pre-college programs.

Project Status:

Phase I will investigate the impact of interactive multimedia on discipline-specific engineering education. It will examine both content and structural issues as well as delivery format and technology issues. A prototype system will be produced for use in the basic deformable bodies (strength of materials) course that is required in most engineering programs. The prototype will be designed around requirements within aerospace engineering, and it will supplement the current courses and allow the students to explore more ‘what-if’ design analyses outside of the classroom. The main thrust of the initial multimedia program will be to teach beam theory and beam design, so results will be readily applicable to similar courses in other engineering programs. Common topics such as shear and moment diagrams, visualization of bending and shear stresses, deflection of beams, built up beams, composite beams, unsymmetrical beams, shear center, and vibrations of beams, will be covered. Phase I will also explore the use of multimedia and hypermedia technologies to stimulate curriculum integration. It will counter the natural tendency to begin decomposing the upper division curriculum into manageable subdisciplines.
Additional phases have been identified and are proposed for continued funding through SUCCEED. Phase 2 will extend a prototype development to other areas of structural engineering including structural dynamics, composite structural mechanics, reliability, and experimental methods. Phase 3 will include the integration of these materials into the capstone design courses that provide the final integration of all the engineering technologies.

The proposed project will rely heavily on present discipline expertise among the investigators and associated faculty. At the same time, both Virginia Tech and Georgia Tech have notable ongoing research programs to develop multimedia and hypermedia technologies, and these activities will serve as potential technology resources for the proposed project. Finally, the proposed project will be tested in the aerospace and engineering science curriculum at both institutions, while it is not a specific task in the proposed work, every effort will be made to extend these results to the mechanics courses common to other engineering disciplines.
Project Title: Improving Student Performance and Retention in a Basic Physics Course
Project Number: GT-005-TC-92
Project Duration: 9/1/92 - 8/31/93

Project Directors:
Name: L. B. Hodges, M. J. Marr, N. Walker, A. Badre, E. Thomas
University: Georgia Institute of Technology

Project Abstract:
The purpose of this project is to develop and evaluate interventions to improve student performance in Introductory Physics. The project addresses two educational challenges. First, fluency in basic skills will be improved through the development and introduction of computer-based Precision Teaching techniques. Second, the ability to solve critical problems specific to electricity and magnetism will be improved through the use of interactive simulation programs. The project is designed to systematically evaluate the impact of these interventions on student performance and retention in the course.

Project Status:
Since the project began last fall we have accomplished the following:

1. **Formed a team** to develop the instructional materials. The team comprises, in addition to the course instructor, two graduate students in physics and two in psychology with a background in the topic (one has an undergraduate degree in electrical engineering and the other is a graduate of Georgia Tech who earned an 'A' in the course).

2. **The materials** consist of a set of five modules per week for the ten-week course covering relevant mathematical skills, units and dimensions, conceptual or intuitive items requiring no calculation, but basic understanding of principles, and a set of elementary physics problems requiring one to three steps for solution. The primary goal of the student is to achieve correct solutions at the highest possible rate. By determining the instructor's rate of correct solutions, we are able to set criterion rates as a percentage of that rate.

3. **Developed an evaluation plan.** During the current winter quarter, we are testing our materials with approximately a third of a class of 150 students. Students in this group receive four modules a week to work through at home to achieve the set level of fluency. They are instructed to spend only a total of 40 minutes on each module. At the end of the week, they do a fifth module of the set in a special class to determine their level of performance and deal with any questions. Their rates on the modules are being correlated with quiz performances during the quarter and final exam, and compared with those students not receiving the modules. We also have available their overall GPAs and grades in the earlier physics course in mechanics. These measures will allow us to evaluate and interpret outcomes based not only on within-course performance, but in relation to previous academic performance. It should be emphasized that this quarter's activities will serve primarily as a pilot project to assess our methods and materials. We are continually requesting feedback from the students about all aspects of the procedures.
4. **Student performance to date** has been very encouraging. Preliminary indications at midterm show that performance is significantly enhanced when students follow the procedures created by this project. Student participation is voluntary but we have determined that participating students have average GPAs which are close to the average GPA of all students in the course; their previous performance in physics courses is actually slightly lower than the class average. However, most students following our procedures are earning A's and B's on weekly quizzes and their quiz averages are almost 10% above the class average. Interviews with students indicate their enthusiastic reception of the materials and have provided anecdotal evidence that they believe their performance is improving.

5. **Began computer-based delivery development.** A Macintosh computer system and supporting software, including the Authorware multimedia authoring tool, has been ordered to begin the task of converting the paper and pencil materials we are now testing to a computer-based delivery system. This system will allow for much better control and development of student performances, as well as greater flexibility in the kinds of materials we can use. One of our members attended the December multimedia materials workshop at VPI. We also added a new team member who is a doctoral student in instructional technology to assist with the ongoing design and development of computer-based materials. We plan to begin testing computer-based learning modules during next quarter (Spring 1993).
The goals of the proposed project are to determine, for an undergraduate engineering course, whether computer-based instruction (CBI) is superior to instruction using traditional media and to determine the types of problems that are most likely to be aided by CBI. Satisfaction of these goals will be a major contribution to engineering educators everywhere who are considering CBI. The project team will develop four CBI units—one each for problems in implementation, design, analysis, and background—for a required third-year engineering course. The team will test the CBI units against each other and against traditional instruction in a controlled experiment at two coalition institutions. The CBI units are likely to be useful in engineering courses across the U.S. for some time, but the major benefit from the project will be the insights into CBI that will apply across all disciplines.

Because funding was unavailable until December, the project started slowly. However, in recent weeks the project team has gained momentum and remains confident that project goals will be achieved on schedule.

The major work items accomplished to this point relate to the selection of computer programs in which the instructional units can be written. The Project Director attended an informative seminar at Virginia Tech that explored available alternatives in multimedia. Many ideas regarding programs and computing environments were exchanged. However, much of the discussion was centered on PC and Macintosh tools, while the project team is committed to workstations. Other explorations by project team members have revealed several workstation-based programs. Our current favorite is cT, a flexible language developed at Carnegie-Mellon that appears capable of supporting the types of applications we have proposed.

Concept development is just beginning. Ideas for unit content have been discussed among project team personnel, but no major achievements can yet be claimed.

The project team has explored experiment design to a limited extent. A seminar at NCSU on evaluation of instruction conducted by Dr. Neff Walker of Georgia Tech was valuable and provoked discussion among project team members. Reading and other discussion have provided other ideas. The project team will concentrate on the computing environment and concept development in the next few months, but the experiment design will not be ignored.
SUCCEED Center: Center for Information and Technology
Project Title: Emulated Flexible Manufacturing Facility
Project Number: UF 023 TC 92
Project Duration: 8/17/92 - 2/28/94

Project Directors

Name: Suleyman Tufecki  Sencer Yeralan  Paul Griffin  S. Manivannan
University: University of Florida  Georgia Tech  Georgia Tech  Georgia Tech

Name: Chen Zhou
University: Georgia Tech

Project Abstract:

This project deals with the development of an emulated flexible manufacturing laboratory which emulates the actual manufacturing facility via a network of personal computers. Each PC will represent a department or a machine in the emulated facility. Each station will be programmed to perform specified tasks. The network of PCs will be re-configured based on the project/product assignment for the integrated engineering project team. Each team will design the assigned product, make necessary process planning, re-configure the manufacturing facility by using only the minimum necessary equipment, decide on the routing, batch sizes etc. Once startup is completed the system will start emulating the actual production. Each PC, through its CD ROM technology, will display the actual digital video images of the machine it is emulating on the screen and the stereo sound effects will provide the actual sounds of the machine as it operates. Also, through windowing the screen will also display the status of the machine and the batch it is operating on. It will produce random breakdowns and repairs as well as regularly scheduled maintenance schedule as well as tool changeovers. Furthermore, it will generate necessary performance data to the CIM database to be used by the students for making tactical production scheduling decisions.

Each batch of work-in-process inventory will be represented by a single floppy diskette. They will be transported via an actual conveyor belt between stations and loaded and unloaded to and from the PCs by using a vision controlled sensory robot. The students responsibility will be to design the product, Material selection, process selection, layout decisions, routing, real-time scheduling and machine loading, and learning the effects of different production control strategies on the cycle time, work-in-process inventory and the meeting customers expectations.

One of the most important aspects of this project is the courseware to be developed in parallel with the laboratory development. In this aspect, the students will be introduced to the just-in-time learning environment where the knowledge needed to tackle the problem at hand will be provided to the students in a "pull" environment.
The OCO budget requested in this project has not been released to us yet. Because of this difficulty, the progress of the project had a serious setback. All activities involving establishing the laboratory acquiring personal computers vision systems, conveyors, robotic arm and all associated network software and multimedia image development software, video images of machine tools, establishing sound effects, developing the network and the integration of the system has been delayed seriously.

On the other hand, we have started developing courseware which will be an essential part of the laboratory. Notes on subjects such as Total Quality management, Design for Quality, Design for Manufacturability, MRP, JIT, Kanban Systems, Machine Scheduling, Optimization, Group Technology, CAD/CAM, CIM, Flexible Manufacturing Cells, Materials, Facility Layout, Engineering Economic Analysis, Production Control, Inventory Control, Processes, CAPP, etc. are currently being developed to be delivered to the students on a need only or just-in-time basis.

We have already compiled a list of machine tools that we will archive in video images and sound effects to be used in the laboratory. This list will be expanded in the later phases of this project to give more flexibility to the laboratory. Several machine tool manufacturers in the U.S.A., Japan, and Europe have been contacted for the availability of video images of their machine tools. For those manufacturers with no such images, permission is being requested for recording some of their equipment in an actual manufacturing environment for realistic sound effects.

The groups from Georgia Tech and University of Florida have met three times in the past to establish the conceptual design of the laboratory. As result of these meetings we are in the final phases of finishing the conceptual design of the laboratory. As a consequence of these series of meeting we have established that the products will be designed and manufactured in a virtual reality environment rather than in a physical environment.

This decision was due to the impossibility of mixing real product parts with the computer simulated operations. Furthermore the laboratories will be easier to maintain and more flexible even if the technologies change in time since this will only necessitate acquiring the images and vital information on the new technologies and loading it onto each PC's CD ROM environment.

Although the software development has not yet commenced, we studied and evaluated candidate platforms for the PC network to be designed. Particularly, we have considered UNIX, UNIX on X86s PCs, MS Windows, and MS Workgroups. Because of the heavy reliance of the laboratory on the multimedia tools for image presentation and sound effects, the group decided to adopt the MS Workgroup as the development platform for the laboratory, since it supports network and multimedia components. MS Workgroup also enjoys the third party vendor support and is expected to be fully compatible with Microsoft's next generation operating system, MSNT
SUCCEED Project Information Directory

SUCCEED Center: Information and Technology
Project Title: Development of Multimedia Teaching Learning Environments in the Framework of SUCCEED's Integrated Engineering Core.
Project Number: VP 001a TC 92  
Project Duration: 7/1/92 - 6/30/93

Project Director

Name: Siegfried M. Holzer
University: Virginia Tech

Project Abstract:

This project is concerned with Stage I Learning, the Integrated Engineering Core, of SUCCEED's Curriculum-21, and is associated with the Center for Information and Technology. Our objectives include: development of multimedia programs that will provide a creative introduction to the engineering design process, development of multimedia programs to improve the quality of the teaching/learning environment for several courses in the Integrated Engineering Core, devising a mechanism for continuous evaluation and improvement of teaching and learning in the spirit of TQM, and sharing of instructional programs with community colleges to strengthen our interface and facilitate recruiting.

The scope of our project is relatively large to create an environment for experimentation, innovation, and integration, as envisioned in the original SUCCEED proposal. It is anticipated that the proposed work will require a multiyear effort. Specifically, our multimedia development will focus on the domains of engineering fundamentals, statics, and dynamics. To make the project manageable, subject area responsibilities are assigned as follows: Engineering Fundamentals: Thomas D. Walker, Statics: Siegfried M. Holzer, Dynamics: L. Glenn Kraige, and Community College and University Interface: James R. Martin.

To meet objectives of SUCCEED, we expect that there will be fundamental changes in the current content and organization of these courses. We will collaborate with representatives of all centers to establish the course framework, course content, and instructional environment for our work.
**Project Status:**

**Engineering Fundamentals.** The initial assessment of the incoming freshman class for the fall of 92 has been completed using primarily the results of a math skills test. The results indicate problems with visualization and verbal skills. The students have virtually no problem with math facts, just with how to use those facts to solve simple problems. The assessment criteria are being revised and the test will be readministered this spring semester.

A multimedia classroom presentation dealing with graphing techniques for technical data and the development of empirical equations from that data is about 50% complete.

One of our primary multimedia presentations to the freshman class involves the use of the CAD package in the spring semester. CADKEY allows us to do excellent presentations concerning engineering design graphics. This semester students will model solids using primitives.

**Statics.** A program was developed to demonstrate the potential of multimedia as a teaching aid for statics. The completed lesson modules reflect components of our standard statics course. In response to an invitation, the program was presented by Kraige at the ASEE Mid-Atlantic Conference, November 7, 1992, which resulted in a considerable number of requests for the program.

Current activities in statics center on the development of lesson tutorials and a graphical user interface (GUI). The focus of our efforts has shifted from the teaching environment to the learning environment. Multimedia tutorials are being designed to accommodate the individual learner. Constructivism asserts that each individual must build his/her own mental models (understanding). This process is unique to each learner and cannot be performed by the teacher for the student. The purpose of our tutorials is to facilitate this learning process. We are planning to provide a user option to reduce the degree of interactivity of the tutorials to make them also suitable as teaching aids in the classroom. The function of the GUI is to facilitate navigation in the program, to provide a common framework for a variety of subjects, and to provide access from any point in the program to common tools used in the workplace such as a wordprocessor, a spreadsheet, a programming language, a math package (Mathematica or Maple), etc.

Another ongoing activity concerns the preparation of a faculty guide for the development multimedia instructional programs. The guide, which we plan to transform eventually into a tutorial, consists of the following segments: opportunities; effective teaching and learning; guidelines for multimedia design; software and hardware requirements.

**Dynamics.** Efforts are being directed toward the standard engineering dynamics course. The decision was made to retain Authorware for the main structure of the software, but it was apparent that the current version, Authorware 1.1, was not adequate to produce animated line drawings (based upon parameters chosen by the user). Various persons and the literature were consulted, and we narrowed our choices down to Microsoft Visual Basic and Microsoft C/C++. Both were put through some fundamental tests. Based on this experience, C/C++ was selected as the main software for generating animated line drawings called from but run outside the main Authorware structure. With this choice made, the overall organizational scheme for dynamics was formulated. An introductory chapter was completed (which by necessity is similar to the introductory chapter for statics), and work is now progressing on the area of particle kinematics.
SUCCEED Center: Technology and Communication  
Project Title: Multimedia Enhancement of Introductory Physics for Engineering Students  
Project Number: VP-009-TC-92  
Project Duration: 8/17/92 - 2/28/92

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<td>Virginia Tech</td>
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<tr>
<td>R. L. Bowden</td>
<td>Virginia Tech</td>
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Project Abstract:

The purpose of this project is the implementation of multimedia instructional/learning techniques in the introductory physics course for engineering students. These techniques include the use of a computer-controlled "electronic blackboard" for a coordinated presentation of graphical information, collection and display of data from classroom demonstrations, effective use of video, presentation of simulations and animations of physical processes, and provision for immediate mathematical calculations and manipulations. The project will develop a set of presentations on various topics relevant to introductory physics. Each presentation will include various multimedia approaches to enhancing the instructor's facility to engage students in learning that topic. The presentations will be formatted in such a way that minimal knowledge of computers or multimedia is necessary for an instructor to choose from the options on a given topic. In later stages of the project, these same features will be made available for individual use by students to enhance their own understanding of physical principles. We will cooperate with other relevant SUCCEED projects in developing these tools, and make the results available to all SUCCEED institutions as well as the engineering community in general.
Project Status:

The primary initial task for this project was to become familiar with existing multimedia materials related to the teaching physics for engineering students--especially the CUPLE system (Comprehensive Unified Physics Learning Environment, directed by J. M. Wilson of Rensselaer and E. F. Redish of the University of Maryland). The structure of this system appears likely to become the standard for multimedia in teaching physics. It has numerous tools already built into the system, as well as presentations and tutorials on various topics in mechanics and optics. The project staff members have become familiar with CUPLE and have begun adapting some of the materials for use in the format of this project, including the quick recording of numerical data from video materials. The staff has also evaluated hardware and software for interfacing demonstration apparatus to the computer, primarily the MultiPurpose Laboratory Interface and Universal Laboratory Interface, both marketed by Vernier Software. It currently appears that the hardware for these systems will be very useful for our presentations, but that we will need to develop our own software for consistency with other aspects of our presentations.

The primary computer system we will be using for developing our presentations (a 486-50 with Videologic DVA-4000 video board and sound board) has just arrived in the current week. A Graduate Research Assistant began work (half-time) on January 12, 1993, and another senior graduate student (unfunded) has recently begun work on this project. It is anticipated that both of these skilled and qualified graduate students will be committed to this project full time during the summer term. Thus the staff and hardware are now up to full capacity on the project.

The staff are currently concentrating on developing full presentations on two sample topics: (1) the magnetic fields of currents and (2) interference and diffraction of light. Each of these presentations will contain multiple components, including a choice of: video presentations on the topic; live demonstrations with facility for quantitative measurements with immediate visual and graphical display of the results; animations/simulations of those aspects of the presentation that are difficult to visualize; tools for manipulating the data displayed; and other components to enhance student learning. The four staff members of the project are each focusing their attention on different aspects of these presentations.

It is expected that the two sample presentations will be ready for testing in classes during the Summer 1993 term. Feedback will be obtained both from instructors using the presentations and from students in the classes, in order to improve those presentations and to plan more effectively for future ones.
Project Abstract:

This proposed two-year exploratory research project aims to produce a multimedia library of cross-disciplinary visual teaching materials for Curriculum 21, using both CD-ROM and videodisc formats. The project will attempt to 1) identify the quality and quantity of existing visual images available in several engineering disciplines for use in developing multimedia materials, and 2) produce new, readily accessible electronic images to supplement engineering instruction in the classroom of the future. Faculty will use these visual materials both in current courses and as a key resource for creating additional multimedia courseware after the completion of this project. The deliverables in the first year are a videodisc, a printed barcoded index, and a keyword-based software index. In the second year, in addition to the revised videodisc and indices, a CD-ROM will be provided.

Phase one will identify, select, and consolidate existing visual materials from Coalition faculty, determine areas where a shortage of materials exists, produce an initial videodisc, and evaluate early faculty responses. Phase two will produce new video demonstrations, animations, graphics, and other images for curricular areas where shortages of visual teaching material were identified in phase one, and also provide the materials in digital form on a CD-ROM. At the completion of the project, a comprehensive, standardized, extensible visual database resource library will be available to engineering faculty. It is expected that the materials produced will be used throughout the SUCCEED Coalition as well as shared with other groups such as the Synthesis Coalition. In addition, the research should contribute to a better understanding of the use of visual databases in teaching, particularly in engineering.
Project Status:

A number of hurdles have been cleared in attempting to develop a useful visual database for engineering. The lack of appropriate, readily accessible, and easily adaptable visual materials has been well substantiated. While engineering faculty in general are eager to use new technologies to improve instruction, many rely heavily on the blackboard as a teaching aid and are reluctant to share the few visual materials they own. Problems of copyright restrictions limit acquisition to only those visuals which are in the public domain or freely shared. An initial survey of eight institutions in the SUCCEED Coalition revealed a strong need for new, relevant materials to replace severely outdated films and illustrations. Example requests are for simulations of fluid flow, 3-D depictions of magnetic fields, videos of drilled shaft construction, and computer animations of Euler rotations. We hope to address these and other needs during the second year of the project.

Work is currently in progress on developing a prototype Hypercard index and soliciting materials from faculty, professional organizations, and government agencies. Slides and photographs are being digitized and stored on optical disks, and video clips are being selected. We are constantly seeking new sources of pertinent materials. Final production of an engineering videodisc should provide a broad array of visual images to enhance Curriculum 21 and assist engineering faculty in motivating today's students.
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MAY 1, 1993

An NSF Engineering Education Coalition

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A. EXECUTIVE SUMMARY

This report describes the accomplishments of SUCCEED over the first three years of its operation as a participant in the NSF EEC Program. It also presents the plans for the Coalition’s continued operation and impact on engineering education at its participating institutions.

SUCCEED has undertaken a broad and ambitious approach in its programmatic efforts to address systemic reform of engineering education for the 21st Century. The Coalition’s purpose is to accomplish four specific results: (1) develop, implement and test the components and structure of a new curriculum model, (2) implement the methods and principles of TQM into the curriculum and its management, (3) increase the enrollment and retention of women and minorities in engineering by 50% and (4) promote interaction between Coalition institutions and the K-14 educational process. The report demonstrates that SUCCEED has made significant progress in the achievement of these goals.

The implementation of a Strategic Plan, which both provided for wide participation and involvement across the eight coalition campuses while at the same time focusing the efforts of these participants towards the goals of the SUCCEED, has been responsible for the progress and impact of the program’s activity. Hundreds of faculty are engaged interactively across the Coalition in sponsored activity. Thousands of students are being impacted by a wide variety of new courses, projects and other related experiences. All of these participants and program efforts are affecting systemic changes in the culture of the education process.

The new curriculum model, Curriculum 21, consists of three learning stages: an Integrated Engineering Core, an Engineering Design and Process Core and a Functional Engineering Core. The model will include the needed reforms and changes in engineering education that have been generally accepted and agreed to by the academic and practicing profession. Curriculum components in this model address new learning/teaching styles, delivery systems, subject integration, new technical content, engineering or professional practice applications and personal student development. A quick review of the list of major accomplishments of SUCCEED indicates that all of these components have been addressed and the results of these efforts are being implemented across the coalition.

Of the more than twenty major accomplishments that are directly impacting the development and implementation of the new curriculum model are the projects integrating math, science and engineering in the freshman year, the longitudinal study of the cooperative learning, the integration of humanities and biological sciences with engineering, the introduction of engineering experience in freshman engineering courses, a variety of successful courses which provide design process experience through vertical integration across the curriculum and interdisciplinary horizontal integration, creation of functional curriculum components in Process Systems Engineering, Internationalization, Technology Management and Materials Processing, creation and introduction of
multimedia course modules in the physical and engineering sciences and many more that are presented in detail in the report.

In introducing TQM principles and methods, SUCCEED has created a Curriculum Renewal Process which makes use of quality tools and procedures to assist faculty in assessing, evaluating and reforming existing curriculum. This process has been applied and tested on a number of programs on several campuses. Together with a Reference Manual, the Curriculum Renewal Process will become one of the major mechanisms and strategies for implementing and institutionalizing systemic curriculum reform across the Coalition. TQM, as new educational subject material, has been introduced into the curriculum through special courses, multimedia modules and the Quality Improvement Partnership program with industry. Quality and continuous improvement process efforts have also become a part of the management philosophy of SUCCEED with assessment and teaming activities at all levels of operation from Coalition administration to individual project direction.

The SUCCEED institutions have increased African American student enrollment over the period 1989-1993 by 45%. This is twice the national increase. During that same period undergraduate engineering degrees awarded to African American students have increased for Coalition institutions by almost 60%. Increases in enrollment of women in engineering at Coalition institutions have not changed as significantly. These enrollments have only grown by 12% which is the same nationally. Engineering degrees awarded to women have only increased by 6% over the same period.

SUCCEED supports two major activities to address the goal of significant improvement in the academic participation and success of women and minority in engineering. To address women's issues and raise these topics to higher levels of priority across the Coalition, the Women's Engineering Board (WEB) was formed. To address the significant loss of women and minority students early in their educational careers, the Minority Retention Mega-Project was implemented. Both programs have been successful in meeting their original objectives. The Minority Retention Mega-Project implemented pre-engineering bridge programs, similar to the very successful Georgia Tech "Pre-Season" program, at three Coalition campuses this past summer. Participants in these three programs performed academically this past fall at a 1/2 point average GPA better than non-participants and 60% were on the Dean's List. The WEB has held two Coalition-wide conferences on women's issues and is planning a third, has developed and provided training for an Equity Workshop and is conducting an extensive coalition-wide survey of students on the subject of "The Educational Climate".

Improving the interaction of the Coalition with the K-14 educational process has been addressed by two major efforts. A Community College Interface Program (CCIP) developed, implemented and tested at the University of Florida and a Mentoring / Professional Success Program implemented by UNC-Charlotte with the Charlotte Mecklenburg School System. The CCIP offers a week long "Transition Program", a year long mentoring program, guaranteed transfer admission based on academic performance
and has created a data base to assess student performance and difficulties. Two other Coalition institutions are planning implementation of similar programs. The Harding High School Program at UNC-Charlotte places undergraduate and graduate engineering students in the secondary school as mentors, provides summer workshops and assisted this past spring in sponsoring a team in the U.S. First Competition.

This summary of accomplishments is indicative of the energy and effort that the SUCCEED institutions and program participants have put into working towards achieving the goals of the Coalition. More examples with greater detail are provided in the full report.

Entering its fourth year of activity, SUCCEED will continue with the implementation of Phase IV of its Strategic Plan. Phase IV further consolidates and focuses the research, experimentation and pilot efforts of the Mega-Projects now underway and initiates a dissemination and institutionalization strategy that will result in greater implementation of sustainable educational reform across the coalition. The final group of Deliverable Teams created will undertake this task with resources redirected from research and development efforts which are now achieving their original goals. This transition from research, development and test to dissemination and institutionalization will take place during the fourth year, while the latter effort will become the focus of SUCCEED in its fifth year. Plans for continuing curriculum development activities, of which there will always be some, are covered in detail in the body of the report.

SUCCEED is proud of the progress it has made over the past three years in creating a new curriculum model, introducing TQM methods and procedures to engineering education, increasing the participation and success of women and minorities and increasing involvement with the K-14 educational system. In the process, the Coalition has learned much about how to work together, to take advantage of common and special strengths and to assess, evaluate and revise plans and programmatic efforts as SUCCEED strives to achieve its vision for the future of engineering education.
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APPENDICES
B. VISION, MAJOR ACCOMPLISHMENTS, AND FUTURE PLANS

1. Vision

a. Background

The Southeastern University and College Coalition for Engineering Education (SUCCEED) was formed during the 1989-1990 academic year in response to a request for proposals from the newly announced NSF Engineering Education Coalitions Program. SUCCEED includes the engineering colleges at Clemson University, Florida A&M University/Florida State University, Georgia Institute of Technology, North Carolina A&T State University, North Carolina State University, University of Florida, University of North Carolina at Charlotte and Virginia Polytechnic Institute and State University.

The selection and grouping of the participating engineering colleges in SUCCEED was motivated by the demographic requirements and objectives of the NSF EEC Program request for proposals. The EEC program goals for engineering education reform were to: improve the quality of engineering graduates, increase women and minority participation, create new curriculum models, content and delivery, and promote interaction among institutions. SUCCEED’s response to the RFP emphasized taking advantage of the Coalition’s unique regional demographics, having a positive impact on engineering education, responding to industry’s changing engineering needs and applying a continuous improvement process to engineering education.

The Coalition submitted a proposal in 1990 and was successful in the second round of awards. A Cooperative Agreement between the National Science Foundation and North Carolina State University, acting for the Coalition, was executed with a starting date of March 1, 1992. Fiscal management and general administration of the Coalition has been directed from the N.C. State campus over the past three years.

Early Coalition management was conducted by the Coalition Director (Project PI) and Associate Director, four programmatic Center Directors and a Campus Representative (Project Co-PI) at each participating institution. The four programmatic Centers were created to take advantage of specific areas of existing educational reform strengths within the Coalition. These Centers focused on Curriculum Content and Integration, Professional Success, Engineering Practice, and Technology and Communications. The Director, Associate Director and Center Directors were responsible for programmatic development and direction. The Campus Representatives provided administrative liaison for faculty participants and together with the Director, Associate Director and Center
Directors formed the Program Committee that approved all programmatic efforts and related budgetary decisions.

b. Mission, Vision, Goals and Objectives

The mission of SUCCEED is to engage in engineering education reform as a coalition of engineering colleges in partnership with the National Science Foundation and industry. Engineering education reform in this generic context is understood to consist of the educational and curricular research, experimentation and development required to establish the content, framework, instructional techniques, advisement and mentoring systems, learning environment, reward mechanisms and evaluation procedures that will produce the desired holistic undergraduate educational experience.

The vision of SUCCEED is to create sustainable engineering education reform having national impact through the collaborative strength of a coalition of engineering colleges. The specific educational reforms to be accomplished are outlined in the work statement in the Cooperative Agreement under two general dictates: substantially improve the quality and relevance of engineering education programs and positively impact engineering education in the 21st Century. These two primary goals are to be achieved through the implementation of educational research programs to produce results in four specific areas. These are listed here as summarized from the detailed statements that appear in the Cooperative Agreement.

1. Develop, implement and evaluate Curriculum 21
2. Implement total quality management into the educational process and its management
3. Increase female and minority enrollment and retention by fifty percent
4. Promote engineering involvement and interfacing with the K-14 educational process

Curriculum 21 is SUCCEED's undergraduate engineering curriculum model for the 21st century. It embodies those elements of educational reform that recognize and address the knowledge and performance capabilities required by the changing technological, communication and personal interaction needs of industry and society in engineering graduates. The characteristics of both Curriculum 21 and the intended graduates are almost identical to those listed under “Reshaping the Curriculum” in the recent ASEE Report “Engineering Education for a Changing World” commissioned and adopted by the Engineering Dean's Council of the ASEE.
The characteristics of SUCCEED’s educational model and its intended graduates are listed below.

### Curriculum
- Content integration
- Continuous improvement
- Engineering practice
- Student mentoring
- Promote life-long learning
- Early design
- Electronic delivery
- Promote success

### Graduates
- Technically competent
- Process developer
- Globally aware
- Problem solver
- Team member
- Integrator
- Product innovator
- Functional specialist

The curriculum model proposed by SUCCEED consists of three distinct learning stages: Stage I - Integrated Engineering Core, Stage II - Engineering Design and Process Core and Stage III - Functional Engineering Core. The first learning stage introduces students to engineering as soon as they begin their university studies. The physical sciences, mathematics, life sciences and humanities are integrated with engineering and its practice. In the second stage students learn to integrate design and process engineering through exposure and experience in team approaches to problem solving with the subject content emphasizing engineering sciences and their applications. In stage three students participate in the solution of complex realistic engineering problems stressing functional aspects of engineering practice like product development, manufacturing, technology assessment, project and financial management, environmental impact, global engineering, etc.

Distinct programmatic and operational strategies were developed and implemented by SUCCEED to meet the requirements of the work statement in the Cooperative Agreement. Both of these strategies have evolved to their current status over the Coalition’s three years of operation.

The programmatic strategy now being employed consists of three Goals with accompanying objectives defined to achieve the results specified in the Cooperative Agreement. The first and second goals listed below map directly onto the first and second work statements. The third goal is directed toward achieving the collective results of the third and fourth work statements.

**Goal 1. Reshape Engineering Curricula for the 21st century**
- a. Increase integration of curricular content
- b. Enhance performance skills; e.g. teamwork, problem solving, communications
- c. Integrate engineering practice experiences
- d. Provide multidisciplinary team experiences
e. Incorporate effective information and communication technology

**Goal 2. Instill Continuous Improvement in Engineering Education**

a. Employ principles and methods of continuous quality improvement  
b. Adopt a customer focus  
c. Enhance participation of students, faculty and industry in the improvement process  
d. Employ continuous evaluation and assessment

**Goal 3. Provide an Educational Environment Fostering Success in Engineering**

**Students**-

a. Commitment to the retention of students  
b. Expand transition, mentoring and networking activities  
c. Provide effective information on careers in engineering  
d. Promote undergraduate research experiences  
e. Nurture success in each student

**Faculty**-

a. Encourage engineering practice experiences  
b. Incorporate diversity  
c. Expand mentoring and networking activities  
d. Develop, promote and reward teaching excellence

The operational strategy was based on the premise that successful educational reform will require the active participation and commitment of innovative and dedicated faculty across the coalition. SUCCEED’s primary initiative in its first year of operation was to identify these committed faculty by funding projects that permitted them to pursue educational research and experimentation in support of the Coalition’s programmatic goals and objectives and assessing the results produced. This constituted the Phase I project activity involving some 150 faculty in 40 projects across the coalition.

To provide focus for programmatic efforts of the four Centers specific deliverables were defined. These deliverables were based on each Center’s mission, and would map directly onto one or more of the results to be achieved in the Cooperative Agreement work statement. These deliverables were used to define “research gaps” in the Phase I project activity. This lead to the funding of Phase II research projects in the Coalition’s second year of operation to correct these earlier omissions. The deliverables also provided a basis and rationale for bringing together and integrating the results of Phase I and Phase II into focused team efforts. These teams will be responsible for achieving the goals and objectives of the Coalition. These focused team efforts were identified as Mega-
Projects and Deliverable Teams respectively depending on the level of integration and/or impact they would have on the achievement of the objectives.

The deliverables, as originally defined and used to initiate the Phase III integration of Phase I and II projects into Mega-Project and Deliverable Team, consisted of:

1. Achieving a coalition wide increase in enrollment of women and minority students by fifty percent.
2. Developing a process for renewal of existing engineering curricula.
3. Developing a new Process Engineering degree program.
4. Developing a baccalaureate degree combining engineering and management.
5. Demonstrating electronic connectivity for educational delivery and interaction.
6. Demonstrating multimedia technology insertion into teaching/learning situations.

Organization of Mega-Projects and Deliverable Teams was begun and continued throughout the third year of operation of the Coalition. The Mega-Projects and two Deliverable Teams that are now operational include:

1. Stage I Integration Mega-Project
2. Curriculum Renewal Process Mega-Project
3. International Awareness Program Mega-Project
4. Process Systems Engineering Mega-Project
5. Industrial Internships Mega-Project
6. Early Design Experiences Mega-Project
7. Technology Management Engineering Mega-Project
8. Women’s Engineering Board Mega-Project
9. Minority Retention Mega-Project
10. K-14 Pipeline Mega-Project
11. Electronic Connectivity Deliverable Team
12. Courseware Development Deliverable Team

A mapping of the Mega-Projects and Deliverable Teams grouped by Centers that direct them programmatically against the desired results of the Cooperative Agreement work statement is illustrated in Figure 1. A characteristic of this mapping is that individual MP/DT’s map onto more than one of the four results specified in the work statement of the Cooperative Agreement.
As might be expected the greatest impact of the projects in the Centers for Curriculum Content and Integration, Engineering Practice, and Communication and Technology are on the development and implementation of Curriculum 21 as the major theme of the Coalition. However, these projects will also make significant contributions to the other work statement results. The same is true of the projects under the direction of the Center for Professional Success except that these will have the greatest impact on the third work statement issue, as would be expected. Although six of the projects will contribute to the involvement and interfacing with the K-14 educational process the activities undertaken to date will have lesser impact on this work statement issue than the other three. This is addressed in the future plans for the Coalition.

A graphical representation of the of the time line and relationship of the Phase I and Phase II projects as well as the Phase III Mega-Projects and Deliverable Teams to the four result areas of the work statement are presented in the enclosed four fold-out Gantt Charts; one for each of the four work statement result areas. These charts further expand on the relationships of the matrix in Figure 1 and introduce the concept and role of Phase IV activity in the Coalition’s Strategic Plan. Only those projects having high (H) or medium (M) impact are included on the Gantt Charts. Phase IV will consist of the development of the final group of Deliverable Teams to be added to the two that are already operational that will achieve the goals of the Coalition and the results specified in the work statement in the Cooperative Agreement.
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Increase Minority/Women Enrollment & Retention 50%
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**Involve & Interface with K-14**

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**Project Status Plan Summary**

- Task Progress
- Milestone Summary
- Rolled Up Task
- Rolled Up Milestone

Page 1
The final group of Deliverable Teams that will be developed along with the Phase II projects and Mega-Projects that will be folded into them are listed below:

Stage I Integrated Engineering Deliverable Team
- Stage I Integration Mega-Project
- Integrating Humanities with Engineering
- Life Science Integration

Stage II Design and Process Deliverable Team
- Early Design Experience Mega-Project
- Engineering Design Center (Clemson)
- Team Teaching in Design
- Studio for Engineering Practice
- Engineering Design Center (Virginia Tech)

Stage III Functional Engineering Deliverable Team
- Internationalization Mega-Project
- Process Systems Mega-Project
- Industrial Internships Mega Project
- Technology Management Mega-Project

Curriculum Renewal Process Deliverable Team
- Curriculum Renewal Process Mega-Project

Diversity Success Deliverable Team
- Evaluation Systems for Academic Advising
- Minority Retention Mega-Project
- Women's Engineering Board Mega-Project

K-14 Pipeline Deliverable Team
- Community College Interface Mega-Project
- Mentoring Program at Harding High School

This group of Deliverable Teams represents some revisions in what was proposed and anticipated when the earlier Coalition deliverables were defined. These changes are a result of lessons learned as the project has progressed and an proactive efforts to direct the Coalition activities to better insure that results in the Cooperative Agreement work statement are addressed.

As time has progressed and the Coalition has assessed the achievements and results of its activity to date, it has become clear that some of the objectives and deliverables it originally proposed were ambitious for the scope of the project and the time and resources available. One specific example was the intent to establish new degree programs in Process Systems Engineering and Technology Management Engineering. To do this posed developmental, organizational,
marketing and implementation problems that far exceed the time, resources and institutional commitment available for this large an effort in a five year period. Moreover, surveys of industry has revealed that while there is clearly a market for the skills embodied in these proposed programs, there may not be a sufficient demand for entirely new degrees. This issue is raised to illustrate that the process of effective and meaningful educational reform may need in some instances to be more evolutionary than revolutionary to be truly beneficial. It is recognized that the lessons and experiences gained from past Coalition activities and efforts must provide the basis for the continuous evolution of specific goals and objectives if the overall coalition project is to achieve meaningful results and outcomes that will truly create sustainable engineering education reform for the 21st century.

In the case of the two new degree programs previously mentioned, it is now recognized that the development of special functional engineering courses and content together with program minors or certificates enabling these specialty areas to be combined with existing programs as part of Stage III of the Curriculum 21 model is the more appropriate way to proceed initially. The lessons learned from these experiences will provide the basis for the decisions necessary to commit the time, energy and resources to create new degree programs if and as appropriate. There are other aspects of the original goals and objectives of the Coalition that will need to be revised as a consequence of the lessons learned from the continuing operation of the overall project. This is not a flaw in the process. Continuous improvement demands continuous assessment and evaluation together with corrections and changes based on these assessments while maintaining a clear focus on the goals and objectives of the Coalition.

2. Major Accomplishments

a. Introduction

Over the past three years, SUCCEED has accomplished a great deal in the areas of educational research, involvement of faculty and students, institutional interactions, and programmatic achievements towards the realization of the goals in the Cooperative Agreement. The Coalition has completed the Phase I and Phase II research project activity of its Strategic Plan. It has implemented Phase III which integrates the research project activities and results of Phase I and II into focused Mega-Projects and Deliverable Teams. As reported by SUCCEED participants in a survey for the NSF EEC Database, there are now in excess of 250 participating faculty, management staff, and other educational personnel directly involved in Coalition activity. Over 2800 students are being impacted in a variety of experimental classes, projects, internships, workshops, etc. In excess of 250 students are actively engaged in educational research, teaching assistantships, and outreach. Details on these statistics and additional personnel are presented in the data section of the Appendix.
Figure 2 illustrates the high degree of coalition participation and interaction that is taking place because of SUCCEED supported projects. This matrix indicates the number of project participants being supported by budgeted SUCCEED funding at each institution and on each Mega-Project and Deliverable Team in year three of the Coalition’s operation. The vertical totals indicate the total number of NSF funded participants on each project. The horizontal sum of all these all project totals, 173, represents the total number of participants coalition wide that are receiving budgeted NSF support. Horizontal totals for each institution, excluding the figures in parentheses, are the sum of all participants on that campus receiving NSF support through SUCCEED. The numbers in parentheses represent individuals on a given campus on two or more projects.

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Numbers in ( ) denote people funded by multiple projects on a particular campus.

Figure 2 - Coalition Participation and Interaction

The matrix in Figure 2 clearly demonstrates the impact and success of SUCCEED in promoting participant interaction across the coalition campuses. Every Mega-Project project and Deliverable Team involves participants from at least three campuses and in two instances from all eight campuses.

Listed below in summary form are the major accomplishments of SUCCEED categorized by the four work statement areas in the Cooperative Agreement. Also included are accomplishments in Evaluation and Assessment and Coalition wide activities. The summarized statements are discussed in greater detail in the following sections by Mega-Projects and Deliverable Teams or in other locations in the report.
Curriculum 21

1. Integrated Math, Physics and Engineering Course offered twice at N.C. State.
2. "Knowledge Studio" project planning completed and studio facility planned at the University of Florida.
3. Three courses integrating Life Sciences with Engineering taught at N.C. A&T State, Georgia Tech, and the University of Florida.
4. Modules completed at Georgia Tech and N.C. State for two courses integrating Humanities with Engineering.
5. Freshman "Take-Apart" Laboratory developed, tested, and institutionalized at N.C. State. Under adoption at the University of Florida.
6. International Awareness Option developed and adopted at UNC-Charlotte & Clemson. 13 Firms supporting program and 11 students placed.
7. Process Systems Engineering cases industry survey completed at the University of Florida.
8. Twelve Hour Mega-Course developed for PSE Minor for fall semester at the University of Florida.
9. Interdisciplinary Design Course for PSE Minor developed at the University of Florida.
13. Competencies for TME program developed at N.C. State.
16. Multimedia module development facility and assistance program implemented at Virginia Tech.
17. Visual Data Base to assist in multimedia courseware creation developed and available at Virginia Tech.
18. Introductory Freshman Engineering Course developed and implemented at the University of Florida.
19. Freshman year revised at UNC-Charlotte.
20. SUCCEED curriculum template being used to study complete engineering program at UNC-Charlotte.
TQM in Educational Process

1. Curriculum Renewal Process for assessing program content and effectiveness completed and in test at the University of Florida, Clemson and N.C. A&T State.
4. Duke University added to QIP participating campuses this spring.
5. Preparation course for QIP taught at N.C. A&T State, N.C. State and UNC-Charlotte for three years over MCNC-Concert Network.
6. “Low Ropes” course for team training designed and built at N.C. State.
7. Multimedia TQM course module developed and used at Virginia Tech.
8. Introductory TQM for Engineers course developed at the University of Florida.

Diversity Success

1. Preliminary study of retention of Women and African American Engineering students completed at N.C. State.
2. Enrollment of African Americans increased by 45% across the Coalition (1989-1993); twice national average.
5. Retention, Mega-Project implements pre-engineering “bridge” programs at N.C. State, FAMU/FSU and N.C. A&T State similar to successful Georgia Tech “Pre-Season” Program.
6. Sixty percent of students in pre-engineering programs on Dean’s List after Fall semester.
7. Average GPA of students in pre-engineering programs are 0.5 higher than control group of non-participants.
8. Georgia Tech expanded Pre-Season Program to Community College transfer students.
10. Women Engineering Board (WEB) operational for three years.
11. Two WEB Conferences held.
12. SUCCEED/WEB Women’s Directory published for two years.
13. WEB sponsored Sensitivity Trainer’s Workshop.
14. Academic Climate Survey of Students developed and implemented by WEB.
K-14 Interface

1. Community College Interface Programs developed and implemented at the University of Florida.
2. SUCCEED Statics courses taught at two Community Colleges in Florida.
3. Data base for transfer students from Florida Community Colleges developed.
5. Sponsorship of U.S. First Competition participation at Harding High School by UNC-Charlotte.

Evaluation and Assessment

1. Evaluation & Assessment Leadership Team established.
2. Development of Qualitative and Quantitative Coalition assessment programs.
3. Development of Primer at Georgia Tech for project evaluation.
4. Evaluation & Assessment Workshop conducted at Second Annual SUCCEED Conference for project directors.
5. Guidance Team established program for TQM training.
6. Consultation for Evaluation & Assessment provided to Mega-Project Teams.
7. Pilot Qualitative Assessment program carried-out at N.C. A&T State.
8. Qualitative Assessment of N.C. State and UNC-Charlotte campus conducted in Spring.

Coalition (General)

1. Two Coalition-wide Conferences held.
2. External Advisory Board reconstituted; two meetings held in past year.
3. Four issues of Coalition Newsletter "Innovator" published; distribution of 4,000.
4. Diversity and Coalition-wide representation added to Guidance Team.
5. Coalition sponsored workshops in Teaching Effectiveness, Early Engineering Design, Effective Presentations and Project Assessment developed and offered.
6. WWW SUCCEED Home Pages established.
7. Over 50 industrial firms supporting Coalition projects.
8. Industry financial support at $600,000/year level.
b. Curriculum 21

The efforts of the Coalition to achieve systemic curricular reform together with the associated delivery systems to meet the objective of developing and implementing Curriculum 21 are encompassed by the activities of the following Mega-Projects and Deliverable Teams associated with the Center for Curriculum Content and Integration, the Center for Engineering Practice, and the Center for Technology and Communications.

Stage I Integration Mega-Project
International Awareness Program Mega-Project
Process Systems Engineering Mega-Project
Early Design Experiences Mega-Project
Technology Management Engineering Mega-Project
Electronic Connectivity Deliverable Team
Courseware Development Deliverable Team

These areas of activity have received the greatest attention and resources since they represent the basis of Curriculum 21, the major theme of the Coalition. The Stage I Integration Mega-Project includes those activities which contribute directly to the Stage I Integrated Engineering Core. The Early Design Experiences Mega-Project provides the basis for the Stage II Engineering Design and Process Core and will also contribute to the Stage I Integrated Engineering Core. The International Awareness Program, Process Systems and Technology Management Mega-Projects provide the foundation for three specific forms of the Stage III Functional Engineering Core. The Courseware Development and Electronic Connectivity Deliverable Teams contribute to and impact all three Stages of Curriculum 21 both in terms of subject material and total course delivery mechanisms.

Stage I Integration

The objective of this Mega-Project is to develop and pilot-test experimental curricula designed to improve the success of students during the initial stage of their engineering education. The hypothesis of the project is that the integration of subject material, including introductory engineering content, will lead to enhanced learning and increased motivation towards a career in engineering.

One such experiment is being conducted at N.C. State as the outgrowth of two Phase I projects: the Integrated Mathematics Physics Engineering Course (IMPEC) sequence and the Longitudinal Study on the use of cooperative learning. The team spent the first half of their first year planning the integrated teaching of the required Calculus and Physics sequence with a new course "Introduction to Engineering". The course was taught in the Fall 1994 term to 52 students.
Although the evaluation and assessment process is ongoing, the results of student surveys indicate they liked the group work, using computers, and the hands-on experiments but disliked the amount of homework.

A second Stage I integration experiment has been initiated at the University of Florida and involves faculty from three completed Phase I projects. The group is injecting considerable structure into the students education, using the concept of a "knowledge studio" as a focus. This "knowledge studio" will provide a single location for faculty to teach and coach, for students to access multimedia tools, conduct laboratories, solve problems as groups, and plan social calendars. This team has completed development of the first term of course work and the design of the "knowledge studio".

A Phase II project was completed at the end of this funding period which has as its main objective the development of introductory life science modules that integrate engineering principles with biology. This material will be integrated into the above two Stage I integration experiments after the initial results of these experiments have been analyzed. During the past year, three courses that integrate life science concepts with engineering principles were taught (at N.C. A&T State, Georgia Tech, and the University of Florida) and approximately 80 students were impacted. One of the courses was offered as a videotape course.

A second Phase II project now being completed addresses methods of integrating the humanities into Stage I learning. Course modules are being developed both at Georgia Tech and at N.C. State. Modules for the Georgia Tech course are 75% complete and for the N.C. State course are 100% complete.

Current engineering curricula start with fundamentals (math, chemistry, physics) and only much later attempt closure and overview with capstone design courses. This traditional approach is being supplemented by a unique project at N.C. State called the Freshman Laboratory, in which students immediately explore engineered products and processes. In teams of two and three, the students in their first year learn about six light-based devices and their associated technology and engineering through three roles: user, assembler, and engineer. The three primary successes of the course have been the collaborative working and learning environment, the time and freedom to tinker with the devices, and developing communication skills to technical audiences. While it is also supporting the activities of the Process Systems Mega-Project that involves several campuses, the Freshman Laboratory is in the process of being institutionalized at N.C. State with its own space and integration into the various engineering curricula. This will impact approximately a quarter of the entering engineering class. The course is also being adopted at the University of Florida.
International Awareness Program

The purpose of this Mega-Project is to respond to the need for engineers educated to function in the global engineering/industrial environment. Complementary components have been developed at Clemson and UNC-Charlotte. The Clemson approach is built around international internship experiences and foreign language proficiency. At UNC-Charlotte an international studies track has been developed that satisfies the general education requirements. The international track at UNC-Charlotte was developed by 13 faculty and 7 departments and began enrolling students in the Fall of 1994.

Outcomes to date include recruitment of 13 sponsoring firms, and placement of the first eleven students with these firms. Two of these students are currently on overseas internships. The second round of program activity (Fall 1994) involved significantly more companies and students than the first year, leading to a projection of 8/16 additional student internship placements in 1995 and increase the numbers of international track students. This next year will also involve students from two other SUCCEED institutions.

Process Systems Engineering

The purpose of this Mega-Project is to develop the content and structure of a new engineering curriculum in process systems engineering. This interdisciplinary undergraduate program will prepare graduates for broad participation in the total life-cycle of product/process design and development.

The immediate objective of the present project is to develop and offer Process Engineering (PE) course work via a Certificate, Minor or Option. The long-term goal of the project is to develop and disseminate the curriculum and course materials that would lead to a process engineering degree (BS or Professional Masters).

A survey of industry indicated overwhelming support (82% affirmative response) for a program leading to a Minor, Certificate or Option in Process Engineering. Opinion regarding a bachelor of science degree in Process Engineering was divided: less than half (36%) of the firms surveyed were in favor of such a program but a considerable majority (75%) would consider hiring its graduates. A certificate program has been approved by the curriculum committee at the University of Florida.

The survey also ascertained industry’s preference for the curricular content of a process engineering program. This has resulted in the development of a profile of the ideal Process Engineer. On the basis of the survey results and the ideal PE profile, a syllabus for a twelve-credit megacourse in PE was developed. The megacourse will be taught in Summer 1995 as a 12 credit (immersion) course.
In addition an interdisciplinary design course sequence in PE is now being developed for an initial offering in the Fall 1995. A planned minor in PE will include both the megacourse and the interdisciplinary design sequence as well as a practice component. Work is also underway to disseminate PE information through the Internet.

Early Design Experiences

The Early-Design Experiences Mega-Project was formed to increase the interaction between several Phase I early design projects and accomplish goals beyond the reach of any single project. The major Mega-Project goal is to disseminate methods of early design involvement by collection and publication of evaluation data and production of the Early Design Manual. The Mega-Project Team has members from six schools and has met five times in Year 3 with an average attendance of thirteen. Each member operates an Early Design Course at different institutions including competitive airplane design projects using teams of freshman and seniors (Virginia Tech), Chemical and Civil Engineering science courses that base course examples in several courses on a single industrial process or building (Clemson), a sophomore Industrial Engineering design course (UNC-Charlotte), an Electrical and Computer Engineering Entrepreneurs Program in which sophomores through seniors create small companies to design and market products (N.C. State), and team-based courses designing and fabricating bridges (N.C. State and N.C. A&T State) and unmanned aerial vehicles (Georgia Tech). Initial Mega-Project meetings have been facilitated and directed towards team-building and reaching consensus on the purpose, content and organization of the Early Design Manual. Later Mega-Project meetings have been directed towards improving the quality of evaluation done by the Mega-Project members. With the help of the Evaluation and Assessment Team, the Early Design Mega-Project has produced a common evaluation instrument that can be used with a variety of types of early-design experiences. At the end of Year 3, the Early Design Manual will be in draft form with a second edition planned for Year 4 which incorporates the team’s increasingly sophisticated evaluation data.

Technology Management Engineering

The initially proposed engineering and management curriculum program began serious planning efforts in Year 3. Two projects at N.C. State and the University of Florida surveyed industry to determine the management skills that industry would like in new hires. Survey results point to the need for general management skills such as team working, communication and TQM, but suggests less need in new graduates for higher level management skills such as accounting, marketing, finance and organizational behavior. A planning team composed of engineering and college of management faculty was formed at N.C. State and began planning a Technology Management Engineering (TME) degree program. This group outlined a four-year program and established the competencies
expected in its graduates. Feedback on the TME program was obtained from a focus group of SUCCEED's Engineering Advisory Board members at its December 1994 meeting. It was recommended that past N.C. State graduates having Engineering Operations or Industrial Engineering degrees be surveyed to identify the management skills that have been most useful to their careers and that the planning group explore other options besides a four-year degree program for producing engineers skilled in management techniques.

**Electronic Connectivity**

Electronic connectivity and collaboration has become one of the very important tools in academia, in research and development, and in industry. The mission of the Electronic Connectivity Deliverable Team is to develop specific strategies and implementation plans to demonstrate and partially establish a suite of electronic connectivity tools for the coalition schools. Four specific areas have been identified in which the Team is implementing and demonstrating the usefulness of electronic connectivity in engineering education. This includes both interactive and non-interactive modes in the areas of distance learning, courseware-supported education, research collaboration, and advising and mentoring.

Experiments have been conducted in the various aspects of electronic connectivity including the use of satellite facilities, leased-line facilities such as ISDN, ready access facilities such as Internet and MBONE, and more advanced technologies such as ATM. In all cases, communication has been established through the use of off-the-shelf components. The ultimate goal is to evaluate and assess the user perception of the system and the resource utilization in the particular connectivity implementation.

An example application that is under study is the use of video office hours to enhance the learning experience of students participating in a distance learning environment. Using the connectivity facilities at their own desktop PCs, faculty and students are able to view one another, hear one another, and interactively use the same software package or draw on the same "white board". The objective is to provide an environment similar to one available to a student who has physical access to a faculty member. This is but one of several experiments to determine the effectiveness of the technology and to develop methodologies for its implementation and practical use in engineering education.

Having started in the second year of the coalition's operation, all connectivity projects are still in their exploratory phases. Because of the nature of the tasks, the Electronic Connectivity Deliverable Team was formed rather quickly, and has functioned with a high degree of interaction and collaboration. With the objective of investigating available technologies nearly completed, the team is now
beginning the process of developing the demonstration projects described in the deliverable statement.

**Courseware Development**

Members of the Courseware Deliverable Team are heavily engaged in producing a variety of courseware modules addressing many different engineering education needs. Because of the diverse needs of the member schools, two different development environments and correspondingly two different platforms are being used. These consist of both IBM PC compatible and Apple platforms. It was similarly difficult to choose a single authoring software. Therefore, two different development packages are being used. Both primary authoring tools have PC and Apple versions and there is some degree of cross platform compatibility. The matter of style and other details of presentation development have been left open as research questions, though some general guidelines have been discussed among the team members. Because we are amongst a diverse group of pioneers in this field, these matters require careful consideration and continuing attention.

Of the individual courseware projects started in years one and two, some projects have come to full fruition, two projects have been terminated, and several projects have been blended together to form an ongoing base for the Courseware Deliverable team. One example of a highly successful project that has been completed is the development of a Visual Database for use in engineering presentations. This collection of digitized still images, movies, and animations provide instructors and students with a library of resources from which to select components for a presentation. An accompanying software package allows the user to search the CD and laserdisk-based library for images of interest. Strong interaction among the coalition campuses made the collection of the resources possible. A set of multimedia modules on Total Quality Management have similarly been finished and locally tested. The remaining step for both of these products is to disseminate the material and provide a nominal level of training on its use at each campus. Another very successful project at N.C. State has been the development of a multimedia program to assist in both the teaching and laboratory experience of students in an introductory course in materials engineering. This material replaces, with graphical animation and video clips, much of the static pictorial materials found in texts on subjects like atomic structure and phase relationships. It is being used extensively on the N.C. State campus and has been exported to other coalition institutions. It has also had national distribution and some international interest has been expressed in it use.

Other projects have availed themselves of the advantages of working in a coalition as well. The project on Precision Teaching of Physics and the Physics Demoware has developed cogent interaction between faculty at Virginia Tech, Georgia Tech, and N.C. State. It is planned that this initial interplay will spread these two tools to the other campuses as part of the 4th and 5th year activities.
Courseware in the areas of Statics, Dynamics, Strength of Materials, TQM, Manufacturing, Geotechnics, General Freshmen Engineering Tools, and a prototype engineering career advising tool will continue to be developed in years four and five. Formative testing across campuses is providing developers with timely feedback that allows them to make their courseware modules usable at all sites. This recognition of the diversity of the campus environments will allow the final products to be disseminated beyond the SUCCEED coalition. Some products are already being tested by schools in other coalitions as well as non-coalition schools and community colleges.

c. TQM in Educational Process

Very different kinds of experiments and projects are being used to introduce TQM into the educational process and its management. The two Mega-Projects that are making the greatest contribution to this issue are the Continuous Curriculum Innovation and Renewal Process and the Industrial Internships Mega-Project through its Quality Improvement Partnerships (QIP) project. The Curriculum Renewal Process effort is directed toward impacting the management of the educational process while the QIP project provides both educational and experiential exposure for students to TQM and quality issues in practice with the assistance of industrial participation.

Continuous Curriculum Innovation and Renewal

This project is directed at the development and testing of quality-based processes that yield continuous improvement of academic units and their curricula. A key outcome of this project is a Reference Manual for “Curriculum Renewal”; a comprehensive resource and guideline for engineering departments to use in reviewing and revising their undergraduate curricula.

The objective of the third year activity has been to develop self-contained modules addressing single aspects of the overall curriculum renewal model and to disseminate and test the proposed methods. The modules taken as a group will document the backbone of the overall methodology and will provide academic departments with the means to both test and implement the methodology in evaluating and reforming their existing curricula.

Modules that are available at this time include: 1) Annotated bibliography of articles on engineering education, curriculum renewal and cognitive styles; 2) A high-level, overall model linking strategic planning to curriculum renewal; 3) Tested survey instruments to obtain feedback on curriculum from employers, alumni, faculty and students; 4) Two tested complementary methods for curriculum analysis: The Augmented Syllabus Method and the Knowledge/Proficiencies Method; 5) A tested improvement method for course
content; and 6) A tested improvement method for course conduct. The manual is now in draft form undergoing final editing.

**Industrial Partner Internships**

Project activity in the Industrial Partner Internship area centered on the Quality Improvement Partnership project. Here, faculty and students from three SUCCEED schools (N.C. State, N.C. A&T State and UNC-Charlotte) have worked together in teams as on-site partners with an industrial sponsor. The QIP project has operated for three years and been co-sponsored by Milliken and Company. In 1994 the project expanded to 75 students in the course, shifted the project director from N.C. State to the UNC-Charlotte and used the CONCERT television network to team-teach the spring course that instructs students in team-building, communication, safety, time management and TQM principles in preparation for the summer team internship. In the summer of 1994 the internship involved 20 students (with large racial and gender diversity) in teams at three Milliken and Company sites working on projects from improving product quality to reducing water consumption. Four faculty directly supervised the teams. Milliken projected large cost savings resulting from the teams. Efforts were also made to broaden the QIP experience by approaching other companies and other schools about participating. In 1995 students from Duke University will take the spring course and arrangements are under way to have them intern with Northern Telecom in the Research Triangle Park. As a part of the QIP project and to assist in the instruction of teaming in the preparatory course a “Ropes Course” was built at N.C. State for team training.

d. Diversity Success

Two of the Mega-Projects under the direction of the Center for Professional Success have both high and direct impact on the third work statement result in the Cooperative Agreement that deals in a broad sense with diversity success in engineering education and more specifically with increasing the participation of women and minorities in the engineering education process. These are the Minority Retention and Women's Engineering Board Mega-Projects.

One of the early Phase I projects funded by SUCCEED was a study of student retention in engineering at N.C. State. A detailed statistical analysis of several cohorts of students broken down by ethnic group and gender showed that the greatest loss in number of students and particularly women and minorities in engineering occurred early in their college careers; principally between the first and second year of enrollment. This loss of students who had been vigorously recruited and in which the university had already made a significant investment was selected by SUCCEED as the area it would address in its efforts to assist the Coalition institutions achieve the 50% increase in participation of women and
minorities in the engineering education process. This effort was where SUCCEED felt it could have the greatest impact since the institutions already had many developing recruitment programs in place that were being successful in attracting minorities and women to their institutions.

Although funded efforts have been restricted to experimentation and program implementation dealing specifically with retention, the Coalition institutions as a whole have made significant progress in achieving the 50% increase in minority and women participation in the engineering education process. More specifically, as is described in greater detail later in this report, minority enrollments since the preparation of the original proposal has increased by 45% across the Coalition institutions and combined women and minority enrollments have increased by almost 25% across the Coalition. Both of these increases are significantly higher than those for the remainder of engineering programs in the U.S. The results of the institutional recruitment efforts and the retention program developed and put in place by SUCCEED give promise that with current trends the Coalition will come close to, if not achieve, the ambitious goal proposed in the proposal.

Minority Retention Project

This project was begun under the Center for Professional Success as the Academic Pre-Season Mega-Project, now renamed the Minority Retention Mega-Project. Under this Mega-Project, representatives from all eight Coalition schools came together to create an ideal retention program. In addition, the regular gathering of those directly responsible for affecting minority students' lives (the MEP directors) has resulted in an exchange of ideas and experiences that truly reflects the ideal of a coalition of engineering schools. These professionals who are dedicated to the retention of minority students can, through the sharing of programs and initiatives, increase their positive impact on minority students and their experience in their engineering major.

The Mega-Project was begun last summer, with four of the schools emulating Georgia Tech's very successful and popular summer workshop (Academic Pre-Season Program). On each campus, organizers took the basic concept developed at Georgia Tech and reformulated it to address the unique needs of their own students. The research conducted in evaluating each university's student needs made all participants more aware of issues affecting diversity on their campuses.

These schools will continue to offer a pre-first year orientation, while the other four schools create modules to enhance the opportunities and potential of minority sophomores, juniors, and seniors. In addition, a data tracking program has been developed and agreed to by all Mega-Project participants, ensuring, as far as possible, that the data collected will be consistent and comparable across the
Coalition. Other exciting innovations in the bridge program effort involves a pilot summer orientation program for new minority graduate students and an orientation program for transfers from the community college system to a four-year engineering school.

Of course, these programs directly impacted the minority retention rate at SUCCEED schools. Better prepared students are simply more likely to be retained to graduation and to become successful participants in the engineering profession.

Women in Engineering Board

Understanding that sheer numbers in and of themselves are crucial for effecting cultural change, the women engineering faculty of SUCCEED have come together into a formal organization to provide a support network for women in engineering. The Women in Engineering Board (WEB), has been in operation since SUCCEED’s first year. A Coalition-wide network of women faculty and graduate students, these professionals are becoming a catalyst for cultural change, including student support as well as a support system for women academicians.

Their efforts focused initially on creating access for women just beginning their careers in academia to the experienced women professors coalition-wide. This access, it was reasoned, would allow new women faculty to negotiate the path from new assistant professor to tenure and promotion with more assurance and success. This access, the SUCCEED WEB (Women’s Engineering Board), has taken many forms. The group has created a directory of all women engineering faculty and administrators which is distributed to women on each campus. Members are in regular contact with one another and have sponsored a number of projects affecting and impacting diversity on each campus. WEB is a coalition-wide activity and has had members from each campus on its Executive Board.

Several thrusts constituted their efforts at affecting the climate at SUCCEED schools. The first is a yearly conference, the first of which was held in February 1994 at Clemson University. The goal of the conference, entitled “SUCCEEDing In Academia”, was to identify and address, for undergraduate and graduate students and for young faculty, the key issues involved in academic success. The conference reached out to male and female SUCCEED participants alike, and was found to be enriching by all those (more than 150 faculty and students) who took part. A second conference scheduled for the Fall 1995 is now in the planning stages.

The WEB also sponsored a sensitivity trainers’ workshop in November 1994. This workshop, which was attended by representatives from a majority of SUCCEED schools, is designed to give the trainers the tools and information they
need to design effective interventions for their home campuses. Attended by a variety of male and female faculty and staff, the workshop and its students will bring the issue of affecting the culture of engineering classroom to the forefront of attention at each SUCEED school.

WEB is now involved in a survey of students across the Coalition to assess and evaluate the educational climate as perceived by students. A formal instrument for this purpose was developed by a professional assessment group at Virginia Tech and was tested on a select group of students. A copy of the survey instrument is included in the Appendix. Six campuses across the coalition are now distributing nearly 10,000 surveys (Clemson 1400, N.C. State 1950, FAMU/FSU 1100, UNC-Charlotte 950, Georgia Tech 3000, and Virginia Tech 1350) and the remaining two institutions (N.C. A&T State and the University of Florida) will do so next year.

e. K-14 Interface

It is a truism that engineering schools cannot retain students who have not enrolled. While “pipeline” issues may not have received as much of SUCEED’s collective attention as other issues some very interesting and experimentation in the K-14 pipeline has taken place under SUCEED’s sponsorship. The major effort in this area has been what began as the Community College Interface project under the Center for Curriculum Content and Integration and has now been transferred to the Center for Professional Success where it is the basis of the K-14 Pipeline Mega-Project.

K-14 Pipeline

An ambitious program for enhancing the community college pipeline is underway at the University of Florida. Recognizing that half of their students enter through the community college system, the engineering program at the University of Florida is upper division, and so the project seeks to make the transition from community college to the university more successful. The program combines long-distance mentoring of community college students by engineering faculty, a summer orientation program, and a peer mentoring effort during the students’ first year at the University of Florida. In addition the project is creating a comprehensive database that will allow the engineering school to identify those students most at risk of failure and to track their subsequent progress.

Another current pipeline project also involves multiple ties between a four year institution and a “feeder” school, in this case a local magnet high school. Mentoring and a summer enrichment program were combined with sponsorship of a team which entered the U.S. First Competition. This culminating effort, which involved faculty, graduate students, and undergraduates at the UNC-Charlotte
with high school students and teachers, was an exciting innovation which produced benefits to all participants. Lessons learned from participation will be integrated into design courses at both the undergraduate and graduate level, an unplanned but important benefit to the university.

Another project, “A Mentoring/Professional Success Program for the Charlotte-Mecklenburg School System”, had several successful elements that will be incorporated into the above-mentioned Mega-projects. This effort involved placing UNC-Charlotte student mentors in the local magnet high school for math and science, and then providing a summer research experience for the high school students. Response from both the high school students and the UNC-Charlotte student mentors was quite positive.

Other SUCCEED projects have not only benefited the participating students, but have produced materials which can impact a much wider audience of potential engineering students. A completed SUCCEED project in this category produced a manual of accessible and interesting engineering-related experiments. Although geared for high school students, this publication, “Adventures in Engineering Design”, has been used successfully in several coalition schools for different age groups as a tool to inform them about the engineering profession.

There is much anecdotal evidence that all of these projects have met with significant student interest and success.

3. Future Programmatic Plans

a. Curriculum 21

As the fourth year begins, the Integrated Math, Physics, Engineering Course (IMPEC) sequence will complete its second offering and the results of this experience will be analyzed during the summer. The IMPEC sequence will be modified and offered again in the next academic year. Plans will be developed for both its expansion and trial on other campuses.

The “knowledge studio” experiment will complete its planning and pre-evaluation activities in the Summer 1995 and begin course offerings in the Fall term. The knowledge studio should open in November 1995.

The modules related to humanities integration will be completed and referred to broad dissemination, and effort will be directed at institutionalizing the new courses at the campuses where they were developed.

The Internationalization of the Engineering Curriculum project will be expanded in the next funding period. This will involve increasing the number of
participating firms to at least 16. Two additional SUCCEED institutions will be added to the program.

With approval of the Process Engineering certificate program at the University of Florida, this project will be put in the testing phase. Two task groups will work in parallel to develop a Mega-course in PE and an interdisciplinary design course sequence. The project will continue providing information about the PE program via the World Wide Web and plans for implementation of the program at FAMU/FSU.

The Early Design Experiences Mega-Project will become the Stage II Engineering Design and Process Deliverable Team. In this capacity the project will continue to do early design, collect evaluation data, update the Early Design Manual and encourage other departments to adopt early design activity as part of Stage II implementations in their programs. The team will also determine those aspects of an early design experience that are most beneficial to the students. Additionally, the Stage II Deliverable Team will begin to function as a resource to other Deliverable Teams in creating the Curriculum 21 model.

The Technology Management Program project will identify and begin planning work at a second campus site. A Leadership Team is now being assembled that will fulfill this dissemination objective and provide an additional campus perspective to the N.C. State TME effort.

The TME planning group at N.C. State will expand to include more faculty who would be likely instructors in TME course offerings. This group will decide on the best initial structural form for this curriculum: as an option or certificate program.

Curricular content for TME will be further refined from surveys to be done on previous graduates of Engineering Operations and Industrial Engineering programs. Collaboration with the Process Systems Engineering Mega-Project will begin to leverage the course development effort.

The next important steps required of the Courseware Development Team will be to further evolve the evaluation and assessment of the products, to continue development of modules, and to begin broader dissemination of the information.

A further task of the Courseware Development Team will be to integrate the free-standing courseware modules into the new curricular material on Technology Management Engineering and Process Systems Engineering; also the techniques and methodologies developed will be made part of the general curriculum renewal process.
Additional Courseware Deliverable Team activities for year four and five will consist of the completion of individual projects and the molding of these projects into tools usable at all of the coalition campuses. Although formative evaluation was performed during the early phases of most projects, more formal evaluations and assessments are planned for each of the courseware products for this interval.

Two of the Courseware Development projects which have completed their development phase will begin a concentrated dissemination phase during which further evaluation will take place. A guide to developing multimedia presentations, which was produced as part of one of the efforts, will be provided to each coalition school along with one or more workshops on this topic. The courseware repository project results will be used as the structure to support the dissemination of courseware.

The Electronic Connectivity Deliverable Team activities for year four and five will consist of coordinated projects that will demonstrate the use of technology in four different areas:

1. Collaboration, interaction, and dissemination within SUCCEED and within the larger engineering education community,
2. Interaction between SUCCEED institutions and community colleges and high schools,
3. Remote access to courseware by faculty and students, and
4. Distance learning.

A supporting effort in Electronic Connectivity will be the implementation of methods to evaluate the usability of electronic connectivity demonstration projects. The team will undertake activities to extend the effective use of the electronic connectivity results beyond these demonstration projects.

b. TQM in Educational Process

The Continuous Curriculum Innovation and Renewal Mega-Project will have completed all draft modules for its reference manual. The editing of the manual will be completed and it will be published in final form. The next activity will be the testing of the manual in a variety of academic settings.

A minimum of four academic units will be involved in the testing phase of the Curriculum Renewal Process project. The results of this testing will then be evaluated and the Manual will be revised to take advantage of the lessons learned.

The Industrial Internships project will continue to recruit companies, conduct the spring preparatory course and operate the summer partnership teams.
At least two more campuses will be added to the four campuses now involved. Effort will be undertaken to recruit additional non-SUCCEED campuses into this activity as Duke University was this past year.

A Marketing Team will be formed to address marketing QIP by creating a line of products that fit different customers. The current product, a student/faculty group of about twelve participants costing about $100,000 for a summer, does not fit the budget or politics of many small and large companies who may prefer smaller teams ranging from four-person teams, to single students or faculty who are used to "seed" TQM methods into company teams, to small research teams that can work on summer research in a university setting. Integrating this product with existing Co-op programs and exporting the product to more schools within and outside SUCCEED is also necessary.

The common core basis of QIP, the spring semester course which teaches communication, teamwork and TQM, will continue to be refined with more exploration of communication and multimedia tools both for delivery of instructional material and allowing team building across the Coalition.

Fourth year efforts for the Guidance Team will be to continue to employ TQM principles and methods in its operation while concentrating on identifying ways to achieve sustainability, dissemination, and assessment and evaluation for the Coalition as a whole. Formal meeting facilitation will be extended to the Program Committee to improve its ability to work as a coherent team.

A plenary and workshop on quality management techniques and team building will be included in the program of the Third Annual Coalition Conference. A program which will assist Mega-project and Deliverable Teams employ quality management tools and techniques will be developed and implemented in the fourth year in conjunction with the activities of the Evaluation and Assessment Team.

c. Diversity Success

WEB will sponsor its third annual conference in the fall of 1995. The theme this year will be “SUCCEEDing Together - Industry and Academe”. WEB will also publish a new directory of Faculty/Research Staff and Administration in time for this conference. The sensitivity workshops will become resident at each campus.

The student survey of the educational climate on each campus will continue to be collected and analyzed throughout the year. The results of this survey, together with information obtained during training sponsored by the WOMEN Engineering Programs Advocates Network, will be used to develop and implement retention programs for undergraduate women at six of the Coalition schools.
The Pre-Freshman orientation programs put in place this past year will be continued at the four schools where they were initiated. Programs aimed at supporting sophomores, juniors and seniors will be developed and initiated at the other Coalition schools.

d. K-14 Interface

The University/Community College Interface (CCI) Mega-Project now under the sponsorship of the Center for Professional Success will be continued and expanded at the University of Florida involving additional community college interactions.

Further evaluation and assessment of the results of the CCI program will be generated and efforts will be initiated to export and implement the program at other institutions in the coalition whose enrollments include significant numbers of transfer students. Most likely these will be N.C. State and the UNC-Charlotte.

The mentoring activity interaction between the UNC-Charlotte and the Mecklenburg School System will be continued and expanded.

A significant effort will be initiated to increase the U.S. First design competition participation by Coalition institutions with local high schools. Since this effort also requires industrial participation the External Advisory Board will be asked to participate in expanding this activity.
C. PROGRAMS OF ACTIVITIES

Every Mega-Project and Deliverable Team is actively engaged to some degree in efforts that address the areas of systemic curricular reform, new teaching/learning systems, and curricular experiments and course materials that increase diversity in the educational process. The matrix diagram in Figure 3 indicates the primary focus and impact of the Mega-Projects and Deliverable Teams on these three areas. Following are some specific examples of the Coalition's programs of activity that address systemic reform, teaching/learning systems and efforts to increase diversity.

| Projects for Systemic Curricular Reform | X | X | X | X | X | X | X |
| New Teaching / Learning Systems | X | X | X | X | X | X | X | X |
| Curricular Experiments & Course Materials to Increase Diversity | X | X | X | X | X | X | X | X |

Figure 3: MP/DT Relationships to Systemic Reform, Teaching/Learning Systems, and Curricular Experiments to Increase Diversity

1. Projects for Systemic Curricular Reform

The purpose of SUCCEED, as well as the other Engineering Education Coalitions, is to stimulate systemic curricular reform. Consensus has largely been reached amongst the leaders in engineering education on the conceptual directions this change must take. This is evident from a reading of the recommendations of the numerous panels, workshops, task forces, and academy reports from the past 10 years. SUCCEED's emphasis is on the restructuring of the curriculum as a whole. While other Coalitions have emphasized certain aspects of the curriculum (e.g. manufacturing, delivery systems, early introduction to engineering), SUCCEED has attempted to address the full curriculum. This includes not only content, but also
framework (the immersion megacourse, the Stage III interdisciplinary teaching of an engineering function), instruction (cooperative learning, self-paced courseware), tutoring (seniors in capstone design course tutoring freshmen), mentoring (upper-class students mentoring community college transfer students), advising (bridge programs), evaluation (alternative methods to evaluate student and faculty progress), engineering practice (internships by quality teams) and administration (alternative faculty reward models).

SUCCEED proposes to manage curriculum change by adapting the quality-based practices used in restructuring industry. This approach includes effective evaluation and assessment to direct change, involvement of all stakeholders, the establishment and facilitation of curriculum design teams, and a concurrent approach to restructuring. Our model for systemic curriculum restructuring incorporates three stages of learning. The first stage teaches the foundation of mathematics, the sciences (including the life sciences), and the humanities. A premise of Curriculum 21 is that these subjects, as well as the engineering thought process and principles of engineering design, should be intellectually integrated. The second stage of involves the integration of design, engineering processes, and professional practice with the fundamental engineering sciences. In the third stage interdisciplinary teams of students integrate and apply their knowledge and skill to functional aspects of engineering (process engineering, manufacturing engineering, technology management). It is SUCCEED’s strategy to concurrently develop each of these stages of learning to reduce the cycle time required for redesigning the curriculum.

Two different experiments are being conducted on the integration of subject material in the Stage I learning experience in which alternative models for the integration of engineering with mathematics, the sciences, and the humanities are being researched and tested. One experiment is being performed at the University of Florida in which a studio environment is being investigated to promote subject integration and early introduction of engineering. Lectures and laboratories are being brought to a technology classroom which provides a common learning environment for both student and teacher usage (e.g., multimedia delivery hardware, problem solving software). It is believed that providing structure to the students’ learning day will develop effective learning skills, while the integration of subject material with engineering content will build a firmer foundation in the engineering thought processes and excite students towards an engineering career. A second experiment is being conducted with a primary focus on alternative teaching methodologies, particularly cooperative learning.

An example of a Stage I Integration activity that is addressing systemic curricular reform is the Integrated Mathematics-Physics-Engineering Course (IMPEC) project being conducted at N.C. State. In the IMPEC course elements of engineering design and operations are being brought into the freshman year and integrated with mathematics and science. Fundamental subject material is presented on a “just in time” basis, after the need to solve real engineering problems is established. The
engineering, science, and mathematics course materials are team taught by math, physics and engineering faculty in a single classroom equipped with computer workstations that have the capability of real time data acquisition.

A "workshop physics" approach that emphasizes hands-on experimentation provides the basis for the science instruction in IMPEC and a symbolic mathematics application program (MAPLE) is used for data analysis in all areas addressed. The instruction in the integrated course sequence makes extensive use of cooperative (team based) experiential learning while de-emphasizing (but not completely eliminating) formal lecturing and individual competition for grades. Homework and examinations contain a mixture of closed (single answer) problems that test understanding of specific methods and skills, open ended multidisciplinary problems that test the student's creativity and ability to integrate the full range of course material and problem formulation exercises. Although the evaluation and assessment process is ongoing, the results of student surveys indicate they like the group work, using computers and the hands-on experiments but dislike the amount of homework.

The Early Design Experience Mega-Project activities demonstrate systemic curriculum reform that addresses important non-analytical aspects of engineering such as communication, teamwork, management and design. Courses emphasizing the design process are being successfully taught in a variety of formats at different levels. Students groups in these courses may be from a single level in a given discipline, combinations of levels or from across different disciplines. Some of all of these combinations are being employed. Evaluation and assessment data is being collected and a Design Course Manual being created from these successful experiments to instruct and assist faculty in how to undertake similar projects.

Accomplishment of systemic curricular reform in design requires education of faculty as to the importance of non-science engineering topics and teaming of advocates for mutual support and assistance. The Early Design Experiences Mega-Project team has supported faculty that advocate design courses and are committed to their development and implementation. Part of this effort was a two-day Design workshop at Virginia Tech attended by 85 participants last August to share experiences, discuss various experiments in design instruction and to encourage networking by design faculty from different schools and disciplines.

The Early Design projects have also influenced other courses. At N.C. State a freshman engineering course is now being planned which uses mentoring by seniors and graduate students to more efficiently teach small group sections of the course. The course will enroll a thousand students per year and has design and practice elements. It was SUCCEED's demonstration of the value and effectiveness of undergraduate mentors in early design experiments that influenced the above course reform decision to be made. A similar course is now being considered at UNC-Charlotte for sophomores with an emphasis on management and communications.
Another area of Stage I activity that demonstrates systemic curricular reform are the experimental courses that integrate the life sciences with introductory engineering concepts being taught in the Biology Department at N.C. A&T State, the Biology Department at Georgia Tech, the Environmental Engineering Department at Georgia Tech and the Agricultural Engineering Department at the University of Florida. Innovative features of the integrated courses include: 1) just-in time learning, 2) statistical analysis of data generated from case studies, 3) use of computer simulations, 4) exposure to problem solving techniques, 5) use of alternative teaching media (e.g., C-D ROM modules, videotapes, self-instruction programs and 6) use of role playing exercises.

In a similar fashion the course modules being developed both at Georgia Tech and at N.C. State to integrate humanities into the engineering in the freshman year are employing approaches for systemic reform. At N.C. State a course on the rise of modern science and technology has been created from modules taught by an interdisciplinary team of faculty. The course is designed to parallel, both in subject matter and schedule other courses the students are taking, especially the first physics course. For example, at the same time that students are studying optics in physics, they learn about the social conditions that gave rise to the invention of the telescope and the social consequences of its use by Galileo and others. At Georgia Tech the new course focuses on specific aspects of the history of Electrical Engineering. The course does this by means of historical case studies and modules focusing on the development of the electrical engineering profession and practice.

A major effort to improve the quality of the Stage II learning experience is associated with the Continuous Curriculum Innovation and Renewal Mega-Project. In most engineering departments, the process to improve and introduce innovation into its curriculum is very difficult and relatively unstructured. As a result, comprehensive renewal is rare and change is often incremental. The objectives of this Mega-Project are to synthesize the existing literature results on curriculum renewal, develop new processes and tools for effective renewal, and introduce quality-based ideas to continuously innovate and renew the curriculum. A major deliverable of this Mega-Project is a manual that organizes these ideas and will be used to transmit them to individual departments. This approach has been used in the Mechanical Engineering Department at Clemson to renew their curriculum and will be broadly tested across the Coalition. The Dean of Engineering at Clemson is now using these ideas to examine the curricula in each of the department within his college. It is our belief that the outcome of this project could have a significant national impact if the manual is a well-prepared document and the results of sufficiently diverse case studies are presented.

The multimedia course module development activity being conducted under the Courseware Development Deliverable Team is a further example of systemic reform in which the computer and its capabilities is playing the dominant role and will impact all stages of the Curriculum 21 model. Whether interactive or stand alone the availability of CD ROM course content material with animation, video clips and self
directed instruction will have a dramatic effect on how course will be taught in the future. With the availability of this form of instructional material, delivery can become more cost effective and faculty can function more as coaches and mentors providing greater individual attention to students responding to their preferred learning styles as contrasted to the role of lecturer that is the more common delivery mechanism now in use. One of the principle products of the Courseware Development Deliverable Team will be a manual and a traveling seminar series describing and demonstrating the methods and techniques that can be used for implementing this important paradigm shift in engineering education.

One of the principle difficulties with current curricula is the rigidness of its structure. Curricula change in the past 30 years has largely been limited to the technology base of the subject content. The recent trend in reducing the credit hour requirements for the B.S. degree have mainly eliminated the elective component. As a result, the structure of most curricula cannot easily adapt to the changing needs of the profession. It is unlikely, however, that educational institutions or industry will support the timely development of new programs to meet these new challenges. Thus, one of the purposes of the Stage III learning experience in Curriculum 21 was to make the structure more flexible so that it could adapt to changing needs. The Stage III component may appear in different forms in different programs such as an option, minor certificate, professional masters (4+1 or 3+2 programs), or possibly a new degree program. SUCCEED has initiated four endeavors in this area: Process Systems, Technology Management, Internationalization, and Materials Processing.

The experiment in Process Systems is directed towards preparing engineering students to function in the development of implementation of manufacturing processes. The model for the Process Systems Engineering program consists of three experiences: a 12 SCH megacourse on the fundamentals of process engineering, 6 SCH, 2 semester multidisciplinary design sequence, and an industrial internship. The megacourse will be taught this summer and tests the effectiveness of teaching by immersion (12 SCH in the summer is considered a full load), using student quality teams to provide feedback to instructors and students, and the use of the megacourse concept to overcome disciplinary barriers between both faculty and students.

As part of the Technology Management Engineering Mega-Project an alumni/industry survey was conducted to determine what should be taught in an undergraduate vs. postgraduate management engineering program. Fifteen hundred surveys were sent out asking which of 57 areas of management and business subjects were important to new engineers (less than 5 years out) and more senior engineers (more than five years out). The three hundred returned surveys pointed to the need for all engineering undergraduates to receive more training in the fundamental management skills (communication, teamwork, time management . . .), whereas higher level skills such as financial, organizational or human resource management are needed more by senior engineers. When presented with the same issue, the SUCCEED External Advisory Board also spoke to the importance of all undergraduate engineers
receiving instruction in the fundamental skills, but that higher level management training was best learned after several years in industry.

2. New Teaching / Learning Systems

An example of the application of new teaching/learning systems is the Longitudinal Study of the Use of Cooperative Learning in the Stage I Integration Mega-Project. In this activity diverse control groups of students in the Chemical Engineering Department at N.C. State are taking sequences of departmental technical courses in their sophomore, junior and senior years all taught by one faculty member emphasizing the cooperative learning pedagogy. The academic performance of these students are being assessed and compared to the performance of control groups of students in regularly delivered departmental courses looking at the effects and influence of a number of factors such as gender, Myers-Briggs classification, social and economic background, academic preparation, part time work involvement, etc. This experiment has been in progress for a number of years and now includes data from several graduating classes. The results strongly support the effectiveness of cooperative learning, the need to recognize differences in learning styles of students and the importance of proper team structuring and composition. This effort has resulted in the introduction of cooperative learning in a number of other Coalition projects.

The Early Design Experiences Mega-Project has explored several methods for achieving more efficient instruction. Mentoring students by upper-class students such as freshman collaborating with seniors in a capstone design project or seniors who are veterans of the Quality Improvement Partnerships preparation course team-teaching a Freshman Design Course under the auspices of a regular Electrical Engineering faculty member. Mentoring benefits both the student who may need academic aid, career guidance or support, and the mentor by developing leadership skills and a firmer understanding of the subject material and activity involved.

The Engineering Entrepreneurs program that is a part of the Early Design Mega-Project fosters another new learning environment by providing the opportunity for students to create a product and it's accompanying company (or vice versa). With the goal of furthering their products or business, students better learn the business and management material presented in accompanying lectures. Team members may remain with the project over multiple semesters with older students being required to perform increased leadership and management functions.

Team-teaching and sharing courses which originate at multiple campuses is a mechanism being used to explore one aspect of distance learning. Team teaching allows faculty to share their expertise and efforts in the creation of curricular materials. In the Quality Improvement Partnerships course, three campuses have regularly engaged in this experience. In the Engineering Entrepreneurs program a variation of
distance learning has emerged that shares lectures by current business experts with other campuses using the Internet for communication of video and audio information. This project has been done in collaboration with the Center for Technology and Communications to utilize their expertise and experience in accomplishing the data compression and transmission protocols.

Instruction by engineers from industry while working with students on a project has occurred both on the QIP and the Entrepreneurs projects. The opportunity for students to "apprentice" with working engineers is both efficient in the use of faculty time and provides students with a different perspective on engineering. This interaction acquaints faculty and students with industry and brings industrial culture and engineering to the university campus.

Learning by doing is being accomplished through project-based experiences. QIP allows students to learn time management, teamwork, communication and TQM in the classroom using the standard tools of lecture, homework and class experience; and then to actually have to put it into practice on an actual summer project. As a part of a team, collaborative learning and mentoring reinforce the summer learning environment. One of the other non-traditional learning experience of these students is Ropes Course Training, provided to help initial team formation. As a part of the QIP project a “Low Ropes Course” was built at N.C. State to be used for team training. While this is not uncommon in industry, this sort of team-building experience is new to most students and faculty.

In the Fall semester 1994, the N.C. State Electrical and Computer Engineering Department offered a sophomore course in introductory design that emphasized communication, time management, design and college survival skills, and was taught by several members of the previous summer's QIP program. The course proved valuable to the sophomore and senior participants and by using supervised student instructors/mentors required little faculty time to prepare lectures or teach the course.

A project entitled Linking Freshman Chemistry to Engineering Curriculum Through Materials Examples, being conducted at N.C. State, is providing valuable information on how different students respond and interact with multimedia subject content modules. During the evaluation of the courseware developed as part of this project, the investigators noted that several visual qualities of the presentation were less acceptable for minority and women students. For instance, it was found that when animated objects were rotated on a screen, women found these animations to be more acceptable when the objects rotated no more than 12 degrees per step. This is opposed to the general student who found the animations to be acceptable when rotated objects moved by 15 degrees per step. Similar interesting differences were found regarding the acceptability of wire-frame figures vs. fully rendered, shaded, and shadowed figures.
Using this type of information, guidelines are being developed for the generation of multimedia materials that are acceptable to a diverse student population. These materials are being integrated into existing courses as well as being constructed for courses that are part of the Curriculum 21 model.

3. Curricular Experiments & Course Materials to Increase Diversity

The purpose of the Retention Mega-Project is to retain and graduate increased numbers of minority students in engineering disciplines. The primary focus in its initial phase was to create summer orientation programs at every SUCCEED university that did not yet have one in place. These have been shown to be crucial in the effort to orient minority students quickly to a sometimes bewildering and frustrating environment. While based on the successful Georgia Tech summer program, each of the new programs was designed to fit the needs of the students at the particular campus where it was offered.

Simultaneously, efforts are underway to create a comprehensive database which will not only track individual student’s progress, but will identify coalition-wide those courses which are a stumbling block to many. Future plans are to use this data to create programs which assist minority students at every stage of their college careers, not just when they “walk in” the door.

The summer programs demonstrate a variety of educational techniques, with special emphasis on collaborative learning. These summer programs are frequently taught by faculty, who have the chance to observe and evaluate the effectiveness of working in groups, and the impact their personal attention can have on an individual students.

Each summer program involves teaching about issues outside the bounds of the classroom. The concern is to prepare the student for college life, not just with academic information, but with time management and study skills, health information, computer competence, and other issues that affect the student’s ability to assimilate successfully into the college system.

The summer programs’ whole focus, of course, is on increasing the numbers of minority students who make the transition to college successfully. The experimental elements of the courses are based on the work of Dr. Uri Treisman, who first explored the teaching of collaborative learning.

The purpose of the K-14 Pipeline Mega-Project is to create new initiatives for encouraging students to enter the engineering education pipeline. Two specific activities are currently being pursued, one at the UNC-Charlotte and the other at the University of Florida. Both of these projects will equip women and minorities to enter
engineering schools more informed about the career opportunities available to them, and more confident of their ability to do the work required. It is expected that a higher proportion of participants will then be retained in engineering.

The UNC-Charlotte project, "A Mentoring/Professional Success Program for the Charlotte-Mecklenburg School System" places undergraduate and graduate engineering students as mentors in Harding High School, the local magnet school for math and science. Some of the engineering students also participate in a two-week summer workshop for Harding High School girls entitled "Explore Engineering!" This workshop, which was taught by the students, Harding High School Teachers, and engineering faculty, featured activities, panel discussions, and field trips. It received favorable evaluations from the girls who attended. This project also sponsored the team which competed in the National U.S. First competition this spring.

The Harding summer workshop brought the Early Design concept into the high school, giving students an early taste of the satisfaction of creating something that works. It also featured significant contact with engineers working in industry, affording the students an early opportunity for career exploration and observation of role models.

The Harding summer workshop was offered exclusively to girls and featured female college students as mentors, female faculty, and female engineers at the plant sites. Use of the student "bubble" concept, as well as the frequent exposure to female role models, should increase retention of these students.

The Community College Interface Mega-Project addresses the needs of students entering a four-year institution via the community college track. This is especially appropriate in Florida, where about half of all engineering degree seeking students start their undergraduate education at community colleges. The goals of the project are to: a) improve the recruitment of students, especially women and minority students, from the community colleges; b) evaluate problem areas, and c) develop methods to ease the transition to a four-year university.

The Community College Interface Mega-Project has four areas of focus. The first is to create a Guaranteed Admissions Program (GAP) for students from three participating community colleges. Selected students who complete the community college courses with a grade of C+ or higher will be guaranteed admission to the University of Florida engineering program. These students will receive academic advising and counseling via phone by engineering faculty.

The second focus of the project is to offer a one-week "Transition Symposium" for community college graduates before they register at the University of Florida. The symposium emphasizes on campus survival skills, engineering problem solving, and computer skills. It also serves as an introduction to the students' mentors for the coming year, peers who are already established at the University of Florida.
The third focus is the year-long mentoring program. Mentors meet with students up to five hours per week, and conduct study groups. The final focus is the development of a database of registration data, community college enrollment data, grades, instructor, family history and participation in SUCCEED for evaluation and assessment purposes of the program. Individual student identities will be excluded from this data source.

The Community College Interface project has noted that over half the women and just under half the minorities seeking BS degrees at University of Florida come from the community college systems. If the interventions described are successful, this project should also increase retention of these underrepresented groups in the College of Engineering.

The Women Engineering Board (WEB) Mega-project was formed in the first year of SUCCEED by dedicated women faculty on several Coalition campuses. The current Coalition-wide activity has four purposes:

1) Make the environment in engineering education more equitable and comfortable for women;
2) Increase the opportunities for mentoring and research collaboration for women students;
3) Improve the visibility of women students and faculty both for communication within the Coalition and for increasing the opportunities for jobs once the students have graduated;
4) Collect the necessary data about the current environment and devise appropriate interventions.

The WEB is attempting to assess and to affect the culture of SUCCEED schools. They are focusing their efforts on some of the fundamental issues impinging on the SUCCEED deliverable of a 50% increase in the number of women enrolled at SUCCEED schools.

Major WEB activities include: an annual conference attended by SUCCEED and non-SUCCEED students and faculty, a sensitivity trainers’ workshop, and qualitative and quantitative data collection. This quantitative data collection project on student perceptions of the educational climate is currently in process at six of the eight SUCCEED schools, and has already generated a healthy debate on several campuses. (See the Appendix for a copy of the survey instrument, “Engineering Education Climate Survey”).

Another product of the Early Design Mega-Project is a Design Project Manual that shows high school teachers how to do a series of low-cost hands-on engineering design projects. One-day projects such as building a scale structural model from simple materials, teaches students a sense of the design process and provides the
opportunity to recognize that engineering involves a variety of skills in addition to mastery of engineering science.

The QIP course is also playing a role in encouraging more minority students to consider a career in academia. In the preparatory course, potential graduate students learn communication, time management and TQM skills and then use them while mentoring with a faculty on a research project during the subsequent summer. This provides them with an opportunity to observe and participate in aspects of the academic profession that can increase their enthusiasm for becoming more permanently involved. It also gives the faculty a means of evaluating their capabilities and to begin to mentor these students toward careers in teaching.

The Courseware Development Deliverable Team has a variety of projects that will have differing degrees of impact on diversity and on K-14 linkages. In general, any multimedia-based tool that improves the retention and recruitment of the general population will also have a very positive effect on the recruitment and retention of a diverse student population. The vision of the developers of this technology is the creation of an academic environment wherein average students are motivated to perform beyond expectations, under-prepared students are given the opportunity to learn and attain success at their own rate, advanced students are challenged to achieve their full potential, and where faculty members truly become guides in every student's quest for knowledge. A tool which addresses each of these goals will also necessarily meet the needs of under represented groups of students.

It is difficult to build a courseware tool that is everything to everybody, as laid out in the developer's vision. Therefore, a number of projects are attempting to determine the attributes of the presentation that improve or diminish the various qualities of the presentation for women and minority students as well as those important to the general K-14 population.
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D. PROGRAMS FOR SYSTEMIC, SUSTAINABLE REFORM

1. Implementation / Dissemination Strategy

First, it must be recognized that the SUCCEED project alone does not have either the authority or the resources to effect systemic change in each of the colleges of engineering. SUCCEED has been given the license to perform bold and relatively large scale experiments. Its credibility is obtained from its association with the NSF and the significant level of funding. SUCCEED has been embraced because of its leadership in curricular reform, and because it has not attempted to mandate institutionalization. It has, however, already lead to significant cultural change within the participating institutions.

Second, it must be recognized that each college of engineering is different (institutional constraints, student population, missions, etc.). Of course, this diversity amongst colleges of engineering is a national asset and should be preserved. However, it is this diversity coupled with the complexity of the education process that makes change more difficult.

To realize sustainable and systemic change, SUCCEED must expand its resources and accommodate the differences amongst colleges of engineering. Strategically, the Coalition must move to the next level of programmatic activity. To accomplish this it is proposed that SUCCEED serve as the facilitator and research arm for the establishment of Curriculum 21 on each campus. SUCCEED would help create a working group of resident faculty and administrators on each campus with the charge of coordinating the implementation of Curriculum 21. This would include the drafting and consensus building for a college mission, vision, goals, objectives, and strategic plan. This group would be trained in quality management principles and develop a plan for continuous evaluation and assessment of the undergraduate program. In order to expand the effective resources, this group would include in its planning process all resources currently dedicated to undergraduate engineering education at their respective institutions. Furthermore, these groups would identify partnership opportunities with industry and facilitate their formation.

As an example, female and minority recruitment and retention is an issue on all campuses. Each campus is currently directing non-SUCCEED resources at various levels (university, college, department) towards such programs. In addition, SUCCEED is funding activity to stimulate innovation in this area. From the experiences of the Coalition it is clear that there are areas of both commonality and differences in the needs of each campus. It is also clear that a full set of programs on a single campus are not well coordinated and thus probably not making the most efficient use of the resources. The full coordination of this activity by the proposed working group (or a subgroup) should result in the design of a more effective program.
adapted to the specific context of that college and, importantly, integrated with other aspects of the engineering educational process/system.

In fact, higher education is so management lean, so dispersed in authority (faculty being the most empowered group of any large organization), that a holistic approach to the management of change is very difficult. A functional group needs to be formulated to design and produce the education process/system.

This group would also serve as the research arm. It would collect results of experiments from other Coalitions and past studies and evaluate their usefulness in the College's strategic plan. A large portion of the SUCCEED funds would still be used to conduct experiments as specified by the strategic plan. Furthermore, this group would be responsible for evaluating and assessing not only the research programs, but the undergraduate education program as a whole.

This group would be responsible for marketing and consensus building. It would interface with faculty, often through department chairs, as well as with the University administration through the Office of the Dean. It would interface with the College's stakeholders: industry, students, community colleges, and government. Through this interface continuous feedback would be provided as a basis for further improvement.

To take advantage of the Coalition concept, a Coalition-wide oversight group should be formed with representatives of each campus working group. The coalition-wide group would provide a mechanism for information/experience sharing as well as identifying opportunities where shared resources could reduce costs. This group would also have many of the responsibilities currently held by the Guidance Team.

2. Database Indicators

Student Involvement and Changes in Student Population

The recent effort of the National Science Foundation to create a database of quantitative information on all of the Engineering Education Coalitions provided SUCCEED with a good opportunity to determine exactly the level of impact it was having on students and faculty across the coalition. The data gathered on participation in SUCCEED, which is included in the Appendix under Personnel Count, was obtained by having project directors on all campuses provide information directly related to their project efforts. The information that can be drawn from this data provides some interesting insights and is summarized here.

Almost 3000 students are being impacted by SUCCEED efforts in some way. This includes both lower and upper division class participation, involvement in educational research and projects, serving as teaching assistants, working in industry,
and performing outreach. Although this is a significant number of participants, it actually represents only about 12% of the total full time enrollment across the Coalition. However, considering the fact that the purpose of the Coalition is educational research, plus the fact that the Coalition has been effectively functioning for only two full academic years, this represents a rather good level of influence by SUCCEED to the overall educational environment. Moreover, when the budget of the Coalition is compared to the total educational budget for all the institutions that make up SUCCEED, the impact made by SUCCEED it quite impressive.

Of the 3000 SUCCEED student participants about 22% are women while about 20% of the total enrollment is women. African American participation among “SUCCEED” students is about 8% while their proportion of the total enrollment is almost double that figure, 15%. This result is somewhat surprising since other indicators would lead one to conclude that more resources are being put into increasing the involvement of minority students in engineering education than is being directed to women in engineering. This low level of African American student participation is an area which must be addressed by SUCCEED in its future plans.

The third item in the work statement of the Cooperative Agreement states that SUCCEED will increase the enrollment of women and minority students across the coalition by 50%. To show the progress the Coalition has made towards this goal an analysis of enrollment data compiled from information published annually by the Engineering Manpower Commission (now called the Engineering Work Force Commission) of the American Association of Engineering Societies, Inc. was performed. The enrollment data submitted every year to the AAES by all the institutions listed is in a common format so it is easy to compare and should be both consistent and accurate. To provide sufficient data to indicate realistic trends as well as absolute figures, the study was begun with 1989 data, the year SUCCEED was formed and proposed this goal.

The percentage change in enrollment for women, African American and Hispanic students for the period 1989 through 1993 is shown in Figure 4 using 1989 as the base year. All data is normalized against the enrollment figures of 1989 (total student enrollments have not varied more than +/- 3% over that same period). The bar graphs represent the SUCCEED institutions and the solid lines are national average changes with SUCCEED enrollments excluded.
It is clearly evident that the Coalition institutions have done very well over this four year period in increasing African American student enrollments by 45%. This is twice the national increase. Over this same period the percentage increase in women students has matched that of the national average of about 12%. Hispanics make up such a small percentage of the total enrollment of SUCCEED schools that no significant conclusions can be drawn from the results presented. These significant improvements in women and minority are a direct consequence of the recruitment efforts that all Coalition institutions had put in place and have had operational even before the existence of SUCCEED. It is for this reason that SUCCEED has placed its efforts and resources into student retention which represents a very fruitful area for increasing the total participation of women and minorities in the engineering education process.

Figure 5 presents the percentage change in undergraduate degrees awarded from 1990 through 1994 for women and African Americans students. Again, these data have been adjusted to the total degrees awarded in the base year 1990 to eliminate the effect of increasing total degrees awarded over the four year period.
Once again the SUCCEED institutions have produced a significant change in degrees awarded to African American students. The African American percentage change has already exceeded 50%. The percentage change in degrees awarded to women has not increased commensurate with their enrollment. This result is not understood and points out the importance of addressing the success of women in engineering.

The SUCCEED institutions have made significant progress towards the goal of increasing minority enrollment by 50%. However, those gains are not well-balanced between women and African Americans. The smaller gains in enrollment for women can be attributed directly to the fact that, while most of the coalition schools had already begun to make substantial progress in recruiting and retaining minorities, recruitment and retention of women has not received the same priority. One of the significant contributions SUCCEED has made toward access for women is to raise that issue to a higher priority level coalition-wide.

Data on enrollments for the first three years of all students in SUCCEED schools from 1989 through 1992 is shown in Figure 6. This data is again drawn from the AAES enrollment reports. What is significant about the data in Figure 6 is that there is that not surprisingly a larger decrease in total enrollment between the first and second years. These losses are even greater for women and African American students than they are for all students. Although these changes are due to a variety of causes which could include academic attrition, transfers both out (and in) to engineering, etc. this coalition-wide data supports the results of a earlier study of two
true cohorts of students undertaken at N.C. State that lead SUCCEED to single out early retention as the area to place its efforts to improve women and minority enrollments since the institutions were already doing a good job in recruitment. This in turn resulted in the development and implementation of the Minority Retention Mega-Project and other Coalition projects to promote retention through early program curricular reform and intervention.

The potential significant impact of effective retention can be demonstrated by the following scenario. Assume that only half of the women and African American students normally lost between the first and second years of enrollment could have been retained in engineering starting in 1989. Further, assume that these retained students would continue through the remainder of the program of study. Based on the same AAES data as used above this would have resulted in total percentage increases in enrollment over the period 1989 - 1993 in SUCCEED schools of 65% in African American students and 20% in women students. Thus, this level of projected impact would have improved the growth through recruitment by another 50%.

The Minority Retention Mega-Project was put in place last summer and some preliminary results of its impact are now available. Recall that the project assisted FAMU/FSU, N.C. A&T State and N.C. State with putting in place and/or improving
pre-enrollment summer programs for minority students that were based on the very successful Georgia Tech Pre-Season program. As a corollary to the programs at the three institutions Georgia Tech initiated a program of a similar nature for community college transfer students. The number of students sponsored by SUCCEED in these four programs numbered 178. The results of their combined performance upon completion of the fall term was that 60% of this group was on the Dean's list. Compared to control groups of minority students that did not participate in the summer programs the SUCCEED students had an average GPA of 3.00, compared to 2.50 for the control groups. The transfer students that participated in the summer program at Georgia Tech also had an average GPA of 3.00 at the end of the fall term. Although these are only preliminary results and more time will be required to totally evaluate the effect of this program on the participating students, the early returns are quite encouraging.

3. Evidence of Change in Faculty Culture

Cultural change is a slow process, especially in a culture with values as ingrained as those of university faculty. These signs of cultural change in the SUCCEED faculty are definitely evident after only three years of operation is a testament to the potential power for change inherent in the Coalition.

Simply counting the number of PIs who have been directly involved in SUCCEED projects is one indication of SUCCEED’s impact. These 250 men and women, representing about 17% of the total full time faculty, are directly impacted by SUCCEED’s mission and the NSF coalition mandate for educational experimentation and reform. They are not, however, the only ones so affected. Non-SUCCEED faculty are attending the SUCCEED annual conferences, the SUCCEED-sponsored annual WEB Conferences and SUCCEED Workshops to learn about innovations in engineering education and their application. This attendance is both an indication of interest and an indication of the commitment by their institutions.

Manuals and course materials developed by SUCCEED-sponsored projects are being used in other courses and other SUCCEED institutions. Courses developed under SUCCEED have been institutionalized into a number of campus curricula.

Other indications of changes in faculty culture are the increasing numbers of faculty who write articles for educational journals and present papers at educational conferences. The faculties willingness to devote their precious time which is under great demand to these efforts points not only to their own changing perspective but to a belief that such research will be respected and rewarded on their campuses.

This belief is supported by an increased interest on SUCCEED campuses in presenting seminars and workshops on engineering pedagogy and on related issues in the classroom. For example, Dr. Richard Felder, who is nationally recognized as a
teaching effectiveness expert, has been invited to present workshops at several SUCCEED schools. The sensitivity trainers workshops presented by Dr. Sarah Rajala and Dr. Hatice Ozturk have heightened awareness among the SUCCEED school engineering deans of climate issues on their campuses. Further awareness is being engendered by the educational climate survey developed by Dr. Deidre Hirschfeld, which is now being conducted with over 9500 students at six of the eight SUCCEED schools.

Presentation of these workshops and collection of data through the educational climate survey are also indicators of the increased use of TQM principles and methods within SUCCEED schools. Others can be found in the growing interest in and knowledge of evaluation and assessment techniques, as well as greater faculty use (by SUCCEED and non-SUCCEED faculty) of student feedback in their evaluation of new courses and materials.

Although all of the above examples are convincing evidence of change, more is required. Dr. Bob Serow, Head of the Qualitative Evaluation and Assessment for SUCCEED, has measured this change in culture as part of his qualitative study of the impact of SUCCEED at N.C. A&T State this past fall, and at N.C. State this spring. Combined results from this first phase activity are expected this summer and will be expanded to all Coalition schools.

4. Evidence of Change in Student Culture

By virtue of its rapid turnover of population, student culture is much more malleable than faculty culture but is correspondingly hard to measure. Nevertheless, anecdotal evidence does exist, and activities has been initiated to measure the qualitative impact of SUCCEED on its students. This will make these anecdotes more reliable as indicators.

A sure sign of change in the student culture is when students involved in SUCCEED related activities are willing to volunteer to participate or initiate activity which is beyond what is minimally required by a specific course or the curriculum. This is a continuing and growing experience that faculty are reporting. Some specific examples follow.

Students who were enrolled in the preparatory course prior to the QIP summer project internships have consistently asked to make suggestions and modification in the content and arrangement of the course to improve its effectiveness. One example was their request to participate in the “Ropes Retreat” twice, once at the beginning of the semester and then again at the end to provide a measure of improvement in teaming skills as a consequence of the course. These retreats take place on weekends and require extra travel on the part of the students.
Another example is the willingness of undergraduate students to work closer with faculty in almost what you would call an "associate" status much like graduate students. Co-authoring papers with faculty and assisting in conference presentations and workshop delivery are just a few examples of this student / faculty collaboration.

The development of greater self-confidence and independence is another change that has been observed. In the entrepreneurs program, students are interacting with industrial partners independently of faculty. Students have proposed and taught special mentoring classes to lower level students on subject material and skills development that they have themselves encountered through some of their SUCCEED interactions.

It is clear that these students are recognizing that there are those in the "system" that care about their education and they are responding to that care and becoming involved in the improvement process of the "system" themselves. It is very likely that these effects in culture change will propagate through the students more rapidly than the faculty since the students are more amenable to change.

5. Dissemination Outside Coalition

Coalition-Wide Conference

A very successful coalition-wide SUCCEED Conference was organized and held in March 1994 on the N.C. State Campus. The two day meeting was attended by over 100 faculty and administrative participants from all participating institutions. The program consisted of simultaneous sessions of formal project presentations covering all aspects of the Coalition’s four Center programmatic efforts. More than 45 papers were presented and discussed. The conference also included a evening poster and demonstration session. There was overwhelming support for this activity being continued as an annual event.

A second annual SUCCEED Conference was held on March 2-4, 1995. Attendance was well in excess of 125 participants. The agenda was similar to the first Conference, involving 37 paper presentations in simultaneous sessions, but also included some panels, forums and break-out sessions. One panel of specific interest was made up of the Dean’s of the SUCCEED institutions discussing the "Implementation & Institutionalization of SUCCEED Results". Workshops on "Teaching Effectiveness" and "Effective Presentations" were conducted following the conference and were equally well attended. Three other coalitions sent representatives to the conference and one of the coalitions scheduled a meeting of their governing board to coincide with the location of the conference to permit more of their participants to attend.
Workshops

A very well-attended and successful Teaching Effectiveness Workshop was conducted by SUCCEED in June 1994. Dr. Richard Felder, nationally recognized for his research and promotion of Collaborative Learning, was the workshop leader. Fifty attendees from across the Coalition attended. One of the consequences of this activity was that Dr. Felder has been requested to repeat the workshop at several other Coalition campuses.

A second workshop was conducted at the 1994 Frontiers in Education (FIE) Conference in November on Quality Improvement Partnerships. The workshop was presented by a team of faculty and students who had participated in the QIP experience with Milliken and Company. The purpose of the workshop was to provide information on how to organize and implement QIP type programs with industry participation.

A two day Early Design/Team Workshop was conducted at Virginia Tech in August 1994. The first day was devoted to SUCCEED activity in this area. The second included presentation by ECSEL and Synthesis and students from Virginia Tech. A session on improving teamwork effectiveness in design projects was also included.

Coalition Newsletter

During 1994 and into 1995 the Coalition has continued the publication of its newsletter, "The Innovator". Three issues were published in 1994, reporting on a wide range of SUCCEED activity and project results together with other general material of interest to the engineering education community. Over 4000 copies of each issue were distributed. Every faculty member in a participating institution of SUCCEED receives a copy and issues are sent to every engineering college in the country. A 1995 winter issue was published this year in conjunction with the SUCCEED Conference.

Participation in Educational Conferences

Since the beginning of SUCCEED, involved faculty have participated on the programs of a large number of educational conferences in which they have reported on their activities sponsored by the Coalition. Most notably SUCCEED has participated in every ASEE Annual Meeting and FIE Meeting since 1992. This involvement has been in the form of individual project reports, overviews of the coalition and its activity and the presentation of workshops. Much of the work of SUCCEED faculty, either as individuals or in groups, has been published in a wide variety of technical and professional publications relating to improvements and innovations in engineering education.
E. INFRASTRUCTURE

1. Management

Background

An effective management and organizational structure is a key ingredient to the success of any multi-institutional undertaking. Emphasis has been placed on a management plan that meets the administrative, programmatic and communication requirements of the activities of SUCCEED.

The Coalition headquarters are located in the College of Engineering on the N.C. State campus. The Coalition is headed by a Director who serves as the Principal Investigator of the project with N.C. State designated as the prime contractor with the National Science Foundation. The Director reports to a Council of Deans made up of the Deans of Engineering of the eight participating institutions. The administrative staff at N.C. State consists of the Director, an Assistant to the Director, a Fiscal Manager and Administrative Assistant. The Associate Director of the Coalition is located at the UNC-Charlotte.

There are two primary management groups with representation from across the Coalition: the Guidance Team and the Program Committee. The Guidance Team is programmatic in nature, while the Program Committee's membership is made up of the Co-PI's of the project. These Co-PI's, together with the Director, are ultimately responsible for the success of the Coalition as defined in the Cooperative Agreement. Each campus Co-PI is on the Program Committee. Approval of project activity and its associated funding level is the responsibility of the Program Committee based on the recommendations from the Guidance Team.

a. Structure & Composition

Taking advantage of the specific interests, capabilities, experiences and resources of four major coalition campuses in concert with the vision and goals of SUCCEED led to the establishment of four mission-oriented Centers to be directed from these campuses. The responsibility of these four Centers and their directors are programmatic: development, direction and monitoring of faculty-originated and conducted program activity across the entire Coalition in the area of that Center's mission. The programmatic missions of these Centers are listed below.

Center for Curriculum Content and Integration

Design, implementation, and evaluation of the content, framework, instructional techniques, learning environment and evaluation procedures of the CURRICULUM 21 undergraduate engineering educational model.
Center for Engineering Practice

Integration of engineering design and engineering practice throughout all stages of the CURRICULUM 21 model and the involvement of industrial partners in both campus and industry site real experiences for students.

Center for Professional Success

Enhancement of the long term professional success of students, staff and faculty and enrichment of the quality of professional life in engineering academia and beyond, with particular emphasis on promoting diversity on all Coalition campuses.

Center for Technology and Communications

Application of new information technologies and electronic communication in the curriculum that enhances the effectiveness and efficiency of the learning process and provides electronic connectivity among the Coalition institutions.

Guidance Team

The Guidance Team directs the programmatic activities of the Coalition and makes recommendations on funding of projects to the Program Committee. Originally, the Guidance Team consisted of the Director, Associate Director, Assistant to the Director, and the four Center Directors. In the last year and a half, the Guidance Team has expanded to include the Leader of the Evaluation and Assessment Team, a meeting facilitator, and representation from the two HBCU's in the Coalition. Presently, the Guidance Team has representation from all eight institutions in the Coalition.

The Guidance Team meets monthly on one of the eight campuses, and in addition to conducting necessary business, engages in some special team building to enhance the effectiveness of the team's leadership role in the Coalition. The Team has also increased its use of quality-based management methods on such things as the refinement of the Strategic Plan, relationship and impact of current activity on the Goals and Objectives, and allocation of resources by project.

Program Committee

The Program Committee consists of the Guidance Team plus the eight Campus Representatives. The Campus Representatives are the Co-PI's for the Project, responsible for the allocation of the matching funds for their campus and providing the administrative liaison between each campus and the Coalition. The Program Committee originally met twice a year, but has recently decided to meet together with the Guidance Team an additional two times a year as the Coalition moves toward implementation and institutionalization of the results of the Coalition's educational experimentation.
Leadership Changes

During the past year and a half a number of important changes occurred in leadership and administrative positions that affect SUCCEED. Two new permanent Deans of Engineering were appointed at SUCCEED institutions effective July 1, 1994: Bill Stephenson at Virginia Tech and Ralph Cavin at N.C. State.

Sue Lasser (Director of Minority Programs at Clemson) accepted the position of Director of the Center for Professional Success replacing Tom Brown (Assistant to the Director of SUCCEED) who was serving as interim Center Director. Sue is now a member of the Guidance Team. The directorship of the Center for Engineering Practice was taken over by Jack Hebrank (Adjunct Professor of Mechanical Engineering at N.C. State) at the beginning of the year following John Sutton’s resignation due to personal commitments. Laurie Hodges, who is with the Georgia Tech Research Institute, has accepted the position of Leader of the Evaluation and Assessment Team. She, too, is now a member of the Guidance Team.

Three of SUCCEED’s institutions have new Campus Representatives. These are Pamela Kurstedt (Assistant Dean of Engineering at Virginia Tech) who has replaced Hayden Griffin, Steve Melsheimer (Professor of Chemical Engineering at Clemson) replacing Bill Barlage who has retired and John Gilligan who has been appointed Associate Dean of Engineering at N.C. State under the new college administration. Everyone cited has already become directly involved in SUCCEED activities. Pamela Kurstedt also serves as the formal facilitator for the Guidance Team. Rodney Harrigan (Associate Dean at N.C. A&T State) and Willard Toliver (Associate Dean at FAMU/FSU) are now also members of the Guidance Team.

b. Resource Allocation Strategy

A recent example of consensus development that was successful involved allocation of fourth year funding to the Coalition Centers. A two day meeting of the Program Committee reviewed all proposed activity for fourth year funding. This resulted in recommendations to the Center Directors regarding direction and funding of specific Mega-Projects and Deliverable Teams. Budgets proposed and requested by the Centers in response to these recommendations and to support their programs in the fourth year of the Coalition exceeded the funding available. Attempts to resolve this issue among the Center Directors themselves was unsuccessful. At the next meeting of the Guidance Team, all members discussed their concerns and opinions about each Mega-Project and Deliverable Team supported by SUCCEED. A facilitated discussion, which allowed all members to express their positions, was followed by an open question and response session. Each team member then recommended the funding level for each Mega-Project or Deliverable Team they felt comfortable with. Following additional discussions, the
results were refined and a consensus about Center funding was reached in a participative and supportive manner. While no Center received as much funding as initially requested, each Center felt the process for allocation was fair and straightforward.

While this method of decision making is time consuming, SUCCEED is truly becoming a coalition of eight engineering colleges working together successfully as a team with shared objectives and goals. Each member of the Guidance Team now appreciates the effort required to function as a team and the importance of consensus building in working toward meeting the vision and deliverables of SUCCEED. The Guidance Team is confident in its ability to continue its quality journey for SUCCEED.

c. External Advisory Board

SUCCEED's National Advisory Board and Technical Council were restructured in 1994 into a single External Advisory Board. Members for this new EAB were recommended by the Deans of the participating institutions from their College Advisory Boards. This membership insured active participation since the individual members already had established an ongoing interaction and interest in one of the Coalition Colleges.

The EAB consists of 21 members representing industry, commercial enterprise and/or government. The membership provides a wide spectrum of background, experience and diversity with interest in engineering education. The first meeting of the restructured EAB was held this past December on the N.C. State campus. Following an introduction to and overview of the Coalition and its operation the EAB members participated in several parallel break-out sessions meeting with Center Directors and reviewing in detail specific program activity on which their input was both relevant and desired. The meeting concluded with a set of recommendations and the Center Directors are currently developing actions plans based on these recommendations.

A second meeting of the EAB has been scheduled for early May at Virginia Tech at which the EAB will review with the Guidance Team the materials and presentations being prepared for the Third Year Review of the Coalition. A year end meeting with the EAB will take place in November.

d. Interaction with Customers

One of the success stories of SUCCEED is the interactions created with its customers. The influence of the Coalition has spread far beyond the Guidance Team and the Program Committee. Interactions with and among faculty are
significant; over 250 faculty directly engaged in supported projects all interacting with multiple faculty on each project across multiple campuses. Over 3000 students are now being impacted by SUCCEED activities and the number continues to grow.

Our customers also include faculty indirectly involved in projects, faculty influenced by activities such as major curriculum revision, and industry. This latter participation and interaction take place through direct project participation and activities such as external advisory panels and the External Advisory Board to the Coalition. Over 45 companies are currently providing some form of support, either personnel, hardware or funding, to ongoing projects.

A specific example of industry support is the Creative Projects Laboratory. This is a facility created and financed by industry to involve students in projects defined as being of economic importance to the company. The project was initiated by IBM and has includes participation by Duke Power Company, Ingersoll-Rand and Siecor at UNC-Charlotte. Other examples are the ongoing QIP program with Milliken and Company and the Entrepreneur Program that interacts with a large number of both large and small companies in the Research Triangle Area.

e. Evaluation & Assessment System

A significant response to the recommendations forthcoming from the second year annual review was the creation of a Coalition Evaluation and Assessment Leadership Team. This Team is responsible for Coalition-wide efforts in this important area. In addition to representation from Coalition PI's, this team includes members with experience and background in qualitative educational program assessment and campus-wide quantitative data accumulation and interpretation.

Background

SUCCEED's Evaluation and Assessment Team (E&A) was constituted in the Summer of 1994 and has been meeting monthly since last September. Operating under the framework that coalitions are educational experiments, the team goal is to measure the impact of SUCCEED in a variety of ways: qualitatively and quantitatively. Two basic principles of the team's philosophy are that evaluation is ongoing and that both planning and performing evaluations contribute to more effective projects. The team is also motivated by the continuous improvement philosophy embraced by SUCCEED as a whole and seeks to meet the evaluation and assessment needs of the National Science Foundation.
Team Mission and Members

The primary activities of the team fall in three areas: qualitative assessment, quantitative assessment and evaluation and assessment education and support for the Coalition. The members by name, role and institution are:

Laurie Hodges Coordinator and Guidance Team Representative, Georgia Tech
Lewis Carson Institutional Research Representative, N.C. State
Ray Hart Representative for Minority Retention Project, Georgia Tech
Deidre Hirschfeld Representative for Women’s Engineering Board, Virginia Tech
Pamela Kurstedt Campus Representative Member & TQM Facilitator, Virginia Tech
Bob Serow Educational Research Consultant, N.C. State
Neff Walker Design/Evaluation Research Consultant, Georgia Tech

Qualitative Assessment

There are two concurrent efforts in this area. Professor Bob Serow at N.C. State is leading a qualitative assessment of the impact of SUCCEED and its activities at individual coalition campuses. The goal of this assessment is to document the process through which changes occur as a result of SUCCEED. Through observation, document analysis and especially interviews, this qualitative evaluation will describe the context of SUCCEED efforts from the perspectives of the participants themselves, including students, faculty, administrators, graduates and employers. To date, a pilot implementation has been completed and documented for the N.C. A&T State campus. Applying what was learned during the pilot about the assessment methods, this study has now been replicated (on a larger scale) at N.C. State and the UNC-Charlotte. Other coalition schools will be scheduled for assessment after that.

The purpose of the three campus studies undertaken was to determine the degree to which SUCCEED had been implemented at each site and to assess the degree of progress made on each campus toward achieving the Coalition’s goals, as
identified in the Cooperative Agreement of March, 1992. These case studies provide the data base upon which the overall qualitative evaluation of the SUCCEED Coalition will be built. In the course of these case studies, some ninety-five individuals were interviewed who had participated in SUCCEED activities, including faculty, administrators, students, alumni, and internship supervisors. Relevant documents were also examined from each site, including project annual reports, course syllabi, and instructional materials. In addition, SUCCEED-related activities were observed, including the informal NSF visits to two sites.

At each site, it was found that SUCCEED-sponsored programs were generally well-received by participants; in a number of instances, students specifically stated that a SUCCEED project had reinforced their decision to pursue engineering as a major and career. Visions at N.C. A&T State was the clearest example of this, but similar comments were received about several courses at N.C. State and at the UNC-Charlotte. Students seemed to appreciate several features of these courses, notably greater emphasis on “real-world” experiences and an exposure to engineering design, practice, and process at an early stage in their undergraduate career (usually freshman year). Likewise, it appears that SUCCEED is helping to gradually reshape the undergraduate engineering curriculum, though the amount of impact varied greatly across projects and across campuses. At a minimum, SUCCEED is providing crucial support for a core group of faculty who are committed to curriculum reform. On the other hand, basic questions remain on at least two of the three campuses (N.C. State and N.C. A&T State) about the pace of institutionalization and the ability of a relatively small number of faculty and administrators to overcome the inertia that supports the status quo.

While Professor Serow’s effort is campus-oriented, another project-oriented qualitative assessment effort is being lead by Professor Neff Walker from Georgia Tech. Professor Walker has completed an Evaluation Primer which was distributed to all SUCCEED investigators. Following this distribution, Professor Walker has begun contacting each of SUCCEED’s Mega-Projects for individual meetings during which they continue to focus their development of evaluation plans, including the collection and reporting of key indicator data. These meetings and their follow-ups are intended to provide individual “coaching” to projects in designing and carrying out valid project-specific evaluations. Project-level evaluations will be expected to include key SUCCEED program indicators (e.g., relevance to deliverables), while also including appropriate research designs and indicators specific to individual project objectives.

Quantitative Assessment

As various assessments across SUCCEED are undertaken, many evaluators need or will need access to a significant amount of data. The E&A Team decided that developing and offering a central internal database to SUCCEED evaluators would be cost-effective and would promote the use of such data with a minimum
disruption on individual campuses. Mr. Lewis Carson (N.C. State) is coordinating the collection of data from each institution in support of SUCCEED deliverables. Two Mega-Projects which have some of the most demanding data needs, the Women's Engineering Board and the Minority Retention Mega-Project, are working closely with Mr. Carson to establish the database that will be maintained for the Coalition’s campuses for summary data for students and faculty at the institution, for the engineering college, and for disciplines within engineering. The initial database will be completed by mid 1995.

**Evaluation and Assessment Education and Support**

In addition to the distribution of Walker’s Evaluation Primer to all SUCCEED investigators in Fall 1994, the consultative nature of the project-level qualitative assessment project provides multiple opportunities to help SUCCEED faculty and students learn about evaluation techniques. The E&A Team also met jointly with the Guidance Team in November 1994 to help SUCCEED’s highest level of management, including the Center Directors, learn to develop program indicators and objectives that can be measured. During the 2nd Annual SUCCEED Conference in February 1995, the E&A Team also lead a two-hour educational session/workshop on evaluation and assessment.

**f. Other Resources**

One reason for forming an engineering education coalition is to create strength through synergy and symbiosis. Where one single school may not have the resources, both fiscal and human, to accomplish a task, working through a coalition permits many common goals to be accomplished. SUCCEED has created a number of programs and facilities that cross institutional boundaries.

Indeed, the structure of the management scheme, focusing on thematic centers is one mechanism to ensure coalition-wide activity rather than single university activities. Also, the creation of mega-projects relies on participation across the entire Coalition. Thus, project participation and management becomes a coalition activity focused on accomplishing the goals and mission of SUCCEED. The Evaluation and Assessment Team is also an example of a program that spans the Coalition.

In addition to projects and programs that span the Coalition, there are certain physical facilities that are shared in common among the universities. These facilities were created at a single location, to avoid duplication and keep cost down but are shared by all the Coalition members. Some examples of these common facilities include:
1. Multimedia Facility (Virginia Tech) - This facility is the common center for creation of multimedia materials. The facility consists both of human resources for advice and consultation and computer facilities to create multimedia packages.

2. Emulated Flexible Manufacturing Facility (University of Florida) - This facility was created by Dr. Tufekci and his associates and students to emulate manufacturing processes. This facility is available both as a teaching laboratory, model for other simulation facilities and for sharing resources.

3. Computer Aided Process Improvement Laboratory (University of Florida) - This facility utilizes the university's newly installed cogeneration plant that has been instrumented to provide real time data for use in class and project activities. The data is available in real time across the Coalition and, in fact, internationally through the WWW.

4. Wastewater Treatment Facility Laboratory (University of Florida) directed by Dr. Spyros Svorinos who is also the Leader of the Process Engineering Mega-Project.

2. Teaming

a. Intra-/Inter-Institutional Collaboration

Campus Visits

Campus visits by the SUCCEED administration to all participating institutions began in the summer of 1993 and were continued this past summer. The Director, together with either the Associate Director or Assistant to the Director, or both, spent at least one day on each of the Coalition campuses. The purpose of these visits is to inform the participating faculty of the progress and plans of the Coalition as a whole and to provide faculty with the opportunity to present their progress and accomplishments to the Director and his staff. These meetings also provided an opportunity for SUCCEED administration to meet with campus administrators, to review the interaction between SUCCEED and the institution and to resolve any problems first-hand. These meetings have proven to be very beneficial and will be continued in the coming year on about the same schedule.

External

The SUCCEED Coalition recognizes the value in sharing and interacting with the other EEC's. We have always advocated this as a means of bringing about systemic curriculum reform. Although formal efforts among the coalitions are still being pursued by NSF, a number of less formal interactions have occurred.
SUCCEED has, and will continue, to participate in these desirable collaborative efforts. Among the activities to date are:

SUCCEED Conferences: Directors and PI's from other EEC's have attended and participated in both the 1994 and 1995 SUCCEED Annual Conferences.

Workshops: SUCCEED has sponsored workshops, both for our PI's and invited participants from other coalitions, on

1. Early Design Experiences
2. Teaching Effectiveness
3. Effective Presentations
4. Mega-Project Team Workshops
5. Minority Program Counselors

Several SUCCEED participants, including two Campus Representatives, are serving as external reviewers for other Engineering Education Coalitions.

Internal

SUCCEED is proud of the collaboration among the eight institutions of which it is comprised. There are significant interactions among the faculty and students. With the largest student population and number of graduates of any of the EEC's, we believe that SUCCEED is having a major impact on engineering education. Indeed, one of twelve students graduating in engineering nationally comes from a SUCCEED institution.

b. Team Building & Communication

Continuous Improvement Education

The Guidance Team is learning to become a team in the truest sense of the word. Developing an appreciation for total quality concepts and their implementation requires training, discussion and consensus as to how and what tools to use in the management of the Coalition. Even though the process requires large investments in time and energy for education and collaboration, the results have been very gratifying.

Examples of topics and tools studied by the Guidance Team include:

1. Understanding differences in decision making styles
2. Planning effective and productive meetings
3. Identifying priorities in SUCCEED future activities
4. Developing consensus through different processes
5. Understanding differences in money management styles
6. Using flowcharts, cause and effect diagrams, deployment diagrams, and project management tools to plan, monitor, and execute the goals of SUCCEED
7. Soliciting opinions and advice from stakeholders
8. Improving assessment and evaluation techniques

Guidance Team Meeting Facilitation

Most of the Guidance Team meeting discussions are now formally facilitated. SUCCEED recognizes that all stakeholder voices must be heard and to do so requires discipline and interest in the good of the whole. The facilitator keeps the discussion focused, identifies and resolves conflict, and ensures that all stakeholders feel comfortable to offer opinions, concerns and questions. Often, the issue is to identify those situations that require consensus and those that don’t. When consensus is required, the group struggles to look at all sides of an issue and find a solution that all can support.

c. Support from Institutional Administration

The Coalition is fortunate to have the level of support provided by the administrations of our institutions, both within and external to the colleges. This support has been both financial, and programmatic. Much of what constitutes the vision and goals of the Coalition has been adopted or is beginning to shape the educational reform efforts at our campuses.

One of the indicators of the acceptance and long term viability of the SUCCEED efforts is demonstrated by the institutionalization that is beginning to take place on a number of Coalition campuses. Also, at a time when budgets, personnel and space are at a premium, support has been allocated at SUCCEED schools for program activities. Some examples of the support accorded by the administration are:

The administration at University of Florida and FAMU/FSU has been successful in obtaining a line item for SUCCEED cost sharing in the Florida educational budget. This budget item will continue past the NSF grant period.

The Dean’s Council has staffed the External Advisory Board for the Coalition with members from their own advisory boards, to strengthen the linkage between the Coalition and the individual colleges.

Several Colleges (Clemson, the University of Florida, N.C. State, etc.) have used SUCCEED presentations as a major portion of their annual presentations to their College Advisory Boards.
The Deans have provided support for both SUCCEED and non-coalition personnel to attend the various Coalition conferences and workshops.

At UNC-Charlotte, the freshman year, affecting 500 new students, has been revised following experiences with SUCCEED projects and participation in curriculum revision activities. The entire curriculum within engineering is under revision utilizing a curriculum template developed together with SUCCEED.

The introductory freshman engineering course for all entering engineering students at N.C. State is being revised at the direction of the College administration to take advantage of lessons learned from the Early Design Experiences Mega-Project.

Special class room space and renovations were provided by the College of Engineering at N.C. State for the IMPEC program.

A further demonstration of administrative support is seen as a consequence of a large variety of curricular and course revisions and initiations that are taking place. Some examples here include:

At the University of Florida, a Process Systems Engineering Certificate Program has been approved as a Stage III initiative.

At Clemson, the Chemical Engineering Department has placed SUCCEED design projects into eight courses (ChE 201, 220, 301, 302, 353, 403, 450 and 421). Also, ChE 422, has undergone substantial changes following a project experience.

At N.C. State, the Civil Engineering Department is revising CE 327, 426 and 420 in accordance with Coalition experiences.

At UNC-Charlotte, the Quality Improvement Partnerships preparatory course has been institutionalized (ENGR 3670, Total Quality) and is offered under various special topics numbers at N.C. State, N.C. A&T State and Duke University.

At Clemson and UNC-Charlotte, students are offered an "International Option". This allows students to participate in special internationalized sections of courses, have access to special language training, and work or co-op in a foreign country.
F. BUDGET INFORMATION

1. Long Range Budget Plan

Following is a brief description of the process used by SUCCEED to decide budget allocations including who is involved and how final allocations are made to the individual projects.

Operationally, SUCCEED has allocated funds to support project and programmatic initiatives through its four mission-oriented Centers. The decision process for the annual distribution of project funding originates with the Center Directors. The Center Directors, in collaboration with their Center Review Panels, annually review activity proposed by participants in response to the programmatic needs of the Centers. Each Center then presents its proposed budget to the entire Program Committee. Based on the estimated total Coalition funding that will be available, as presented by the Coalition Director, revisions to these Center budgets may then take place in light of their relationship to each other and what is planned to be accomplished that year.

The final proposed programmatic budget arrived at by the Program Committee, together with the Coalition-wide activities to be included, is then reviewed by the Coalition Director and his staff. The proposed budget is reviewed in relation to other Coalition needs such as Administration and Evaluation and Assessment. Annual Center operating budgets are decided on and awarded to the Center Directors. The Center Directors then make any additional changes required in individual projects, notify the PI’s as to what their funding award is and the PI’s prepare their final project budgets. These are first approved for cost sharing on the campus of origin and are then submitted to the SUCCEED office where allocations are approved and committed against a specific task number for that project under the subcontract for that particular campus.

Shown in Table I is a summary of the fiscal status of the NSF funding to SUCCEED which includes both third year information and fourth year estimates. The first column presents estimated budgets established in April 1994 as the Coalition entered its third funding year. The total exceeds the allocated annual NSF funding of $3,000,000 by $487,657 which was the estimated reserve carried over from the total funding received in years one and two. The second column represents actual funding allocations as of December 1994 to the same line items in the first column. This date is chosen for this report since it represents the Coalition’s fiscal status at the time initial decisions were made regarding fourth year funding distributions. It can be noted that actual allocations to projects was less than originally budgeted but the administrative allocation as well as that for Evaluation and Assessment increased.
### Third/Fourth Year Budget Summary

<table>
<thead>
<tr>
<th>Centers</th>
<th>April</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Third Year</td>
<td>Third Year</td>
</tr>
<tr>
<td>CCCI</td>
<td>$933,227</td>
<td>$890,731</td>
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<tr>
<td>CEP</td>
<td>596,482</td>
<td>585,531</td>
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<tr>
<td>CPS</td>
<td>620,122</td>
<td>580,195</td>
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<tr>
<td>CTC</td>
<td>691,398</td>
<td>681,378</td>
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<tr>
<td><strong>Subtotal</strong></td>
<td><strong>$2,841,229</strong></td>
<td><strong>$2,737,835</strong></td>
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<tr>
<td>Admin</td>
<td>$475,300</td>
<td>$513,243</td>
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<tr>
<td>E&amp;A</td>
<td>36,000</td>
<td>77,534</td>
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<tr>
<td>Reserve</td>
<td>135,128</td>
<td>102,181</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$3,487,657</strong></td>
<td><strong>$3,430,793</strong></td>
</tr>
</tbody>
</table>

**Table I**

The net reserve available to be carried over to the fourth year remained about the same as originally estimated. The budget estimates for the entire fourth year, again by the same line items, is represented in column three. Project allocations will need to be reduced to account for the larger allocation to Evaluation and Assessment as well as to account for the reduced reserve carried forward from the third year. The required adjustments in Center allocations has been taken into account in the planning of fourth year project activity. The decreased total amount between the third year and the fourth year is a consequence of the leveling out of the exceptional allocations in the second year of operation resulting from the very large carry over from the first year.

It is now anticipated that fourth year funding will be provided in two six month increments as a consequence of the delay of the third year review. If this does take place only half of the proposed fourth year funding will be made available to the operating groups for the first six months of the contract year. The budgets and Coalition program will then be reviewed and decisions for the second six month allocations will be made which may alter the proposed distribution.

Figure 7 shows how the Center budgets have compared to one another over the first three years of SUCCEED's operation. The distribution for year four is an estimate based on the review of project activity made last November and expected needs for the coming year. The very large differences between the first and second year are in part due to the large carry over of first year funding that needed to be committed in the second year of operation.
Figure 7 - Coalition Funding Distribution

Some other points to be noted in the distributions in Figure 7 are:

1. Administration of the Coalition has been reduced somewhat following the first year allocations but remains at about $500,000 per year. It is anticipated that this will stay about the same for the remainder of the project.

2. The high level of funding to the Center for Curriculum Content and Integration in the second year reflects the emphasis it was felt this area needed to undertake the level of research required for Curriculum 21 components. Future funding may be further reduced as dissemination and institutionalization efforts expand.

3. Funding to projects in the Center for Technology and Communication peaked in the third year. They will probably continue to decrease for the same reasons cited for CCI.

4. The Center for Engineering Practice is also undergoing a budget reduction in the fourth year as its activity becomes more integrated with the previous two Centers.

5. The budget for the Center for Professional Success has increased substantially in the first three years and is being kept at the same level for the fourth year to continue its emphasis on increasing minority and women participation and K-14 activity.
6. Funding of Evaluation and Assessment efforts just begun last year are being doubled in Year 4. This budget will continue to grow for the remainder of the project.

Due to the delay of the Third Year Review of the Coalition it is anticipated that fourth year funding will be provided by NSF in two six month increments. The Coalition will take advantage of this opportunity to further adjust the budget distribution among the Centers along the lines already discussed.

2. Budgets by Areas / Functions

Summarized budget distributions by programmatic Centers, Administration and Evaluation and Assessment areas for the first three years of operation as well as estimates for year 4 has been covered in Section 1. The “Accounting Budget” in the data base information in the Appendix gives a detailed break down of how total third year moneys which include allocated NSF funds, cost sharing by institutions and contributions from industry are distributed by function. Repeated below is a summary of the totals of this data.

Accounting Budget Summary (3rd year)

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty and Technical Staff Salaries</td>
<td>$2,013,689</td>
</tr>
<tr>
<td>Student Fellowships, etc.</td>
<td>$855,623</td>
</tr>
<tr>
<td>Student Workers not on Fellowships, etc.</td>
<td>$941,730</td>
</tr>
<tr>
<td>Equipment and Material Purchases</td>
<td>$609,974</td>
</tr>
<tr>
<td>Administrative Salaries and Expenses</td>
<td>$602,466</td>
</tr>
<tr>
<td>Travel</td>
<td>$375,608</td>
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<tr>
<td>Publication and Printing</td>
<td>$67,454</td>
</tr>
<tr>
<td>Indirect Costs</td>
<td>$2,273,199</td>
</tr>
<tr>
<td>Others (misc.)</td>
<td>$195,875</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$7,914,199</strong></td>
</tr>
</tbody>
</table>
These figures show that about 1/3 rd of the total budget is going for indirect costs which is about right for a university conducted project. Although the Administrative Salaries and Expenses line does not include some costs such as travel and communications it is interesting that this major line is accounting for less than 10% of the total budget. When consideration is given to the size, scattered nature and complexity of the effort being supported this seems quite good. It should also be noted that the total funds budgeted for some form of student support is not much appreciably than that for faculty and staff salaries.

3. Funds Not Obligated

At the end of its first year of operation SUCCEED had allocated only about $2M of the $3M award it received from the NSF. This was a consequence of the time it took to get the new program under way. This included identification of faculty, selection of projects to be funded, preparation and approval of budgets, establishment of subcontract agreements and allocation of project awards. Recognizing that dealing with these factors the first time through could delay project initiation, the NSF permitted the Coalition to carry over into the second year of operation about $1M in unobligated funds. This was done with the understanding that SUCCEED would not end up at the end of its second contract year with more than 20% of its first two years funding unobligated.

Allocations during the second year amounted to about $3.5M leaving something less than $500K as carry-over for the third year. This was within the guidelines specified and full funding was provided for the third year of operation for the Coalition. During the 3rd year, allocations to continuing projects had to be reduced from the previous year to meet available resources and provide funding for new initiatives. Final budget awards amounted to about $3.4M leaving only $100K as carry over for the fourth year. This represents only about 5% of the total budget which is considered to be a minimum amount to account for unforeseen contingencies.

4. Fourth Year Budget Plans

For SUCCEED's first three years of operation the contract period as established by the Cooperative Agreement started March 1st and ended on February 28th of the following year. For a variety of reasons involving both the Coalition and the NSF, approval of second and third year funding along with the budgeting and allocation process to campus participants has gotten out of phase with the contract period. In the third year this phase shift resulted in funds not being available to most coalition participants until about mid June. During the first two funding periods this shift was accommodated internally to the project by permitting participants to continue expenditures beyond the contract termination date. To get the process back in
synchronization SUCCEED has requested a mid project “no-cost” extension of 3 1/2 months which would result in a new contract year starting date of June 16th. This request is now under consideration by the NSF.

A second aspect of the current project extension request is that half of the fourth year budget be approved immediately so that the momentum of the program efforts not be adversely impacted by the delay of the Third Year Review from this past January until the end of this May. Although this will increase the amount of administrative effort required to approve budgets and allocations to participants to encumber all of the anticipated fourth year funding it will provide an opportunity for mid course program corrections and reallocations following the Third Year Review and changes in program effort that might be suggested. It is anticipated that this will be required to fine tune Phase IV of the Strategic Plan as it is implemented and adjusted. The Coalition is clearly entering a transition state between the earlier research, development and test phases and those activities that will result in the implementation and institutionalization of the results created to date.

It is anticipated that if the current request for the new start date for fourth year funding on June 16th is approved, then budget and allocation reviews for all program activity over the next two years will take place about mid October 1995 for the second half of fourth year funding, mid April 1996 for the beginning of fifth year funding and mid September 1996 for the any corrections necessary for the last half of the fifth year of operation. Although it would be premature to attempt any specific distribution allocations at this point it is clear that the past emphasis on funding research and development efforts will be decreased as more resources are placed into evaluation and assessment, implementation and institutionalization activity.

5. Matching Funds

In the most recent information forwarded to the NSF for the EEC Data base the matching funds provided by the participating institutions and industry for the past three years is shown to exceed the total NSF funding received on the project by 23%. The distribution of these moneys by year and major source is summarized below.

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Totals</th>
</tr>
</thead>
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<tr>
<td>Institutions</td>
<td>$2,348,520</td>
<td>$3,571,316</td>
<td>$3,869,969</td>
<td>$9,789,805</td>
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<tr>
<td>Industry</td>
<td>$61,025</td>
<td>$622,115</td>
<td>$620,264</td>
<td>$1,303,434</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td>$11,093,239</td>
</tr>
</tbody>
</table>

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Further detail which includes a break down of these summary figures into state, university and industry contributions as well as equipment and personnel, etc. is provided in the Data base section of the Appendix under “Sources of Support”. Greater detail on individual project cost sharing by line item expenditure categories are available through the SUCCEED office but are not include here to keep the overall size of the report reasonable. There is also information in the Appendix under “Matching Funds” on the break down of these moneys by institution.

The fact that the first year’s cost sharing total is less than the NSF award for that period is a consequence of the time it took initially to get the program under way. This included selection of projects to be funded, budgets to be approved and funding allocations to be awarded.

Although cost sharing need only be matched totally at the end of the five year project it is being committed and made available on virtually a project by project basis to permit the participating faculty to make the most effective use of these resources as they need them.
APPENDIX

Biographical Information of Principal Participants

Coalition Data Base Report
Biographical Information of Principal Participants
BIOGRAPHICAL SUMMARY FOR TIMOTHY J. ANDERSON

Business Address
Chemical Engineering Department
University of Florida
Gainesville, FL 32611

Education
Iowa State University 1973 BS Chemical Engineering
University of California, Berkeley 1975 MS Chemical Engineering
University of California, Berkeley 1980 PhD Chemical Engineering

Industrial and Academic Experience
1978-Present Assistant Professor / Associate Professor / Professor of Chemical Engineering, University of Florida, Gainesville, FL
1988 Acting Chairman, Chemical Engineering Department, University of Florida, Gainesville, FL
1985-1986 Visiting Professor, Laboratoire de Thermodynamique et Physico-Chimie Metallurgiques, CNRS, Grenoble, France
Summer 1980 Summer Faculty Research Associate, Rome Air Development Command, Hanscom AFB, Bedford MA

Professional Activities
American Society for Engineering Education
• Associate Editor of Chemical Engineering Education Journal (1988-present).
• New Engineering Educators Affairs Committee (1980-present), Chair (1982-1983).
• Chemical Engineering Division Summer School, Organizing Committee Block Chair for Workshop on “Emerging Technologies,” Santa Barbara, CA (1982).
• Task Force on “Preparation for the Teaching of Engineering,” Quality of Engineering Education Project (1984-86), Member.
• New Engineering Educator Excellence Award, Committee (1986-88), Chair (1986-87).
• Program Chair, Chemical Engineering Division, Annual Meeting, Portland, OR (1986).
• Chemical Engineering Division Summer School, North Dartmouth, MA (1987), Organizer of “Electronic Materials Processing Workshop.”
• Task Force “Strategies to Increase ASEE Awareness Among Prospective and New Engineering Educators,” Chair (1988).

American Institute of Chemical Engineers
• Meeting Program Committee, Orlando, FL (1983).
• Area 8e: Electronic Materials Processing Programming Committee, Vice Chairman (1987-present).
• Editor of Electronic Materials Module of AIChe’s New Technology Educational Materials Project (1988-90)

American Association of Crystal Growers
• Meeting Program Committee, 3rd Workshop on Purification of Materials for Crystal Growth and Glass Processing, Orlando, FL (1989)

American Vacuum Society
• Meeting Program Committee, 36th National Symposium, Electronic Materials and Processing Division

Universities Space Research Association

Society Memberships and Honors
1985-86 Fulbright Award — Senior Research Scholar
1983 Tau Beta Pi “Excellence in Undergraduate Education” Award
1981 Dow Outstanding Young Faculty Award
Field of Research Interest
Electronic Materials: Synthesis, Crystal Growth and Properties

Ten Most Recent Publications

Education-Related:

Research-Related:

Associations With Graduate Students/Post-Doctoral Scholars For Last Five Years
1. K.M. Chang, PhD, 1985
2. P. Chludzinski, MS, 1986
3. J. Edgar, PhD, 1987
4. J. Hsieh, PhD, 1987
5. J. Krawczyk, MS, 1988
6. C. Coughanowr, PhD, 1989
7. G. Palczewska, MS, 1989
8. J. Hurst, PhD, 1990
9. H.D. Lee, PhD
10. A. Howard, PhD
11. C. Park, PhD
12. B. Sears, PhD
13. R. Aparicio, PhD
14. S. The, PhD
15. M. Montoya, PhD
16. E. Bretschneider, PhD
17. J. Cho, PhD
18. S. Misra, PhD
19. K.-C. Chou, PhD
20. K.-Y. Kao, PhD
21. S. Cherian, PhD
22. S.S. Chang, Post-Doc 1986-87
23. F. Hong, Post-Doc 1986-87
24. J.L. Ponthenier, Post-Doc 1987-88
25. F. DeFoort, Post-Doc 1987-88
26. A. Khan, Visiting Professor, 1988-89
27. V. Jovic, Visiting Scientist, 1989-90
28. P. Ayoub, Visiting Scientist, 1989
29. Y. Feutelais, Visiting Professor, 1990
31. Y. Hayakawa, Visiting Professor, 1988-90
32. B. Pathangey, Post-Doc
33. M. Yoshioka, Post-Doc
34. J.J. Kim, Post-Doc

Scientific Collaborators During Last Four Years
1. Dr. D. Ast, Cornell University, Ithaca, NY
2. Dr. G. Olsen, Epitaxx, Inc., Princeton, NJ
3. Dr. T. Spring Thorpe, Bell Northern Res., Ottawa, CN
4. Dr. H. Ansara, Univ. Grenoble, France
5. Dr. M. Hilbert, Royal Institute of Tech., Stockholm, Sweden
BIOGRAPHICAL SUMMARY FOR ROBERT N. BRASWELL

Business Address

FAMU/FSU College of Engineering
P.O. Box 2175
Tallahassee, FL 32316-2175
(904) 487-6427

Education

University of Alabama 1957 B.S.I.E.
University of Alabama 1959 M.S.E.
Oklahoma State University 1964 Ph.D.

Industrial and Academic Experience

1992 - Present Professor of Industrial Engineering and Director of Graduate Studies and Research, FAMU/FSU College of Engineering

1986 - 92 Professor of Electrical Engineering and Director of the Computing Center, Florida State University

1984 - 88 Professor of Industrial and Systems Engineering, University of Florida (on leave of absence with the U.S. Department of Defense under three Presidential appointments in the U.S. Senior Executive Service

1959 - 64 Systems Engineering Manager, Teledyne Brown Engineering

Society Memberships and Honors

President Student Government; Omicron Delta Kappa; Tau Beta Pi; Phi Theta Kappa; Pi Mu Epsilon; Chi Alpha Phi; Alpha Pi Mu; Sigma XI; Sigma Tau; Blue Key; Epsilon Lambda Chi; U.S. Steel Graduate Fellow; NASA Fellow; University Fellow: Science Achievement Award.

Publications

Authored/Co-Authored 239 papers and monographs.
BIOGRAPHICAL SUMMARY FOR THOMAS H. BROWN, JR.

Business Address

North Carolina State University
College of Engineering
120 Page Hall, Box 7901
Raleigh, NC 27695-7901
(919) 515-1871

Education

B.S. Aerospace Engineering Georgia Tech 1969
M.S. Engineering Science & Mechanics Georgia Tech 1973
Ph.D. Mechanical Engineering North Carolina State University 1989

Industrial and Academic Experience

1993-Present Assistant Director of SUCCEED
1981-Present Visiting Instructor/Lecturer, Department of Mechanical & Aerospace Engineering, North Carolina State University
1980-1981 Corporate Material Handling Group, Burlington Industries, Greensboro, NC
1/77-9/77 Engineering Department, John D. Hollingsworth on Wheels, Greenville, SC
1970-1972 United States Navy, Lt.j.g., Naval Flight Officer

Professional Activities and Society Memberships

American Society of Engineering Education (ASEE)
Pi Tau Sigma
BIOGRAPHICAL SUMMARY FOR ROBERT J. COLEMAN

Business Address

Department of Electrical Engineering
The University of North Carolina At Charlotte
Smith Building
Charlotte, NC 28223
(704) 547-4141

Education

Auburn University 1963 B.S. Electrical Engineering
Auburn University 1965 M.S. Electrical Engineering
Auburn University 1970 Ph.D. Electrical Engineering

Industrial and Academic Experience

Associate Professor and Associate Chairman of Electrical Engineering, The University of North Carolina at Charlotte, 1977-Present
Assistant Professor of Electrical Engineering, The University of North Carolina at Charlotte, 1970-1977
Instructor Auburn University, 1968-1970
Research Assistant, Auburn University, 1963-1967

Professional Activities

Regions 3 Representative, Student Activities IEEE National Committee, 1975-1976
Student Branch Counselor for IEEE for 17 years
Member, NC Energy Advisory Public Education Committee, 1977-1979

Society Memberships and Awards

Senior Member, Institute of Electrical and Electronic Engineers
Member, Society of Engineering Science
Member, American Society for Engineering Education
Phi Kappa Phi/Eta Kappa Nu/Tau Beta Pi
NCNB Teaching Excellence Award ($1,000)-1982
IEEE Service Award (1979)
IEEE Branch Council Service Award-1989
UNCC Faculty President-1985
IEEE Counselor Award-1983 (one of ten worldwide)
Principal Investigator, FIPSE Grant 198701990, U.S. Dept. of Education
Principal Investigator on Several Small Local Grants
Member and/or Chair of a Majority of University Committees at UNCC
Field of Research Interest

Antennas and Microwave Theory, Bio-Engineering, Engineering Ethics, Interactions of Technology and Society Improvements in Engineering Education Delivery Systems

Ten Most Recent Refereed Publications


2. Author and co-author of 22 research reports and publication in the areas of antennas, biomedical engineering, rehabilitation engineering, engineering and society, and engineering education. Recipient of education and research grants from Charlotte-Mecklenburg Heart Association ($1500), Faculty Research ($1000), Charlotte Rehabilitation Hospital ($500), U.S. Department of Education ($56,000). Extensive conference presentations.

Associations With Graduate Students/Post Doctoral Scholars For Last Five Years

1. W.W. Johnson, M.S., 1985
2. T.D. Le, M.S. 1987
4. P.M. Hoang, M.S., 1988
BIOGRAPHICAL SUMMARY FOR JOHN G. GILLIGAN

Business Address
College of Engineering - Academic Affairs
North Carolina State University
120-C Page Hall, Box 7901
Raleigh, NC 27695-7901
(919) 515-3693

Education
B.S.E. Engineering Science, Purdue University 1971
Ph.D. Nuclear Engineering University of Michigan 1977

Industrial and Academic Experience
Research Associate, Princeton Plasma Physics Laboratory, 1974-77
Assistant Professor, University of Illinois, 1977-83
Associate Professor, NC State, 1983-90
Professor, NC State, 1990-present
Director of Graduate Programs, Department of Nuclear Engineering, 1986-94
Associate Dean, Academic Affairs, College of Engineering, 1994-present
Editor, Nuclear Engineering Education Sourcebook, 1987-present

Professional Activities
Editor, Nuclear Engineering Education Sourcebook, 1987-Present
Consultant, State of Arkansas, Army Research Lab, Texas Tech University

Society Memberships and Honors
ANS, EDT and Fusion Division, ETD, Chairman 1991
IEEE, Executive Committee, Plasma Sciences Society
Fusion Power Associates
Coordinator (NCSU) for the DOE Magnetic Fusion Energy Technology Fellowship Program (1986-)
DOE Magnetic Fusion Energy Technology Fellowship Advisory Committee (1980-)
Co-Chair, Program Committee, ANS Fusion Topical Meeting 1994
IEEE Conference on Plasma Science, Raleigh, Chairman 1998

Field of Research Interests
Fusion Fuel Cycles and Fusion, Technology, Plasma-Material Surface Interaction, Low Temperature Plasmas

Principal Publications During the Last Five Years


BIOGRAPHICAL SUMMARY FOR JOHN H. HEBRANK

Business Address
Department of Mechanical and Aerospace Engineering
North Carolina State University
Box 7910
Raleigh, NC 27695-7910
(919) 515-5238

Education
Duke University 1971 BS Electrical Engineering
Duke University 1975 Ph.D. Mechanical Engineering

Industrial and Academic Experience
1976-1977 Mechanical Engineer, Center for Building Technology, National Bureau of Standards Gaithersburg, Maryland
1978-Present Visiting Instructor/Visiting Assistant Professor/Adjunct Associate Professor, Department of Mechanical and Aerospace Engineering, N.C. State University, Raleigh, North Carolina
1978-Present Consulting Engineer, Durham, North Carolina
1985-Present Senior Design Engineer, EMBREX, Research Triangle Park, North Carolina
1993-Present Director of the SUCCEED Center for Engineering Practice, N.C. State University, Raleigh, North Carolina

Professional Activities
Professional Engineer in North Carolina
Board of Directors, Duke School For Children, Durham, North Carolina
Board of Directors, Environmental Machine Systems, Asheville, North Carolina

Society Memberships and Honors
American Society of Mechanical Engineers
Sigma Xi
American Society of Engineering Education
Fairchild Alumni Extension Award, N.C. State University

Field of Research Interest
Machine and product design, biomechanics (fish locomotion and avian embryos), engineering education

Ten Most Recent Publications (from about 20)


Associations with Graduate Students for Last Five Years

Lane Miller, Ph.D. 1990

Scientific Collaborators During the Last Four Years

S.A. Wainwright, Duke University, Durham, N.C.
BIOGRAPHICAL SUMMARY FOR LAURIE B. HODGES

Business Address

Georgia Institute of Technology
GTRI/EOEML
925 Dalney Street
Atlanta, GA 30332-0800
(404) 853-3074

Education

B.S. University of Georgia 1982
M.S. Georgia Tech 1985
Ph.D. Georgia Tech 1987

Industrial and Academic Experience

1982-1987 Graduate Research and Teaching Assistant, GA Tech
1988-1989 Assistant Professor, George Washington University
1989-1991 Member of the Technical Staff, Belcore (Bell Communications Research)
1991-Present Research Scientist II, GA Tech

Professional Activities and Society Memberships

Association for Computing Machiners, Lecturer, National ACM Lectureship Program, Member, SIGGRAPH
The Institute for Electrical and Electronics Engineers Society, Member, Computer Society
Regents’ Opportunity Scholarship, GA Tech
Phi Beta Kappa
Phi Kappa Phi
National Merit Scholar

Fields of Research Interest

Multimedia applications for education and training; scientific data visualization; realistic image synthesis.

Ten Most Recent Publications


Pamela Kurstedt, Assistant Dean  
333 Norris  
College of Engineering  
Virginia Tech  
Blacksburg, VA 24061  
phone: 703/231-9764 fax: 703/231-3031

EDUCATION:  
B.S. Mechanical Engineering, Virginia Tech, 1977  
Ph.D. Industrial and Systems Engineering, Virginia Tech, in-progress

PROFESSIONAL MEMBERSHIPS  
ASEE, ASEM, POMS, IIE

COURSES TAUGHT  
EF 1005, Introduction to Engineering  
ISE 4015-4016, Management Systems Engineering Theory, Design, and Applications  
ENGR 4984, Special Study Courses for Study Abroad Programs: Eurotunnel Design and Project Management, Kansai International Airport Design and Project Management, NAFTA Effects on U.S./Mexico Trade and Partnerships, Management Differences in American Companies Acquired or Merged with European Community Corporations. Virginia Tech Staff Workshops, TQM Concepts and Tools

CONSULTING EXPERIENCE  

PUBLICATIONS  

GRANTS AND CONTRACTS  
Sponsors include Northern Telecom, Corning, Junior Engineering Technical Society, Department of Energy

SERVICE  
National Board of Directors, JETS, Alexandria, VA 1988-present  
Giles County, VA Industrial Development Commission, 1993-1996  
Giles County School Board, 1985-1989

TEACHING/RESEARCH INTERESTS  
Quality Cultures, Productivity, Continuous Improvement, Project Management
BIOGRAPHICAL SUMMARY FOR SUSAN J.S. LASSER

Business Address

Clemson University
22-A Riggs Hall
Clemson, SC 29634-0914

Education

University of Maryland  1978  B.A. in Performing Arts Administration
Clemson University   1986  M.Ed. in Post-Secondary Counseling & Guidance

Industrial and Academic Experience

1992-Present  Director, Minority Engineering Program, Clemson University, Clemson, SC
1987-1992  PEER Coordinator, Clemson University, Clemson, SC
1986-88  Lecturer and Administrative Assistant, Clemson University, Clemson, SC
1982-1983  Resident Tutor, Harvard University, Cambridge, MA

Society Memberships and Honors

1991 Retention Excellence Award, National Conference on Student Retention
1991 Faculty/Staff Person of the Year, Clemson University, NAACP
Centennial Outstanding Graduate, College of Education, Clemson University

Publications


BIODGRAPHICAL SUMMARY FOR JACK R. LOHMANN

Business Address
302 Administration Building
College of Engineering
Atlanta, Georgia 30332-0360
(404) 894-5355 FAX: (404) 894-9809

Education

Ph.D. Industrial Engineering, Stanford University, Stanford, California 1979
M.S. Industrial Engineering, Stanford University, Stanford, California 1975
B.S. Mechanical Engineering, Oklahoma State University, Stillwater, Oklahoma 1974
Associate Degree (Engr.) Eastern Oklahoma State College, Wilburton, Oklahoma 1971

Selected Industrial and Academic Experience

Associate Dean, Academic Affairs,
College of Engineering, Georgia Institute of Technology 1991-present
Professor, Industrial and Systems Engineering, Georgia Institute of Technology 1991-present
Program Director (1989-90) and Senior Program Director (1990-1991),
Undergraduate Science, Engineering and Mathematics Education,
Directorate for Education and Human Resources,
National Science Foundation (Intergovernmental Personnel Assignment) 1989-91
Associate Dean, Graduate and Undergraduate Studies,
College of Engineering, University of Michigan, Ann Arbor 1987-89
Associate Professor, Industrial and Operations Engineering,
University of Michigan, Ann Arbor (On Leave to NSF, 1989-1991) 1985-91
Professor Associe, Sociales Economiques, Sciences et Humaines,
Ecole Centrale des Arts et Manufactures, Paris, France, and
Visiting Associate Professor, Industrial and Systems Engineering,
University of Southern California (Sabbatical Leave) 1985-86
Assistant Professor, Industrial and Operations Engineering,
University of Michigan, Ann Arbor 1979-85
Project Engineer, Continental Oil Company, Houston, Texas 1976
Project Engineer, Amoco Production Company, Odessa, Texas 1974

Selected Professional Activities

THE ENGINEERING ECONOMIST: Editor (elected), 1991-present.
IIE TRANSACTIONS: Department Editor - Engineering Economics, 1982-87.
AMERICAN SOCIETY FOR ENGINEERING EDUCATION
ENGINEERING ECONOMY DIVISION: Chairman (elected), 1984-85
INDUSTRIAL ENGINEERING DIVISION: Chairman (elected), 1987-88, Awards Chairman, 1988-89.
INSTITUTE OF INDUSTRIAL ENGINEERS
ENGINEERING ECONOMY DIVISION: Research Forum Program Chairman (elected), 1984-85.
NATIONAL SCIENCE FOUNDATION


Member, Advisory Committee for Education and Human Resources. Directorate for EHR, 1994-1996.

Selected Honors and Awards

<table>
<thead>
<tr>
<th>Honor / Award</th>
<th>Year(s)</th>
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<tr>
<td>Centennial Certificate, American Society for Engineering Education</td>
<td>1993</td>
</tr>
<tr>
<td>Director’s Award of Excellence, Office of the Director, National Science Foundation</td>
<td>1991</td>
</tr>
<tr>
<td>Presidential Young Investigator, White House Office of Science &amp; Technology</td>
<td>1984-89</td>
</tr>
<tr>
<td>Outstanding Young Manufacturing Engineer, Society of Manufacturing Engineers</td>
<td>1987</td>
</tr>
<tr>
<td>Young Engineer of the Year-Ann Arbor Chapter, Michigan Society of Professional Engineers</td>
<td>1985</td>
</tr>
<tr>
<td>Dow Outstanding Young Faculty, American Society for Engineering Education</td>
<td>1985</td>
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<tr>
<td>Outstanding Teaching Citation, College of Engineering, University of Michigan</td>
<td></td>
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<td>Honor Societies: Alpha Pi Mu, Omicron Delta Kappa. Ti Tau Sigma, Sigma Xi, Tau Beta Pi</td>
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</tbody>
</table>

Ten Most Recent Publications (from a total of 46)


**Association with Graduate Students for Last Five Years**

1. Joseph Hartman, Ph.D., In Progress
2. Kevin Suttorer, Ph.D., 1993

**Scientific Collaborators During the Last Five Years**

1. James Bean, Industrial and Operations Engineering, Univ. of Michigan
2. Nejat Karabakal, Industrial and Operations Engineering, Univ. of Michigan
3. Robert Smith, Industrial and Operations Engineering, Univ. of Michigan
4. Anderson Smith, College of Sciences, Georgia Institute of Technology
5. Denice Denton, Electrical Engineering, University of Wisconsin
6. Ed Ernst, College of Engineering, University of South Carolina
7. Robert Oakford, Industrial Engineering, Stanford University (Emeritus)
8. Michael Parsons, College of Engineering, University of Michigan
9. Ray Hart, Office of Minority Educational Development, Georgia Institute of Technology
BIOGRAPHICAL SUMMARY FOR STEPHEN S. MELSHEIMER

Business Address
College of Engineering
107 Riggs Hall
Clemson University
Clemson, SC 29634-0901
(803) 656-4440

Education
Louisiana State University 1965 B.S. Chemical Engineering
Tulane University 1969 Ph.D. Chemical Engineering

Industrial and Academic Experience
1969-Present Assistant/Associate/Professor of Chemical Engineering, Clemson, University, Clemson, SC
1993-Present Acting Associate Dean of Engineering for Undergraduate Studies, Clemson University, Clemson, SC
1986-87 Acting Head, Chemical Engineering Department, Clemson University, Clemson, SC
1972, 1973 Summers with E.I. duPont Savannah River Laboratory, Aiken, SC

Professional Activities and Society Memberships
American Institute of Chemical Engineers - local section officer (3 offices), nation committees, national meeting programming (chaired 10 technical sessions).
American Society for Engineering Education (member).
Technical reviewer for AIChE Journal, NSF.
Visitor for Accreditation Reviews, Southern Association of College and Schools.

Fields of Research Interest
Process dynamics and control; artificial intelligence applications in chemical engineering; numerical solution of partial differential equations; computer applications in process automation and in education.

Ten Most Recent Publications

(Melsheimer - Continued)
Associations with Graduate Students/Post-Doctoral Scholars in Last Five Years
1. Jindrich Liska, Ph.D., 1994
2. Lin-En Kuo, Ph.D. 1994
3. Edward Aufuldish, M.S. 1990
4. Lin-En Kuo M.S., 1990

Scientific Collaborators During Last Four Years
1. Dr. John N. Beard, Department of Chemical Engineering, Clemson University, Clemson, SC
BIOGRAPHICAL SUMMARY FOR KENNETH H. MURRAY

Business Address
Civil Engineering
North Carolina A&T State University
Greensboro, NC 27411
(910) 334-7737

Education
B.S. Civil Engineering Virginia Polytechnic Institute 1965
M.S. Structural Engineering Virginia Polytechnic Institute 1967
Ph.D. Civil Engineering Virginia Polytechnic Institute 1969

Industrial and Academic Experience
1990-Present Chairman, Civil Engineering, North Carolina A&T State University
Responsible for faculty, curriculum and budget for establishing and maintaining the department.

1989-1990 Acting Associate Dean of Engineering, North Carolina A&T State University
1989-1990 Chairman, Civil Engineering, North Carolina A&T State University
Responsible for faculty, curriculum and budget for establishing and maintaining the department.

1981-1986 Principal Engineer, Civil/Structural Engineering, Gilbert/Commonwealth, Inc., Reading PA.
* Government Marketing, Responsible for developing and writing proposals.
* Deep Basing Systems Support Project, Responsible for facilities engineering with contracts and budgets of over $500,000.
* Perry Nuclear Power Plant Project, Worked directly with the Project Structural Engineer, assuming his responsibilities as necessary.
* Gianna Nuclear Power Station, Responsible for investigations for the tendon surveillance program and served as consultant on finite element analysis problem.

1968-1981 Assistant Professor/Associate Professor of Civil Engineering/Assistant Dean/Associate Dean of Engineering, Old Dominion University, Norfolk, VA
* Associate Dean of Engineering; Responsible for the coordination and evaluation of budgets, scholarships, student advising and curricula. Taught in the Department of Civil Engineering (usually one semester).
* Assistant Dean of Engineering; Responsible for Student Affairs including: advising, recruitment, suspension, appeals, academic schedules and scholarships. Taught in the Department of Civil Engineering (usually three a year).
* Associate Professor of Civil Engineering: Responsible for the continued development and teaching of undergraduate and graduate courses.
* Assistant Professor of Civil Engineering: Responsible for teaching undergraduate and graduate courses.


1968 Instructor, Virginia Polytechnic Institute
Professional Activities

Registered Professional Engineer in Virginia and North Carolina
American Society of Engineering Education
American Society of Civil Engineers, Fellow
* Norfolk, VA Branch - Secretary 1977-78
* Vice President 1978-79
* President, 1979-80
American Concrete Institute Fellow
* Board of Direction 1991-94
* Financial Advisory Committee 1992-94
* Certification Programs Committee 1993-95
* Educational Activities Committee, Chairman 1986-92
* E-702 Designing Concrete Structures, Past Chairman 1980-84
* 408 Bond and Development of Reinforcement - National Society of Professional Engineers
* MathCounts Chairman 1989 and 1990
* Second Vice President, North Piedmont Chapter 1989-90
* First Vice President, North Piedmont Chapter 1989-90
* President, North Piedmont Chapter 1991-92
* Professional Engineers in Education, Chairman 1992-93
Tau Beta Pi - Member
Chi Epsilon - Member

Society Memberships and Honors

ASCE - Outstanding Teacher Award at ODU 1973
Outstanding Civil Engineering Professor at A&T 1988
ABET-ASCE Accreditation Visitor since 1987
Henry L. Kennedy Award for outstanding service from ACI 1993
American Society of Engineering Education
American Society of Civil Engineers, Fellow
American Concrete Institute Fellow,
National Society of Professional Engineers
Tau Beta Pi - Member
Chi Epsilon - Member

Field of Research Interests

Structural analysis and design especially reinforced concrete and design education

Principal publications during the last five years:


K.H. Murray, “Experiences in a Capstone Course with Civil Engineering and Architectural Engineering Students” presented at ASEE Southeastern Meeting, Vanderbilt, April, 1993


K.H. Murray, “Opportunities in Education through the ACI”, ACI Convention, Dallas, TX, Nov. 1991

K.H. Murray, “Experiences in a Capstone Course with Civil Engineering and Architectural Engineering Students” presented at the 1993 ASEE Southeast Meeting, Vanderbilt University, April 1993


**Associations with Graduate Students/Post Doctoral Scholars for Last Five Years**
None

**Scientific Collaborators During Last Four Years**
Dr. W. Mark McGinley, Arch. Engineering, North Carolina A&T State University
Dr. Peter Rojeski, Arch. Engineering, North Carolina A&T State University
BIOGRAPHICAL SUMMARY FOR M. JACK OHANIAN

Business Address
College of Engineering
300 Weil Hall, P.O. Box 116550
University of Florida
Gainesville, FL 32611

Education
Robert College Engineering School
(Istanbul, Turkey) 1956  B.S.E.E. (magna cum laude)
Rensselaer Polytechnic Institute 1960  M.E.E.
Rensselaer Polytechnic Institute 1963  Ph.D.  (Nuclear Engineering and Science)

Industrial and Academic Experience
1963-70  Assistant Professor/Associate Professor
         Department of Nuclear Engineering Sciences
         University of Florida, Gainesville, FL
1970-Present  Professor of Nuclear Engineering Sciences, University of Florida
1969-79  Chairman, Department of Nuclear Engineering Sciences, University of Florida
1979-89  Associate Dean for Research, College of Engineering, University of Florida
1989-91  Associate Dean for Administration and Planning, College of Engineering,
         University of Florida
1991-present  Associate Dean for Research and Administration, College of Engineering,
             University of Florida
Summers 1972 and 1973  Consulting Engineer, Generation Environmental and Regulatory Affairs
         Department, Florida Power Corporation, St. Petersburg, FL
1976-78  Visiting Scientist, Institute for Energy Analysis, Oak Ridge, Tennessee

Society Memberships and Honors
Fellow, American Nuclear Society
Fellow, American Association for the Advancement of Science
Rensselaer Alumni Association Fellow (1994)
Florida Blue Key Distinguished Faculty Award (1984)
President, American Nuclear Society (1990-91)
Chairman, American Associate of Engineering Societies (1994)
President, Alpha Nu Sigma (National Honor Society for Nuclear Science and Engineering) (1981-82)
Tau Beta Pi (Eminent Engineer), Sigma Ii, Eta Kappa Nu, Phi Kappa Phi

Fields of Interest
Nuclear energy systems; energy and public policy. Effective management of cross-disciplinary R&D programs.
Some Recent Publications


BIOGRAPHICAL SUMMARY FOR JOSEPH G. TRONT

Business Address
College of Engineering
Virginia Polytechnic Institute and State University
444 Whittemore
Blacksburg, VA 24061-0111
(703)231-5067

Education
University of Dayton 1972 BS Electrical Engineering
University of Dayton 1973 MS Electrical Engineering
State Univ. of New York at Buffalo 1978 Ph.D Electrical Engineering

Industrial and Academic Experience
1978-83 Assistant Professor, Department of Electrical Engineering, Virginia Polytechnic Institute and State University, Blacksburg, Virginia
1984-90 Associate Professor, Department of Electrical Engineering, Virginia Polytechnic Institute and State University, Blacksburg, Virginia
1991-present Assistant Dean for Engineering Computing, College of Engineering, Engineering Administration, Virginia Polytechnic Institute and State University, Blacksburg, Virginia

Professional Activities/Consulting, Patents
1977-78 McDonnell Douglas Aeronautics, St. Louis, MO
1979-81 Naval Surface Weapons Center, Dahlgren, VA/White Oak, MD
9/16-18/81 VEPCO, Richmond, VA
12/81-4/82 Naval Surface Weapons Center, Dahlgren, VA
8/83-4/84 Poly-Scientific Corp., Blacksburg, VA
12/84 Westmoreland Coal Co., Big Stony Gap, VA
12/85-4/88 Tavenol Laboratories, Round Lake, IL
8/92-12/94 NSF Study on Paradigm Shifts in Engineering Education
2/94-10/94 Tate, Lowe & Rowlett, Abingdon, VA

Society, Memberships and Honors
IEEE Senior Member
IEEE Computer Society
IEEE Electromagnetic Compatibility Society
IEEE Technical Committee on VLSI
IEEE Computer Society Electronic Products and Services Committee
International Symposium Committee on Electromagnetic Compatibility, May 1979, Rotterdam, 500 guilders.
Certificate of Recognition and Accomplishment, IEEE Region 3 Director, In recognition of accomplishments in the development of new IEEE members, 12/87

Field of Research Interest
Fault tolerant computers for spaceborne applications, Integrated circuit radiation hardening, Upset tolerant software systems, Autonomous computing systems, VLSI Design, Microprocessor applications, Built-in self-testing, circuits, RF-interference in Ics, and Multimedia computing
Ten Most Recent Publications (from total of 90)


Associations with Graduate Students/Post-Doctoral Scholars for Last Five Years
Drayer, Tom, Ph.D., EE, 1995
Wright, John C., MS in EE, 1994
Cho, Chang, Ph.D., EE, 1994
Nair, Rajesh, MS in EE, 1994
Lee, Hyung, Ph.D., EE, 1993
Mayhew, David, Ph.D., EE, 1993
Ryan, Christopher, Ph.D., EE, 1993
Liang, Kirk, MS in EE, 1993
Griffin, Glenn, MS in EE, 1993
Marchany, Randolph, MS in EE, 1993
Ng, Chong Tech, Ph.D., EE, 1993
Becker, Brian A, MS in EE, 1993
Clem, Kevin, MS in EE, 1992
Jett, David B., MS in EE, 1992
Marchand, Roger., MS in EE, 1992
Higgins, Robert, MS in EE, 1992
Bettinger, David D., MS in EE, 1992
Bollinger, Wayne, Ph.D., EE, 1992
Bears, Steve, MS in EE, 1992
Walters, Ryp, MS in EE, 1991
Sama, Anil, MS in EE, 1991
Hopkins, Martha, MS in EE, 1991
Shah, Sandeep, MS in EE, 1991
Holland, K. Chris, MS in EE, 1991
Drayer, Thomas, MS in EE, 1991
Dhawan, Sanjay, MS in EE, 1991

Scientific Collaborators During Last Four Years
“Multimedia, Intelligent Tutoring Systems, Visualization and Distance Education Robert Thomas, Department of Electrical Engineering, Cornell University, Ithaca, New York"
BIOGRAPHICAL SUMMARY FOR CARL F. ZOROWSKI

Business Address
SUCCEED
North Carolina State University
Box 7901
Raleigh, NC 27695-7901
(919) 515-6597, 6605

Education
Carnegie Mellon University 1952 BS Mechanical Engineering
Carnegie Mellon University 1953 MS Mechanical Engineering
Carnegie Mellon University 1956 PhD Mechanical Engineering

Industrial and Academic Experience
1956-1962 Assistant Professor/Associate Professor, Department of Mechanical Engineering, Carnegie Mellon University, Pittsburgh, Pennsylvania
1962-Present Associate Professor/Professor/R.J. Reynolds Professor, Department of Mechanical & Aerospace Engineering, N.C. State University, Raleigh, North Carolina
1972-1979 Department Head, Mechanical & Aerospace Engineering, N.C. State University, Raleigh, North Carolina
1979-1985 Associate Dean for Academic Affairs, College of Engineering, N.C. State University, Raleigh, North Carolina
1986-1992 Director, Integrated Manufacturing Systems Engineering Institute, N.C. State University, Raleigh, North Carolina
1992-1993 Department Head, Mechanical & Aerospace Engineering, N.C. State University, Raleigh, North Carolina
1993-Present Director, SUCCEED-NSF Engineering Education Coalition Program, N.C. State University, Raleigh, North Carolina

Professional Activities
American Society of Mechanical Engineers
National - Vice President for Engineering Education; Chairman and Vice Chairman, Mechanical Engineering Department Heads Committee; Representative to Policy Board-Education; ASME Visitor, Accreditation Board for Engineering and Technology
Regional - Chairman, College Relations Committee; Chairman, Committee on Nominations; National Nominating Committee Representative
Eastern North Carolina Section - Member of Board of Directors, Chairman, Vice Chairman, Treasurer, Secretary

Society Memberships and Honors
American Society of Mechanical Engineering
American Society of Engineering Education
Fiber Society
Society of Manufacturing Engineering
R.J.R. Nabisco Award for Excellence in Teaching, Research and Extension - 1989
Fellow, ASME, 1983
Charles R Richards Memorial Award, Pi Tau Sigma and American Society of Mechanical Engineers - 1975
Fiber Society Achievement Award, Fiber Society - 1970
R.J. Reynolds Professor of Mechanical Engineering, North Carolina State University - 1969
ASEE Western Electric Award, Southeast Region - 1968
Society Memberships and Honors (Continued)

Sigma Xi Research Award, North Carolina State University - 1967
Outstanding Teacher Award, North Carolina State University - 1966, 1969
Organization for European Economic Cooperation Senior Visiting Fellowship, British Iron and Steel Research Association - 1961

Field of Research Interest
Product design for east of automated assembly, manufacturing systems integration of design, fabrication and assembly functions, CAD/CAE tool development to aid product design function, mechanical behavior of composites, fabric and fiber assemblies containing non-linear materials.

Ten Most Recent Publications (from total of 80+)

Associations with Graduate Students/Post-Doctoral Scholars for Last Five Years
1. J.T. Warfford, PhD in M.E., 1993
2. I.M. Richani, PhD in M.E., 1993
3. C.L. Pan, Master of IMSE, 1990
4. Diana Silva, PhD Student

Scientific Collaborators During Last Four Years
1. Dr. John Sutton, Electrical and Computer Engineering Department, N.C. State University, Raleigh, North Carolina
2. Dr. Jaime Trevino, Industrial Engineering Department, N.C. State University, Raleigh, North Carolina
Coalition Database Report

List of Tables

Coalition Information
Area Budget Summaries
Personnel Counts
Accounting Budget
Functional Budget
Sources of Support
Matching Funds
Industrial Partners
Non-industrial Partners
Coalition Information
### Key Personnel

<table>
<thead>
<tr>
<th>Name</th>
<th>Carl F. Zorowski</th>
<th>Name</th>
<th>Robert J. Coleman</th>
<th>Name</th>
<th>Thomas H. Brown, Jr.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organizational Role</strong></td>
<td>Administration and Staff</td>
<td><strong>Organizational Role</strong></td>
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<tr>
<td><strong>Title</strong></td>
<td>Director</td>
<td><strong>Title</strong></td>
<td>Associate Director</td>
<td><strong>Title</strong></td>
<td>Assistant to the Director</td>
</tr>
<tr>
<td><strong>Address</strong></td>
<td>North Carolina State University College of Engineering 113-C Page Hall, Box 7901 Raleigh, NC 27695</td>
<td><strong>Address</strong></td>
<td>UNC-Charlotte Electrical Engineering Department 334 Smith Building Charlotte, NC 28223</td>
<td><strong>Address</strong></td>
<td>North Carolina State University College of Engineering 120-B Page Hall, Box 7901 Raleigh, NC 27695-7901</td>
</tr>
<tr>
<td><strong>Phone</strong></td>
<td>(919) 515-6597</td>
<td><strong>Phone</strong></td>
<td>(704) 547-4141</td>
<td><strong>Phone</strong></td>
<td>(919) 515-1871</td>
</tr>
<tr>
<td><strong>Fax</strong></td>
<td>(919) 515-768</td>
<td><strong>Fax</strong></td>
<td>(704) 547-2352</td>
<td><strong>Fax</strong></td>
<td>(919) 515-7685</td>
</tr>
<tr>
<td><strong>Email</strong></td>
<td><a href="mailto:carl_zorowski@ncsu.edu">carl_zorowski@ncsu.edu</a></td>
<td><strong>Email</strong></td>
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<td><strong>Email</strong></td>
<td><a href="mailto:tom_brown@ncsu.edu">tom_brown@ncsu.edu</a></td>
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## Coalition Information

**SUCCEED**

### Key Personnel

<table>
<thead>
<tr>
<th>Name</th>
<th>Shirley E. Baldwin</th>
<th>Patricia M. Innamorato</th>
<th>Timothy J. Anderson</th>
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<td>(904) 392-9513</td>
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<td><a href="mailto:baldwin@page.ncsu.edu">baldwin@page.ncsu.edu</a></td>
<td><a href="mailto:tim@nervm.nerdc.ufl.edu">tim@nervm.nerdc.ufl.edu</a></td>
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<th>Name</th>
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<tr>
<td>John (Jack) Hebrank</td>
<td>Guidance Team</td>
<td>Director, Center for Engineering Practice</td>
</tr>
<tr>
<td>Laurie B. Hodges</td>
<td>Guidance Team</td>
<td>Leader, Evaluation &amp; Assessment Team</td>
</tr>
<tr>
<td>Pamela S. Kurstedt</td>
<td>Guidance Team Facilitator</td>
<td>Guidance Team Facilitator</td>
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### John (Jack) Hebrank
- **Organizational Role**: Guidance Team
- **Title**: Director, Center for Engineering Practice
- **Address**: North Carolina State University
  Mechanical & Aerospace Engineering
  3183 Broughton Hall, Box 7901
  Raleigh, NC 27695-7910
- **Phone**: (919) 515-5238
- **Fax**: (919) 515-7968
- **Email**: hebrank@eos.ncsu.edu

### Laurie B. Hodges
- **Organizational Role**: Guidance Team
- **Title**: Leader, Evaluation & Assessment Team
- **Address**: Georgia Institute of Technology
  GTRI/EOEML - 925 Dalney Street
  Atlanta, GA 30332-0800
- **Phone**: (404) 894-0018
- **Fax**: (404) 894-6285/894-5073
- **Email**: laurie.hodges@gtri.gatech.edu

### Pamela S. Kurstedt
- **Organizational Role**: Guidance Team Facilitator
- **Address**: Virginia Tech
  College of Engineering
  333 Norris Hall
  Blacksburg, VA 24061-0901
- **Phone**: (703) 231-9764
- **Fax**: (703) 231-3031
- **Email**: pkursted@vtvm1.cc.vt.edu
# Coalition Information

## SUCCEED

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<tr>
<th>Name</th>
<th>Susan J.S. Lasser</th>
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</table>
| **Address**           | Clemson University  
                      | Engineering Minority Program  
                      | 22-A Riggs Hall  
                      | Clemson, SC 29634-0901 |
| **Phone**             | (803) 656-5541 |
| **Fax**               | (803) 656-1397 |
| **Email**             | slasser@eng.clemson.edu |

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<tr>
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| **Address**           | Virginia Tech  
                      | College of Engineering  
                      | 444 Whittemore  
                      | Blacksburg, VA 24061-0111 |
| **Phone**             | (703) 231-5067 |
| **Fax**               | (703) 231-3362 |
| **Email**             | jgtront@vtvm1.cc.vt.edu |

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| **Address**           | FAMU/FSU  
                      | College of Engineering  
                      | 2525 Pottsdamer Road, Room 332  
                      | P.O. Box 2175  
                      | Tallahassee, FL 32310-2175 |
| **Phone**             | (904) 487-6427 |
| **Fax**               | (904) 487-6486 |
| **Email**             | braswell@evax.eng.fsu.edu |
### Coalition Information

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                        | Raleigh, NC 27695-7901 |
| **Phone**             | (919) 515-3693  |
| **Fax**               | (919) 515-7685  |
| **Email**             | john_gilligan@ncsu.edu |

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| **Address**           | Georgia Institute of Technology  
                        | College of Engineering  
                        | 301 Administration Building  
                        | 225 North Avenue  
                        | Atlanta, GA 30332-0360 |
| **Phone**             | (404) 894-3355  |
| **Fax**               | (404) 853-0168/894-9809 |
| **Email**             | jack.lohmann@coe.gatech.edu |

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                        | College of Engineering  
                        | 107 Riggs Hall  
                        | Clemson, SC 29434-0901 |
| **Phone**             | (803) 656-5706  |
| **Fax**               | (803) 656-0859  |
| **Email**             | melsheimer@eng.clemson.edu |
# Coalition Information

**SUCCEED**

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<tr>
<td><strong>Phone</strong></td>
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<tr>
<td><strong>Email</strong></td>
<td><a href="mailto:kmurray@garfield.ncat.edu">kmurray@garfield.ncat.edu</a></td>
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<td><strong>Fax</strong></td>
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<td><a href="mailto:coleman@mosaic.uncc.edu">coleman@mosaic.uncc.edu</a></td>
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<tr>
<td>Name</td>
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<td><a href="mailto:pkursted@vtvm1.cc.vt.edu">pkursted@vtvm1.cc.vt.edu</a></td>
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Area Budget Summaries
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<td>A Materials Certificate Program (UF016C192)</td>
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**Deliverable:**
- OM OC OW OY OD OS OT OO

*M = Course Module; C = Course; W = Courseware; Y = Full Year of a Curriculum; D = New Degree Program; S = Delivery System; T = Teaching/Learning Improvement; O = Other.

<table>
<thead>
<tr>
<th>Last Name</th>
<th>First Name</th>
<th>Middle Initial</th>
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<tbody>
<tr>
<td>Mecholsky, Jr</td>
<td>John</td>
<td>J</td>
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**Undergraduate Level**

- U=Upper Level, L=Lower Level
- A=All Levels, O=Other

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<tr>
<td>MS</td>
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**Outside Institutions (Check all Levels that apply):**
- CC=Community College
- HS=High School
- MS=Middle or Jr. High School
- ES=Elementary School
- NA=Not Applicable

**Current Year Budget:** 7,000

**Next Year Budget:**
## Area Budget Summaries

**Area:** Curriculum Content and Integration

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Coalition Schools
University of Florida

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Coalition Schools
North Carolina A&T State University
Georgia Institute of Technology
University of Florida

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### Area Budget Summaries

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## Area Budget Summaries

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**Area:** Engineering Practice

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Coalition Schools
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**Coalition Schools**

- Georgia Institute of Technology
- Virginia Polytechnic Institute and State University
- North Carolina State university

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### Area: Professional Success

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## Area Budget Summaries

**Area:** Technology and Communications

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<td>Integrating Multiple Types of Courseware in Exploratory Educational Environments (GT104TC93)</td>
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**Coalition Schools**
Georgia Institute of Technology

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**Coalition Schools**
North Carolina State University
## Area Budget Summaries

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Personnel Counts
### Personnel Counts

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**Disciplines:**

- Engineering, Minority Affairs, Nuclear Engr., Mechanical Engr., Electrical Engr., Chemical Engr., Civil Engr., Industrial Engr.
- Education, Physics, Learning Assistance, Video Broadcasting, Industrial Psychology, Mathematics, History, Biology, Life Science, Chemistry
- Electrical Engr., Mechanical Engr., Business, Bio & Ag Engr., Industrial Engr., Civil Engr., Psychology, Physics, Human Factors
- Civil Engr., Engineering, Mechanical Engr., Aerospace Engr., Psychology.
## Personnel Counts

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Minority Status for U.S. citizens and permanent residents only: (NA) Native American; (AA) African American, not of Hispanic origin; (C) Caucasian, not of Hispanic origin; (H) Hispanic; (PI) Pacific Islander; (A) Asian.

All entries are whole numbers and count each individual involved in a Coalition ONCE.
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Functional Budget
### Functional Budget

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Indirect Costs
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**Notes:**

1. NSF and other at the Coalition Level, not individual PI support; including ARPA/TRP Supplements.
2. Gifts + Loans + Discounts
3. Valued at Industry's fully loaded cost level.
4. Base Award + Supplement(s)
Matching Funds
## Matching Funds

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<thead>
<tr>
<th>Institution</th>
<th>Univ. Cash</th>
<th>Univ. Equip.</th>
<th>Univ. Release Time</th>
<th>Industry</th>
<th>Other Federal Agencies</th>
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### Matching Funds

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<tr>
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<td>620,264</td>
<td>112,175</td>
<td>81,056</td>
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Coalition Award
Industrial Partners
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<th>Engineering Production</th>
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<td>Hire</td>
<td>Unkn</td>
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<td>Exxon</td>
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<td>Union Camp</td>
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### Industrial Partners

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Non-industrial Partners
### Non-Industrial Partners

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<td>U. S. Army Construction Engineering Research Laboratory</td>
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<td>Duke University</td>
<td>Personnel</td>
<td>Direct</td>
</tr>
<tr>
<td>North Carolina Biotechnology Center</td>
<td>Cash</td>
<td>Direct</td>
</tr>
<tr>
<td>Mecklenberg County School System, NC</td>
<td>Personnel</td>
<td>Direct</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>Advisory</td>
</tr>
<tr>
<td>State of Florida Community College System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of North Carolina - Asheville</td>
<td>Personnel</td>
<td>Technical</td>
</tr>
<tr>
<td>Organization</td>
<td>Type of Support</td>
<td>Role</td>
</tr>
<tr>
<td>--------------------------------</td>
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</tr>
<tr>
<td>Wake County Public Schools, NC</td>
<td>Cash Personnel</td>
<td>Technical</td>
</tr>
<tr>
<td>Jet Propulsion Laboratory</td>
<td>Cash Personnel</td>
<td>Advisory</td>
</tr>
<tr>
<td>Woodruff Foundation</td>
<td>Cash Personnel</td>
<td>Advisory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technical</td>
</tr>
</tbody>
</table>
Dear Engineering Student,

A major component of your experience in the engineering program at North Carolina State University is the educational climate. How you feel about interactions with faculty, other students and the pace of the program overall can have a significant effect on your progress here. Your opinions on various facets of the engineering education climate is critical to faculty and deans as they attempt to improve the quality of programs provided to you and other students selecting engineering at NCSU.

North Carolina State University is participating in a climate study sponsored by the National Science Foundation’s Southeastern University and College Coalition for Engineering Education (SUCCEED). Your name was chosen as part of a sample of students at this university being asked to give their opinions on these matters. In order that the results will truly represent students in your program, it is important that each survey be completed and returned. You may be assured of complete confidentiality. The numbers stamped on the questionnaires are for follow-up purposes only. Your name will be not be associated with the final data file or the summary results. Please return your completed survey to us as soon as possible.

A postage-paid envelope is enclosed for your convenience. If you wish to receive a summary of the results, please write “copy of results” along with your complete mailing address on the back of your return envelope. Do not put this information on the questionnaire itself. Please contact Dr. Sarah Rajala at 515-5114 or email sar@eos.ncsu.edu if you have any questions.

Thank you in advance for your cooperation.

Sincerely,

Ralph K. Cavin
Dean

Sarah A. Rajala
Professor

North Carolina State University is a land-grant university and a constituent institution of The University of North Carolina.
Engineering Education
Climate Survey

Southeastern University and
College Coalition for
Engineering Education
Part A. The following items present various events or impressions that students experience or observe in their engineering program. Please consider the following items and indicate how often you have experienced or observed each in your engineering program. Circle one response for each item using the following scale:

1 = Often  2 = Occasionally  3 = Seldom  4 = Never
NA/DK = Not Applicable/Don't Know

Engineering Faculty and Instruction

1. Engineering faculty encourage collaborative learning in which students work together.  
2. Faculty encourage my participation in class discussions.  
3. In class, my comments and opinions are taken seriously by faculty.  
4. I am interrupted by other students when responding in class.  
5. I feel ignored by the instructors of my classes.  
6. Teaching assistants make more demands of male students than of female students.  
7. I have visited informally with an instructor outside of class.  
8. I have heard women complain about being treated unfairly by faculty.  
9. I have heard men complain about being treated unfairly by faculty.  
10. Curve grading procedures are used by engineering instructors to "weed-out" students.  
11. I have worked with a faculty member on a research project.  

Engineering Faculty Advising

12. Faculty are available to help with career-planning.  
13. I have discussed my educational plans and goals with faculty in my program.  
14. My faculty advisor is not accessible.  
15. I consult with a member of the faculty for academic advice.  
16. I consult with a member of the department staff for advice about  
17. Meeting with my advisor is helpful.
Engineering Student Experiences

18. I participate in study groups. 1 2 3 4 NA/DK

19. Students work in study groups composed only of members of the same gender. 1 2 3 4 NA/DK

20. I have heard negative comments about men in this program. 1 2 3 4 NA/DK

21. I have heard negative comments about women in this program. 1 2 3 4 NA/DK

22. I feel more comfortable in my non-engineering classes than I do in my engineering classes. 1 2 3 4 NA/DK

23. I have reservations about being a student in this engineering program. 1 2 3 4 NA/DK

24. I feel as if I don’t belong in this program. 1 2 3 4 NA/DK

25. I feel isolated in this program. 1 2 3 4 NA/DK

26. I have considered switching to a non-engineering program. 1 2 3 4 NA/DK

Department/College/Program

27. Social activities are arranged by the department to bring students and faculty together. 1 2 3 4 NA/DK

28. Opportunities to develop hands-on equipment skills are provided by my department. 1 2 3 4 NA/DK

29. Mentoring programs provide access to alumni, peers and faculty in my field. 1 2 3 4 NA/DK

30. My department helps me meet faculty, graduate students or alumni who are the same gender as I am. 1 2 3 4 NA/DK

31. My department/college provides support services focused on the development of leadership, assertiveness or building self-confidence. 1 2 3 4 NA/DK

32. My department/college provides resources for academic help. 1 2 3 4 NA/DK

PLEASE CONTINUE ON TO THE NEXT PAGE.
Part B. The following statements reflect different perspectives that may be expressed by students in engineering. Please indicate the extent to which you agree or disagree with each given your own experiences in engineering. Circle one response for each item using the following scale:

1 = Strongly agree  2 = Somewhat agree  3 = Somewhat disagree  4 = Strongly disagree
NA/DK = Not Applicable/Don’t Know

### Engineering Faculty Instruction and Advising

1. The quality of faculty teaching in my program is very good.  
   1  2  3  4  NA/DK

2. I have been helped by an individual faculty member at a crisis point in my program.  
   1  2  3  4  NA/DK

3. Individual faculty members have proved to be good role models for me.  
   1  2  3  4  NA/DK

4. I feel comfortable approaching faculty members about academic concerns.  
   1  2  3  4  NA/DK

5. Faculty are equally supportive of both male and female students in this program.  
   1  2  3  4  NA/DK

6. Faculty are too tolerant of rude behavior.  
   1  2  3  4  NA/DK

7. I feel my advisor is interested in me as an individual.  
   1  2  3  4  NA/DK

8. It is important to me to meet regularly with my advisor.  
   1  2  3  4  NA/DK

9. Humor is sometimes used at the expense of women in class.  
   1  2  3  4  NA/DK

10. Humor is sometimes used at the expense of men in class.  
    1  2  3  4  NA/DK

11. Most teaching in engineering is structured around individual competitive activities rather than group learning.  
    1  2  3  4  NA/DK

12. The quality of teaching provided by teaching assistants is very good.  
    1  2  3  4  NA/DK

13. Teaching assistants are too heavily employed for teaching fundamentals in basic engineering classes.  
    1  2  3  4  NA/DK

14. Most of my engineering classes seem very impersonal.  
    1  2  3  4  NA/DK

15. Some faculty members address women students as "honey" or "dear" or other such terms.  
    1  2  3  4  NA/DK

### Department/College/Program

16. There is too much competition for grades in my engineering program.  
    1  2  3  4  NA/DK

17. The curriculum in my program is not diverse enough.  
    1  2  3  4  NA/DK

18. The curriculum in my engineering program is structured to allow students to finish their program easily in four years.  
    1  2  3  4  NA/DK

19. I feel comfortable with "hands on" technical activities required in my engineering program.  
    1  2  3  4  NA/DK
20. I feel intellectually challenged and encouraged in my engineering program. 1 2 3 4 NA/DK

21. I feel my department/college is committed to developing a student climate that does not allow discriminatory behavior. 1 2 3 4 NA/DK

22. Departmental/College leaders are committed to meeting the needs of a diverse student population from a broad range of backgrounds. 1 2 3 4 NA/DK

23. In general, I am happy I chose this engineering program. 1 2 3 4 NA/DK

**Engineering Student Experiences**

24. I seem to work harder than most other students in my engineering program. 1 2 3 4 NA/DK

25. If I ask too many questions in class, I feel other students will think I am not as smart as they. 1 2 3 4 NA/DK

26. It is easy to meet students of the same gender as myself in this program. 1 2 3 4 NA/DK

27. Scholarships awarded on the basis of race or ethnic identity are necessary to attracting a diverse student population. 1 2 3 4 NA/DK

28. Relationships between male and female students in my engineering program are generally cooperative. 1 2 3 4 NA/DK

29. The career options available to engineering students are worth the emotional stress of the program. 1 2 3 4 NA/DK

30. The climate for women in my engineering program is very comfortable. 1 2 3 4 NA/DK

31. The climate for men in my engineering program is very comfortable. 1 2 3 4 NA/DK

32. My family would not be pleased if I switched to a non-engineering program. 1 2 3 4 NA/DK

33. Study groups have helped my academic performance. 1 2 3 4 NA/DK

34. Being in study groups has helped me feel more involved in my program. 1 2 3 4 NA/DK

35. Study groups have been a good social experience for me. 1 2 3 4 NA/DK

36. Preferential scholarships based on gender are a strain on relations between male and female students. 1 2 3 4 NA/DK

37. Competitiveness in the program makes it difficult to build good working relationships with other students. 1 2 3 4 NA/DK

38. Men are just naturally better than women at engineering skills. 1 2 3 4 NA/DK

39. Women have an unfair advantage over men in today's engineering job market. 1 2 3 4 NA/DK

40. Men have an unfair advantage over women in today's engineering job market. 1 2 3 4 NA/DK
Part B. (Continued)

Institutional Environment

41. I feel intellectually challenged and encouraged at this institution. 1 2 3 4 NA/DK
42. In general, I am happy I chose to attend this institution. 1 2 3 4 NA/DK
43. I feel that I fit in at this institution. 1 2 3 4 NA/DK
44. There is too much competition for grades at my institution. 1 2 3 4 NA/DK
45. The quality of faculty teaching at this institution is very good. 1 2 3 4 NA/DK

Part C. Individual Information

1. How much did each of the following persons influence your plans to pursue a degree in engineering? (Circle one response for each.)
   a. Your father? A great deal Somewhat Not at all NA/DK
   b. Your mother? A great deal Somewhat Not at all NA/DK
   c. Other relatives? A great deal Somewhat Not at all NA/DK
   d. Your high school guidance counselor? A great deal Somewhat Not at all NA/DK
   e. High school teacher(s)? A great deal Somewhat Not at all NA/DK
   f. Friends? A great deal Somewhat Not at all NA/DK
   g. Faculty in your engineering program? A great deal Somewhat Not at all NA/DK
   h. Others? (Please specify: A great deal Somewhat Not at all NA/DK)

2. Please estimate how well you have done in all your college courses and in your engineering courses since you left high school. (Circle one response for All courses and one response for Engineering courses.)

<table>
<thead>
<tr>
<th>Grade Description</th>
<th>All</th>
<th>Engr</th>
</tr>
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<tbody>
<tr>
<td>Mostly A's</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Half A's and half B's</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Mostly B's</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Half B's and half C's</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Mostly C's</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Half C's and half D's</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Mostly D's</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>
3. Did you enter college as an engineering major or did you decide to major in engineering after being enrolled in another non-engineering program? (Check one.)

Entered as an engineering major _____
Changed to engineering from a non-engineering program _____

4. What would you estimate is the likelihood that you will complete the engineering degree program in which you are presently enrolled? (Check one.)

Certain or almost certain _____
Very likely _____
About a 50-50 chance _____
Somewhat unlikely _____
Very unlikely _____

5. Please indicate which of the following best describes your graduate program plans: (Check one.)

Will seek a graduate degree in engineering _____
Will seek a graduate degree in a non-engineering field _____
Will not be seeking a graduate degree _____
Undecided about graduate program plans at this time _____

THANK YOU FOR YOUR RESPONSES.

Please place the completed survey in the postage paid envelope provided or mail to:

SUCCEED Engineering Education Climate Survey
Center for Survey Research
207 West Roanoke Street
Blacksburg, VA 24061-0543