



## UNC-NCSU Joint Department of Biomedical Engineering 2008/09 Annual Report Summary



### **OVERVIEW**

The 2008/09 academic year has been a challenge for the department. Even though our budget was reduced mid-year, we were still able to conduct a very successful Spring Design and Research Symposium at NCBC with over 200 participants as well as a memorable graduation ceremony in May at the McKimmon Center with nearly 500 in attendance. We were also able to hire two new faculty members who will join BME in August 2009. Greg Sawicki, Assistant Professor, will accelerate our efforts to establish a Rehabilitation Engineering research program. Anka Veleva, Research Associate Professor, will be joining us from the Chemical and Biomolecular Engineering Department.

### **COMPACT PLAN**

The BME department's goals for 2008-09 and their status are summarized below.

- (a) Continue to assist the School of Medicine and College of Engineering efforts to recruit a permanent head/chair for BME until the new chair is in office. *Status:* The three finalists from the external search withdrew. An internal search is now underway and the department is continuing its assistance by hosting visits by the candidates and providing new information as it is requested.
- (b) Continue our medical device development program in conjunction with the UNC SOM CTSA effort. Develop a financial plan to stabilize funding for this new initiative. *Status:* The UNC SOM CTSA program has been completely restructured under its new Director, Dean Etta Pisano. BME is no longer involved in the CTSA medical device development program. Instead, we have redirected all our efforts towards launching the NCSU-UNC Graduate Certificate in Medical Devices.
- (c) Complete a BME Strategic Plan in collaboration with the new permanent chair, and submit it to the Deans of Engineering and Medicine for approval. *Status:* This effort will be launched once the new department chair is recruited.
- (d) In partnership with the College of Engineering and School of Medicine, launch an initiative to improve the national ranking of our BME department. *Status:* Our rankings are greatly influenced by how our peers perceive our academic and research programs. New linkages with the SOM publicity infrastructure have been implemented. The COE communications office helped the department prepare new improved versions of our publicity brochures in Fall 2008. Our BME website is being professionally redesigned to enhance our "web presence." We are planning new publicity campaigns for Fall 2009 announcing our new building and its facilities. When the new chair is appointed, we anticipate launching a new semiannual department newsletter to circulate to our alumni and heads of other BME departments around the country.
- (e) Prepare a planning document for a new rehabilitation-engineering center at NCSU. *Status:* Space for the new center has been designed and is currently being constructed. Our position for a full professor in rehabilitation engineering remains open. Attracting a leader for the center remains a top priority for the department. This planning effort is awaiting the installation of our new department chair.
- (f) Prepare a training grant in collaboration with the BME Industry Liaison Committee. *Status:* The department is continuing to seek opportunities for new training grants to be centered at NCSU and UNC. Preliminary proposals for two IGERTS were submitted in the last year.

(g) Finish the design for renovated BME space in the Mary Ellen Jones building on the Chapel Hill campus. *Status:* During the negotiation for space by the new chair candidates, the future home for BME has moved from Mary Ellen Jones to the Biomedical Research Imaging Center. This new building will be completed in 2013 or later. The new chair will be negotiating for this space and its specific design is yet to be determined.

(h) Continue discussions with the Alfred E. Mann Foundation for Biomedical Engineering about establishing an Alfred E. Mann Institute (AMI) at UNC-NCSU. *Status:* With the recent downturn in the economy, Alfred E. Mann has suspended creating any new Institutes. Our future chances of renewing this opportunity appear to be very remote.

## **DIVERSITY**

We made attempts to increase the diversity of applicants in the pool of candidates by advertising widely and soliciting candidates through our current female and minority staff members. We also have hosted future minority candidates through the NCSU Office of Equal Opportunity. Those efforts will help in future recruiting years. It is fair to say that minority PhD candidates with the proper credentials in biomedical engineering are very few in number and continued focus on this effort will be needed every year.

## **UNDERGRADUATE PROGRAM**

*Enrollment Trends.* The enrollment history for our ABET-accredited BS-BME at NC State is as follows:

Academic Year	Enrollment	Degrees awarded
2004-05	113	33
2005-06	129	34
2006-07	138	36
2007-08	116	45
2008-09	143	45

*Instructional Program Advances.* Our curriculum continues to be improved using ABET processes. Two weaknesses were identified and addressed.

1. Students following the bioinstrumentation area of emphasis were not adequately prepared for upper level instrumentation courses. To address this problem, a new course, BME 210 Biomedical Electronics, was created. The course will replace ECE 331 and a separate one hour circuit lab in the curriculum. By tailoring the course to BME students, it is possible to give BME students exposure to digital circuits and A/D and D/A sampling needed to accurately measure biopotentials and to eliminate some topics taught in ECE331 such as AC motors, transformers and polyphase power that have little relevance for Biomedical Engineers.

2. Students in the Biomaterials and Tissue Engineering area of emphasis were not receiving adequate exposure to tissue engineering. After careful review of the curriculum, the CCC determined that sufficient exposure to tissue engineering necessary to develop a moderate level of proficiency was not possible within the credit hour limits of the major. In response, the Biomaterials and Tissue Engineering area of emphasis was renamed to Biomaterials to more accurately reflect the course content. To allow interested students to study Tissue Engineering, a Tissue Engineering minor was developed. The minor is open to all BME students regardless of

their area of emphasis as well as to students in other engineering majors. In the process of developing the Tissue Engineering Minor, two new courses were developed and piloted. Tissue Engineering Technologies is a lab course that was taught with the support of BTEC. In the course, students grow epidermal cells, induce differentiation, analyze angiogenesis potential of the tissue, and learn how to make histological measurements. Tissue Engineering Fundamentals is a lecture course that exposes students to the engineering fundamentals involved in tissue engineering and the state of the art of tissue engineering technology.

### ***Student Honors***

Jennifer Puetzer	COE Scholarly Achievement Award
Anna Godwin	COE Citizenship and Service Award
Jennifer Puetzer	NSF Graduate Research Fellowship
Peter Hamilton	NSF Graduate Research Fellowship
Amy West (class of 2008)	NSF Graduate Research Fellowship
Nicole Lewis	2009 Undergraduate Research Symposium Award
Pavak Shah and Daniel Jeck	Plexus Entrepreneurship Award (featured on front cover of Sunday Raleigh News and Observer)
Robert Bedsole	Caterpillar Top Ten Scholar Athlete
Pavak Shah	ICSU Award for Excellence in Undergraduate Chemistry
Jennifer Boyd	Whitaker Foundation Fellowship
Elliot Greenwald, David Zilber, Omar Awan and Swarna Solanki	Finalists for the national Student Design Competition sponsored by RESNA

### ***Student Scholarships***

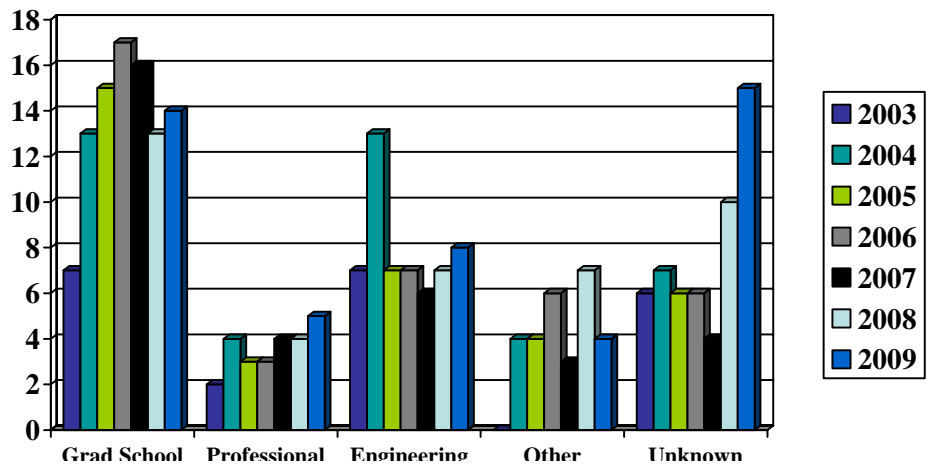
Ashley Hilton Winfree, Sonya Vipul Patel, Suman Medda, Delissa Adams, Monica Martin - Park Scholar  
 Helen Marinas Aboulhosn - John McCarter Engineering Scholarship  
 Kristen Lee Garrison - Engineering Merit Award Scholarship  
 Anna Kathleen Godwin - Syd B. Alexander College of Textiles Scholarship  
 Anna Kathleen Godwin - Rotary Club "Service Before Self" Scholarship  
 Anna Kathleen Godwin - State Employees Credit Union "People Helping People" Scholarship  
 Brittany Paige Johnson - Louis S. Whatley Scholarship  
 Brittany Paige Johnson - Raleigh Wesley Foundation McGlamery Scholarship  
 Brittany Paige Johnson - W.C. Billy Creel Memorial Scholarship  
 Elizabeth Rose Sommerville - Howard Hughes Medical Institute Research Scholar  
 Meredith Thompson - Freshman Academic Enhancement Scholarship  
 Meredith Thompson - NC Education Lottery Scholarship  
 Riley Thomas Zeller-Townson - Joseph D. Moore Scholar  
 Margaret R. Widmyer - Caldwell Fellow  
 Ashley Hilton Winfree - Phi Kappa Phi Study Abroad Scholarship

***Student Organizations and Activities.*** Professional society relations are maintained with the following organizations:

IEEE – Institute of Electrical and Electronics Engineers

**Cooperative Education Program.** Students in the BME Program are encouraged to participate in a summer internship experience. Students choose either a research or industry-based experience. This summer, ten students are participating in a summer research program and thirteen students are participating in an industrial internship. Two students are participating in the traditional Co-op Program offered at NC State.

**Career Placement.** After completing a 4-year degree, BME graduates enter graduate school, medical or professional schools, and have accepted engineering industry positions. The chart below summarizes our placement data for the Class of 2009. Note that our students choose graduate school above industry (engineering), and industry above professional schools. Historically, the national trend has been a more even split between these three choices.



**GRADUATE PROGRAM**

Our Joint Graduate Program was established in August 2003, and since that time, we have awarded approximately 105 degrees (some from the earlier program at UNC Chapel Hill) as shown in the following Table.

Date Awarded	MS	PhD	Total
12/31/2003	3	1	4
5/9/2004	2	2	4
8/16/2004	3	5	8
12/30/2004	7	2	9
5/15/2005	1	2	3
8/9/2005	2		2
12/30/2005	6	2	8
5/14/2006	1	2	3
8/09/2006	4	2	6
12/20/2006	1	7	8
5/13/2007	6	10	16
8/08/07	3	4	7
12/18/2007	4	3	7
5/10/2008	4	3	7
8/13/2008	2	2	4

12/17/2008	2	3	5
5/9/2009		4	4
Grand Total	50	55	105

Approximately 85 students at UNC and NCSU were enrolled in the Joint Graduate Program for 2008-2009. 15 new students joined the program, 14 at the PhD level and 1 at the MS level for 2008-2009.

**Instructional program advances.** Summary of curriculum and program actions for the year -

- *Core Topic Course Approvals:* BME 551 Medical Device Design was added to the core topics list under a new category of “Medical Devices.” BME 543 Cardiovascular Biomechanics was added to the core topics list under the category of “Biomechanics.”
- *Curriculum Summary Changes:* Curriculum summaries were changed to reflect modified requirements for PhD-level courses. PhD students must now have twelve credits of PhD-level coursework. The old requirement was stated as “four PhD-level courses.” Similarly, the MS requirement is now stated as three credits of PhD-level coursework.
- *Policy on students pursuing degrees as employees of companies and doing work-related research:* While the universities develop their own policies on this, the committee agreed that BME’s standard should be that the work should be publishable, both of publishable quality and free enough from proprietary restrictions to be published. To protect all parties, the committee recommended that any such students should develop a detailed research plan very early in the student’s career.
- *Stipend Structure:* The committee determined that it will recommend uniform graduate student stipends and adjust them each year. Initial stipend levels were established.
- *Change to Definition of Math Requirement:* The committee continues work on a modified math requirement for all grad students.
- *Continuing Work Items:* The committee continues to work on ideas for streamlining the written preliminary exam process and a non-thesis MS degree.

**Graduate Student Awards and Honors**

Josephine Bodle, Ryan Gessner, Amy West - NSF Fellows

Karthik Sekar, Michael Lee Williford - Alpha of North Carolina Chapter of Phi Beta Kappa

**Graduate Student Career Placement**

	Engineering/Med	Bioengineering		
MS	School/Postdoc	Industry	Other	Unknown
2006	4	4	1	2
2007	2	4	2	2
2008	5	2	1	2
PhD				
2006	1	1	1	3
2007	9	9		3
2008		7		1

## DEPARTMENT AWARDS AND HONORS

### **Faculty Awards and Honors**

Caterina Gallippi - Center for Women's Health Research Award for Excellence  
 David Lalush - College of Engineering's Outstanding Teacher Award  
 Elizabeth Lobo - NCSU Faculty Research Award, Chapter of Sigma Xi  
 Peter Mente - NC State's Alumni Distinguished Undergraduate Professor Award  
 Troy Nagle - Alexander Quarles Holladay Medal for Excellence, NC State University  
 Roger Narayan - 2008 Faculty Research Award, NC State Chapter of Sigma Xi  
 Roger Narayan - Structural Materials Division JOM Best Paper for 2009  
 Bruce Oberhardt and Don Wilson (affiliates) - Fellows of AIMBE  
 Glenn Walker - Coulter Foundation Award

### **Staff Awards and Honors**

Iris Holt - UNC's Star Heel Award  
 Lesley Hubbard - NC State's 15-year Service Award  
 Stefan Ufer - NC State's 10-years Service Award  
 Susan Bernacki - NC State's 5-year Service Award

### ***Courses Taught***

	Number	Title	Instructor	Enrollment*	UG
Fall 2008	BMME 400	Intro to BME	Quint	50	
	BMME 510	Biomaterials	Banes/Narayan	10	4
	BMME 515	Intro to Systems Biology	Gomez	3	
	BMME 560/BME 560	Medical Imaging: X-ray, CT, Nuclear	Lalush	12	
	BMME 570	Genes to Tissues	Banes	12	
	BMME 580	Mirocontroller Applications I	Goldberg	5	28
	BMME 589	Systems Physiology	Tommerdahl	12	
	BMME 730	Digital Signal Processing II	Favorov	4	
	BMME 765	Instrumentation II	Hsiao	6	
	BMME 890	Cardiac Medical Devices	Knisley	1	
	BMME 890	Medical Device Design I	Finley	1	
	BME 541	Biomechanics	Mente	2	15
	BME 543	Cardiovascular Biomechanics	Steele	1	4
	BME 522	Medical Instrumentation	Hsiao	9	
	BME 551	Medical Device Design I	Nagle	6	
	BME 790G	Physiologic Control Systems	Steele	2	
Spring 2009	BMME 465	Biomedical Instrumentation	Knisley	2	32
	BMME 505	Biomechanics	Gross	6	16
	BMME 532	Microelectrode Techniques	Knisley	3	9
	BMME 581	Microcontroller Applications II	Goldberg	0	6
	BMME 770	Functional Genomics Methods	Banes	4	

	BMME 790	Systems Physiology II	Tommerdahl	11	
	BMME 795	Info Proc CNS	Tommerdahl	2	
	BMME 840	Rehabilitation Engineering Design	Goldberg	1	6
	BMME 890	Reverse-engrg Biological Networks	Gomez	6	
	BMME 890	Bioimaging Practicum	Dayton	9	
	BME 512	Biomedical Signal Processing	Lalush	6	4
	BME 525	Bioelectricity	Cartee	4	17
	BME 590G	Tissue Engineering Fundamentals	Gamcsik/Bernacki	2	4
	BME 790T	Tissue Mechanics	Mente	5	

**Seminars.** The department offers a wide variety of seminars to the research community. BME faculty give annual reports on their research activities. Visitors give reports at the invitation of BME faculty members and the BME Seminars Committee. Potential collaborators from the clinical departments at the UNC School of Medicine give summaries of unmet needs in clinical applications. These clinical seminars frequently lead to new research project working groups. Developing multidisciplinary research teams that span both universities is a primary mission for the Joint BME department. Eighteen seminars were conducted over the last year as listed below:

Dr. Molly Stevens, Institute of Biomedical Engineering at Imperial College, London; 6/18/2008;  
 “Bio-inspired Materials for Tissue Regeneration and Biosensing”

Caterina Gallippi, PhD, Joint Department of Biomedical Engineering; 10/16/2008;  
 “ARFI Ultrasound for Detection and Characterization of Atherosclerotic Plaques, In Vivo”

Elizabeth G. Loba, PhD, Joint Department of Biomedical Engineering; 9/11/2008;  
 “Functional bone tissue engineering via electrical stimulation of adipose-derived human mesenchymal stem cells using conductive, electrospun, nanocomposite scaffolds”

Jeff Macdonald, PhD, Joint Department of Biomedical Engineering; 10/16/2008;  
 “Mechanisms of Alcoholic “Wasting” Disease”

Michael Vanauker, PhD; Department of Internal Medicine, University of South Florida; 11/6/08;  
 “Engineering Approaches to Cardiovascular Disease, from the Neonatal to the Geriatric”

Dr. Anshu Mathur; Depts. of BME and Reconstructive Plastic Surgery, The University of Texas Anderson Cancer Center; 12/5/2008; “Regeneration of Tissues via Engineered Biologics”

Brooke Steele, PhD; Joint BME; 1/15/09; “Developing tools for the quantification of hemo-dynamics from angiographic data to do computational analyses for clinical decision-making”

Todd C. McDevitt, PhD; Department of BME, Georgia Institute of Technology; 2/11/2009; “Engineering Pluripotent Stem Cell Technologies”

Dr. Kate Veness-Meehan; University of North Carolina Department of Pediatrics; 2/16/2009; “Clinical Needs in Neonatal-Perinatal Medicine”

Dr. Charles Scarantino; Rex Cancer Center; 2/23/2009;  
 “Clinical Needs in Radiation Oncology”

Dr. Mark Farber; University of North Carolina Department of Surgery; 3/16/2009;  
 “Clinical Needs in Vascular Surgery”

Richard M Davis, MD; University of South Carolina Department of Ophthalmology; 3/19/2009; “Remote Retinal Assessments in Patients with Diabetes: A Need for Cost-effective Technologies”

Diane Holditch-Davis; Duke University Medical Center Department of Nursing; 3/23/2009;  
 “Clinical Needs in Neonatal Intensive Care”

Dr. Catherine Hammett-Stabler; UNC Dept. of Pathology & Laboratory Medicine; 3/30/2009;  
 “Clinical Needs in Clinical Chemistry”

Nancy Allbritton, M.D., Ph.D.; University of North Carolina Departments of Chemistry & Pharmacology; 4/2/2009; “Exploring Single Cells with Microanalytical Tools”

Dr. Helen Hoenig; Durham VA & Duke University Medical Center; 4/6/2009;  
“Clinical Needs in Rehabilitation”  
Dr. John van Aalst; University of North Carolina Department of Surgery; 4/13/2009;  
“Clinical Needs in Plastic Surgery”  
Hadley Callaway; Raleigh Orthopaedics and UNC Department of Orthopaedics; 4/20/2009;  
“Clinical Needs in Sports Medicine”

## **MEMBERS OF THE BME FACULTY AND STAFF**

### **UNC**

Albert Banes, Professor  
Bob Dennis, Associate Professor  
Oleg Favorov, Research Associate Professor  
Charles Finley, Associate Professor  
Caterina Gallippi, Assistant Professor  
Richard Goldberg, Research Associate Professor  
Shawn Gomez, Assistant Professor  
Henry Hsiao, Professor Emeritus  
Stephen Knisley, Professor  
Jeff Macdonald, Associate Professor  
Roger Narayan, Associate Professor  
Stephen Quint, Research Associate Professor  
Mark Tommerdahl, Associate Professor

Harriett Brewer, Accounting Tech  
Steve Emanuel, Lab Manager  
Iris Holt, Business Manager  
James Jordan, Joint Systems Administrator  
Haakil, Lee, Technical Director  
Nancy McKinney, Joint Student Services Mgr.  
Sharon Womble, Accounting Tech

### **NCSU**

Lianne Cartee, Associate Professor  
Paul Dayton, Associate Professor  
Michael Gamsik, Associate Professor  
Edward Grant, Professor  
David Lalush, Associate Professor  
Elizabeth Loba, Associate Professor  
Greg McCarty, Assistant Professor  
Marian McCord, Associate Professor  
Peter Mente, Associate Professor  
Troy Nagle, Professor/Founding Chair  
Hatice Ozturk, Associate Professor  
Brooke Steele, Assistant Professor  
Glenn Walker, Assistant Professor

Rekha Balasubramanyam, Business Manager  
Susan Bernacki, Operations Manager  
Steve Callender, Lab Manager  
Stephanie Gootnick, Accounting Tech  
Richard Green, Asst. Systems Administrator  
Lesley Hubbard, Student Services Assistant  
Stephan Ufer, Operations Manager  
Jack O’Daly, Joint Director of Research

## **RESEARCH PROGRAMS**

The BME department’s research office, under the direction of Jack O’Daly, manages our contacts and grants as well as the operation of our core facilities. The office also organizes our seminars program.

**Grant Submissions.** Over the last year, 24 BME faculty members (up from 19) submitted 93 research grant applications (up from 70) and in this same period 31 research grants were awarded. This gives an annual success ratio of 0.333. The fiscal year 2008/09 research grant awards were valued at \$2,948,385 (up from \$2,519,098). As we achieved in fiscal year 2008/09, in 2009/10 we expect to at least maintain our success ratio while increasing the number of submissions and awards.

**Active Research Projects.** The department is engaged in a wide range of biomedical engineering research projects. Our primary areas of research are biomechanics, tissue engineering and biomaterials, metabolomics and functional genomics, biomedical imaging, systems biology, medical devices, rehabilitation, biorobotics and medical textiles. A complete list

of the active research projects for 2008/09 may be found on our website (<http://www.bme.ncsu.edu/research/projects.html>).

**Research Facilities.** The department faculty and students have access to a wide range of facilities to support research in biomedical engineering:

*U.N.C. Based Facilities:*

Name	Activity	Faculty Contacts
Biomechanics Laboratory	Evaluation of synthetic biomaterials for clinical applications	Paul Weinhold
Biomedical Instrumentation Laboratory	Senior Design facility	Richard Goldberg, Henry Hsiao, Steve Quint
Cardiac Electrophysiology Laboratory	Optimize the interactions of the electric current with biological tissue	Stephen Knisley
Cochlear Implant Laboratory	Basic science, engineering design and clinical application of cochlear prostheses for the severely and profoundly hearing impaired	Charles Finley
Vascular Dynamics Laboratory and Fontan Research Group	Determining optimal vascular configuration and optimal configuration of the total cavopulmonary connection (TCPC) for long-term use	Brooke Steele
Metabolomics Laboratory	Non-invasive analysis of biological systems by NMR and MRI; generation of metabolomic data; bioartificial liver and other tissue models	Jeff Macdonald
Systems Neuroscience Laboratory and Cortical Information Processing Laboratory	Determine mechanisms involved in cortical information processing; study responses evoked by tactile stimulation	Mark Tommerdahl, Oleg Favorov
Tissue Engineering Systems Laboratory (TESLa) and Biomechanical Motors Laboratory	Musculoskeletal and cardiovascular functional tissue engineering, tissue culture bioreactor development, bio-hybrid robotics, prosthetics, and biomechatronics	Robert Dennis
Ultrasound Imaging Laboratory	Advanced ultrasonic imaging methods for signal isolation, noise reduction, velocity measurement, motion tracking, contrast agents, and ARFI imaging	Caterina Gallippi, Paul Dayton

*N.C. State Based Facilities:*

Name	Activity	Faculty Contact
Tissue Engineering Laboratory	Develops new technologies in musculoskeletal functional tissue engineering	Michael Gamcsik
Biomedical Imaging Laboratory	Designs and fabricates prototype biomedical imaging instruments	David Lalush
Biomedical Instrumentation Lab	Designs and fabricates prototype medical instrumentation units	Troy Nagle
Biomedical Microsensors Laboratory	Designs and fabricates sensors using microfabrication technologies for use in medical applications	Greg McCarty
Cell Mechanics Laboratory	Focuses on understanding the effects of mechanical stimuli on cell function and differentiation	Elizabeth Lobo

Center for Robotics and Intelligent Machines	Fosters increased interaction in the interdisciplinary technologies of advanced robotics and intelligent machines research	Edward Grant
Tiny Biotools Laboratory	Characterizes the effect of different microenvironments on cell culture and develops microfabricated tools that allow new biological questions to be asked	Glenn Walker
Tissue Mechanics Laboratory	Provides access to state-of-the-art mechanical testing capabilities for the use of the faculty and students for the university and industrial community	Peter Mente

**FINANCIAL SUMMARY**

At UNC, contracts and grants increased by 45.4% from FY 2007/08 to FY 2008/09. Our total expenditures for the year 2008/09 are estimated at \$3.53 million, with \$1.13 million in expenditures in Contracts & Grants. Overhead expenditures account for 8 % of overall expenditures in 08/09, or approximately \$286K. Overhead return totaled \$32,005 or approximately 12.6% of indirect costs generated in 2007/08.

The NC State budget is primarily funded by state dollars with total expenditures in FY 2008/09 across all accounts totaling \$4.23 million. Because the department is still primarily new, the junior faculty are writing grants and we anticipate the contracts and grants to increase over the next couple of years. Overhead expenditures include the release time return dollars from the College of Engineering that go to the faculty to spend. We received \$5,455 in overhead return from the Dean’s office or approximately 8.3% of the indirect costs generated in 2007/08.

Expenditures across both campuses totaled approximately \$7.75 million dollars in FY 2008/09 with the breakdown by sources shown below.

**Joint Dept 2008/09 Expenditures by Source**

