

**“Write things worth reading, or do things worth the writing:”
A dual-degree program in engineering and the liberal arts**

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*If you would not be forgotten, as soon as you are dead & rotten,
either write things worth reading, or do things worth the writing.*

--Benjamin Franklin

I. Introduction

In recent years, much has been written about the role of liberal education in engineering, especially in light of Engineering Criteria 2000 (EC 2000) of the Accreditation Board for Engineering and Technology (ABET) (for example, see [1,2]). While some attention has been focused on traditional three-two programs or Bachelors/Masters Programs, little has been focused on dual degree programs in engineering and non-technical fields. In this paper we present a status report on the Benjamin Franklin Scholars (BFS) Dual-Degree Program now in its fifteenth year of operation at North Carolina State University. Students in the program earn a Bachelor of Science degree in engineering or computer science from the College of Engineering, and a Bachelor of Arts or Bachelor of Science degree from the College of Humanities and Social Sciences. Students may elect second majors in traditional academic departments such as English, History, Political Science, and Anthropology, or pursue interdisciplinary majors in Arts Applications, Science, Technology, and Society, or a self-designed option in Multidisciplinary Studies. In addition, all students enroll in a series of three courses that illustrate the mutual interaction of engineering and society in the areas of contemporary human values, ethical dimensions of progress, and technology assessment and policy. Through the first ten cohorts of graduates, more than seventy-five students have completed the program and gone on to careers in business, industry, and government, or to graduate and professional study in engineering, computer science, medicine, law, and public policy.

In addition to providing details of the Program's curriculum and course offerings, we discuss co-curricular activities that have proven vital to the success of the Program, including social, professional, and service events conducted by the Franklin Student Council, and program recognition of outstanding students on the basis of academic achievement and community service. We also focus on the nuts-and-bolts of running the program including program administration; funding for scholarships, faculty support, and co-curricular activities; and student recruitment, selection, and advising. We report on program retention rates and placement of students following graduation, and conclude with discussion of ongoing challenges.

II. Background

A. Overview of Program Structure

The Benjamin Franklin Scholars Program is a dual degree program offered by the Colleges of Engineering (the COE) and Humanities and Social Sciences (CHASS) at North Carolina State University. Students in the program earn two degrees, a Bachelor of Science in a field of engineering or in computer science, and a Bachelor of Arts or a Bachelor of Science in the humanities, social sciences, or one of three interdisciplinary majors currently offered by CHASS. In addition to meeting all of the requirements for both degrees, the students complete three courses especially designed for the program offered through the CHASS-based Science, Technology, and Society Program [3] in science, technology, and human values; ethical dimensions of progress; and technology assessment and policy. The program usually takes five years to complete; some students with a substantial amount of Advanced Placement credit have completed the program in 4 or 4.5 years while others who are cooperative education students or who spend substantial time in study abroad programs have taken 5.5 to 6 years to completion.

B. Program History

The Franklin program is one of six dual-degree programs sponsored by CHASS in partnership with NC State's professional colleges (other programs involve the Colleges of Agriculture and Life Sciences, Textiles, Management, Design, and Natural Resources). The earliest of these programs were founded in the mid 1980s and early 1990s in order to enable "graduates who are knowledgeable not only in technology and science, but also in human affairs." [4] The Franklin Program, which accepted its first "cohort" of students in 1990, is the largest and second oldest of the dual-degree programs. Its goal is the "integration of engineering, the humanities, and social sciences throughout the program [to develop] the students' technical skills and ethical, historical, political, and economic insights which are so essential to the conduct of national and global affairs." [5]

C. Relationship of Program to Overall Mission of the COE

The Mission of the College of Engineering at NC State is to:

... provide students with a sound engineering education, advance the understanding and application of scientific principles, enhance economic development, and improve the quality of life of our citizens through teaching, research, and outreach programs. In addition to ensuring that our students are exposed to modern engineering principles and have access to modern equipment and technology to support their educational experience, the College seeks to create a team-oriented environment throughout our academic enterprise. Our goal is to produce well-rounded engineers who can function effectively in the technical arena as well as possess the skills to assume leadership roles in industry, academia, and government.

Within the College, degree curricula have been developed that combine technical and non-technical subject matter in an integrated fashion. The goal of the College is to graduate not only excellent technical engineers, but engineers who have a sound foundation in effective communication, and an understanding of the ethical and social context of engineering designs and decision. We seek to graduate a modern engineer who can work effectively in multi-functional and cross-discipline teams, and to be able to not only appreciate the human and social perspective but also feel comfortable adopting this perspective.

ABET, in their new EC 2000 Program Criterion, has very explicitly set expectations for engineering degree programs related to the integration of technical and non-technical disciplines. The Franklin Program provides our students the opportunity to enhance and enrich the depth and texture of the technical and non-technical integration already found in their engineering degree.

III. Curriculum

A. Engineering Majors

Within the COE there are currently 18 distinct degree programs from which undergraduate students graduate. These programs are offered out of 12 academic departments and are housed administratively in three colleges within the university. The COE's annual undergraduate enrollment is 5,500 students, and annually over 1,200 of those students graduate. This places the college in the top 5-10 in the nation in these categories. Table I below lists enrollment of BFS cohorts in the various academic departments, from the beginning of the program to today. As seen in the table, BFS students are enrolled in a wide range of engineering degree programs. There are larger numbers of BFS students in the larger departments, and smaller numbers in the smaller programs.

B. Humanities/Social Sciences Majors

Students in the Franklin Program can choose from over forty disciplinary and interdisciplinary majors in the College of Humanities and Social Sciences (or an Economics major in the College of Management). In the early years of the program, most students opted to pursue a self-designed major in Multidisciplinary Studies (largely at the urging of the program's former engineering advisor). Beginning with Cohort 7, however, students have been encouraged to select from any of the available majors and more than 75% now elect majors in the traditional disciplines. (Franklin scholars have received degrees from every CHASS department except Social Work.) CHASS offers BA degrees in all of its fields as well as a BS degree in some areas. Compared to the BA degree, the latter is more intensive in science, technology, and mathematics courses and less intensive in humanities and social sciences courses. Franklin scholars are encouraged to pursue the BA option but may elect the BS option. Table II shows the CHASS majors of graduates and students currently in the program.

As indicated in Tables I and II, a few Franklin Scholars have completed dual majors in either the COE or CHASS along with a third major in the other college. In addition, two scholars have completed third majors in the physical or biological sciences, and many have earned academic minors in addition to their majors.

Table I-Engineering Majors by Cohort and Department

	Cohorts			
	1-6 (a)	7-11 (b)	12-14 (c)	1-14
Total Number Of Students	39	46	45	130
Engineering Majors By Department				
Biological & Agricultural	0	1	0	1
Biomedical (d)	-	-	9	9
Chemical	10	8	6	24
Civil, Construction & Environmental	11	5	3	19
Computer Science	3	9	5 (f)	17 (f)
Electrical & Computer (e)	4	10	6 (f)	20 (f)
Industrial	2	1	3	6
Materials Science	2	4	1	7
Mechanical & Aerospace	6	7	11	24
Nuclear	0	1	1	2
Paper Science	0	0	1	1
Textile	1	0	0	1

- (a) Graduates
- (b) Graduates for cohorts 7-9; graduates and expected graduates for cohorts 10-11
- (c) Active as of January 2005 (includes 7 students in cohorts 13-14 who have not yet declared a humanities/social sciences major)
- (d) New major established in 2003.
- (e) Includes 4 students with double majors in electrical and computer engineering
- (f) Total includes one dual major in Electrical Engineering and Computer Science

Table II-Humanities/Social Sciences Majors by Cohort and Department

	Cohorts			
	1-6 (a)	7-11 (b)	12-14 (c)	1-14
Total Number Of Students	39	46	38	123
Humanities/Social Sciences Majors By Department				
Multidisciplinary/ Interdisciplinary Studies (d)	38	26 (e)	11	75 (e)
Sociology & Anthropology	0	1	3	4
Communication	0	1 (e)	1	2 (e)
Economics	1	0	4	5
English	0	5	6	11
Foreign Languages	0	5	1	6
History	0	2	3	5
Philosophy & Religion	0	4	4	8
Political Science	0	2	3	5
Psychology	0	1	2	3

- (a) Graduates
- (b) Graduates for cohorts 7-9; graduates and expected graduates for cohorts 10-11
- (c) Active students with declared second major as of January 2005
- (d) Includes self-designed major in Multidisciplinary Studies; Science, Technology, and Society (STS) major (established 2000); and Arts Applications major (established 1999)
- (e) Total includes one dual major in STS and Communication.

C. Required Courses

In addition to meeting all of the degree requirements for both of their majors, all Franklin Scholars are required to complete a sequence of three courses offered through the STS Program [3] in CHASS:

STS 302H-Contemporary Science, Technology, and Human Values
STS 304H-Ethical Dimensions of Progress
E497B-Franklin Scholars Capstone Course

STS 302H is an honors version of a Science Technology and Society (STS) survey course, taken in the first semester of study, in which students are exposed to such topics as diverse views on technology, technology forecasting and assessment, democratic control of technology, technology and global issues, dilemmas posed by rapid advancements in technology, and alternative visions of technology. STS 304H, taken in the fall of the second or third year, is a course that was especially developed for the Franklin Program that challenges students to think critically about ethical issues raised by the concept of progress, as well as the relationship between technological progress and social/ethical progress. Both STS 302H and STS 304H meet NC State's unique General Education Requirement in Science, Technology, and Society.

E497B, taken in the fall of the fourth or fifth year and also developed especially for the Franklin Program, is designed to integrate the scholars' academic programs in engineering and humanities/social sciences by focusing on the theme of technology assessment and public policy. Topics covered during the first four weeks of the semester include the history, theory and methodology of technology assessment. During the remainder of the semester, the students work in teams on a specific technology assessment project in which they research an important public policy problem with significant technical components, and develop policy options for solving the problem. Projects typically require assessment of economic, social, environmental, and ethical aspects of the technology under consideration. Topics have included low-level radioactive waste disposal, alternative fuels vehicles, artificial organs, intelligent transportation systems, smart cards, nanotechnology, copyright in the digital age, gene therapy, wearable computing, renewable energy for developing countries, a national identification system, and electronic voting.

All three of the required courses can be used in the STS major. E497B fulfills a partial course requirement in the self-designed major in Multidisciplinary Studies. Further details on the curriculum can be found on the Franklin Program website [6].

D. Study Abroad

Although study abroad is not required in the Franklin program students are encouraged to consider it. Most students find that having a second major in the humanities/social sciences provides additional flexibility for using study-abroad courses in their academic programs. The fact that the Franklin Program usually takes more than four years to complete also provides added flexibility for scheduling study-abroad semesters as compared to traditional four-year

engineering programs. While most study-abroad experiences have been in Europe, Franklin Scholars have also studied in Africa, Asia, Central and South America, and Australia.

IV. Co-curricular Activities

A. Franklin Council

The Franklin Program has an active student council that plans and sponsors a variety of professional, service, and social activities. Officers of the council as well as representatives of the upper-class cohorts are elected at the end of each academic year for service in the following year. The first-year cohort elects their council representatives during the third or fourth week of the fall semester. Professional activities include guest speakers from industry and field trips; service includes volunteer activities with such organizations as Habitat for Humanity, Food Bank of North Carolina, and Raleigh's Walk/5k Run for PKD (polycystic kidney disease); social activities include an annual camping trip, coffee nights, game nights, and just hanging out. The Council also sponsors a series of interdisciplinary seminars for the campus community that feature faculty from different disciplines across the university. Topics of the seminars have included music and technology, genetic engineering, globalization, artificial intelligence, and terrorism. At year's end the Council hosts a "Spring Feast and Banter" featuring a guest speaker and elections of new Council officers. The Council also has a mentoring program for first-year students and sponsors information sessions for students who are having difficulty identifying a CHASS major. The Council maintains its own website [7] and a discussion listserv.

B. Awards and Banquet

Since the first graduating class, the Franklin Program has hosted a spring dinner honoring the scholars on the completion of the program. Graduates are presented with a certificate, a "Franklin key" from CHASS to wear with their academic regalia, and a gift from the COE. Since 2000 the program has also featured two awards, The Richard L. Porter Award for the outstanding upper-class student in the program based upon academic achievement and community service (where community service includes service to both the university and local communities) and the Robert L. Hoffman Award for the outstanding first-year student in the program based upon academic achievement and community service (where community service includes service to both the university and local communities). In 2003 a third award was added, The Erin Malloy-Hanley Ethics-In-Action Award for high ethical principles as exemplified by service to the local community. The honors include a certificate and small cash award. Finalists and winners are chosen by a faculty committee.

C. Individual student activities

In addition to involvement with the Franklin Student Council, many of the Franklin Scholars are active in other student organizations, including student government and student publications. Franklin Scholars have served as Student Body President, Student Senate President, Senior Class President, Tau Beta Pi President, and, on two occasions, Student Commencement Speaker. Franklin Scholars have been active in initiating and perpetuating the campus chapter of Engineers Without Borders and *Americana* [8], an online magazine of arts and letters.

V. Program Graduates

The Franklin Program began accepting students for the Fall 1990 semester and the first graduating class was honored in Spring 1995. Since then, more than 75 students have completed the program. Table III indicates the number of graduates by cohort.

Student response among those who have completed the Franklin Program has been generally positive. For example, the following unsolicited testimonials were included in the author bio section of the final report for the Fall 2004 capstone course:

“BFS has been a great experience that has opened my eyes to the human, ethical side of engineering.”

“I can think of no area of academic research more important today than multidisciplinary studies. As our world becomes more globalized and people and ideas become more interconnected, it is only by approaching problems from multiple angles—by expanding our modes of thinking in non-traditional ways—that we will be able to arrive at satisfactory solutions.”

“True engineering considers not only what we can do, but also what we should do. Today's engineer must understand the social, political, and environmental impacts of technology to achieve true progress.”

“Books by Volti and Teich: \$32. Alarm clock to wake up for service activities: \$4. Extra coffee for Capstone all-nighters: \$6. Earning the right to call oneself a Franklin Scholar: Priceless.”

“Being able to approach a problem from two directions is a feat in itself, but being surrounded by such an amazing group of people for five years is beyond compare.”

Franklin Scholars have gone on to careers in engineering and management consulting in such areas as transportation, alternative energy, and environment, as well as working in such industries as electric utilities, aerospace, and chemicals. Others have pursued graduate and professional study in engineering, computer science, management, law, medicine, and public policy. One graduate of the program was first in his law school class at Harvard and subsequently clerked for a Supreme Court Justice. A formal assessment of career advancement and attitudes toward the Franklin Program on the part of its graduates is expected to be completed during the Spring 2005 semester.

Academically, the students who graduate from the Franklin Program are among the best and brightest at NC State. For example, the median GPA of 2004-2005 recipients of Franklin scholarships at the beginning of the academic year was about 3.8 (on a 4.0 scale) and more than 20% had 4.0 GPAs. Franklin Scholars have received many prestigious awards for graduate study from sources such as the National Science Foundation, Fulbright Foreign Scholarship Board, and Truman Scholarship Foundation.

Table III-Graduates By Cohort

Cohort	Initial Year (Fall)	Graduates
1	1990	5
2	1991	8
3	1992	9
4	1993	8
5	1994	5
6	1995	4
7	1996	8
8	1997	9
9	1998	13
10 (a)	1999	9
11 (a)	2000	7
Total		85

(a) Includes expected graduates

VI. Nuts-and-Bolts

A. Program administration and faculty

The Franklin Program is jointly administered by the COE and CHASS. The Program Director (Dr. Herkert) is a tenured faculty member in CHASS reporting jointly to the Dean's offices in both colleges. The Program Director is responsible for teaching the first-year and capstone courses, advising students on their CHASS requirements until the major is declared, advising the Franklin Student Council, and general program administration. The Assistant Dean of Academic Affairs in the COE (Dr. Lavelle) is the college's main contact and coordinator; he works with the Program Director on program finances and student recruitment, selection, and orientation. He also volunteers his time as affiliate faculty for the capstone course along with a faculty member in the STS Program in CHASS (Dr. Patrick Hamlett).

CHASS pays for the program Director's two courses plus one course-release for program administration. In addition CHASS pays for the second of the three required Franklin courses (currently taught by Ms. Nell Kriesberg). The COE pays the Program Director one month's summer salary.

B. Scholarship eligibility and funding

Providing scholarships to BFS students is an important component of the program. However, it is not the central focus. Rather, scholarships are used to recruit excellent students and to provide a small extra incentive for students to continue in the program and excel in their studies. Each academic year roughly \$50,000 are distributed to 30-40 eligible students in the Franklin Program. The size of these awards range from \$500-2000 per student for the academic year. The NCSU Engineering Foundation has been very active in recruiting endowed accounts and annual corporate gifts to fund BFS scholarships. Individuals and corporate partners are attracted to the program because of the type of student being educated.

To be eligible for a scholarship a BFS student must meet three criteria: (1) be a matriculated student in the COE, (2) have worked with the BFS Director to declare their CHASS major, and (3) have an overall GPA of at least 3.00. The first component, matriculation, involves passing the required first-year engineering courses with a minimum GPA of 2.90. A student who has done this then selects which of the 18 engineering degree programs they wish to join (matriculate into). To declare a CHASS major the student will work with the BFS Director to explore student interests. Once an appropriate major is identified and planned, it is added as the student's second major in the university system. If a student has at least a 3.00 GPA overall, they are then eligible for BFS scholarship funds. The size of the annual scholarship award is based on two factors: (1) overall GPA, and (2) a student's time in the program. Students with higher GPAs and longer time in the program receive higher annual awards. If a student is participating in the engineering cooperative education program their scholarship is withheld for the time that they are working.

To date CHASS scholarship funds for Franklin Scholars have been limited to three sources: a small gift and a small endowment that have been used to supplement the COE scholarships on a

competitive basis, and a somewhat larger staged endowment that will eventually contribute to enlarging the pool of scholarships provided by the COE.

C. Funding for co-curricular activities

Co-curricular activities are an important component of the program. They weave the program into an integrated experience for the BFS students. In addition to funding the annual scholarship allocation, the COE also provides the funds to support these important program expenses. Again, these monies come from the COE endowed and annual individual and corporate sources specifically recruited to support the program. Events such as the new student orientation summer recruiting pizza party, the capstone design course, the BFS annual spring awards banquet, and BFS Council program expenses are paid from these funds.

D. Student recruitment, selection, and orientation

For any student-based program, activities associated with recruitment, selection and orientation influence program success and the effectiveness of students' experiences. This is certainly true for the Franklin Program at NC State. The recruitment process involves two basic components: (1) ad hoc education, and (2) direct invitation. Ad hoc education refers to the process of telling "any and all" prospective students (and parents) about the program whenever and wherever they are encountered. As a large engineering program, the COE holds several types of recruiting events for perspective students and families throughout the year. Examples include open houses, Spend A Day At State, engineering receptions, semi-weekly information sessions, and summer camps. During these events, as well as other events such as new student orientation, the Franklin Program is discussed as one of the programs available to students. This "word of mouth" recruiting makes students aware of the program's existence and does pique the interest of many students to find out more about the program. In addition to new students, current NC State students may find out about the program through the web, or by talking to current BFS students. Students interested in applying to the program are given an application to fill out. For new students this occurs in March/April before their fall enrollment. Direct invitation refers to the solicitation to new entering students for interest in the program. An invitation to apply is sent to newly admitted students each spring. SAT-total and SAT-verbal scores are used to designate those who are invited to apply.

Currently, entering cohorts are being kept in the range of 25-30 students. This restriction is a function of program resources to teach the required courses and effectively deliver the components of the program. Students are accepted into the program based on their academic credentials and responses to essay questions on the application. Drs. Herkert and Lavelle select the students to join each cohort in early summer each year. During the COE summer orientation program a special information session and pizza party is held for Franklin Scholars and their parents that includes informal presentations by students and faculty; additional applicants to the program are often recruited during these sessions.

New students are enrolled in the first required course during the fall semester. This course, taught by Dr. Herkert, serves as the students' first experience with the program as well as having important content. In the course students find out a lot about the program, how it works,

requirements, and other opportunities. In addition, the course provides a format to begin melding a cohort identity.

A select number of students are admitted to the program during the first or second year based on student interest and GPA. While some of these students are re-applicants who were not admitted initially, most students seeking late admission do so after hearing about the program from their peers. The number of late admissions has increased over the years—there are currently 6 such students in the second year cohort (Cohort 14).

E. Student Advising

The Franklin Program requires intensive advising especially prior to the point where students declare their humanities and social sciences major. In addition to their regular academic advisor in the COE, students are required to meet with the Franklin Program Director to discuss the selection of their humanities and social sciences major, double counting of general education requirements, and other questions and issues. Since students rarely have the same combination of interests and majors, advising is typically far more time-consuming than in the case of traditional engineering students. Once students declare their CHASS major they are assigned an academic advisor in the appropriate CHASS department, but they may still call on the Program Director for general advice and encouragement. The Program Director maintains a website for student advising [6] and an email listserv for program announcements.

VII. Ongoing challenges

A. Program Retention

Retention has been an ongoing issue for the Franklin Program. The average completion rate for cohorts 9-11 is 27% (see Table IV). While some students leave the university or the COE, most students leaving the program do so because they decide not to complete their second (CHASS) major. Reasons include poor academic performance, changing interests, and the desire to begin graduate school at an earlier date. In recent years several factors have led to improved retention rates. First, beginning with Cohort 7, first year students were required to submit a written application to the program (previously they merely had to reply to a letter of invitation), which has helped filter out students who lack a sincere interest in the humanities and social sciences. Second, also beginning with Cohort 7, students were actively encouraged to pursue the CHASS major of their choice rather than limiting their choices to a self-designed major. Third, in 2000 (Cohort 11) the Program Director began teaching the first-year course and first-year enrollments were reduced from 30-35 to 25-30, thus facilitating and providing more time for more intensive advising of the students. As indicated in Table III, the number of graduates has gradually increased over the years, averaging 6.5 for Cohorts 1-6, and slightly more than 9 for Cohorts 7-11.

Table IV- Retention Rates for Cohorts 9-15

Cohort	Initial year (Fall)	Students admitted to cohort (includes late admits)	Graduates and Expected Graduates	Students Currently Active	Retention Rate (%)
9	1998	39	13		33
10	1999	42	9		21
11	2000	27	7		26
Total 9-11		108	29		27
12	2001	26		10	38
13	2002	29		14	48
14	2003	35		21	60
15	2004	21		18	86
Total 12-15		111		63	57

B. Fundraising

As was mentioned earlier, the NCSU Engineering Foundation office has been very successful in recruiting funds to directly support the Franklin Program. Individual and corporate partnerships have been created with people and businesses that believe in, and want to support, the goals of the program. The COE continues to seek additional funding sources to ever-increase the effectiveness of the program from scholarship, academic, and student development perspectives. In addition, CHASS seeks to continue to provide scholarship opportunities for Franklin Scholars as part of its growing commitment to overall fundraising activities.

VIII. Conclusions

Benjamin Franklin is well known for his accomplishments as an inventor, statesman, and philosopher. In this dual-degree program at NC State named in his honor we seek to educate young men and women equally prepared to deal with the technical and societal contexts of the challenges facing humankind in the twenty-first century. Critical to the success of our program has been the ability to attract and retain excellent students, to marshal adequate faculty and financial resources from the Colleges of Engineering and Humanities and Social Sciences, and to produce successful graduates. Both colleges engaged in this partnership have benefited through this collaboration. It has spawned a level of respect, interest, and activity with the involved faculty in both colleges. In addition, it provides an opportunity, especially in the COE, to reach out to benefactors and sponsors who have become excited about the program. It gives them an opportunity to do something that they enjoy—touching students' lives in significant ways.

IX. References

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X. Biographical Information:

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