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ABSTRACT

Since 1992, the Southeastern University and College Coalition for Engineering Education (SUCCEED) has been funded by the National Science Foundation (NSF) to improve undergraduate engineering education. Faculty from eight southeastern colleges of engineering have developed innovations in key focus areas such as freshmen engineering, design, tools for accreditation, partnerships, student mentoring, faculty development, integrated programs, and teaching with technology. The focus of this report is to chronicle the work of the Coalition since the last report in April, 2001. This report accounts for significant changes in infrastructure, curricula, and institutional priorities. Significant developments outlined in the Major Accomplishments section all address culture change. SUCCEED continues to develop a cadre of faculty who are engineering education innovators. Partly due to the efforts of the program, the engineering education research community has strengthened in the past decade. In this report, special attention has been given to the number of ways that the community of innovators develop within SUCCEED. In addition to the qualitative changes, quantitative measures also point to the growth of this community. SUCCEED institutions contributed articles to engineering education in the past year. Another measure is the ability of SUCCEED faculty to obtain other funding for their educational research--$58 million in grants or endowments for educational research has already been identified from industrial, government, or foundation sources. Another $3,725,600 has been given by industrial concerns as cash or in-kind contributions in situations in which a return is expected. In addition to cash support, students on such projects commonly work with a liaison provided by the company, a significant value that has not been estimated in these figures. While some of this support is difficult to document, the significant amount noted is a clear indication of lasting change. The results of a market survey helped SUCCEED identify both the types of innovation most in demand and the market channels through which schools would be receptive to that innovation. As a result, SUCCEED has reached a significant number of schools with its innovations in the past year through regional conferences and campus visits. (SOE)

SUCCEED

SOUTHEASTERN UNIVERSITY AND COLLEGE COALITION FOR ENGINEERING EDUCATION

Year 10 Annual Report

September 25, 2002

Curriculum 21

SUCCEED

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

A. Executive Summary

As SUCCEED completes its ten years of engineering education innovation, assessment, implementation, and dissemination, the focus in this last year has been to secure a legacy at our own institutions and at other institutions. A final report will be developed that focuses on this legacy in quantitative and qualitative terms. The focus of this report is to chronicle the work of the Coalition since our last report in April 2001. Nonetheless, since the work in securing the Coalition's legacy drew significantly upon the successes of previous years, this report will necessarily refer to the collective effect of programs over multiple years.

This report eliminates the Culture Change section. Significant developments outlined in the Major Accomplishments section all address culture change—this report accounts for significant changes in infrastructure, curricula, and institutional priorities. We have continued to develop a cadre of faculty who are engineering education innovators. We are confident that, partly due to our efforts, the engineering education research community has strengthened in the past decade. The improvement in quality and quantity of educational scholarship in engineering is clear from review of the Journal of Engineering Education and various conference proceedings, most notably those of the American Society of Engineering Education. In this report, we pay special attention to a number of ways we observe that community of innovators developing within SUCCEED.

In addition to the qualitative changes we observe more closely later in this report, quantitative measures also point to the growth of this community. SUCCEED Institutions contributed articles to the engineering education in the past year. Another measure is the ability of SUCCEED faculty to obtain other funding for their educational research—$58 million in grants or endowments for educational research has already been identified from industrial, government, or foundation sources ($5 million from non-governmental sources); over $14 million of this was since SUCCEED's last report. Another $3,725,600 has been given by industrial concerns as cash or in-kind contributions in situations where a return is expected (e.g., design projects with deliverables). In addition to cash support, students on such projects commonly work with a liaison provided by the company—a significant value that has not been estimated in these figures. While some of this support is difficult to document, the significant amount noted is a clear indication of lasting change.

The results of a market survey helped SUCCEED identify both the *types* of innovation most in demand and the *market channels* through which schools would be receptive to that innovation. As a result, SUCCEED has reached a significant number of schools with its innovations in the past year through regional conferences and campus visits.

SUCCEED's community of engineering education researchers is improving the United States engineering education system in exciting ways. Our comprehensive approach to engineering education innovation, driven by enhanced dissemination and assessment efforts, will have a significant and lasting impact on the nation's engineering education system.

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B. Response to Recommendations of Prior Review Teams

The NSF issued no recommendations after the submission of our previous annual report, and the SUCCEED External Advisory Board did its final review of the Coalition's plans on March 21, 2001. A response to the Board's recommendations was included in the Year 9 Annual Report. Therefore, a brief review of the status of previous recommendations is given below (responses are in italics).

- The Board strongly supports the concept of an Engineering Faculty Development Institute. *Proposals to support such an institute have been made to the National Science Foundation: "A National Institute for Engineering Faculty Development and Dissemination of Effective Educational Practices, Principal Investigator Timothy Anderson, Co-PI(s) Claudia Brent, Nelson Baker, Richard Felder, and "Establishment of an Engineering Faculty Development Institute (EFDI), Principal Investigator Timothy Anderson, Co-PI(s) Claudia Brent, Nelson Baker, Richard Felder.*
- The Board recommends SUCCEED pursue the development of a Digital Library to serve as a repository of best products and best practices for improving engineering education. The Board is concerned about funding the web site, maintaining current information, connecting to other coalitions and the existence of multiple libraries. The Board strongly feels that SUCCEED should develop a robust business plan before embarking on this commitment of resources. *An NSF digital libraries proposal was submitted in conjunction with Columbia University which was not funded; discussions for a second submission with the Foundation indicated it was not a good match for the program and was not pursued.*
- The Board strongly suggests partnering with professional societies to help dissemination efforts. *In addition to SUCCEED innovations incorporated into the American Society for Engineering Education's National Effective Teaching Institute and pre-conference workshops, SUCCEED faculty were leaders in the development of the American Society for Civil Engineering's Excellence in Civil Engineering Education (ExCEED). SUCCEED is also on the program of the American Institute of Chemical Engineers.*
- The Board recommends that SUCCEED focus assessment efforts on producing a summative assessment of all aspects of SUCCEED activities over the last ten years. *The status of this is described later in this report.*
- The Board encourages continued use of professional marketing expertise as part of the overall plan for ensuring successful dissemination of its products and services. The Board also recommends that SUCCEED expand their marketing targets to include key constituencies such as institutional leaders and legislators. *SUCCEED is reaching US Deans effectively through surveys and direct contact. The CNSF conference attracts legislators, and SUCCEED has reached that constituency.*
- The Board recommends that SUCCEED develop a set of case studies describing the activities of the SUCCEED schools, and that this compilation be distributed to Deans of Engineering schools. *This is part of the work of the summative assessment.*
- The Board recommends that SUCCEED explore additional opportunities for inter-coalition efforts during the next year as part of developing a plan for life after SUCCEED. *Share the Future III expanded further the workshop-conference in collaboration with other Coalitions. The Foundation Coalition will host Share the Future IV in Tempe, AZ (March 16- 18, 2003).*
- The Board encourages the NSF to work with SUCCEED to help ensure an appropriate and effective closure to NSF funding. *A no-cost extension has been approved to maximize our legacy and ability to assess and disseminate our efforts.*

C. Major Accomplishments

Major gains in dissemination merited the inclusion of a special Dissemination section. These included revisions to the website, the distribution of a brochure of SUCCEED workshops, and the extensive delivery of workshops to a wide audience outside of the Coalition, including those given at disciplinary conferences.

> ***"[SUCCEED's] support to our process for developing and implementing an Outcomes Assessment process was critical. We have SUCCEED's support in high regard since the workshops... information from the different resources were invaluable."***
> *– Cuauhtémoc Godoy,*
> *Associate Dean of Engineering, Polytechnic University of Puerto Rico*

Faculty development. SUCCEED's goal of engaging 60% of engineering faculty in faculty development activities has certainly been exceeded—using a system that tracks the events that individual faculty participate in, we are able to document the participation of 61% of the faculty. The inadequacies of the system (failure of an event or attendance to be reported, events where attendance is not taken) would suggest that actual participation rates are even higher. Of this 61%, participation rates for individual institutions are generally 55% or more. Virginia Tech has established a White Teaching Chair with an endowment of $700,000—the recipient serves for a period of two to three years. Faculty mentoring is becoming institutionalized as well; Clemson and Georgia Tech have instituted Faculty Mentoring Awards. The success of Richard Felder and Rebecca Brent in faculty development—particularly the Effective Teaching Workshop—is well known. Felder and Brent have given about 250 workshops, including 12 offerings of the National Effective Teaching Institute, to well over 5000 faculty members, administrators, faculty developers, and graduate students. Their workshops have been given on about 100 campuses throughout the U.S. and in Europe, Asia, the Middle East, Brazil, and South Africa, and the NETI has reached engineering faculty from about 140 campuses.

Summer bridge programs. SUCCEED institutions have contined to improve and study summer bridge programs for minority students. Georgia Tech's Challenge program continues to thrive, and has expanded with SUCCEED's support to address the transition issues of transfer students. In addition, a peer coaching program was added to both programs. A longitudinal study of Clemson's Math Excellence Workshop is being prepared for publication. The study identifies statistically significant improvements on a range of outcomes: grades and passing rates in the first math class, passing rates in subsequent math classes, and university graduation rates. In addition, the trend indicates an improvement in engineering graduation rates that may be bear out as significant as recent participants have enough time to graduate. NC State's STP, Virginia Tech ASPIRE, and Florida's STEPUP programs, all described extensively in earlier reports, continue to thrive. FAMU-FSU's Engineering Concepts Institute is the subject of a study using the SUCCEED Longitudinal Database. The study, which is in press to appear in the October issue of the Journal of Engineering Education, reviews the programs benefits to graduation rates using high school grade-point average to control for a selection bias. The University of North Carolina at Charlotte has university-level bridge programs.

First-year programs. SUCCEED's influence on the freshman year for engineers has resulted in significant changes at each of our institutions, having an affect on the education on each engineering student in the Coalition—a number that amounts to 1/8 of the nation's production of engineers. NC State's Introduction to Engineering Problem Solving course has been strengthened and is required in all engineering curricula. The course will affect the education of nearly 1300 students/year. At UNC Charlotte, Introduction to Engineering Practices and Principles I moved to smaller section sizes and is using dedicated faculty to teach the course. College resources support freshman success in many ways at UNC Charlotte—through freshman engineering TAs, peer mentors, Supplemental Instruction leaders, and a Student Professional Development program assistant. FAMU-FSU's First Year Program has been upgraded to a General Engineering Program that is required in all BS programs. Virginia Tech's *Engineering Fundamentals* has implemented a design based course that is delivered to 1,200 students. Large allocations of funds and of space by Clemson's College of Engineering and Science have bolstered efforts to improve the General Engineering program there. Changes to Clemson's General Engineering courses affect approximately 800 students each year. The University of Florida has committed to provide state support for a position dedicated to freshman year programs, and UF's Introduction to Engineering has been expanded to include a design-based option. North Carolina A&T's College of Engineering has adopted a Common First Year that promotes interdisciplinary exposure to freshman students and allows easy transferability among majors after one year. The decision was based on assessment data and motivated by the need to consolidate and centralize recent initiatives—summer bridge, supplemental instruction, and study groups. All departments have agreed to cluster scheduling of freshman students to promote learning communities.

Multidisciplinary design. The cumulative impact of multidisciplinary design efforts at SUCCEED institutions is notable. Florida's Integrated Product and Process Design program has had 46 different program sponsors pay a total of $2,325,000 to support 921 students from 10 disciplines engaged in 156 multidisciplinary capstone design projects since 1995. Since 2001, Dave Ollis at NC State has delivered multidisciplinary design workshops and seminars at 25 universities and conferences, and another 39 are planned. Clemson's multi-campus multidisciplinary design program has been transferred to another faculty member, so its continuation is assured. FAMU-FSU College of Engineering's Multidisciplinary Design Training Clinic (MDTC) has permanent space and staffing with state and corporate sponsorship for 46 projects since 2001. At UNC Charlotte, a common multidisciplinary course for all departments was created to bring students from the different departments together, a structure that is a precursor for the creation of a common senior design course next year.

The use of laptop computers in the classroom. The use of computers in engineering curricula is ubiquitous, and various Universities and Colleges require students to purchase a computer. Virginia Tech's College of Engineering was the first state University in the U.S. to require its students to own a personal computer. While many Universities have considered the adoption of a laptop requirement in recent years, the collective experience of laptop pilot programs at various SUCCEED partners was a significant catalyst that facilitated early (and

nearly simultaneous) adoption by Clemson (Fall 2000), Florida (Fall 2001), and Virginia Tech (Fall 2002). North Carolina State University is continuing a pilot program in Fall 2002.

The institutionalization of college-level outcomes assessment. While ABET's Engineering Criteria will ensure that all accredited programs track and study student outcomes, a part of SUCCEED's model is to establish college-level or university-level outcomes assessment. Such an infrastructure anchors program objectives to College objectives, and measures a higher level of outcomes. NC State, Georgia Tech, and FAMU-FSU have established permanent positions in the College of Engineering for assessment specialists already. At NC State, the culture is sufficiently data and assessment driven that there is never a lack of demand for Joni Spurlin's skills. At Georgia Tech, Joseph Hoey's position is permanent and will be funded by the provost. The ECE school has just hired its own assessment director and the ME school is planning to because Hoey is too busy to do everything. North Carolina A&T will probably end up with a joint appointment between engineering and Institutional Research. UNC Charlotte plans to hire an assessment person on the lines of Georgia Tech and NC State, but a hiring freeze delayed the process. It will be the responsibility of an associate dean. Clemson created an Office of Assessment at the University level.

Other Funding for Educational Research and Improvement

We have always recognized that a critical part of SUCCEED's legacy must be the development of a cadre of engineering faculty engaged in educational research and scholarship. SUCCEED's website catalogs an extensive publication list that helps demonstrate the level to which we have established a community of scholarship. Another excellent measure of how we are achieving this objective is the amount of funding secured by SUCCEED investigators from other sources to continue or extend the educational research initiated with SUCCEED funding. It has always been difficult to document such successes, so the documentation of over $14 million of educational research since SUCCEED's last report is even more impressive.[1] A comprehensive list of all educational grants awarded since SUCCEED's inception is also available. Since SUCCEED's inception, nearly $58 million in educational research and improvement has been catalogued, of which $5 million has come from corporate or private sources. This list continues to be developed and is being studied to identify trends in the development of an educational research community.[2,3]

D. Faculty Development

> ***"Yes, we are very much interested in partnering with you in the SUCCEED program. Please find our responses below. Please let me know if there is anything else that is needed from our end."***
> *–from a response to SUCCEED's market survey of US Engineering Deans*

The faculty of a university is one of the most important factors in creating an intellectually enriching environment for students and faculty. Clemson joined Georgia Tech in recognizing the importance of the research and teaching development for faculty members through a Faculty Mentoring Award. The award was first given at Clemson at the end of the Spring 2002 semester.

At Virginia Tech, the recipient of the White Teaching Chair maintains the SUCCEED-CEUT (Center for Excellence in Undergraduate Teaching) partnership and continues to coordinate faculty development activities. The White Teaching Chair has an endowment of $700,000 and the recipient serves for a period of two to three years.[4] This will institutionalize the SUCCEED faculty development program. The current recipient, William Devenport, has already coordinated joint activities with CEUT. For example, he organized seven engineering "Faculty Study Groups." The groups have 36 engineering faculty members who meet monthly to discuss teaching and learning strategies and issues.

Richard Felder's videotape "Active Learning" is already available in the libraries of university faculty development offices.[5] An updated active learning videotape is being produced using videotape of Richard Felder's class obtained with two cameras. The new active learning tape will be useful for teaching seminars at all levels—graduate students, new faculty, and experienced faculty. An edited tape was produced and narration written. The tape will include four students giving a taped interview. Voiceovers and narration were taped in early 2002. In addition to the New Faculty workshop described earlier, Felder and Brent have also designed and presented "Designing Engineering Courses to Address EC2000." Felder and Brent presented one of these course design workshops at the 2001 Frontiers in Education Conference. They will present another teaching leader workshop at FIE 2002.[6]

A survey of faculty teaching practices has been administered for the third time. Reports on the survey and on the data collection techniques have been published.[7,8,9,10] The workshops designed and delivered by Felder and Brent, the updated active learning videotape, and the faculty survey are all integral parts of a comprehensive model of faculty development. Part of that model is to ensure that there is a system in place that rewards exemplary teaching, and a large number of rewards that have been used at different universities have been identified by Felder and Brent. The approaches on this list are discussed at workshops for administrators, and the list (always in progress) is available for review.[11] Papers on various aspects of the model are being written for inclusion in the literature of both engineering education and faculty development.[12,13,14,15,16,17,18,19] Rafic Makki of UNC Charlotte has also been sharing the expertise developed within the SUCCEED faculty development team through a workshop presented to the American Association of Higher Education.[20] Makki also developed a "webshop"—a workshop available through the internet—that addresses Peer Observation of Teaching.[21]

The FAMU-FSU College of Engineering has institutionalized annual faculty development workshops. The third annual workshop was held at FAMU-FSU on August 24, 2001 with Dr. Warren Viesmann, Jr., University of Florida as the featured guest speaker. The workshop content was to prepare faculty for ABET EC2000 (see workshop materials). An instructional technology update was also provided for Blackboard. Thirty-eight faculty and select staff attended the half-day workshop. The FAMU-FSU College of Engineering has conducted summer workshops for the past three consecutive years. Attendance for the workshop has increased. One continuous component of the annual faculty workshop is a timeslot to keep faculty informed of new technology. The fourth annual faculty development workshop focused on the collection of artifacts and other documentation as part of the assessment and evaluation of program outcomes. As in the three previous faculty development workshops, promotion and tenure and instructional technology were also addressed. The instructional technology segment of the fourth workshop included a demonstration of the new online student portfolio created by Florida State University.

Faculty Development Participation

As one of our key milestones, SUCCEED promised to engage 60% of our faculty in faculty development efforts. The continuation proposal review team viewed that target value with some concern that it was too high (as did some of us in SUCCEED). We have, in fact, surpassed that mark as a Coalition, and are close to reaching 60% of engineering tenure-track faculty when each institution is reviewed individually. Separate statistics for the level of participation of administrators, staff members, and people from other institutions are also available.[22] Participation figures are available for all documented faculty development activities under the present cooperative agreement. Matthew Ohland of Clemson University developed a database that cross-references all SUCCEED engineering faculty and all faculty development events—such a comprehensive approach was necessary to prevent redundancy in counting faculty participation—we must be sure that we actually reach 60% of the faculty, not merely the usual 10% six times each. Current faculty development statistics are shown in the table below. Note that since the inception of this database, Georgia Tech and Virginia Tech have begun tracking faculty participation internally, so the figures shown are reported by those institutions.

Note that, despite the fact that many faculty development events are not reported to SUCCEED, that most member schools have surpassed 50% already, and that Virginia Tech, through its innovative and highly successful 3-day summer Faculty Development Institute, more than 95% of its faculty has participated. In addition to the FDI, the Center for Excellence in Undergraduate Teaching offers a large number of workshops. SUCCEED is counted as a partner to the CEUT, and workshop material designed through SUCCEED is incorporated in CEUT offerings.[23]

Nelson Baker of Georgia Tech has helped institutionalize SUCCEED's faculty development institute wide, and has compiled statistics that show faculty involvement to average 60% across all the schools in the institute.[24] It is important to note that these statistics represent annual participation in faculty development activities. While the data compiled above are

Unit	Participating	Percentage	Total
College of Architecture	37	(78.7%)	47
College of Computing	66	(85.7%)	77
College of Engineering	198	(53%)	377
Dupree College of Management	69	(63.9%)	108
College of Sciences	100	(54.6%)	183
Georgia Tech Total	**502**	**(60.0%)**	**838**

across all of Georgia Tech are from 2000-2001, the rate of participation appears to be unchanged for 2001-2002, where data for College of Engineering participation are available.[25] SUCCEED's influence on Georgia Tech's faculty development is through partnership with the Center for the Enhancement of Teaching and Learning at the institute.[26]

School	Participating Engineering Tenure-Track Faculty	Total Engineering Tenure-Track Faculty	Percentage
Clemson	76	139	55%
FAMU-FSU	44	78	56%
GT	198	377	53%*
NCAT	42	75	56%
NCSU	142	245	58%
UF	147	312	47%
UNCC	56	97	58%
VT	277	292	95%**
Totals	**982**	**1615**	**61%**

*Reported in aggregate by institution; not generated from the SUCCEED faculty participation database.
**Based on documented Institute faculty participation rates of 95%. Due to the institutional makeup of Virginia Tech, it is reasonable to assume that this number is representative of the behavior of engineering faculty.[27]

New Faculty Orientation Workshops

A New Faculty Workshop was held August 6-10, 2001 at NCSU for 20 new faculty in the College of Engineering and the College of Physical and Mathematical Sciences. All participants rated the workshop excellent (19) or good (1). A description of the workshop, list of presenters, list participants, and list of participant comments is available.[28]

Richard Felder and Rebecca Brent are well known within and beyond the engineering education community for their Effective Teaching workshops. They have delivered about 250 workshops, including 12 offerings of the National Effective Teaching Institute (NETI) associated with the ASEE annual conference, to well over 5000 faculty members, administrators, faculty developers, and graduate students. Their workshops have been given on about 100 campuses throughout the U.S. and in Europe, Asia, the Middle East, Brazil, and South Africa. The NETI has reached engineering faculty from about 140 campuses. Expanding on their success with their effective teaching workshops, Felder and Brent designed a New Faculty Workshop.[29] In addition to delivering the workshop themselves, they

train campus faculty developers to deliver the workshop, accelerating the adoption of their model.

Felder and Brent's model was first tested at NC State, where the New Faculty Workshop has received full support from department heads and administrators for its continuation through Academic Affairs in the College of Engineering. The College of Engineering has also joined with another related college (PAMS) to include their faculty in the workshop further institutionalizing the workshop for the future.[30,31] Two follow-up sessions were held for new faculty attending the 2000 or 2001 New Faculty Workshop. A survey was administered to all new faculty in the College of Engineering (not just workshop participants) during the summer of 2001 to assess the new faculty satisfaction since instituting the New Faculty Workshop in 2000. Findings included a high degree of use of active learning among workshop participants and a much wider-spread use of faculty mentoring at the department level. The survey was completed and analyzed by Joni Spurlin who holds the SUCCEED assessment position at NCSU, and a long-term study was started to analyze effects of the new faculty workshop on research productivity and teaching effectiveness by analyzing new faculty annual activity reports.

At Clemson, Doug Hirt delivers an "Orientation to Teaching" workshop that is modeled after the Felder-Brent New Faculty Workshop. Orientation to Teaching has been offered in August 2000 and August 2001, for approximately 60 new faculty. The workshop is a part of the orientation process for new faculty, and will be continued with funding from Clemson's College of Engineering and Science. At FAMU-FSU, George Buzyna coordinates an "Assistant Professor Workshop" that includes elements of the Felder-Brent model as well. The FAMU-FSU offering describes the vision of the universities and college, college expectations of faculty, curriculum-related requirements, how to succeed in research, promotion and tenure annual evaluation and 3-year review, and "experiencing the P&T procedure" a presentation by a recently promoted and tenured faculty member. At the University of Florida, Charles Glagola coordinates the New Engineering Faculty Orientation Workshop that is part of a larger faculty development initiative. As an outgrowth of SUCCEED-sponsored faculty development at the University of Florida, a "Faculty Success" team was created and its members have individual responsibility for the areas of: Faculty Rewards; Faculty Enhancement Program; Faculty Social Programs; and Faculty Mentoring. These individual programs have been planned, documented and made ready for full implementation starting in Fall 2002 with support from the College of Engineering.

E. Outcomes Assessment

> ***"I thought you might like to see some pictures from one of my classes yesterday. During the exercise, for which we allowed 20 minutes, the students were highly interactive, both with each other and with us. This effort is a result of the SUCCEED Early Design work."***
> *– Hayden Griffin, Director, Engineering Fundamentals, Virginia Tech*

As has been discussed in earlier reports, after the Coalition had promised to incorporate outcomes assessment practices into engineering education, a number of faculty from SUCCEED schools were leaders in the establishment of ABET's EC 2000. Subsequently, EC 2000 became the dominant driver for the adoption of outcomes assessment processes within SUCCEED schools and across the country, and SUCCEED funding was focused in other areas. Still, various noteworthy efforts around the Coalition have sought to find approaches to measuring certain outcomes and designing particular assessment processes.

UNC Charlotte continues to be a leader in the electronic management of a wide variety of student and faculty outcomes.[32] Faculty outcomes are tracked using FACTS (Faculty Activity Tabulation System) under continuing development.[33] ASPIRE (Academic Strategic Planning and Institutional Reporting Environment) is used by the College of Engineering to record and report learning outcomes data.[34,35] ICAP (Individual Course Assessment Process) and FAIT (Focus Area Improvement Team) modules are complete and the development of PROBE (PRogram OBjective Evaluation), a method for collecting and reporting data for the next level in the continuous improvement assessment process, has been proposed and is in the revision stages.[36,37] The use of these electronic methods is extensive—100% of UNC Charlotte's engineering departments are using the ICAP process to keep track of their learning outcomes, which have been graphed and published to a website for easy access by College of Engineering faculty and staff.[38] All the units in the College of Engineering used ASPIRE to create their academic plans and annual reports.

Since UNC Charlotte initiated their work on ASPIRE and related systems, other SUCCEED universities have developed very specialized electronic data management systems. Kamal Tawfiq of FAMU-FSU continued development of college-level system for assessing alumni performance. The civil engineering department initiated its first alumni performance study, and results from this study have been finalized and will be available to the faculty in the civil engineering department and the college. To streamline the alumni performance survey and to prepare it for continued use, an electronic form of the survey was initiated the spring semester of 2002. When combined with results from the employer survey, exit interview survey, and internal assessment, the results of the alumni performance survey will be used to drive a comparison between direct and indirect assessment in order to close the continuous improvement loop.[39]

Virginia Tech, under the direction of Bevlee Watford, also sought to improve the quality of information obtained about alumni through enhancements to employer feedback instruments. Data from focus groups held in February 2002 was shared with various employers to obtain their opinion of this activity and the results it has produced.[40] The employers believed that

the new process was a very simple yet effective means of obtaining the perspective of industry regarding a program's outcomes. Employers also indicated that the data accurately reflected their thoughts regarding Virginia Tech students and engineering degree programs. Employer focus groups will be held every other year in conjunction with the Engineering Expo Career Fair. The college is committed to providing sufficient resources for both the group implementation and the data analysis.

An assessment specialist was hired to assist all departments at FAMU-FSU. This person is currently assisting all departments with "Alumni Performance Surveys" through a college-level system recently established. A search for a higher-level assessment coordinator is in progress. This mirrors efforts that have taken place or are in progress at other institutions—some of which have been described extensively in earlier reports. An additional higher-level assessment coordinator was hired in July 2002. Also, Kamal Tawfiq is currently developing a college-level "Student Learning Portfolio" system that will utilize parts of a new FSU-sponsored "Student Portfolio" project as a component. The first version of this system should be in place by the end of Summer 2002. FAMU-FSU has also implemented a web-based system for collecting feedback information from employers and alumni.[41]

Mike Leonard refined and tested prototype approach to curriculum renewal using strategic planning approach with the Department of Industrial Engineering at Clemson University.[42] At NC State, an ABET/assessment web site was created to support faculty in assessment efforts. Director of Assessment Joni Spurlin is investigating the impact of the New Faculty Workshop on new faculty. A study of E101, Introduction to Engineering Problem Solving shows positive feedback with indications of improvements needed in report writing. Students, faculty, and staff in the Laptop Computer Program were surveyed to determine the impact of the technology on student learning.[43]

Richard Goff coordinated a renewal of the Virginia Tech Engineering Fundamentals curriculum using the SUCCEED curriculum renewal process. The entire Engineering Fundamentals faculty was engaged in this process, and committed to creating a comprehensive design-based course that is being fully implemented in all sections of the new course for the fall.[44,45]

Mary Cummings of Virginia Tech continues her work developing a multimedia, online engineering ethics class that addresses ABET's charge to develop "an understanding of professional and ethical responsibility" (Criterion 3f), one that many schools find difficult to address adequately, especially in the case of transitioning students. SUCCEED's earlier support encouraged the Virginia Tech College of Engineering to provide instructor funding for the Fall 2001 semester and tentatively for future semesters. This on-line approach is most needed to meet the needs of transitioning students, as it is the only vehicle that allows transitioning students to meet ABET requirements. Students access the course through the Internet, listen to lectures in a power point format, receive their assignments, and debate ethical dilemmas using a discussion list serve. While the course was originally designed for transfer engineering students lacking the ABET required ethics instruction, the majority of the students in the class are taking it as an elective. This clearly indicates the students' desire to learn more about engineering ethics. Engineering Fundamentals expects to offer this

course every fall for the transfer student ethics instruction gap, and may expand the class to 3-credit course that is part of the core curriculum. A summer workshop for engineering Virginia Tech faculty who would like to learn more about integrating ethics into their classes was held August 19th and 21st, 2002.[46,47,48]

The University of Florida designed a Freshman Retention Survey, which is being administered this semester. University of Florida assessment personnel also generated a first draft of a Co-op/Intern Survey modeled after the Georgia Tech survey, and have sent the draft to the Office of Career Services for review. End-of-Semester course evaluations are performed to assess extent to which course learning objectives are being met. This data is reviewed by permanent course committees and is used to guide curriculum revision.

F. Student Transitions

SUCCEED has supported a large number of innovations to promote student success in the engineering curriculum. While some innovations address student success throughout the whole curriculum, most address critical transition points—those where special conditions make it most likely that students will leave engineering. Each of the following sections addresses one such area, spanning summer bridge programs, first year programs, mentoring programs, multidisciplinary design, and other programs to prepare students for the engineering workforce.

> ***"I really like the First Class program. I thought at first that it would be stupid, but I like it a lot better being in classes with lots of people I know. It seems easier to go to class and actually enjoy it."***
> *– from a participant in Clemson's First Class program by email to Rachel Collins*

Summer bridge programs

S. Gordon Moore completed a redesign of the CHALLENGE (summer bridge) program at Georgia Tech. A technology based classroom environment was completed for the 2002 summer program. The program's computer science class has been revamped, and an updated and revised English component was also implemented in summer 2002. An analysis of the performance of the summer 2001 CHALLENGE cohort indicated that program participants outperformed their peers once again. The CHALLENGE program has been reconfigured so that it is better aligned with the new semester system that Georgia Tech switched to in the Fall of 1999. The participation target has been raised to sixty-five percent (65%) of the incoming freshmen. CHALLENGE has always been supported by the institute and is now being supported at the increased level. The institute covers the full time salaries of the coordinators, and is looking at putting more state dollars into the budget. Corporations have also identified this effort as one for long term support with their dollars. TRANSITIONS, a transfer student bridge program, was also redesigned. The program is expanded to a full week format (formerly the program was 2 days). More time for personal interaction and academic advising is now built into the program, and the program distributed software bundles to all participants this year. The TRANSITIONS program was also reconfigured so that it is better aligned with the new semester system that Georgia Tech switched to in the fall of 1999. The institute covers the full-time salaries of the program coordinator, and corporate support is strong as well.

The most significant change in the CHALLENGE and TRANSITIONS program was to integrate the Team Coach programs to complete year-long transitions. The participation levels for the programs have continued to rise and are now at approximately 50%. The performance of the participants is greater than their non-participant peers. Team Coach keeps the students connected, which allows for better monitoring of their progress during the term. Community college students are included in the transfer student Team Coach program. Both the freshman and transfer Team Coach programs use trained upperclassmen, who work with the program participants while in residence during the entire program.

North Carolina State University delivered the Summer Transition Program (STP) to 35 incoming freshman. All of the STP participants have enrolled and completed the fall semester in engineering. Funding for the continuation of STP will be from a combination of university and external sources.

While Clemson's Math Excellence Workshop program has been conducted since 1990, SUCCEED resources have been used to assess the program longitudinally. A study is being prepared for publication by Matthew Ohland (now of Clemson) that shows that the MEW program has had a positive effect on a variety of outcomes, including math passing rates, grades in program math courses, grades in follow-on courses, overall grades, retention at the university, and retention in engineering.

A significant longitudinal study of the FAMU-FSU College of Engineering's minority student development program, which has been founded upon the Engineering Concepts Inventory is in press with the Journal of Engineering Education. The study used high school GPA to control for a selection bias in a multiple logistic regression model. While multiple individual cohorts remain statistically significant, the aggregate of all cohorts lacks significance due to the small number of participants and the possible overly stringent penalty imposed by the addition of high school GPA. Nevertheless, The results continue to show the positive trend observed earlier—that Minority Engineering Program participants are 25% more likely to be retained and graduate in engineering than students who had similar high school GPA but did not participate in the program—it is expected that continuing longitudinal study will bear out this trend as statistically significant.

Bevlee Watford reported on the implementation and expansion of support for at risk students through the ASPIRE program for black and hispanic engineering students. The State Council for Higher Education in Virginia funded a proposal for the summer and academic year components of the program, and the summer program was implemented with 33 students in 2001. All ASPIRE summer participants are enrolled as freshman engineering students. ASPIRE also receives funding from the University Provost's Office, the Office of Minority Engineering Programs, and various corporate sources.[49] The Math skills of program participants (as measured by the Math Readiness Test) improved from 3% prior to the start of the program to 77% at the end of the program. A report of the retention of ASPIRE participants shows that black and hispanic students were retained at a rate of 93 and 100 % respectively. A detailed report is available.[50,51,52,53,54]

First-year programs

NC State has revised its Introduction to Engineering Problem Solving course, E 101, to strengthen the library research and writing components of the course. The revised course was delivered to approximately 1150 incoming freshman during Fall 2001 ending with Freshman Engineering Design Day on December 5, 2001. The course is required in all engineering curricula. Funding to teach the course will continue to be provided by the university. The course will affect the education of nearly 1300 students/year. A comprehensive assessment of the course was initiated in Fall 2001 and is ongoing.[55]

Virginia Tech's *Engineering Fundamentals* has undergone curriculum renewal under the direction of Rich Goff, as described in the Outcomes Assessment section. In addition to implementing a design based course, computer tools were introduced in a workshop environment (Laptop computers will be used in class in the fall). Design will be taught using several increasingly more complex design activities starting with hands-on devices and MacGyver boxes funded by the Student Engineers' Council and concluding with one or more lengthy system design projects. Autodesk Inventor CAD software will be introduced in the first semester course. This course is being delivered to 1,200 students in fall 2002.[56]

Researchers at Clemson have continued to improve Clemson's Introduction to Engineering Problem Solving (ENGR 120) course. Matt Ohland and Ben Sill received a major NSF award supporting research in the ENGR 120 classroom. The research seeks to determine if seeing real-time graphical output from sensors yields benefit for students learning about physical phenomena and for learning how to draw graphs in general.

The inclusion of science participation in Clemson's traditional Introduction to Engineering (ENGR 101) course is being evaluated, and the temporary course Introduction to Engineering and Science (CES 101) is being offered in Fall 2002. If Clemson's College of Engineering and Science accepts a proposal to have a common College year (engineering currently has a common first year), the revised course will be the cornerstone. The acquisition and renovation of new classroom space (more than 20,000 square feet) is of significant benefit to the program. In the coming year, most departmental presenters are using hands-on activities to more effectively engage the students. Changes to Clemson's General Engineering courses affect approximately 800 students each year (ENGR 101 is only offered in the Fall, and Fall enrollment in ENGR 120 is primarily transfer students). Industry involvement is also being incorporated into class design projects. Further freshman program developments at Clemson University include newly renovated, computer–enabled auditorium from an old YMCA theater, a new computer-based sensor lab, and a new Workshop for Women (CES 110).

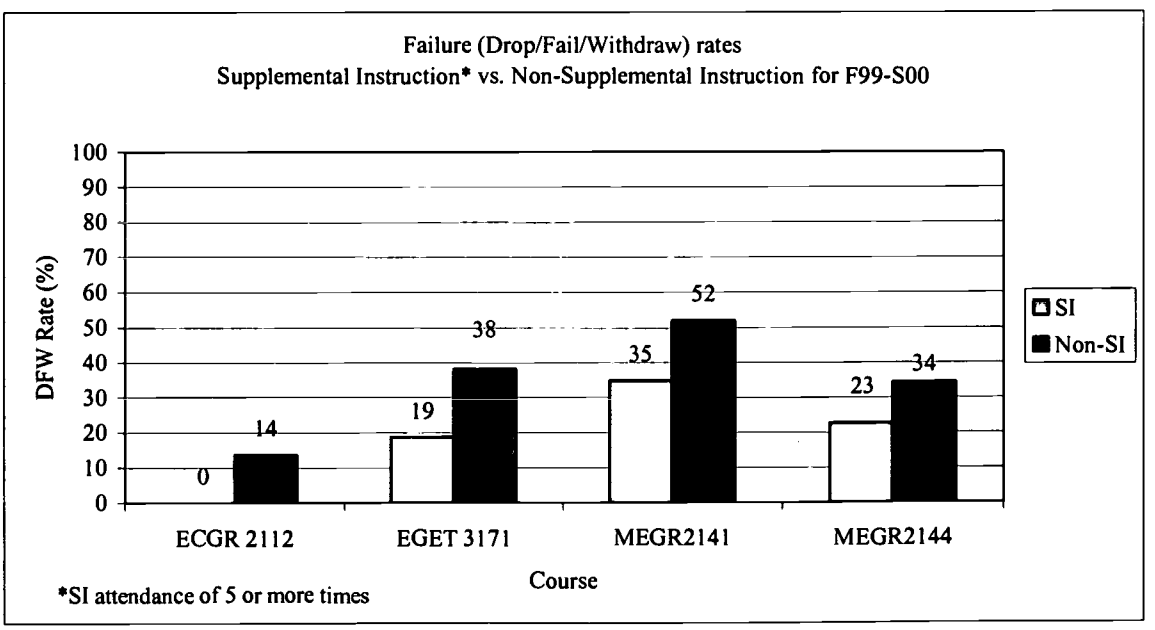
Clemson's FIRST CLASS (FIRST for First Year, CLASS for Community for Learning And Student Success) learning community was initiated in Fall 2000 semester. The program occupies two floors of a dorm—one floor of males, one floor of females; demand for the program far outstripped the space available. Students are scheduled in cohorts (in up to four of their classes), and the lounge in their dorm has been modified with computers, printer, etc. A variety of quantitative and qualitative assessments are underway. A cohort of students who volunteered to participate in the program but were not admitted (due to space requirements) will serve as a control group in order to avoid a selection bias in the study.

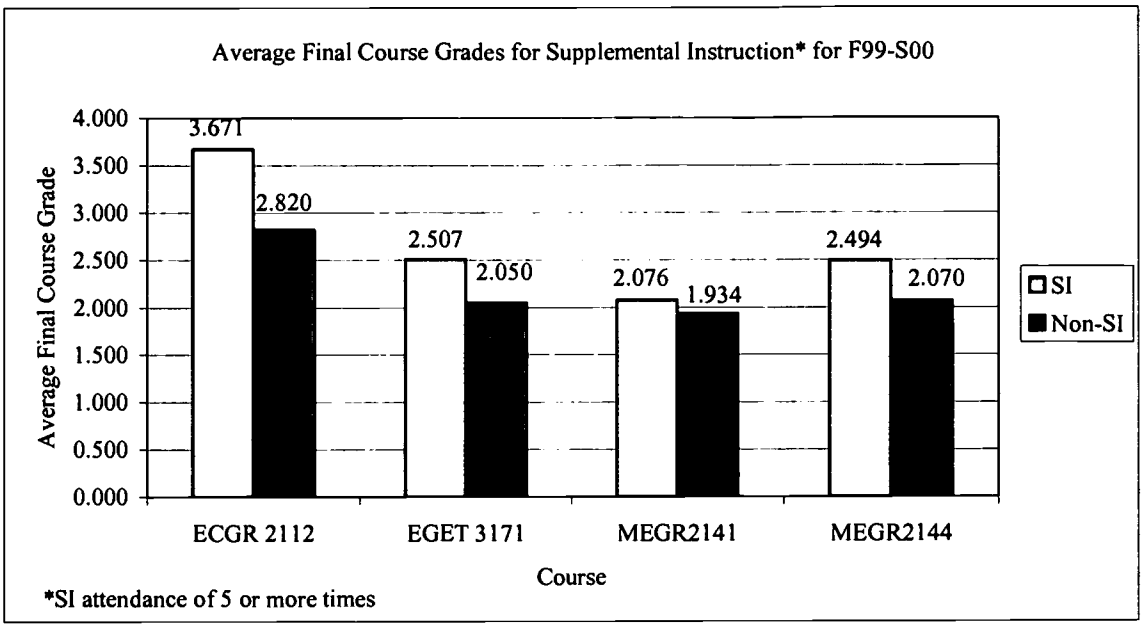
At UNC Charlotte, Patricia Tolley has worked to complete institutionalization of a variety of programs to enhance the success of freshman in engineering. Revisions to ENGR 1201, Introduction to Engineering Practices and Principles I included smaller section sizes and dedicated faculty to teach the course (previously, the lead instructor role was rotated among faculty from the departments). In addition, a freshman engineering TA handbook was completed and used for the first time this fall. The College has provided funding for freshman engineering TAs, peer mentors, Supplemental Instruction leaders, and a Student Professional Development program assistant. In order to support improved team functioning,

a new web-based, password protected peer evaluator application was developed and implemented in the fall semester.

UNC Charlotte's engineering departments assumed the majority of the funding for Supplemental Instruction in this past year, ensuring the institutionalization of the program. Students believe that SI plays a key role in helping them build learning communities and study groups. Multiple assessment processes are balanced between quantitative and qualitative analyses including student, SI leader, and faculty feedback; attendance rates; final course grades; DFW rates (percentage of students receiving a course grade of D or F, or withdrawing from the course); and retention. Assessment results indicate that SI is making a statistically significant positive effect on final course grades and on DFW rates. Initial retention results also indicate that College of Engineering students who attended SI at least five or more times during a semester are more likely to be retained. Qualitative feedback from faculty suggests that SI participation is often the determining factor in whether or not a student repeats a course.

Retention rates are obtained by tracking the students enrolled in a specific course and section for which SI is offered. Sophomore to junior (SO-JR) and junior to senior (JR-SR) retention rates are used because, in the UNC Charlotte College of Engineering, SI is offered primarily for sophomore courses. Retention rates were calculated for College of Engineering students enrolled in SI courses from fall of 1996 through spring of 1999. Since students typically take at least one year to be promoted, retention rates are based on students who were promoted to juniors or seniors as of spring 2000, the latest date for which data are available. The study compared the retention rates for College of Engineering students attending SI sessions five or more times during a semester with those who did not. The retention rate for both sophomores and juniors who attended SI is 89%, which represents a difference of +10 percentage points compared non-SI students. This result correlates with other studies conducted by Blanc, DeBuhr, and Martin.[57] The figures show improvements in course passing rates and grades for





Fall 1999—Spring 2000. In short, students who participate in the UNC Charlotte Supplemental Instruction program are more likely to pass their classes, have higher grades, and stay in engineering.[58]

The First Year Program at FAMU-FSU has been upgraded to a General Engineering Program, and is required in all BS programs. FAMU-FSU's First Year Engineering Laboratory is being scaled up, and over 100 students participated in the First Year Program in Spring 2001, when the Lab (EGN 1004L) was team-taught by six (6) senior faculty. Plans are now underway to include a peer-mentoring component in the FYP. Coordinated by Ms. L. Herring, this peer-mentoring component will suitably connect new students to trained peer mentors. A second one-credit-hour course is being planned that will focus on "Freshman Product Redesign."

The University of Florida has committed to provide state support for a position dedicated to freshman year programs, in addition to corporate support and federal funds. Marc Hoit reports that an extension to UF's Freshman Lab was created which offers a design component. The extension to the freshman lab will be examined for its cost effectiveness and a determination of its future will be based on its success. This design-based offering had 32 students in summer 2001, and 40 students in Fall 2001. Math Placement test results are used at many institutions to advise students regarding registration for math classes. The cut-off values used at the University of Florida are guided by recommendations of SUCCEED supported project.

North Carolina A&T's College of Engineering has adopted a Common First Year that promotes interdisciplinary exposure to freshman students and allows easy transferability after one year. The decision was based on assessment data and motivated by the need to consolidate and centralize recent initiatives—summer bridge, supplemental instruction, study groups. All departments have agreed to cluster scheduling of freshman students to promote

learning communities. This was implemented in Fall 2001 and continues. The process of placing students in Freshman Calculus has been revised based on a SUCCEED-supported study. Work on Math Placement Tests is ongoing—the team is awaiting results of Fall student grades in two math courses. As a result of Math Placement and Tutoring, student performance in Freshman Calculus has improved by 11%.

Mentoring programs

Mimi Philobos at Georgia Tech reported on the status of the M&M Mentoring Program. The mentoring program was opened to all students for the first time and we had 116 members joining. The participation percentage was very high this year (about 53%) throughout the year. The third Engineering Career Conference (ECC) was held. The conference is open to all M&M students as well as high school Juniors and Seniors. Ninety-three students attended, 69% of those who attended the conference are now enrolled at GT college of Engineering. A student coordinator was hired who accelerated the implementation of the program—a higher level of contact was maintained with students and the effect was evident in the participation numbers. The overall goal of the M&M and ECC is to recruit more women to engineering fields as well as to increase the retention of women majoring and considering careers in engineering by providing accurate information about each major.[59,60]

Based on student feedback and assessment results, the MAPS (Maximizing Academic and Professional Success) Program peer mentoring sessions at UNCC were restructured to better support students, particularly freshmen. Activities initiated by SUCCEED will continue post-funding. The Office of Student Development and Success (OSDS) was created July 1999 and is lead by the Assistant Dean for Student Development and Success. A Faculty Associate for Recruiting and Advising, the Director of the MAPS Program, a Faculty Associate for Student Professional Development and three full-time secretaries are also part of the OSDS.

Sarah Rajala of NC State reports that peer mentoring programs for underrepresented minorities and women are in place. All freshman minority students are provided a peer mentor. All women students are offered peer mentoring. The peer mentoring program will continue, and funding will be from a combination of university and external sources.

Multidisciplinary design

The University of Florida's Integrated Product and Process Design (IPPD) program,[61] SUCCEED's flagship multidisciplinary design effort, continues to have more project demand than can be satisfied. In 2001-2002, corporate sponsors[62] pay support of $15,000 per project[63] to engage 155 students from 10 disciplines in 23 multidisciplinary capstone design projects.[64] Each design project is aided by a liaison from the company and one of 23 faculty coaches.[65] Since the program's inception in 1995, 46 program sponsors have paid a total of $2,325,000 to support 921 students from 10 disciplines engaged in 156 multidisciplinary capstone design projects.[66,67,68] This mutually beneficial university/industry partnership is institutionalized at the University of Florida with approximately 25% of engineering undergraduates participating. Industry funding covers about 2/3 of the program expenses, the remaining 1/3

is covered by State of Florida and the University of Florida Foundation. In later years, SUCCEED funds have comprised less than 2% of IPPD support.

Marvin Dixon has led a multidisciplinary, multi-campus design program for a number of years at Clemson University. The focus in the past year has been to extend the program to additional sponsors and departments and to find a new faculty champion. More than 100 Clemson students from three or four disciplines participate in this program in a typical semester, and participating industries pay a $5000 fee plus student expenses to participate, which will also help to institutionalize the model. Typically 7 design projects from different industries are addressed each semester, and students learn to address industrial projects while working in design teams composed of students from six different engineering disciplines and who attended four different American and two different German universities. The multidisciplinary program at Clemson has matured to the point where many industries are waiting to participate. Coordination of the multidisciplinary activity at Clemson is difficult whereas coordination of the multi-university activity is almost impossible. Different disciplines at Clemson have different course structures such that the multidisciplinary activity can best occur only during one semester of the academic year. The different universities involved have different calendars, with starting and final dates varying by as much as four weeks. Therefore it is very hard to establish a common start and finish date without shortening the time frame for the design activity. Also some faculty are unwilling to participate in the multi-university activity without additional financial remuneration. Since these funds will not be available on a long-term basis the multi-university activity will not exist in the future. The multidisciplinary activity will continue at Clemson with at least four different engineering disciplines and a host of industrial sponsors. Georges Fadel of Clemson's Mechanical Engineering department will coordinate this project in the future since Dixon has retired. Dixon's work has been presented at the 1997 and 1998 SUCCEED conferences, the 2001 and 2002 ASEE conferences,[69] and received an honorable mention in ASME's 1997 Curriculum Innovation Awards.[70]

Yousef Haik has continued the development of a multidisciplinary design clinic at FAMU-FSU College of Engineering.[71] The Multidisciplinary Design Training Clinic (MDTC) is a center of operation for industry-sponsored projects. There were eight industry-sponsored projects during fall 2001, and 51 students worked on these projects. A system has been established to maintain industrial sponsorship projects, and several companies have multiple of projects. The funds paid by industry sponsors have helped the MDTC support a club of students from ME and EE to build a robot for the TV show competition BattleBots. Eight high school students participated in the project. In addition, an electric car race club will also be sponsored by MDTC. The use of the MDTC has been integrated into the curriculum of all 5 engineering departments, and the departments have accepted a system of evaluation and assessment for the MDTC projects. Modeled after the University of Florida's IPPD program, FAMU-FSU provides office space for the MDTC coordinator, a multimedia equipped conference room, working space, and offices for the MDTC projects. In Spring 2002, twenty-three projects from industrial and government agencies were active, with more than 80 students engaged in those projects. An additional 15 projects are expected during the fall 2002. SUCCEED's support was essential in developing an umbrella for the whole college to institutionalize multidisciplinary team activities. Both Florida A & M University and Florida

State University are supporting this initiative in the college of engineering by waiving the overhead cost for projects under 10k and charge 5% overhead for projects over $10,000. The MDTC will continue to facilitate and provide support to the faculty and student in acquiring multidisciplinary industrial projects.

Anuj Chauhanof Chemical Engineering and David Mazyck of Environmental Engineering the University of Florida have investigated another approach to multidisciplinary design, collaborating on a project in which freshmen students design a pilot potable water treatment plant.[72,73,74,75,76] Students from environmental, civil, mechanical, electrical, computer, and chemical engineering participate, and senior undergraduate students assist with the course and serve as mentors for the freshmen.[77,78,79,80,81,82,83,84] The plants fabricated by students work efficiently and can reduce the turbidity of water to values smaller than the tap water. The project helps students see a link between theoretical concepts and the real life design applications, and introduces them to team design and group presentations. The course is expected to be institutionalized by the college. In the first two offerings, nearly 100 students volunteered to take this course, and 76 were accepted (34 summer and 42 fall). Several students volunteered to assist with future course offerings. Students successfully designed 4 treatment plants that efficiently purify water (i.e., remove suspended and colloidal impurities). Student surveys report that this class has been successful at imparting design skills, demonstrating teamwork, providing a valuable hands-on experience, and has reinforced their decisions to pursue engineering. Four undergraduate student assistants have worked on the project to date, making presentations, and increasing their depth of knowledge about the design projects, and two of these students recently committed to graduate school, an unplanned benefit. A website dedicated to the project includes a course schedule, PowerPoint slides, and photos.[85]

Bob Coleman developed a cross-department team experience for undergraduate students. A multidisciplinary ethics seminar was sponsored by the UNC Charlotte College of Engineering and implemented in the Fall of 2001, modeled on the highly successful university seminar on "Ethics in the World of Business." A common multidisciplinary course for all departments was created to bring students from the different departments together, a structure that is a precursor for the creation of a common senior design course next year. A faculty multidisciplinary design team is working on the formulation of a new common course offered to any senior in the COE. The emphasis in the 2001-2002 academic year was on the creation of the common ethics component of the multidisciplinary experience in order to break down departmental barriers and encourage students to work across disciplinary lines in their design teams. The design team will be the focus of the experience next year, which will also be funded by the College of Engineering.

Preparation for the engineering workforce

While there is significant focus on the transition into engineering from high school or from a transfer institution, SUCCEED's model for successful student transitions also addresses the transition from engineering study to the workplace. SUCCEED's greatest focus in that regard is in developing multidisciplinary design experiences, but SUCCEED institutions use other strategies to focus on preparing students for working in engineering. Bevlee Watford reports

that Virginia Tech provides workshops to guide students through the workplace transition. Programs offered include Resume Review and Writing, Preparing for a Career Fair, Interviewing Skills, and Business Etiquette. Several of these workshops are scheduled for spring just prior to the February Career Fairs. The Career Fairs are sponsored by Career Services, the Student Engineers' Council and CAMEO (a student organization), so these events are self-supporting.[86] The workshops are supported with supplemental funding from the State Council of Higher Education in Virginia, Corning, General Electric, Ingersoll Rand, Cummins Engine; three additional companies have expressed an interest in both participating and providing funding for this program.

John Mecholsky of the University of Florida helped students learn about engineering and patent issues in a patent design class. Students learned to analyze technical patents in a course titled "Engineering Innovations for the 21st Century." Several Department Chairs have expressed interest in sending their students to the course, and the course has been submitted as a formal course with an engineering course number to be offered in future semesters. Patty Tolley of UNC Charlotte reports that multidisciplinary ethics and entrepreneurial components were included in the junior/senior professional development course this fall. In addition, a Fundamentals of Engineering review course was implemented this fall.

At NC A&T, the FE Review Course is required in all but one of the engineering programs. In addition, the CAAE (Civil, Architectural, and Agricultural Engineering) department has developed an interactive FE preparation tutoring laboratory with SUCCEED support and a GE donation – this lab is open to all students in the college of engineering. These three programs now require that all seniors take the FE Exam prior to graduation.

G. Technology-Based Curriculum Delivery

> ***"Special thanks go to Bill Moss at Clemson University who has provided us—and the entire WebCT community—countless suggestions and advice regarding this topic."***
> *– Editor's note on Math Symbols in WebCT Assessments*[87]

The use of technology to improve the educational process has become ubiquitous. Techniques for using technology to improve effective teaching have been incorporated into the faculty development workshops described earlier. Technology is used to facilitate outcomes assessment through the use of databases to track objectives and outcomes. Through all the broad range of experiments SUCCEED has conducted to study and improve the use of technology in the classroom, the overwhelming influence of work in this area has recently been directed toward the deployment of laptops in undergraduate education.

The Use of Laptop Computers in Education

The use of computers in engineering curricula is ubiquitous, and various Universities and Colleges require students to purchase a computer. Virginia Tech's College of Engineering was the first state University in the U.S. to require its students to own a personal computer.[88] While many Universities have considered the adoption of a laptop requirement in recent years, the collective experience of laptop pilot programs at various SUCCEED partners was a significant catalyst that facilitated early (and nearly simultaneous) adoption by Clemson (Fall 2000), Florida (Fall 2001), and Virginia Tech (Fall 2002). North Carolina State University is continuing a pilot program in Fall 2002.

Various findings among the SUCCEED institutions led to this change:

- many students were purchasing laptops already
- students liked the portability and connectivity of laptops
- a laptop requirement includes the cost of a laptop in financial aid consideration
- students can use the computer as a tool throughout the day rather than just for homework
- an increase in the degree of collaboration on design projects
- students can customize their computing environment
- students can install specialized software
- students can bring their computer to a faculty member's office for help
- students will learn how portable computers are used by engineers

Among the SUCCEED institutions, Clemson was the first to conduct pilot studies, initiating a pilot laptop program that began in 1998 with 100 College of Engineering and Science students. Over 125 freshmen joined the program in 1999, 2000, and 2001.[89] Approximately 40 freshmen in the College of Architecture, Arts, and Humanities joined this group in 2000 and 2001. Laurie Sherrod directed these pilot studies with SUCCEED support, and with great success. Clemson's Board of Trustees made laptops mandatory for incoming freshmen and sophomores in the College of Engineering and Science and the College of Business and Public Affairs in 2002, and the University committed $150,000 per college for support. It is

anticipated that there will be some saving in decreased labs and support costs.[90,91,92,93] Other colleges at the University are expected to follow suit in future years. Management of the laptop program has been taken over by our central IT department with elimination of some public labs, so centralized support for the program has been secured.[94,95] Classrooms are being configured to handle laptops during class and many classes are planning to begin incorporating laptops into the classroom—81 sections of classes for Fall 2002 will incorporate laptops into the classroom. Sixty faculty and staff who participate in technology workshops will earn a laptop computer and/or grant to facilitate incorporating technology to their classes. The program currently covers 2800 students and over 60% of Clemson's incoming freshmen and at least one additional college is committed for 2003.[96,97]

A group of faculty at the University of Florida is investigating the use of laptop computing in junior and senior-level courses. Sherman Bai studied the use of laptops in a new Industrial and Systems Engineering course on web-based decision support systems.[98] Wireless networks allowed students to use various Internet tools. He set up Internet-live exercises to be used in the classroom via a class web server. Students published their work to the Internet in real time, and student teams worked on collaborative web-based development projects. In Spring 2002, not all students in the class had laptops, because they were not required to purchase them. As a result, the capability and performance limits of the wireless connection in classroom were not fully tested, and testing will continue in Fall 2002.

Eric Schwartz studied the use of laptop computers in Digital Logic and Computer Systems (EEL 3701), an upper-level computer engineering laboratory. Wireless networking in the classroom allowed students immediate access to class resources available online, including PowerPoint notes, laboratory assignments, and class examples.[99] Approximately 60 students participated in the laptop section of the course. A study of the performance of these students will be compared to the approximately 120 students in non-laptop sections to supplement the results of a survey administered to the students.[100] Schwartz plans a study of laptop use in Discrete-Time Signals and Systems (EEL 3135) for the Spring 2003 semester.

William O'Brien explored using laptops for problem-based undergraduate construction engineering education. O'Brien developed self-guiding course material with self-assessment quizzes and built a cache of multimedia content for use in multiple courses.[101,102,103] Student feedback (a non-statistical survey sample) on the use of laptops is very positive and they encourage further development—a more rigorous assessment of the approach is planned. O'Brien will continue to deploy modules in undergraduate classes in the construction engineering curriculum, affecting approximately 75 students per year.

Kathy Mayberry is NC State's Coordinator of Student Owned Computing, and directs NC State's efforts to assess the feasibility and desirability of a laptop mandate. Five courses were taught during Fall 2001 integrating wireless laptops with instruction, and 33 students built a dual boot Windows 2000/Linux laptop during the first Introduction to Computing class for use in those laptop courses. Three additional laptop courses were taught in Spring 2002 (Introduction to Java, Foundations of Graphics, and Honor's Colloquium). Results from a survey administered to the students in December are as showed that 82% of students agreed that the laptop enhanced learning outside of class, 86% of students agreed that the laptop

facilitated teamwork, and 89% agreed that the laptop made learning more enjoyable. The pilot will continue (without funding from the SUCCEED Coalition) in Fall 2002. The results from the assessment of NC State's pilot laptop program are available.[104]

Laptop Student Perception On Course Material at NC State

Rated from Positive to Negative: Percent who said Positively or Very Positively* – Across all courses						
	Laptop Integrated into Courses			**Laptop Not Integrated into Courses**		
	How did use of technology to present lecture outlines affect:	How did use of electronic communication affect:	How did use of web pages, etc affect:	How did use of technology to present lecture outlines affect:	How did use of electronic communication affect:	How did use of web pages, etc affect:
Understanding of course material	74	71	87	11	11	13
Interaction with instructor	63	64	63	0	0	0
Interaction with other students	78	81	77	22	22	13
Participation in class	70	67	73	11	11	13
Organization of content covered	73	67	74	0	11	0
Feedback from instructor	64	64	63	0	0	0
Satisfaction with course	73	72	77	22	22	25
*Laptop students had questions on a 5-point scale, Not in Program students had questions on a 3-point scale						

Angela Lindner at the University of Florida used laptops and CAChe software to enhance lectures in Chemistry of Carbon Compounds (EES4200) as a means of reinforcing lecture points via 3-D visualization of molecules.[105,106] Classes of 45 students in Spring 2001 and 47 in Spring 2002, with enrollment from environmental engineering and natural resources used the CAChe software in groups during lecture and during office hours. She is also publishing the design of modules that directly link lecture notes to the use of the CAChe software. The modules,

- Calculating Geometry of Molecules and Ions of Environmental Relevance
- Polarity of Small Representative Environmental Contaminants
- Molecular Orbitals of Simple Molecules

- Kinetics of Substitution Reactions of Alkyl Halides

will allow students to work with the software at their own pace while completing homework assignments required in their student portfolios. The efficacy of the modules will be tested by a comparison to classes where CAChe was not used (1998-2000), where CAChe was used only as a lecture enhancement (2001-2002), and where CAChe was used both in the classroom and in homework assignments (2003).

With the use of computing in the classroom becoming ubiquitous, David Mikolaitis at the University of Florida is investigating the effect of computer usage on examination performance. He found that students in introductory engineering courses are receptive to the use of computational software during class time. Nevertheless, given the choice to use computational software on examinations, those students tend to decline and fall back on familiar tools (calculators). Mikolaitis conducted his study in Fall 2001 in both Elements of Statics (EGM 2500) and Dynamics (EGM 3400). He continues his work and is still collecting data to see if *requiring* the use of computational software in a non-examination setting (on multiple homework assignments) changes the use patterns during examinations.

Other uses of technology in the classroom

SUCCEED's support helped Bill Moss at Clemson become a national leader in web-based course tools. Locally at Clemson, he created a Perl script to automatically enroll and drop students from WebCT courses using the registrar's notifications as input, and upgraded the two WebCT servers to Red Hat 7.1 and WebCT 3.6.2.[107,108] As of September 2001, there were 14,424 WebCT course enrollments by 8101 students in 299 courses using WebCT at Clemson. This year the college paid for half of the cost of the WebCT license and the Legato Networker license. This past year is the third year that Moss has been asked to give a paper on using mathematics with WebCT at the international WebCT conference.[109,110] Moss' contribution to the implementation and testing of mathematical expressions in web-based course tools is well-recognized.[111] His summary article "Mathematics in WebCT IV" was delivered at the annual International WebCT conference in Boston in July 2002. With Barbara Weaver, Moss conducted workshops to train faculty in the use of educational technology, including a two-day Maymester workshop for new laptop faculty, introductory WebCT workshops, and a WebCT quiz workshop for mathematics instructors.[112,113] Demonstrating the extraordinary integration of SUCCEED's innovations, the first day of the workshop for new faculty focused on pedagogy using SUCCEED materials. The second day covered technical issues using a smart classroom and commonly used software applications. Moss also assisted the Office of Off-Campus, Distance, and Continuing Education in the creation of PowerPoint presentations containing video narration.[114,115] These presentations were burned on a CD and sent to Dubai to support a distance learning course. These presentations were also made available on the college Real Server.[116] Camtasia was used to develop video tutorials for WebCT.[117] The Office of Off-Campus, Distance, and Continuing Education has received a second contract for narrated PowerPoint presentations, and other colleges are now beginning to make use of streaming media and Camtasia. Moss also delivered a keynote address given at the Raritan Valley Community College at a joint meeting of the NJ Virtual Community College consortium and the NJEdge.net consortium.

Braketta Ritzenthaler at FAMU-FSU published third and fourth volume of EProf, a newsletter for faculty development and instructional technology. Faculty articles in Eprof describe instructional and technology best practices. EProf has been printed for distribution to the University communities, members attending a meeting of Advancing Minorities Interest in Engineering (AMIE), and faculty and staff of FAMU-FSU's College of Engineering. The distribution of the publication to various parties has greatly increased since the first Volume, and the publication continues to be well received. The Associate Dean's Office and respective budget will continue to support this initiative in the absence of SUCCEED funding. The Dean holds this publication in high regard and is a prime supporter of the use of this document to inform others of the activities for faculty development and instructional technology. The most recent volume was distributed at the faculty meeting as part of activities to kick off the 2002-2003 academic year, and included information about: documentation and artifacts for assessment and evaluation of program outcomes (ABET), the similarities of SACS and ABET accreditation, tips on securing sponsored research funding, teaching best practices, an update on the Multidisciplinary Design and Training Clinic, partnering companies and government agencies, and Industry Day 2002.

Charles Price of UNC Charlotte delivered four synchronous distance learning courses using Centra Symposium and five additional courses are scheduled for the spring. Wireless networking was tested for possible use in on-campus classroom activities. A support arrangement was formalized with the campus office of Continuing Education through which that office will provide user support, training, and basic administration for faculty and students using Centra for synchronous courses. Two additional receiving sites with about 25 additional students were added to the Engineering 2+2 program, and two programs outside the College of Engineering adopted Centra Symposium.[118] UNC Charlotte is considering adopting Centra for synchronous distance learning and making it available to all classes.

Glenda Scales has worked to create an instructional web presence for sophomore and junior level engineering courses at Virginia Tech. Such a resource would help students to obtain information about a course before they take it, promote and advertise new courses in a central location for the College of Engineering, demonstrate examples of instructional technologies, and attract prospective students to the program. The prototype course materials were added to the database with help from key faculty, the administration page for adding new courses and content was implemented and the initial functionality testing was conducted, and usability testing was performed in spring 2002.

Mark Jones at Virginia Tech designed a progression of programming lab assignments based on the use of Lego Mindstorms that emphasizes the hardware/software interface essential to computer engineering. These assignments were integrated into ECE 1574, an Engineering Core Course. Jones developed a set of tutorials and reinforcing online quizzes designed to help students learn key programming concepts and a framework for graphics-based, large programming assignments. Approximately 300 students enrolled in this course during the Spring 2002 semester.

H. Assessment

> ***"Educational research could adhere more closely to the health research model. Health research relies on clinical trials and longitudinal studies to track health behaviors and health problems."***
> *– excerpt from a RAND report on the ten most important issues facing the current Presidential administration*

In 1993, in response to NSF concerns that assessment was insufficient across engineering education, SUCCEED initiated program assessment at the curriculum level and helped inform ABET and SACS changes. During years three and four, Bob Serow of NC State performed a formative qualitative assessment of the coalition as a whole. The Coalition also developed a longitudinal database (LDB) that provides common measures across campuses, but is limited to data that all or most campuses collect. During years six and seven, Cathy Brawner of Research Triangle Educational Consultants continued the qualitative assessment process focusing on the implementation of Coalition goals at the campus level and continuous quality improvement. During that assessment, she found that project and campus level assessment was lacking. That led to creating positions within the colleges of engineering to do assessment of the educational research in the colleges.

An assessment team was formed with a dual charge—one responsibility is to perform project level assessment and college assessment that asks what the effect of SUCCEED has been over the life of the project.[119] This effort will inform SUCCEED's final report, being written as a collaborative effort. This team also has a responsibility to the college—to become integrated into the college, to develop educational plans and assessment plans in proposals to support further educational innovation. People in this position would also give expert advice on programmatic issues based on data collected.

Serow, Brawner and their team have a rich set of qualitative data collected throughout the years that show the history of SUCCEED and how it has changed over time. The third complete round of qualitative data collection has been initiated, and all 8 schools are complete. He has found tremendous changes over the years. In the beginning SUCCEED was project focused and entrepreneurial. SUCCEED funded projects on and across campuses in the first five years. In the second five years, there was a shift to a more holistic approach that sought to prioritize what had been learned, institutionalize the best work, and disseminate all the findings from the first five years. There is a lot of institutional memory among the PIs around the coalition, and he has done most of the data collection and some of the analysis in capturing that experience. In late 2002, SUCCEED's leaders will concentrate on meshing the qualitative data collected by Serow with the findings from the LDB.[120,121] The focus now is on SUCCEED's legacy—to provide persuasive evidence on the effect and effectiveness of the Coalition itself. The assessment is no longer formative, but rather a summary evaluation.

One issue that complicates the assessment of SUCCEED's influence is that SUCCEED is not the only factor that has influenced engineering education in the last 10 years. Other factors include ABET, which has certainly made institutions change. These effects are confounded, because there is a lot of synergy between ABET and what the coalitions have come up with and they influence each other. Quantitative evidence seems of particular value, especially in

convincing engineers, but without qualitative assessment, quantitative evidence is lacking the descriptive information needed for context.

NC State, Georgia Tech, and FAMU-FSU have established permanent positions for assessment specialists already. At NC State, the culture is sufficiently data and assessment driven that there is never a lack of demand for Joni Spurlin's skills. At Georgia Tech, Joseph Hoey's position is permanent and will be funded by the provost. The ECE school has just hired its own assessment director and the ME school is planning to because Hoey is too busy to do everything. North Carolina A&T will probably end up with a joint appointment between engineering and Institutional Research. UNC Charlotte plans to hire an assessment person on the lines of Georgia Tech and NC State, but a hiring freeze delayed the process. It will be the responsibility of an associate dean.

The Assessment team has met twice, in December 2001 and March 2002 to discuss campus level and coalition-wide assessment progress and plans.[122,123,124] El Nault has completed a survey of coalition Multidisciplinary design practices for the team.[125]

SUCCEED's assessment team

Eleanor Nault, Director of Assessment for Clemson University has mapped the SUCCEED goals to the campus activities and is working to sort out SUCCEED's influence. At FAMU-FSU, an assessment specialist is already in place to assist all departments at FAMU-FSU, and there are plans to hire an additional higher-level assessment coordinator. Tim Anderson has worked with faculty at the University of Florida to develop assessment plans for the freshman design class and the new faculty workshop.[126] Jack Marr reports that SUCCEED support in the area of assessment at Georgia Tech has had significant effects instructing, discussing, reviewing, and disseminating methods and results of assessment activities at all levels of academic functioning by means of the Georgia Tech Assessment Seminar. The Seminar is a faculty forum for presentation and critique of assessment-related activities at Georgia Tech and beyond. An average of thirty faculty attend this monthly function. Topics have included capstone course design and evaluation, employment-related assessment, senior exit survey and interview design and results, instructional design assessment, retention, women and minority issues, teaching and course evaluation, accreditation-driven assessment, advisement, graduate program assessment, and many others.

At UNC Charlotte, Patty Tolley and Cathy Blat focus on two components of assessment challenge. They have nearly completed a document analysis and interviews to identify SUCCEED supported initiatives, and are compiling both qualitative and quantitative data to support the effectiveness of the initiatives using the LDB and on-campus resources. At Virginia Tech, students will be surveyed for their perspective in order to verify faculty interview data as it related to different course groups. A course group is defined as a set of different courses that received a similar SUCCEED innovation. Faculty interviews suggested students attained improved teamwork skills, writing skills and motivation. It is believed that faculty development and outcomes assessment activities led to changes in the College of Engineering and additional data through a faculty survey will be acquired to verify this. Faculty use of new teaching strategies and their impact on the student knowledge and skills

has been noted through faculty interviews and additional data to verify this will be acquired through the student survey. The Phase One report is available online.[127] The second phase of the project is survey students and faculty. The surveys administered as a web survey for use in spring 2002. The question format from Likert scale is adapted from the TLT Group's Flashlight Program. The Statistical Consulting Center will be utilized for analysis.[128,129,130] There is evidence at UNC Charlotte that SUCCEED influenced aspect of the University's culture.[131]

The assessment program in the College of Engineering at NC State University, led by Dr. Joni Spurlin, director of assessment for the College, has developed a website in which data are stored by outcomes and are accessible to faculty. The newly developed website has been the subject of recent presentations by several members of the program to the American Association for Higher Education (AAHE) and the American Society for Engineering Education (ASEE). Spurlin has completed an assessment of E101, Introduction to Engineering Problem Solving, and feedback is positive with indications of improvements needed in report writing. Spurlin has also undertaken an assessment of Laptop Computer Program, in which students, faculty, and staff were surveyed. The focus of the assessment was on determining the effect of the technology on student learning.[132] Spurlin indicates that there is a lot going on at NC State that addresses the legacy goals.[133]

The assessment team has discussed common measures as they related to the key milestones and deliverables for SUCCEED and chose people to lead the common measure creation in each focus area.[134,135] There is some concern that some outcomes are measured at the time of graduation, while objectives that relate to performance in the workplace can only be measured a number of years after graduation. It is very difficult to relate the objectives to the outcomes under such conditions. In addition, Mike Leonard's work has demonstrated the difficulty of getting reliable and valid employer feedback relative to these objectives. Matthew Schenk-Turner of UNC Charlotte is preparing a review of mentoring programs across the Coalition.[136] Rufus Carter of Florida is gathering summative data on SUCCEED's bridge programs.[137]

Matthew Ohland of Clemson is leading a research group that has proposed to develop a better peer evaluation method for cooperative learning. The work seeks to address the need for an instrument that is reliable and valid, yet is simple enough to achieve widespread adoption. The proposed work builds from what is known about cooperative learning, and because there is no known true measure of teamwork, the researchers will use multiple assessment methodologies and seek concurrence of them. Instrument validity will be established through verbal protocol analysis, behavioral observation, and concurrence with results obtained with other validated instruments, and both test-retest reliability and inter-rater reliability will be assessed. The research team has a core of SUCCEED researchers from Clemson, NC State, and Florida, and also includes faculty from Rose Hulman, Valparaiso, and Kettering.

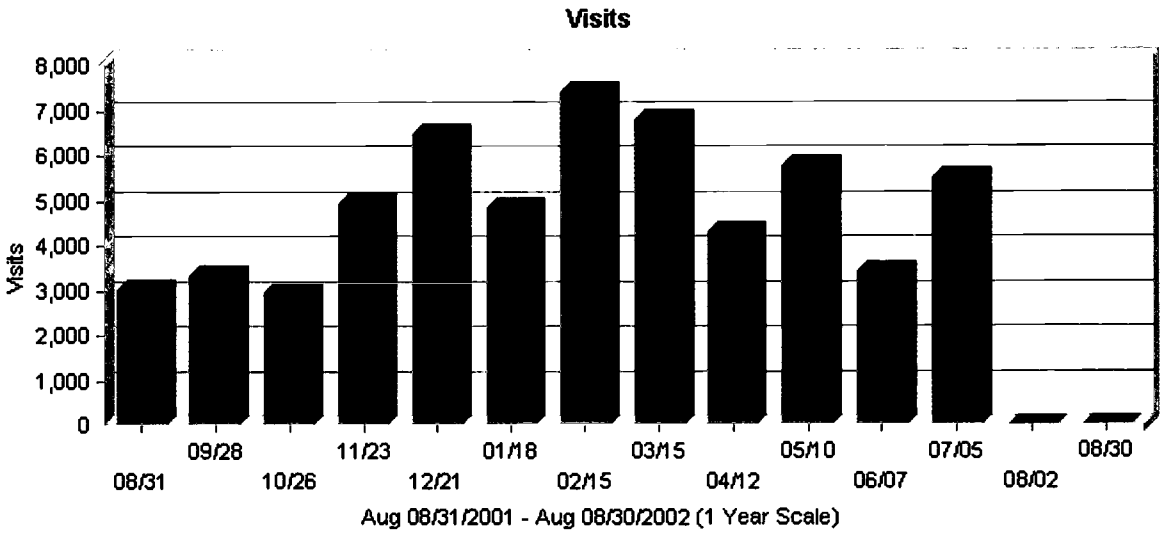
Ohland also secured the release of a number of corrections to the Longitudinal Database, including baseline information from the Florida Board of Regents (previously missing), corrected cumulative GPA and cumulative hours data from Clemson University, missing

graduation data from Clemson University, and missing terms from North Carolina A&T. These corrections, along with the release of data updates from each of SUCCEED's nine institutions are being incorporated. In order to make the database more accessible to SUCCEED faculty, Ohland developed a "Using the SUCCEED Longitudinal Database" handout,[138] which has the layout of the database fields on the back.[139] He also developed and maintains a list of ongoing studies.[140]

The strength of the SUCCEED Coalition relationship and previous successes with the SUCCEED Longitudinal Database (LDB) has made possible a research project that can answer questions that no single Institutional Research office can answer. The LDB, which in recent work is beginning to show its full potential, lacks course enrollment and grade data. Research using the LDB is also hampered by a cumbersome an underfunded validation process. In a recent proposal, the SUCCEED institutions have promised to provide these additional data, thus creating a unique resource that enables the study of multiple institutions using the same methods. The proposed Multiple-Institution Database For Investigating Engineering Longitudinal Development (MIDFIELD) will be used to address questions of interest to admissions officers, academic advisors, department chairs, college deans, university presidents, and federal funding agencies. This proposal, submitted to the ROLE program, had letters of support from the SUCCEED institutions indicating their support for the work, and the work plan was supported by skilled institutional researchers. If the research is successful in producing compelling results, efforts will be made to add other institutions to the database, developing a significant national resource. As the number of institutions participating in the database increases, the anonymity of each institution is easier to assure.

I. Dissemination

Recent improvements to SUCCEED's website, www.succeednow.org include improved searching and a calendar. A conference page and new archived documents were added. Two part-time staff serve as librarians, and a new webmaster has been hired (40% time-shared). The traveling display booth was re-structured and appeared at ASEE 2001 and 2002 and FIE 2001. Website usage statistics are available online.[141]



SUCCEEDNOW.ORG General Statistics for the period 8/31/2001-8/31/2002

Hits	Entire Site (Successful)	421,058
	Average per Day	1,153
	Home Page	8,725
Visits	Visits	59,069
	Average per Day	161
	International Visits	18.70%
	Visits of Unknown Origin	0.23%
	Visits from United States	81.06%
Visitors	Unique Visitors	18,373
	Visitors Who Visited Once	15,426
	Visitors Who Visited More Than Once	2,947

Richard Felder and Rebecca Brent have been prolific in workshop delivery to improve faculty development. In the past year, SUCCEED has worked to create other experts who will deliver workshops around the country to reach non-Coalition faculty. Starting off with a multidisciplinary design workshop for FAMU-FSU College of Engineering faculty on August 22, 2000 in Tallahassee, Dave Ollis at NC State has delivered a large number of seminars and half-day workshops on multidisciplinary design reaching a wide audience. Institutionalization will be achieved in two ways: through regular sessions on multidisciplinary design at the annual professional meetings (ASEE, AIChE, etc.) and through the delivery of a commercial workshop on multidisciplinary design patterned after the successful Felder/Brent faculty development workshops. The demand for these workshops thus far indicates that it will be a commercial success. More than 100 non-Coalition deans were surveyed in June 2001 regarding their interest in a SUCCEED

multidisciplinary design visit, and since then, multidisciplinary design workshops and seminars have been presented at 25 universities and conferences, and another 39 are planned; a complete list is available.[142] Delivery has included the Johansen-Crosby Lecture in Chemical Engineering at Michigan State University.[143]

Bob Coleman of UNC Charlotte coordinated various dissemination workshops. Three different sessions were held at Old Dominion University on January 8, 2002, and attendees were from ODU and surrounding colleges and community colleges. Seven SUCCEED dissemination workshops were held at the "Share the Future III" coalitions conference in Gainesville, FL, on March 3-5, 2002—this was in conjunction with workshops held by all the active coalitions. SUCCEED coordinated the workshops presented on June 16, 2002 at the ASEE Annual Conference in Montreal, Canada. Other workshops are planned at Kettering, Virginia Commonwealth University, and the University of Puerto Rico Mayaguez. Other institutions have requested workshops that are currently being scheduled. A brochure of SUCCEED's workshops is available and is being distributed nationally.[144] Potential presenters were contacted and workshop abstracts were created that will be available for on-campus and conference workshops. Brochure copy was written and White Satterfield contracted to create a brochure of available workshops from SUCCEED and our coalition partners. Statistics that focus on the web pages dedicated to SUCCEED's workshops show a surge immediately following the ASEE conference, and a resurgence as the fall semester approached after a second mailing of our brochure to deans and department heads of engineering programs around the country.[145,146]

As Dave Ollis is disseminating multidisciplinary design best practices to a wide audience, workshops by other SUCCEED investigators are growing in popularity as well. Joseph Tront's *Introduction & Development of Synchronized Streaming Media* and Matthew Ohland's *Planning Engineering Education Research* have been offered at two Coalition conferences (Share the Future II and III), two ASEE Conferences (St. Louis and Montreal), and have been offered or are planned at a number of the workshops set up by Bob Coleman by non-Coalition institutions (Old Dominion University, University of Puerto Rico at Mayaguez, Kettering University). The Foundation Coalition will host Share the Future IV in Tempe, AZ (March 16- 18, 2003).

In addition to special workshops given by invitation to a particular school, SUCCEED faculty are delivering workshops at the technical meetings of various professional societies. As examples, SUCCEED faculty were leaders in the development of the American Society for Civil Engineering's Excellence in Civil Engineering Education (ExCEED), and SUCCEED is on the program of the upcoming Annual Meeting of the American Institute of Chemical Engineers.

J. Industrial Involvement

SUCCEED continues to have a wide variety of industrial involvement—through program (and Coalition) evaluation/advisory roles, through direct financial support, and through contact with our students. Mentoring is the most active of these, usually incorporating some element of the advisory/support role. In cases where direct financial support is provided as a grant, and there is no additional industrial interaction, that support has been listed in the section of Major Accomplishments, and this section is reserved for support that is accompanied by a relationship with an industrial partner.

Mentoring/Consulting to students or teams

This section pertains to industrial involvement of a mentoring/consulting nature. While support level is included where the mentoring was accompanied by financial support, these figures do not include estimates of the value of the industry employee's time.

Activity supported	Supported by	Support level if available
Cost estimating and ethics lectures at UNC Charlotte	local business professionals	
NC State Women's E-mail Corporate Mentoring Program	33 mentor/mentee pairs have been connected	
UF Integrated Product and Process Design	In addition to mentoring student teams, each of 28 companies contributes $15,000 per project (31 projects in all) to offset program expenses. There is a long list of past sponsors and potential sponsors for future projects.[147]	$2,325,000 since program inception
"Automated Orientation Device to enhance the production of automotive tubeless tire valves" at UNC Charlotte	Schrader-Bridgeport	$9,800
Clemson Engineering Program for International Careers (EPIC)	48 students placed with 11 companies 48+ domestic and 41 international internships (many students do 2 domestic internships)	$835,000
UNCC Mechanical/Electrical Engineering joint project	Caterpillar	$10,000
UNCC "An Emergency Medical Device to stabilize a fractured pelvis"	Carolinas Medical Center	$14,800
UNCC "Search and Discovery Tools in Intranet	First Union	

Activity supported	Supported by	Support level if available
Environments"		
UNCC "Establishing Effective, Multi-University, Student Teams for Addressing Interdisciplinary Projects"	Ryobi, Torrington, Michelin, GE, Carolina Filter, and Alcoa Fujikura, Ltd.	
UNCC "Design and Manufacture Components for an Electric Golf Cart"	DAA	$76,000
Multidisciplinary design teams at Clemson University	7 projects per semester supported by $5000 plus expenses support from companies. Companies also provide an engineer as liaison to the project.	$350,000 since 1997
Multidisciplinary projects through the Multidisciplinary Design Training Clinic at FAMU-FSU	ASHRAE, Cargill Fertilizer, Cummins Engine, Dow Chemical, Federal Highway Administration, Harbor Branch Oceanographic Institute, Harris Corporation, Jim Stidham and Associates, Inc., and Talla-Com have all sponsored projects.	$100,000 est.
Clemson's Introduction to Engineering and Science class	Fuji Greenwood will provide 200 cameras for use in a course project to design a delay timer and prizes for design competition. Fuji employees will serve as competition judges.	$5000

K. Budget Information

This section includes a detailed description of allocations for the period September 1, 2001 through August 31, 2002, referred to as "Year 10" or "Y10."

Funding was provided to the participating institutions by subcontracts for the annual period September 1, 2001 through August 31, 2002 of the cooperative agreement between the NSF and SUCCEED. The work to be performed under these subcontracts is a series of specific tasks. Each task is identified by a specific work statement under management by a designated principal investigator (PI). Each participating institution is required to specify a matching amount of cost sharing approved by the responsible institutional fiscal officer. Detailed budget allocations and matching funds for Year 10 follow.

This section includes a verification of cost sharing signed by each of the participating institutions for the time period July 1, 1997 through April 30, 2002.

These budget pages are replete with acronyms in order to avoid smaller print—please refer to Appendix I for a complete set of definitions.

Appendix I. Glossary of Acronyms

SUCCEED	Southeastern University and College Coalition for Engineering Education

SUCCEED's institutions

Ga Tech, Georgia Tech, GT	Georgia Institute of Technology
FAMU	Florida A&M University
FSU	Florida State University
NCAT, NC A&T	North Carolina A&T State University
NC State, NCSU	North Carolina State University
UF	University of Florida
UNC C, UNCC, UNC-C	University of North Carolina at Charlotte
Va Tech, Virginia Tech, VT	Virginia Polytechnic Institute and State University

SUCCEED personnel and affiliates

CFT	Coalition Focus Team
CIT	Campus Implementation Team
CST	Coalition Service Team
COS	Council of Schools
PI	Principal Investigator
EAB	External Advisory Board

SUCCEED focus areas

FD	Faculty Development
OA	Outcomes Assessment
ST	Student Transitions
TBCD	Technology-Based Curriculum Delivery

SUCCEED Council of Schools members

PUPR	Polytechnic University of Puerto Rico
SIUC	Southern Illinois University at Carbondale
UPR	University of Puerto Rico (Mayaguez)
MSU	Mississippi State University

Organizations, administrative units, and conferences

AAES	American Association of Engineering Societies
ABET	Accreditation Board for Engineering and Technology
ASEE	American Society of Engineering Education
EC 2000	Engineering Criteria 2000
CES	College of Engineering and Science (at Clemson)
COE	College of Engineering
FIE	Frontiers in Education Conference
ICEE	International Conference on Engineering Education
NSF	National Science Foundation

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