University of North Carolina

Report on Engineering

Committee on Educational Planning,
Policies and Programs

March 20, 2003

Includes

Needs Assessment by NCHEMS

and

Report by a Visiting Team
of Engineering Deans

Office of the President

Contents

INTRODUCTION

The 2001 General Assembly required the Board of Governors to do a feasibility study of engineering at East Carolina University, University of North Carolina at Asheville, and at Western Carolina University. The Office of the President made a preliminary report to the Educational Planning Committee in the Summer 0f 2002, and reported the need to have 2000-2010 data from the North Carolina Employment Security Commission in order to have the most recent NC data on employment and openings in the field of engineering. Due to a new system there was a delay in obtaining that data, but the ECS made a special effort and provided the data for engineering prior to releasing the full 2002-2010 projections. The Office of the President received that data at the end of January 2003. We agreed to have an external consultant do a needs assessment for engineering in NC, then follow that with a team of engineering deans visiting each campus to assess specific proposals for engineering and facilities within the context of the needs assessment.

NEEDS ASSESSMENT BY DENNIS JONES OF NCHEMS

The Office of the President contacted the National Center for Educational Management Systems (NCHEMS), one of the premier national organization for analyzing educational data. The organization through its President, Dennis Jones, agreed to do the needs assessment and it was scheduled for the month of January 2003 to coincide with the time frame we had been given by the ESC for receipt of the new engineering employment data for North Carolina. The study uses both national and state data to compare NC with regional states and states with high tech industry. It uses all degrees produced in NC in the engineering and computer applications area from both public and private colleges and universities. Based on data and analysis, Jones reached the conclusions reported in the following section. The full report from NCHEMS is in Appendix C.

CONCLUSIONS OF THE NCHEMS ASSESSMENT

On the basis of these findings, I come to the following conclusions:

1. North Carolina does not have need for additional engineering programs. The state already produces more graduates than current and projected annual job openings. Further, the parts of the state that do not have a nearby engineering school are characterized by having relatively low levels of engineering employment. There is no compelling case in the data for additional engineering programs.

2. Because high engineering employment is geographically coincident with locations of engineering programs, there will inevitably arise what I call the "field of dreams" argument—build it (an engineering program) and they (jobs) will come. There are too many examples of very large and strong engineering programs located in communities without commensurate job growth (Purdue and the University of Illinois come to mind) to make this argument credible. If all the other stars are in alignment (venture capital, critical mass of professional employment, airports, etc.), the presence of programs becomes a necessary element—but it is not a sufficient element—to generation of high levels of engineering employment.

3. One place where North Carolina does fall short is at the Master's level. This suggests a shortage of ready access to continuing professional education for those engineers already in place. The pattern in hiring engineers is that:

    - Baccalaureate level engineers are recruited from a wide geographic area and moved to wherever the job is—thus the high rates of mobility of individuals with engineering degrees.

- Once located, however, it is important that they have ready access to coursework (not always programs) that will ensure that they have up-to-date information in their fields. The availability of graduate level education is a factor in recruitment, retention, and currency of an engineering workforce. Given the nature of most graduate level engineering education, this coursework can be delivered at a distance from existing programs. It is not necessary to create new programs, with the unneeded undergraduate capacity, to achieve this objective.

4. The greatest need in North Carolina is for computer science/software engineering graduates. It is here that the projected growth is the largest and the gap between job openings and degree production is the greatest. If an investment is to be made, I would suggest it be here rather than in engineering programs. Institutions can have very good computer science programs without companion engineering programs.

CHARGE TO THE TEAM OF ENGINEERING DEANS DOING THE FEASIBILITY STUDY

After a review of the needs assessment, a charge for the visiting team of engineering deans was prepared. The NCHEMS report and the charge to the visiting team were shared and discussed with the six chancellors directly involved, the three at the institutions being visited, and the three at the institutions with existing engineering schools. The Charge is in Appendix D. At that point all chancellors agreed that the charge was a reasonable basis on which to proceed, and the chancellors of the three institutions to be visited indicted that they were not seeking a full engineering school or college but specific programs that would enhance their campus and their region. (Prior to the visit, UNCA indicated it was interested in just Phase I at this time.) The deans selected for the visiting team were Professor Carl Locke, former dean of engineering at the University of Kansas, Dean Peter Crouch, Professor of Engineering at Arizona State University, and Dean Robert Mattauch, Professor of Engineering at Virginia Commonwealth University.

The team arrived in Chapel Hill on Sunday, February 23, and met with the deans (or representative) of the three existing engineering schools for an orientation to what was currently available in engineering at UNC institutions. On Monday the team flew to Asheville, visited the UNCA campus in the morning, and traveled to WCU for an afternoon visit. On Tuesday the team drove to Greenville to visit ECU. At each campus there was interaction with faculty and administrators including the chancellors, and at WCU and ECU there was an opportunity to tour new facilities under construction.

RECOMMENDATIONS BY THE TEAM OF ENGINEERING DEANS

The full report by the Engineering visiting team is in Appendix D. Here are the recommendations the team made.

There are some overarching recommendations that the Feasibility Team offers.

1. The Team does not recommend the formation of any school or college of engineering at the institutions considered. If any new engineering programs are approved, the Team recommends that those programs be organized in existing schools/colleges at the institutions in the UNC system. The costs of supporting additional schools/colleges do not seem justified at this time. None of the chancellors at the three institutions visited are seeking a school or college of engineering at this time. Therefore, the Team did not devote much attention to the costs associated with start-up of a new school or college of engineering. However, Dr. Mattauch has been involved in start-up of a new school of engineering at Virginia Commonwealth University and through his experience a rough estimate of the costs for a new engineering school was made. Attachment II contains this estimate. The total start-up cost for 800 students in 2 engineering programs is estimated to be $36 million which includes a building, laboratory equipment, and

the IT infrastructure. This does not include faculty and staff salaries but represents just the physical facilities needed.

2. The Team recommends that at this time the names of any school/college in which an engineering program is organized not have the name changed to include the word "engineering."

3. The Team recommends that all institutions develop more detailed and realistic cost proposals for all proposed programs.

Findings, observations, and recommendations for each campus are discussed separately.

Recommendations-UNC Asheville

1. The Team recommends that UNC Asheville does not develop independent, freestanding engineering programs.
2. The Team recommends that UNC Asheville continue to work with NC State in offering the Mechatronics program.
3. The Team recommends that UNC Asheville and NC State consider development of a computer-engineering program following the same model used in the Mechatronics program.
4. The Team recommends that the UNC Office of the President implement a policy whereby students completing programs like the Mechatronics program receive dual degrees (one each from UNC Asheville and NC State) or that their diploma indicates the degree is a joint one from UNC Asheville and NC State.
5. The Team recommends that the UNC Office of the President study other administrative and accounting policies that are barriers to these joint degree offerings.
6. The Office of the President of the University of North Carolina should consider providing additional funding to both UNC Asheville and NC State to support the expansion of these programs.

Recommendations-WCU

1. The Team recommends that faculty and administration at Western Carolina University continue to work with industry in the region and seek to increase those contacts. It might benefit all concerned if those contacts could result in funded projects that could support students and faculty in these projects.
2. The Team recommends that Western Carolina not develop a freestanding engineering program in electrical and computer engineering.
3. The Team recommends that the faculty and administration at Western Carolina initiate conversations with the School of Engineering at UNC Charlotte to discuss cooperative engineering programs with that institution. It might be possible to offer engineering degrees at Western Carolina in a manner similar to the program in Mechatronics that is offered on the UNC Asheville campus by NC State. This should include a policy whereby students receive formal recognition of having studied on the Western Carolina campus while receiving instruction from UNC Charlotte. This formal recognition should be included on their diploma.
4. The Team recommends that the UNC Office of the President study other administrative and accounting policies that are barriers to joint degree offerings.
5. The Team recommends that the UNC Office of the President provide additional infrastructure support for both institutions if a cooperative engineering program is developed by Western Carolina and UNC Charlotte. This support should be such that would allow both institutions to offer distance-learning opportunities in the new degree program.
6. The Team recommends that Western Carolina also develop formal 2+2 engineering programs in cooperation with NC State and UNC Charlotte.

Recommendations-ECU

1. The Team recommends that East Carolina University partner with NC State to develop formal 2+2 programs and possibly in the future develop a program using the same concept now being used by UNC Asheville for the Mechatronics degree. In this program, NC State would provide a degree program taken by students on the East Carolina campus using distance learning techniques and resident faculty at East Carolina.

It is the opinion of the Team, that this approach will allow the faculty, staff, and administration to develop an engineering culture on campus. The program developed in cooperation with NC State could be designed to fulfill the goals for a new and different engineering program as outlined by the Provost.

RECOMMENDATIONS TO THE BOARD OF GOVERNORS BY THE OFFICE OF THE PRESIDENT

One item of note is the parallel discussion in the Office of the President at the time of the visit regarding the need for campuses to have an opportunity to offer joint degrees with each participating campus's name on a single diploma. Two universities (NCSU and UNC CH) have already proposed a joint degree program as a way to leverage both strengths and resources. That idea has developed to the point that it can now become the vehicle to more explicitly realize what the engineering teams was recommending in several cases.

The recommendations by the Office of the President in the case of UNCA and WCU track very closely the recommendation by the visiting team and incorporate the concept of a joint degree.

UNCA

Discussions should be initiated immediately between NC State and UNC Asheville about transforming the baccalaureate Mechatronics program into a joint degree program in engineering between the two campuses. A consideration will be to have some engineering faculty resident at UNCA to interact with local and regional business and industry where appropriate.

UNC Asheville and NC State should jointly sponsor a needs assessment to see what kind of computer applications or computer engineering degrees might be justified in this region, and, if need is demonstrated, the two campuses would explore the best combination of UNC Asheville offered computer applications, and jointly offered computer engineering.

The existing cooperative programs with other engineering programs should be maintained.

WCU

WCU should explore the expansion of its technology programs where justified by need and student demand.

Discussions should be initiated immediately between UNCC and WCU to explore the extension of UNCC's baccalaureate programs in electrical and computer engineering to the WCU campus, with the goal of establishing a joint degree between the two campuses in one or both of these areas. A consideration would be to have some engineering faculty resident at WCU to interact with local and regional business and industry where appropriate.

WCU could explore the development of cooperative programs in other areas with UNCC or other existing engineering programs (NCA&T, NCSU).

ECU

We recommend that ECU initiate planning activities for their proposed new program in general engineering, and prepare a more detailed account of the features of the program for further review by the Office of the President.

Where need can be identified, ECU should initiate discussions with other engineering programs in the state (NCA&T, NCSU, UNCC) regarding cooperative programs in engineering and possibly joint degree programs.

One recommendation for ECU by the Office of the President goes beyond what the visiting team recommended. The Office of the President does this for several reasons. The team was struck by the potentially innovative nature of the ECU proposal, but did not think it was well worked out at the point of their visit. The proposal, if successfully worked out in detail, would not appear to lend itself to a joint program format since it is so different from the standard programs in engineering. Finally, ECU made the case that many of the business firms in their region were small and typically wanted a generally trained engineer not a specialist in one area.

General

The Office of the President concurs with the conclusion of the NCHEMS Assessment and with the recommendation of the Visiting Team of Engineering Deans that no new schools or colleges of engineering be established at this time nor should any new schools or colleges carry "engineering" in their name.

All programs are recommended with the understanding that they are to maintain or achieve accreditation by the appropriate engineering accrediting agency.

The Office of the President will address barriers to students having efficient access to programs from multiple campuses, campus concerns regarding tracking such students and the consequences for graduation rates.

The NCHEMS Report identified computer applications as an area where NC may need to produce more graduates. The Office of the President will initiate a review of the capacity of our campus to produce more graduates in this area and the feasibility of increasing the capacity for our campus in the area of computer applications.

The NCHEMS Report concluded that NC comparatively seems to be under producing graduates at the master's level in engineering and that this fact might have consequences for supporting high tech industry in NC, since both the companies and engineering employees want access to continuing education and advanced degrees. The Office of the President will initiate discussion with the current schools with master's programs in engineering (North Carolina A&T State University, North Carolina State University, and the University of North Carolina at Charlotte) about ways to make advanced engineering continuing education and degrees available across the state for engineers employed in NC companies.

The recommended planning initiatives are to result in proposals from the institutions, which will include specific steps and expected costs for both immediate steps and for the longer-term maintenance of the programs.

CONCLUSION

The Office of the President believes it has identified some significant next steps to take in engineering education that can both enhance several campuses' academic offerings and provide a vehicle for laying the groundwork to stimulate economic development. While there will be cost associated with these developments, we believe they will be modest in comparison to establishing a full school or college of engineering on one or more campuses. Enhancing capacity in computer applications (and all but one of our campuses have computer science) will respond to a need identified in the NCHEMS assessment, and expanding our master's offerings in engineering to employees throughout the state may be a significant factor in convincing high tech firms to come or stay in the state. Given the mobility of baccalaureate recipients in engineering, this may prove to be an effective strategy for economic development.

APPENDIX

A. Legislation

B. Current Engineering Degrees Offered at UNC Institutions

C. Needs Assessment by NCHEMS

D. Charge to the Engineering Visiting Team

E. Report by the Engineering Visiting Team

F. Engineering and Computer Science Degrees Awarded

Current Engineering Degree Programs in the University of North Carolina

Three campuses currently have Schools of Engineering: North Carolina A&T State University, North Carolina State University, and the University of North Carolina at Charlotte.

The programs and levels offered by each campus:

North Carolina A&T State University

Agricultural Engineering	BS
Architectural Engineering	BS
Chemical Engineering	BS, MS
Civil Engineering	BS, MS
Electrical Engineering	BS, MS, PhD
Engineering Physics	BS
Industrial Engineering	BS, MS, PhD
Mechanical Engineering	BS, MS, PhD

North Carolina State University

Engineering	BS, M
Prof. Aerospace Engineering	PB
Aerospace Engineering	BS, MS, PhD
Biological Engineering	BS
Biological and Agricultural Eng.	BS, M, MS, PhD
Biomedical Engineering	BS
Prof. Chemical Engineering	PB
Chemical Engineering	BS, M, MS, PhD
Prof. Civil Engineering	PB
Civil Engineering	BS, M, MS, PhD
Construction Eng. & Management	BS
Computer Engineering	BS, MS, PhD
Prof. Electrical Engineering	PB
Electrical Engineering	BS, M, MS, PhD
Environment Engineering	BS
Prof. Industrial Engineering	PB
Industrial Engineering, Furniture Manufacturing	BS
Industrial Engineering	BS, M, MS, PhD
Integrated Manufacturing Systems Engineering	M
Materials Science and Engineering	PB, BS, M, MS, PhD
Professional Mechanical Eng.	PB
Mechanical Engineering	BS, M, MS, PhD
Prof. Nuclear Engineering	PB
Nuclear Engineering	BS, M, MS, PhD
Textile Technology	BS
Textile Materials Science	BS
Textile Engineering	BS, MS
Textile Chemistry	BS, MS
Textile and Apparel Management	BS
Textile Technology & Management	PhD
Fiber and Polymer Sciences	PhD
Textiles	M, MS
Agricultural and Environmental Technology	BS

University of North Carolina at Charlotte

Engineering	ME, MSE
Civil Engineering	BSCE, MSCE
Computer Engineering	BS
Electrical Engineering	BSEE, MSEE, PhD
Mechanical Engineering	BSME, MSME, PhD
Engineering Management	MS

University of North Carolina at Asheville-North Carolina State University

The University of North Carolina at Asheville offers jointly with North Carolina State University a Bachelor of Science in Engineering (BSE)-Mechatronics Concentration degree from NC State University on the UNCA campus. The BSE degree is a multidisciplinary field of study which integrates electrical engineering, mechanical engineering, computer and control engineering and information technology. Courses are offered in the evening and weekends and through online delivery. In addition, UNCA has articulation with NCSU for several additional engineering programs in which the first two years are taken in Asheville and the last two at NCSU. (Some are 1½ at Asheville and the remainder at NCSU.)

The University of North Carolina at Chapel Hill does not have an engineering school, but it does have engineering materials science degrees at the master's and doctoral levels. It also has a master's and a doctoral program in biomedical engineering. There are additional programs at campuses in engineering technology but historically they have not been considered engineering programs, nor have they been classified as such.

NCHEMS

Analysis of Needs for Engineers in North Carolina

Dennis P. Jones

Prepared for
University of North Carolina
Office of the President

February 2003

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Analysis of Needs for Engineers in North Carolina

In early January 2003, the University of North Carolina Office of the President contracted with the National Center for Higher Education Management Systems (NCHEMS) to undertake "a needs assessment analysis of whether additional engineers are needed in North Carolina and whether there are variations by field of expertise." The desire of the University of North Carolina (UNC) is that this needs analysis include a statewide perspective and focus on eastern and western North Carolina and the cities of Greenville and Asheville.
It was agreed that NCHEMS would:

- Review national data concerning degree production in engineering fields relative to employment in those fields.

- Review in-state/regional employment patterns for engineers, data on occupations trends and projected job openings and growth in engineering fields, and in-state degree production in these fields—compare supply with projected demand both statewide and on a regional basis.

- Based on a review and analysis of available data, "prepare a memo interpreting the results and drawing conclusions regarding the balance or lack thereof between the need for engineers and the production of engineers in North Carolina on a statewide basis and to the extent possible in selected regional and metropolitan areas of the state, especially those where East Carolina University, Western Carolina University, and the University of North Carolina at Asheville are located."

This brief report is submitted in fulfillment of the requirement state in the last of the bulleted points above.

Analyses Undertaken

In compiling the information from which to draw conclusions, NCHEMS undertook the following analyses:

1. A profile of engineering employment in North Carolina in comparison to the nation as a whole and to a selected set of states (regional and states that have a substantial high-tech industry base—Texas, Washington, Massachusetts, New Jersey, Colorado):
    - Engineering employment as a proportion of total employment.
    - Concentrations of engineering employment by field.
2. Similar profiles at the in-state/regional level. The seven North Carolina workforce regions were used as the basis of these comparisons.
3. Engineering degree production in North Carolina in comparison with the nation as a whole and selected states:
    - Both masters and baccalaureate degree production.
    - Degrees relative to undergraduate enrollments.
    - Degrees relative to engineering employment.

4. Annual degree production relative to projected number of annual job openings:
    - United States
    - North Carolina
    - Regions

    The national and state data are current and carry the projections to 2010. The regional projections are two years old and extend to 2008.

5. In addition, we attempted to look at interstate migration of engineering graduates. Unfortunately, the 2000 Census files that will allow this analysis are not yet available and the Current Population Survey (CPS) has sample sizes that are too small to yield trustworthy data at the state level.

Observations and Findings

These analyses lead to a series of findings which in turn inform the conclusions reached as a result of the assessment effort. Key among the observations and findings are the following:

1. Engineering employment represents a substantially smaller proportion of overall employment in North Carolina than is the case for the nation as a whole and for all but one of the comparison states (Figure 1).

Figure 1. Engineering Occupations as a Percent of Total Occupations 2001

State	Total Engineering	Total Occupations	Percent Engineering
Washington	42,180	2,580,750	1.63
Massachusetts	39,844	3,230,160	1.23
Virginia	40,614	3,399,920	1.19
Colorado	25,394	2,159,370	1.18
Texas	101,470	9,229,130	1.10
Maryland	26,080	2,428,660	1.07
South Carolina	17,198	1,748,510	0.98
United States	**1,173,510**	**127,980,410**	**0.92**
Georgia	30,960	3,837,320	0.81
New Jersey	30,610	3,848,330	0.80
Illinois	40,644	5,861,660	0.69
Tennessee	16,480	2,585,280	0.64
North Carolina	**23,558**	**3,725,250**	**0.63**
Florida	43,354	7,058,610	0.61

Source: Bureau of Labor Statistics 2001

2. The distribution of engineering employment by field of engineering is different from the national pattern. Specifically:
    - A higher proportion is employed as chemical engineers in North Carolina. Very few of the comparison states have a greater proportion in this field.
    - A substantially lower proportion in civil engineering. Only two of the comparison states are lower in this category.
    - Slightly below average in computer engineering.

- Considerably above the national average and most comparison states in both electrical and industrial engineering.
- Pretty much in the middle of the pack with regard to mechanical engineering.
- Much below the nation and most other comparison states in proportion of engineering employment that is in "other engineering" fields.

The data behind these statements are found in Figure 2.

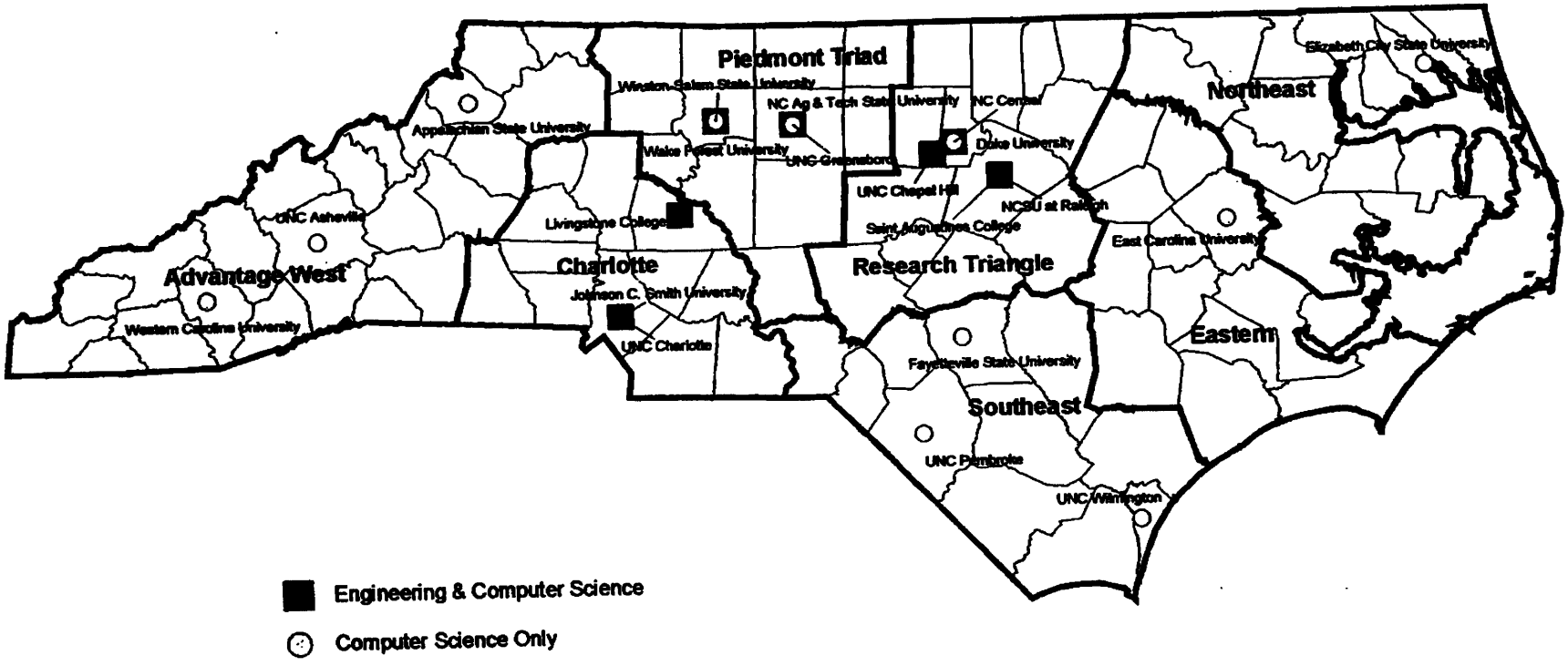
Figure 2. Engineering Occupations 2001 (Percent)

State	Chemical	Civil	Computer	Electrical	Industrial	Mechanical	Other	Total
Colorado	1.2	24.2	6.5	19.1	11.3	11.8	25.9	100.0
Florida	0.9	25.4	5.3	11.4	9.9	12.1	35.0	100.0
Georgia	2.4	15.5	5.7	10.3	19.4	12.5	34.3	100.0
Illinois	3.4	17.6	3.2	12.0	18.1	26.7	18.9	100.0
Maryland	3.6	13.8	7.9	12.4	9.1	18.1	35.1	100.0
Massachusetts	2.0	13.5	8.2	18.1	15.1	17.2	25.9	100.0
New Jersey	5.2	21.4	6.1	14.2	7.7	17.5	27.8	100.0
North Carolina	**4.1**	**15.2**	**5.1**	**17.1**	**18.2**	**18.2**	**22.1**	**100.0**
South Carolina	5.4	20.1	2.2	9.3	17.7	19.8	25.5	100.0
Tennessee	4.9	17.0	4.0	14.5	15.5	20.9	23.2	100.0
Texas	4.2	15.8	8.7	12.1	10.8	17.9	30.5	100.0
Virginia	2.1	16.3	5.5	16.7	9.0	14.7	35.8	100.0
Washington	1.4	24.2	3.2	7.2	6.6	10.6	46.9	100.0
United States	**2.7**	**17.5**	**5.8**	**12.9**	**13.8**	**17.4**	**30.0**	**100.0**

Source: Bureau of Labor Statistics

3. The distribution of types of engineering employment varies considerably across the workforce regions of the state (see Figure 1 for a map indicating the locations of these regions).

Figure 3. North Carolina Workforce Regions and 4-Year Public/Private Institutions Awarding Engineering and Computer Science Degrees



Source: North Carolina Department of Commerce; IPEDS Completions 2000-01

In percentage terms:

- Chemical engineering jobs are more prevalent in the Southeast Region than elsewhere.
- Civil engineering jobs are proportionately evenly distributed.
- The Research Triangle is most heavily oriented to computer and electrical engineering jobs—and least oriented to mechanical engineering.
- Engineering employment in the eastern and western regions is predominately in industrial, mechanical, and "other" fields (see Figure 4).

Figure 4. Engineering Occupations by Workforce Region 2002 (Percent)

Region	Chemical	Civil	Computer	Electrical	Industrial	Mechanical	Other	Total	Total Engr. Employment
Advantage West	1.7	–	–	6.4	34.1	23.7	34.1	100.0	1,730
Charlotte	3.6	14:1	1.5	9.7	14.4	18.6	38.0	100.0	7,140
Piedmont Triad	3.9	12.3	1.1	–	32.3	15.9	34.5	100.0	3,590
Southeast	16.2	15.7	–	12.1	11.1	21.7	23.2	100.0	1,980
Research Triangle	1.7	13.4	10.0	16.9	12.1	9.8	36.1	100.0	10,690
Eastern	3.4	12.4	0.7	6.9	19.3	17.2	40.0	100.0	1,450
Northeast	12.0	–	–	–	40.0	24.0	24.0	100.0	250
North Carolina	3.6	13.0	4.4	15.4	16.0	14.3	33.4	100.0	29,440

Source: North Carolina Employment Security Commission

4. Engineering employment is expected to grow more slowly in North Carolina over the next decade than is the case for the U.S. as a whole (29.9% in North Carolina versus 37.2% for the nation). This is true for most of the sub-fields as well, with the exceptions being chemical and electrical engineering (see Figure 5).

Figure 5. Projections of Engineering Occupations from 2000 to 2010— North Carolina Compared to Nation

ENGINEERING SECTOR	NORTH CAROLINA			UNITED STATES		
	2000	2010	% Change	2000	2010	% Change
Engineers	53,260	69,200	29.9	2,160,000	2,963,000	37.2
Aerospace engineers	210	230	9.5	50,000	57,000	14.0
Agricultural engineers	-	-	-	2,000	3,000	50.0
Biomedical engineers	130	190	46.2	7,000	9,000	28.6
Chemical engineers	1,040	1,150	10.6	33,000	34,000	3.0
Civil engineers	3,800	4,180	10.0	232,000	256,000	10.3
Computer hardware engineers	1,240	1,420	14.5	60,000	75,000	25.0
Computer software engineers	17,750	30,300	70.7	697,000	1,361,000	95.3
Electrical and electronics engineers	6,770	7,800	15.2	288,000	319,000	10.8
Environmental engineers	1,270	1,610	26.8	52,000	66,000	26.9
Industrial engineers	4,880	4,900	0.4	198,000	210,000	6.1
Marine engineers and naval architects	-	-	-	5,000	5,000	0.0
Materials engineers	680	700	2.9	33,000	35,000	6.1
Mechanical engineers	4,740	5,490	15.8	221,000	251,000	13.6
Mining and geological engineers	200	240	20.0	6,000	6,000	0.0
Nuclear engineers	290	330	13.8	14,000	14,000	0.0
Petroleum engineers	60	70	16.7	9,000	8,000	-11.1
All other engineers	3,380	3,180	-5.9	253,000	254,000	0.4

* Does not include engineering teaching and management occupations

Source: North Carolina Employment Security Commission

5. The largest and fastest growing engineering field is computer software engineering. Employment growth in North Carolina in this field is expected to be much higher than in all other fields, but projections are much lower in North Carolina than in the nation as a whole (see Figure 5).
6. Projections of engineering employment growth indicate that this growth will be heavily concentrated in three of the seven North Carolina Workforce Regions. Slightly more than half the growth is expected to occur in the Research Triangle region, another 25% in the Charlotte Region and 12% in the Piedmont Triad (see Figure 6).

Figure 6. Projections of Engineering Occupations from 1998 to 2008
North Carolina by Region

ENGINEERING SECTOR	ADVANTAGE WEST			CHARLOTTE			EASTERN			NORTHEAST		
	1998	2008	Change	1998	2008	Change	1998	2008	Change	1998	2008	Change
Aerospace engineers	20	20	–	20	20	–	60	60	–	10	10	–
Agricultural engineers				10	10	–						
Chemical engineers	100	110	10	220	240	20	70	80	10	40	40	–
Civil engineers	210	260	50	750	880	130	270	340	70	60	70	10
Computer engineers	250	360	110	2,510	4,060	1,550	360	460	100	50	60	10
Electrical and electronics engineers	510	580	70	1,890	2,370	480	480	590	110	80	90	10
Industrial engineers	420	470	50	950	1,080	130	280	320	40	60	60	–
Marine engineers and naval architects				10	10	–	10	10	–			
Mechanical engineers	610	700	90	1,660	1,960	300	470	560	90	110	120	10
Mining and geological engineers	30	30	–	10	10	–	10	10	–			–
Nuclear engineers	40	40	–	120	120	–	50	60	10	20	30	10
Petroleum engineers												
Safety engineering, except mining	40	40	–	140	160	20	40	40	–	10	10	–
All other engineers	720	870	150	2,650	3,160	510	810	980	170	190	230	40
Engineers	2,950	3,480	530	10,940	14,080	3,140	2,910	3,510	600	630	720	90

ENGINEERING SECTOR	SOUTHEAST			PIEDMONT TRIAD			RESEARCH TRIANGLE			NORTH CAROLINA		
	1998	2008	Change	1998	2008	Change	1998	2008	Change	1998	2008	Change
Aerospace engineers	50	50	–	10	10	–	40	40	–	200	190	(10)
Agricultural engineers							10	10	–			–
Chemical engineers	130	160	30	130	160	30	190	250	60	890	1,040	150
Civil engineers	240	310	70	320	390	70	790	1,020	230	2,710	3,400	690
Computer engineers	230	360	130	890	1,560	670	5,740	8,810	3,070	10,280	16,710	6,430
Electrical and electronics engineers	390	500	110	880	1,080	200	3,300	4,440	1,140	7,710	9,640	1,930
Industrial engineers	220	240	20	810	870	60	810	900	90	3,590	3,730	140
Marine engineers and naval architects							10	10	–			–
Mechanical engineers	480	580	100	1,010	1,170	160	1,220	1,550	330	5,630	6,500	870
Mining and geological engineers	30	30	–	30	30	–	10	10	–	120	110	(10)
Nuclear engineers	50	70	20	30	40	10	200	220	20	540	590	50
Petroleum engineers							–	10	10			–
Safety engineering, except mining	30	40	10	90	100	10	100	120	20	470	520	50
All other engineers	750	970	220	1,490	1,780	290	4,910	6,280	1,370	11,680	13,690	2,010
Engineers	2,600	3,310	710	5,690	7,190	1,500	17,330	23,670	6,340	43,820	56,120	12,300

Source: North Carolina Employment Security Commission

7. The four regions that combined are the special focus of this assessment—Advantage West, Eastern, Northeast and Southeast—had about 21% of the state's total engineering employment in 1998 and were expected to have about 16% of the engineering employment growth in the 1998-2008 decade (see Figure 6).
8. The growth that is expected will be primarily in the fields of computer, electrical, and mechanical engineering (see Figure 6).
9. The U.S. has more annual job openings in engineering fields than can be filled by the number of new engineering graduates in the country. North Carolina on the other hand has more engineering graduates than annual job openings. The only field with a substantial numeric deficit is computer software engineering. There is a large percentage (but small numeric) deficit in environmental engineering. For most fields, there is a large (numeric and proportionate) surplus (see Figure 7).

Figure 7. Engineering Bachelor's Degrees Awarded per 100 Annual Job Openings—North Carolina Compared to Nation

ENGINEERING SECTOR	NORTH CAROLINA			UNITED STATES		
	Average Annual Openings	Bachelor's Degrees Awarded 2000-01	Degrees Awarded per 100 Annual Openings	Average Annual Openings	Bachelor's Degrees Awarded 2000-01	Degrees Awarded per 100 Annual Openings
Engineers	2,440	2,772	113.6	114,200	101,407	88.8
Aerospace engineers	10	25	250.0	2,200	1,413	64.2
Agricultural engineers		29		100	611	611.0
Biomedical engineers	10	86	860.0	400	1,318	329.5
Chemical engineers	30	166	553.3	700	5,651	807.3
Civil engineers	90	169	187.8	6,000	7,482	124.7
Computer hardware engineers	40	179	447.5	2,300	5,064	220.2
Computer software engineers *	1,380	1,107	80.2	71,100	24,524	34.5
Electrical and electronics engineers	230	358	155.7	8,400	13,183	156.9
Environmental engineers	60	20	33.3	2,400	530	22.1
Industrial engineers	80	98	122.5	4,500	3,388	75.3
Marine engineers and naval architects				100	249	249.0
Materials engineers	20	24	120.0	900	531	59.0
Mechanical engineers	220	270	122.7	9,400	12,779	135.9
Mining and geological engineers				100	282	282.0
Nuclear engineers	10	–	0.0	300	103	34.3
Petroleum engineers				200	293	146.5
All other engineers	70	241	344.3	5,100	24,006	470.7

* Includes bachelor's degrees awarded in all computer science areas.

Source: North Carolina Employment Security Commission; IPEDS Completions 2000-01

10. Relative to number of engineering jobs in the state (as shown in Figure 8):
    - North Carolina produces many more engineering degrees (baccalaureate and masters combined) than the national average and is second only to Massachusetts among the selected set of comparison states.
    - With regard to bachelor's degrees only, North Carolina outpaces both the U.S. average and all the comparison states.

- At the Master's level, North Carolina produces fewer degrees relative to employment than the national average and most of the comparison states.

11. Except for chemical engineering, where North Carolina is slightly below the national average, the state is systematically at or above the national average, and above most comparison states, with regard to number of baccalaureate degrees awarded relative to employment in the field (see Figure 8).
12. Conversely, North Carolina is below the national average and many of the comparison states when this same calculation is made at the Master's level. The exceptions are civil and computer engineering. The comparative worst performances are in electrical and mechanical engineering (see Figure 8).

Figure 8. Engineering Degrees Awarded per 100 Engineering Jobs, by Area

BACHELOR'S AND MASTERS		BACHELOR'S ONLY		MASTERS ONLY	
CHEMICAL ENGINEERING					
Colorado	58.1	Colorado	50.0	Massachusetts	9.8
Florida	48.8	Florida	44.3	Colorado	8.1
Massachusetts	36.5	Massachusetts	26.8	Florida	4.5
United States	**21.2**	Virginia	18.7	**United States**	**3.4**
Virginia	20.6	**United States**	**17.8**	Illinois	3.2
North Carolina	**20.3**	**North Carolina**	**17.3**	New Jersey	3.1
Georgia	18.5	Georgia	16.8	**North Carolina**	**3.0**
Tennessee	17.1	Tennessee	14.1	Maryland	3.0
Illinois	16.5	Illinois	13.3	Tennessee	3.0
New Jersey	13.4	Washington	10.9	Washington	2.4
Washington	13.3	New Jersey	10.3	Virginia	1.9
Texas	10.8	South Carolina	9.6	Texas	1.9
Maryland	10.8	Texas	8.9	Georgia	1.7
South Carolina	10.8	Maryland	7.7	South Carolina	1.2
CIVIL ENGINEERING					
Massachusetts	8.5	Tennessee	6.3	Massachusetts	4.2
Tennessee	8.1	**North Carolina**	**5.7**	Illinois	2.2
North Carolina	**7.8**	Virginia	4.5	**North Carolina**	**2.0**
Illinois	6.6	Illinois	4.4	Colorado	2.0
Virginia	6.0	Massachusetts	4.3	Tennessee	1.8
South Carolina	5.2	South Carolina	4.2	**United States**	**1.6**
United States	**5.2**	**United States**	**3.6**	Georgia	1.5
Florida	4.2	Florida	3.1	Virginia	1.5
Georgia	4.1	Georgia	2.6	Texas	1.3
Colorado	3.9	Texas	2.3	Maryland	1.2
Texas	3.6	Maryland	2.1	Florida	1.2
Maryland	3.3	Colorado	1.9	South Carolina	1.1
New Jersey	2.8	New Jersey	1.9	New Jersey	0.9
Washington	2.6	Washington	1.8	Washington	0.8

BACHELOR'S AND MASTERS		BACHELOR'S ONLY		MASTERS ONLY	
COMPUTER ENGINEERING					
South Carolina	57.6	Illinois	23.3	South Carolina	36.5
Illinois	25.3	South Carolina	21.1	Florida	7.3
Florida	24.8	Florida	17.5	**North Carolina**	6.5
North Carolina	21.5	**North Carolina**	15.0	New Jersey	5.7
New Jersey	16.5	New Jersey	10.7	Massachusetts	3.8
Virginia	10.7	Virginia	9.7	**United States**	2.6
United States	10.1	**United States**	7.5	Illinois	2.0
Massachusetts	7.8	Georgia	6.0	Washington	1.9
Washington	7.2	Washington	5.4	Texas	1.7
Georgia	6.0	Massachusetts	4.0	Virginia	1.0
Colorado	4.5	Colorado	3.9	Colorado	0.6
Texas	4.3	Tennessee	3.5	Georgia	0.0
Tennessee	3.5	Texas	2.6	Maryland	0.0
Maryland	1.7	Maryland	1.7	Tennessee	0.0
ELECTRICAL ENGINEERING					
Illinois	19.7	Illinois	11.0	Illinois	8.7
Florida	16.1	Florida	10.9	Maryland	7.7
Maryland	15.9	Washington	9.6	Georgia	7.2
Georgia	14.8	Tennessee	9.1	Massachusetts	6.5
Massachusetts	14.7	**North Carolina**	8.9	Florida	5.3
United States	13.2	**United States**	8.7	Colorado	4.7
Texas	12.0	Massachusetts	8.2	**United States**	4.5
Washington	11.9	Maryland	8.2	Texas	4.3
Tennessee	11.8	Texas	7.7	New Jersey	3.5
North Carolina	11.1	Georgia	7.6	South Carolina	3.3
South Carolina	10.8	South Carolina	7.5	Tennessee	2.7
New Jersey	10.3	New Jersey	6.8	Washington	2.3
Colorado	8.3	Virginia	4.3	**North Carolina**	2.2
Virginia	6.0	Colorado	3.6	Virginia	1.7
INDUSTRIAL ENGINEERING					
Georgia	6.5	Georgia	4.8	Massachusetts	3.2
Massachusetts	4.5	Tennessee	2.5	Tennessee	2.0
Tennessee	4.5	**North Carolina**	2.3	Virginia	1.8
Virginia	3.9	Virginia	2.1	Texas	1.6
North Carolina	3.5	Illinois	2.1	Georgia	1.6
United States	3.4	**United States**	2.1	New Jersey	1.6
Texas	3.3	Texas	1.7	**United States**	1.3
New Jersey	3.2	Florida	1.7	**North Carolina**	1.2
Illinois	2.8	New Jersey	1.7	South Carolina	1.2
Florida	2.6	Washington	1.5	Florida	1.0
South Carolina	2.1	Massachusetts	1.3	Illinois	0.7
Washington	2.0	South Carolina	1.0	Washington	0.5
Maryland	0.5	Maryland	0.5	Colorado	0.0
Colorado	0.1	Colorado	0.1	Maryland	0.0
MECHANICAL ENGINEERING					
Massachusetts	10.0	Colorado	6.8	Massachusetts	3.4
Georgia	9.7	Tennessee	6.8	Georgia	3.3
Colorado	8.5	Massachusetts	6.6	**United States**	1.7
Tennessee	8.3	Florida	6.4	Colorado	1.6
Florida	7.9	Georgia	6.4	Florida	1.5
United States	7.9	**North Carolina**	6.3	Maryland	1.5
North Carolina	7.3	**United States**	6.3	Tennessee	1.5
Washington	7.0	Washington	5.5	Washington	1.5
Virginia	5.9	Virginia	5.1	Illinois	1.3
Illinois	5.7	Illinois	4.4	South Carolina	1.3
South Carolina	5.3	Texas	4.4	**North Carolina**	1.0
Texas	5.3	New Jersey	4.1	Texas	0.9
Maryland	5.2	South Carolina	4.0	New Jersey	0.9
New Jersey	5.0	Maryland	3.7	Virginia	0.8

BACHELOR'S AND MASTERS		BACHELOR'S ONLY		MASTERS ONLY	
OTHER ENGINEERING					
North Carolina	**9.8**	**North Carolina**	**7.5**	Massachusetts	4.1
Colorado	9.5	Colorado	6.4	Illinois	3.5
Illinois	9.1	Illinois	5.6	Maryland	3.1
Massachusetts	7.9	Tennessee	4.9	Florida	3.1
Tennessee	7.6	Massachusetts	3.8	Colorado	3.1
Florida	6.4	Florida	3.3	Virginia	2.7
Maryland	5.5	**United States**	**3.0**	Tennessee	2.6
United States	**5.2**	Maryland	2.4	**North Carolina**	**2.3**
Virginia	4.9	Virginia	2.2	New Jersey	2.3
New Jersey	4.4	New Jersey	2.1	**United States**	**2.2**
Texas	2.8	Georgia	1.5	Texas	1.5
Georgia	2.7	Texas	1.4	Georgia	1.2
South Carolina	1.7	South Carolina	0.7	South Carolina	1.0
Washington	1.2	Washington	0.7	Washington	0.5
TOTAL					
Massachusetts	9.6	**North Carolina**	**7.1**	Massachusetts	4.4
North Carolina	**9.1**	Tennessee	6.2	Illinois	2.8
Illinois	8.7	Illinois	5.9	Florida	2.7
Tennessee	8.2	Florida	5.5	Maryland	2.6
Florida	8.1	Massachusetts	5.3	Colorado	2.5
United States	**7.2**	**United States**	**4.9**	**United States**	**2.2**
Colorado	7.0	Colorado	4.5	Georgia	2.2
Georgia	6.3	Georgia	4.2	New Jersey	2.1
New Jersey	6.1	Virginia	4.1	South Carolina	2.1
Virginia	6.0	New Jersey	4.0	Tennessee	2.1
Maryland	5.9	South Carolina	3.6	**North Carolina**	**2.1**
South Carolina	5.7	Maryland	3.3	Virginia	1.9
Texas	5.0	Texas	3.3	Texas	1.8
Washington	3.3	Washington	2.4	Washington	0.9

Source: Bureau of Labor Statistics; IPEDS Completions 2000-01

13. If one compares computer science degrees awarded relative to number of computer application and software engineering occupations, North Carolina performs at a rate slightly below the national average—but considerably ahead of states like Colorado, Washington, and Massachusetts that have high proportions of such jobs in their employment mix (see Figure 9).

Figure 9. Computer Science Degrees Awarded per 100 Computer Application and Software Engineering Occupations, 2001

State	Computer Science Degrees Awarded per 100 Occupations	Number of Computer Science Degrees Awarded	Computer Application and Software Engineering Occupations—2001
South Carolina	11.0	395	3,600
Tennessee	8.7	401	4,600
Georgia	8.5	1,517	17,820
Florida	8.2	1,940	23,590
Illinois	8.0	1,992	24,910
Maryland	7.2	1,378	19,140
United States	**7.0**	**43,369**	**623,210**
North Carolina	**6.6**	**1,107**	**16,670**
New Jersey	5.1	1,373	26,870
Texas	4.4	2,103	47,810
Massachusetts	4.3	1,526	35,870
Virginia	3.9	1,312	33,780
Colorado	3.7	817	21,810
Washington	2.5	608	24,220

Source: Bureau of Labor Statistics; IPEDS Completions 2000-01

When a regional view is taken, the eastern and western parts of the state have very high degree production relative to the number of jobs in the regions (see Figure 10).

Figure 10. Computer Science Degrees Awarded per 100 Computer Application and Software Engineering Occupations, 2002

Region	Computer Science Degrees Awarded per 100 Occupations	Avg. Annual Computer Science Degrees Awarded 1999-2001	Computer Application and Software Engineering Occupations—2002
Advantage West	47.6	71	150
Charlotte	5.2	183	3,520
Eastern	127.0	114	90
Northeast		25	-
Piedmont Triad	17.5	180	1,030
Research Triangle	4.5	280	6,160
Southeast	28.2	99	350
North Carolina	5.4	953	17,610

Source: North Carolina Employment Security Commission; IPEDS Completions 2000-01

In the absence of available data, I reviewed research findings on migration of scientists and engineers. The best study to my knowledge is *Who Will Stay and Who Will Leave?* [1]That study reported that:

> Engineering and physical science majors are significantly less likely to be retained than computer/math and social

[1] Southern Growth Policies Board. *Who Will Stay and Who Will Leave? A Report of the Southern Technology Council.* May 2001, p. 24.

science majors (but not compared to life science). The odds of retaining a computer/math major are 26 percent higher and the odds of retaining a social scientist are 29 percent higher than an engineering major (which had the lowest retention). A post hoc comparison of math versus computer science majors demonstrated that computer science majors were significantly lower on retention and, thus, more like engineers and physical scientists.

These findings are consistent with results of many interviews I've conducted with employers who consistently recruit out-of-state for engineers and with data from states like Colorado and Utah that depend on in-migration to fill labor market needs substantially larger than their degree-production histories.

Conclusions

On the basis of these findings, I come to the following conclusions:

1. North Carolina does not have need for additional engineering programs. The state already produces more graduates than current and projected annual job openings. Further, the parts of the state that do not have a nearby engineering school are characterized by having relatively low levels of engineering employment. There is no compelling case in the data for additional engineering programs.
2. Because high engineering employment is geographically coincident with locations of engineering programs, there will inevitably arise what I call the "field of dreams" argument—build it (an engineering program) and they (jobs) will come. There are too many examples of very large and strong engineering programs located in communities without commensurate job growth (Purdue and the University of Illinois come to mind) to make this argument credible. If all the other stars are in alignment (venture capital, critical mass of professional employment, airports, etc.), the presence of programs becomes a necessary element—but it is not a sufficient element—to generation of high levels of engineering employment.
3. One place where North Carolina does fall short is at the Master's level. This suggests a shortage of ready access to continuing professional education for those engineers already in place. The pattern in hiring engineers is that:

    - Baccalaureate level engineers are recruited from a wide geographic area and moved to wherever the job is—thus the high rates of mobility of individuals with engineering degrees.
    - Once located, however, it is important that they have ready access to coursework (not always programs) that will ensure that they have up-to-date information in their fields. The availability of graduate level education is a factor in recruitment, retention, and currency of an engineering workforce.

    Given the nature of most graduate level engineering education, this coursework can be delivered at a distance from existing programs. It is not necessary to create new programs, with the unneeded undergraduate capacity, to achieve this objective.
4. The greatest need in North Carolina is for computer science/software engineering graduates. It is here that the projected growth is the largest and the gap between job openings and degree production is the greatest. If an investment is to be made, I

would suggest it be here rather than in engineering programs. Institutions can have very good computer science programs without companion engineering programs.

University of North Carolina

Charge to the Team Reviewing Engineering in North Carolina

Team Members:

Dr. Carl Locke, Formerly Dean of Engineering, University of Kansas
Dr. Peter Crouch, Dean of Engineering, Arizona State University
Dr. Robert Mattauch, Dean of Engineering, Virginia Commonwealth University

The 2001 General Assembly charged the Board of Governors of the University of North Carolina to "study the feasibility of establishing...a School of Engineering at East Carolina University. The Board shall also study the feasibility of establishing a School of Engineering at the University of North Carolina at Asheville and Western Carolina University."

The University of North Carolina currently has engineering schools at North Carolina A&T State University, North Carolina State University, and at the University of North Carolina at Charlotte and offers advanced degrees in materials science and biomedical engineering and mathematics at the University of North Carolina at Chapel Hilll.

We seek your advice and recommendations regarding what is needed in engineering education in North Carolina and particularly in our public universities. While you are asked to focus specifically on three universities in the system, we also seek a balanced assessment of the direction engineering education should take at UNC.

By legislative mandate we are to address the feasibility of engineering schools at East Carolina University, the University of North Carolina at Asheville, and Western Carolina University. This assessment should grow out of the need for additional engineers generally and in specific fields, the capabilities of the universities for supporting an engineering school, and the full cost to establish and maintain an engineering school and the benefits that might accrue to the state of North Carolina if an additional school or schools were established. In assessing the feasibility of additional engineering schools, the current role and capacity to expand of existing engineering schools should be considered.

Any current or anticipated developments in engineering education that might bear on the direction for North Carolina should be considered, such as online delivery of courses and degrees, and the extent to which UNC needs to provide advanced degree work and continuing education for place bound engineers.

In additional to addressing the issue of the feasibility of new engineering schools, we seek advice and recommendations regarding the specific programs proposed by the individual universities:

East Carolina University
BS in General Engineering

University of North Carolina at Asheville
Phase I
Mechatronics
Computer Science Engineering
Phase II
Bioengineering
Environmental Engineering

Western Carolina University
Electrical and Computer Engineering

In assessing these programs, please consider the support for them at the campuses, the cost to establish and maintain the programs, and the need for the programs in light of the NCHEMS study and other recent assessments of engineering degree needs. Assessment of individual programs should take into account existing programs and what is the best direction for the University of North Carolina to take.

Accreditation issues should be addressed, as they may be relevant to the recommendations.

The University of North Carolina is a significant force in the economic development of the state, and, where appropriate, the implications for regional or statewide economic development should be considered.

We seek advice and recommendations on whether to establish any additional schools of engineering in North Carolina, whether to establish or expand specific programs in engineering or related fields such as computer applications, and in general the direction for engineering education in North Carolina.

Report of Engineering Feasibility Study Team

University of North Carolina
February 23-25, 2003

Dr. Peter Crouch,
Dean of Engineering
Arizona State University

Dr. Carl E. Locke, Jr.
Professor of Chemical and Petroleum Engineering and Former Dean of Engineering
University of Kansas

Dr. Robert Mattauch
Dean of Engineering
Virginia Commonwealth University

Introduction

The North Carolina General Assembly mandated that Board of Governors of the University of North Carolina study the feasibility of establishing a School of Engineering at East Carolina University, Western Carolina University, and the University of North Carolina at Asheville. The Office of the President of the University of North Carolina asked the Study Team listed above (called the Team) to provide advice to the President on the feasibility of establishing these schools of engineering.

The Charge given to the Team for this feasibility study is Attachment A.

The Team first met with representatives from the institutions that presently offer engineering degrees. The team met with the following individuals on the evening of February 23.

North Carolina A&T University: Dr. Joseph Monroe, Dean of Engineering
North Carolina State University: Dr. Sarah Rajala , Associate Dean of Engineering
University of North Carolina at Charlotte: Dr. Robert Johnson, Dean of Engineering

The team also met with Dr. Nino Masnari, Dean of Engineering at North Carolina State University on February 24.

The representatives of North Carolina A&T and UNC Charlotte indicated they had the capacity to accept more students than were enrolled at the present time. The representative of NC State indicated with some expansion of faculty and space that additional students could be accepted.

The team visited the campus of the University of North Carolina at Asheville and the campus of Western Carolina University on February 24. The team also visited the campus of East Carolina University on February 25.

This report contains the findings and observations of the Team and presents the recommendations to the Office of the President of the University of North Carolina.

There are some overarching recommendations that the Feasibility Team offers.

2. The Team does not recommend the formation of any school or college of engineering at the institutions considered. If any new engineering programs are approved, the Team recommends that those programs be organized in existing schools/colleges at the institutions in the UNC system. The costs of supporting additional schools/colleges do not seem justified at this time. None of the chancellors at the three institutions visited are seeking a school or college of engineering at this time. Therefore, the Team did not devote much attention to the costs associated with start-up of a new school or college of engineering. However, Dr. Mattauch has been involved in start-up of a new school of engineering at Virginia Commonwealth University and through his experience a rough estimate of the costs for a new engineering school was made. Attachment B contains this estimate. The total start-up cost for 800 students in 2 engineering programs is estimated to be $36 million which includes a building, laboratory equipment, and the IT infrastructure. This does not include faculty and staff salaries but represents just the physical facilities needed.
2. The Team recommends that at this time the names of any school/college in which an engineering program is organized not have the name changed to include the word "engineering".
3. The Team recommends that all institutions develop more detailed and realistic cost proposals for all proposed programs.

Findings, observations, and recommendations for each campus are discussed separately.

University of North Carolina at Asheville

Information Provided

Dr. Mark Padilla, Vice Chancellor of Academic Affairs, made a presentation to the Team concerning the proposal to offer engineering degrees at the University of North Carolina at Asheville. He was accompanied by other administrators and faculty members from several departments. A copy of the slides he used in his presentation are on file with the Office of the President, University of North Carolina. The Team also met with the Chancellor, Dr. James H. Mullen, Jr.

Findings and Observations

The administration proposes to assume full responsibility of a degree program in Mechatronics (listed under the General Engineering Education CIP code) now

offered on the Asheville campus by North Carolina State University. They also proposed to begin a new program in Computer Engineering.

The leaders and faculty at UNC Asheville are proud of the strong liberal arts focus of this institution. The Board of Governors of the University of North Carolina have designated UNC Ashville as a Public Liberal Arts University. Apparently, the faculty have developed programs that have good reputations. The institution attracts high quality students who have, on average, the third highest SAT scores of the UNC institutions.

Formal agreements for 2+2 degree programs in engineering have been in place with North Carolina State University for about 20 years. These program have been attractive to a number of students and are well accepted by faculty on both campuses. In 2000 a special program in Mechatronics was begun on the UNC Asheville campus by NC State University. In this program, students take all courses on the Asheville campus but receive a degree from NC State. The upper division engineering courses are taught by NC State using distance learning techniques and adjunct faculty. Some faculty from UNC Asheville also participate in the instructional program.

UNC Asheville administrators are concerned about losing graduation credit for the students in the Mechatronics program.

Faculty in several departments attended the open meeting held for the Team and many of those were enthusiastic about the prospect of having engineering programs at UNC Asheville.

Recommendations

1. The Team recommends that UNC Asheville does not develop independent, free standing engineering programs.
2. The Team recommends that UNC Asheville continue to work with NC State in offering the Mechatronics program.
3. The Team recommends that UNC Asheville and NC State consider development of a computer engineering program following the same model used in the Mechatronics program.
4. The Team recommends that the UNC Office of the President implement a policy whereby students completing programs like the Mechatronics program receive dual degrees (one from UNC Asheville and NC State)or that their diploma indicates the degree is a joint one from UNC Asheville and NC State.
5. The Team recommends that the UNC Office of the President study other administrative and accounting policies that are barriers to this joint degree offerings.
6. The Office of the President of the University of North Carolina should consider providing additional funding to both UNC Asheville and NC State to support the expansion of these programs.

Western Carolina University

Information Provided

Chancellor John W. Bardo described the perceived need for an engineering program at Western Carolina University. A copy of the slides he used for his presentation is on file in the Office of the President, University of North Carolina. Mr. Frank Stiles, President of a bank in Franklin, NC introduced a local businessman, Mr. Don Rogers. Mr. Rogers described the need his company, Duotech Services, had for engineers, particularly electrical and computer engineers. Both Mr. Stiles and Mr. Rogers recommended formation of the engineering program at Western Carolina University.

Dr. Duane D. Dunlap, Chair of Engineering Technology described a new research center, the engineering technology programs, and detailed plans for the proposed engineering program. Dr. Dunlap and Dr. Noelle Kehrberg, Interim Dean of the College of Applied Sciences led a tour of existing laboratories and the new building under construction.

The Team also received a compilation of materials describing the proposed program and the role of the university in the regional economic development. A copy of these materials is on file in the Office of the President, University of North Carolina.

Findings and Observations

Administration and faculty members feel a strong need to support the economic development of the Advantage West region of North Carolina. They think that West Carolina University can support this development by creation of an electrical and computer engineering program.

They perceive that the geographical location of Western Carolina University in North Carolina places them at a disadvantage within the State. They perceive that Western North Carolina is "more naturally linked to Atlanta, Knoxville, Tri-Cities, and Greenville-Spartanburg than to the Triangle". They also state "Within the Advantage West, you could be closer to the capitals of six different states than you are to Raleigh"

They have recently been awarded funding for a research center in optoelectronics. This center brings together Clemson, UNC Charlotte, University of Southern California, and Stanford University joined with West Carolina University. This center has received an impressive amount of funding for facilities, equipment, and project support. The Center was made possible through the efforts of Congressman Charles Taylor.

They have several programs in engineering technology that apparently are of high quality. Faculty who the Team met are enthusiastic about the programs and seem to be dedicated to providing high quality, hands-on instruction. Equipment for these programs

is of excellent quality and apparently is sufficient for the program. Space for these programs in their present location is commodious and of good quality. A new building, constructed with Federal earmarked funds, is close to completion. It is an impressive structure and will provide additional and higher quality space for the degree programs and research center.

Faculty and students have worked with and are working with industry in the area on a variety of problems. It seems that these efforts have been valuable to the organizations involved. It is unclear if the local industry is providing financial support for these projects or if the faculty and students are conducting the projects as a service activity.

Two of the engineering technology programs (Electronics Engineering Technology and Manufacturing Technology) are accredited by ABET through the Technology Accreditation Commission.

Recommendations

1. The Team recommends that faculty and administration at Western Carolina University continue to work with industry in the region and seek to increase those contacts. It might benefit all concerned if those contacts could result in funded projects that could support students and faculty in these projects.
2. The Team recommends that Western Carolina not develop a freestanding engineering program in electrical and computer engineering.
3. The Team recommends that the faculty and administration at Western Carolina initiate conversations with the School of Engineering at UNC Charlotte to discuss cooperative engineering programs with that institution. It might be possible to offer engineering degrees at Western Carolina in a manner similar to the program in Mechatronics that is offered on the UNC Asheville campus by NC State. This should include a policy whereby students receive formal recognition of having studied on the Western Carolina campus and receiving instruction from UNC Charlotte. This formal recognition should be included on their diploma .
4. The Team recommends that the UNC Office of the President study other administrative and accounting policies that are barriers to this joint degree offerings
5. The Team recommends that the UNC Office of the President provide additional infrastructure support for both institutions if a cooperative engineering program is developed by Western Carolina and UNC Charlotte. This support should be such that it would allow both institutions to offer distance learning opportunities in the new degree program.
6. The Team recommends that Western Carolina develop formal 2+2 engineering programs in cooperation with NC State and UNC Charlotte.

East Carolina University

Information Provided

Dr. Elmer C. Poe, Interim Dean, School of Industry and Technology and Dr. Rosina C. Chia, Interim Chair, Department of Industrial Technology provided the Team with a demonstration of robotic surgery at the Brody School of Medicine. They also conducted a tour of a new building close to completion that will house the School of Industry and Technology later this spring.

Dr. William Swart, Provost and Vice Chancellor for Academic Affairs, presented the plans to establish an engineering program at East Carolina University. The Team also received a large notebook with information concerning the region, planning for the region, and plans for the proposed new engineering program. A copy of the slides he used in his presentation and a copy of a notebook containing extensive information on economic development of the region and plans for the new program are on file in the Office of the President, University of North Carolina.

Chancellor Muse, who had been called away from campus in the earlier part of the day, joined the group and endorsed the proposal. He spoke also about the regional service mission of East Carolina University.

Findings and Observations

Administration and faculty at Eastern Carolina University propose to initiate a degree program in General Engineering. This program would build on a general education component, a engineering common core, and contain five different upper-level specialty tracks which include options in health, education, art, economic development, and systems engineering. These specialties would be based on existing strengths and areas of focus at East Carolina

They suggest the curricula that will be developed will be of a new type. No specific program was presented that was substantially different than engineering curricula that exist at many other institutions.

The impetus for this proposal, in the opinion of the administration at East Carolina, is to stimulate economic development in the Eastern Region of North Carolina. A document, Vision 2030 which was initiated by Governor Hunt in 1999, recommended that the State of North Carolina "Create an Engineering School in Eastern North Carolina". This recommendation specifically mentions this new school be created at either East Carolina University or UNC Wilmington.

East Carolina offers several degrees in industrial technology and one in construction management. Several of the industrial technology programs are accredited by the

National Association of Industrial Technology. The construction management program is accredited by the American Council of Construction Education.

The NAIT web site has posted a definition of Industrial Technology

> *"Industrial Technology is a field of study designed to prepare technical and/or management oriented professionals for employment in business, industry, education, and government. Industrial Technology is primarily involved with the management, operation, and maintenance of complex technological systems while Engineering and Engineering Technology are primarily involved with the design and installation of these systems."*

The industrial technology programs are substantially different than engineering or engineering technology programs.

East Carolina includes the Brody School of Medicine. The Team viewed a robotic surgery that was in progress during the visit via a closed-circuit TV. The research program that developed this capability was a joint effort between the Brody School of Medicine and the engineering program at NC State. It was not obvious that there was a working relationship between the Industrial Technology program at East Carolina and the Brody School of Medicine.

The Team toured a new building that is close to completion which is being constructed with funding provided by the North Carolina Higher Education Bond program. This building will house the School of Industrial Technology in very impressive, commodious facilities.

The new Provost has initiated a re-organization of the academic programs and, according to the printed information provided, will create a College of Engineering and Computer Science. The Provost verbally indicated he does not intend to use the name engineering in the name of this new organization.

The Team was provided with resumes of 11 East Carolina University faculty members who have doctoral degrees in engineering. The Provost indicated a 12th person with a PhD in engineering had recently been employed as his special assistant to review business processes campus-wide. The Provost is presently conducting a search for a new dean of the School of Industry and Technology and that person will have a doctorate in an engineering field.

The Team was introduced to very few faculty members in the ongoing industrial technology or construction management programs so there was no way to judge the quality or activities of these programs.

The proposed program was envisioned to be possible with out any new funding for the University. The Provost stated that the present funding level, the space available, and the

faculty presently at East Carolina are sufficient to begin the proposed engineering program.

Recommendations

1. The Team recommends that East Carolina University partner with NC State to develop formal 2+2 programs and possibly in the future develop a program using the same concept now being used by UNC Asheville for the Mechatronics degree. In this program, NC State would provide a degree program taken by students on the East Carolina campus using distance learning techniques and resident faculty at East Carolina.

   It is the opinion of the Team, that this approach will allow the faculty, staff, and administration develop an engineering culture on campus. The program developed in cooperation with NC State could be designed to fulfill the goals for a new and different engineering program as outlined by the Provost.

Attachment A

University of North Carolina

Charge to the Team Reviewing Engineering in North Carolina

Team Members:

Dr. Carl Locke, Formerly Dean of Engineering, University of Kansas
Dr. Peter Crouch, Dean of Engineering, Arizona State University
Dr. Robert Mattauch, Dean of Engineering, Virginia Commonwealth University

The 2001 General Assembly charged the Board of Governors of the University of North Carolina to "study the feasibility of establishing...a School of Engineering at East Carolina University. The Board shall also study the feasibility of establishing a School of Engineering at the University of North Carolina at Asheville and Western Carolina University."

The University of North Carolina currently has engineering schools at North Carolina A&T State University, North Carolina State University, and at the University of North Carolina at Charlotte and offers advanced degrees in materials science and biomedical engineering and mathematics at the University of North Carolina at Chapel Hilll.

We seek your advice and recommendations regarding what is needed in engineering education in North Carolina and particularly in our public universities. While you are asked to focus specifically on three universities in the system, we also seek a balanced assessment of the direction engineering education should take at UNC.

By legislative mandate we are to address the feasibility of engineering schools at East Carolina University, the University of North Carolina at Asheville, and Western Carolina University. This assessment should grow out of the need for additional engineers generally and in specific fields, the capabilities of the universities for supporting an engineering school, and the full cost to establish and maintain an engineering school and the benefits that might accrue to the state of North Carolina if an additional school or schools were established. In assessing the feasibility of additional engineering schools, the current role and capacity to expand of existing engineering schools should be considered.

Any current or anticipated developments in engineering education that might bear on the direction for North Carolina should be considered, such as online delivery of courses and degrees, and the extent to which UNC needs to provide advanced degree work and continuing education for place bound engineers.

In additional to addressing the issue of the feasibility of new engineering schools, we seek advice and recommendations regarding the specific programs proposed by the individual universities:

East Carolina University
BS in General Engineering

University of North Carolina at Asheville
Phase I
Mechatronics
Computer Science Engineering
Phase II
Bioengineering
Environmental Engineering

Western Carolina University
Electrical and Computer Engineering

In assessing these programs, please consider the support for them at the campuses, the cost to establish and maintain the programs, and the need for the programs in light of the NCHEMS study and other recent assessments of engineering degree needs. Assessment of individual programs should take into account existing programs and what is the best direction for the University of North Carolina to take.

Accreditation issues should be addressed, as they may be relevant to the recommendations.

The University of North Carolina is a significant force in the economic development of the state, and, where appropriate, the implications for regional or statewide economic development should be considered.

We seek advice and recommendations on whether to establish any additional schools of engineering in North Carolina, whether to establish or expand specific programs in engineering or related fields such as computer applications, and in general the direction for engineering education in North Carolina.

Attachment B

ESTIMATED COST TO BUILD AND EQUIP A BASIC SCHOOL OF ENGINEERING IN 2003

BUILDING

Building area needed per student[2] ~ 170 to 200 gross square feet

Cost of such construction in a mid-size city on the east coast ~ $250. per square foot

Resulting cost of construction per student planned[3] ~ $42,500 to $50,000

Cost to build a building to house 800 undergraduate engineering students ~ $ 34 million
Note: VCU cost was $37 million for a high-end facility to accommodate 800 students.

OUTFITTING WITH LABORATORY EQUIPMENT AND IT INFRASTRUCTURE

Cost to outfit a complete laboratory set for a computer engineering program ~ $0.50 million

Cost to outfit a complete laboratory set for an electrical engineering program[4] - $0.50 million

Cost to provide needed IT infrastructure for 800 students and associated faculty ~ $0.8 million

TOTAL COST for an 800 student, two program school ~ $36 million

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[2] This is a value which generally occurs once one takes into account such items as teaching classrooms, teaching laboratories, faculty offices, student study space, computer laboratories, general gathering (foyer) and even faculty research space.

[3] It is important to remember that this cost can not be extrapolated to the case of one or just a few students, but must be used with a base building in mind. The opinion of an architect who recently oversaw the construction of such a school is that this number only makes sense if considering a unit to accommodate at least 500 students.

[4] This assumes a curriculum without major power equipment

rjm 03/14/03