

Joint Appointment Personifies New Engineering Approach

by Alan Flurry

When exploratory committees and review panels from the Faculty of Engineering first conceived of putting together the faculty and facilities that would bring the initiative to life, they had to remind themselves to think beyond conventional disciplinary limits. For only in doing so could they identify and bring to campus those young researchers who would fulfill the promise embodied by the Faculty of Engineering: to complete UGA as a major research institution by establishing a dynamic and boundaryless nexus for its past investments to its future ambitions.

MEET ANDREW SORNBORGER. The newest Faculty of Engineering hire, Andrew arrived in Athens this fall semester as a joint appointment with the College of Arts & Sciences in the Math department, bringing with him the diverse academic background and convergent research interests that exemplify the UGA engineering concept of building a fluency across disciplines. With him, this fluency could be taken literally. As an undergraduate at Dartmouth, Andrew was able to set up a special major in computational linguistics, inserting a practical element to his course study in languages with computers and artificial intelligence. He learned Mongolian during a summer studying abroad, as well as Chinese and German. "I love languages and since then I've taught myself to read Italian and I'm trying to learn Russian and little bit of Spanish right now," he says. "It's been a lifelong interest of mine and it just happened to end up being my major."

Doesn't quite sound like a future engineer. Perhaps that's the point - that building this faculty could be a path to the future of engineering.

"Meeting our needs and the needs of the math department was not the intent of this position," says E. Dale Threadgill, Director of the Faculty of Engineering. "In creating this new position, we resolved to alter the dynamic so as to establish convergence across the interface of engineering and mathematics at UGA."

After college, Sornborger worked two years at Wang Laboratories only to discover that programming day after day would not bring the intellectual satisfaction he sought. So, having discovered an interest in astronomy as an undergrad, he turned his attention towards physics. Dartmouth had provided a good background in math but Andrew moved back home to Providence to take some undergrad classes in physics at Brown University. "Then I got into Brown grad school and ended up doing theoretical physics and studying cosmology," he says. After taking a PhD in cosmology he went to Cambridge for a post-doc and then to Fermilab, outside of Chicago, for another. But the sub-field of cosmology he was working in was slowly becoming obsolete at

the same time Sornborger's interests were continuing to coalesce. "I realized that I wanted to be working a little more closely with data, a little closer to real life."

In pursuit of work which held the promise of a little more impact, Sornborger, newly married, moved to New York and started working again as a post-doc at Mt. Sinai Medical School, in a



Andrew Sornborger

group concentrating on neuroscience, primarily from a theoretical perspective. "I was in an applied mathematics group in the biomathematics department," he says. The group performed analysis of imaging data taken of the brain. This melding of several particular facets of mathematics and physics with an application in biology marked the beginning of his current career. "I was using the mathematics, but applying it to the analysis of bioimaging data," Sornborger recalls with

the clarity that illuminated his path and eventually led him to the UGA Faculty of Engineering.

The notion of students winding their way through various courses of study to arrive later at one which weds their past experiences together is not a new one. In fact, it could be said that this tack, which is the backbone of the liberal arts educational model, remains the best model for not only creating scholars - by allowing them to discover and refine their own interests - but is the best way to optimize their talents. It has only been during the age of specialization, in which higher education has become more job-driven and vocation-oriented, that this idea has been sidetracked. And even then it has not been without its successes.

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Paradigm Shift Toward New Approach

Tight budgets and expanding programs don't always go hand in hand, but the state of American science and engineering education is witnessing a paradigm shift that puts fiscal constraints into perspective. The recent seven-figure NSF grant award to Faculty of Engineering researchers along with presentations and discussions at NSF, NIH and ABET conferences reveal a changing reality in the engineering world. Engineers that will be needed in the future, and hence the way engineering should be taught in the present, must develop a multi-faceted expertise that can produce imaginative and innovative solutions that transcend traditional disciplines.

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Pharmaceutical Bioengineering

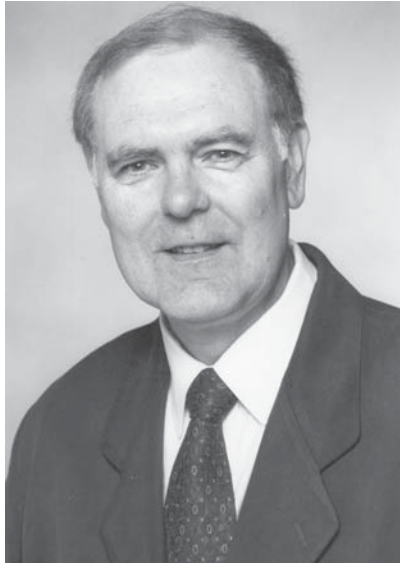
By Svien Øie

As a faculty member at the University of California, San Francisco, Svien Øie was intimately involved in the formation of the joint bioengineering department between UCSF and UC Berkeley. Currently the Dean of the College of Pharmacy at the University of Georgia, Dean Øie is working with the Faculty of Engineering on the collaborative groundwork for Pharmaceutical Engineering at UGA through two joint appointments between Pharmacy and Engineering.

To effectively meet the academic mission today, it is imperative to embrace an interdisciplinary approach when planning for the discovery and dissemination of new knowledge and the development of new technologies and products. Engineering is uniquely positioned to take advantage of this new model. In particular, Bioengineering has the exciting potential of becoming an outstanding center of excellence in the application of engineering sciences and technologies to biological and medical sciences. Here we have a melding of biology, medicine, chemistry, material sciences, computer technology and engineering that has not only created new products and research but is poised to revolutionize medicine and technology. The rapid growth of this area can be placed squarely on the willingness to abandon the protection of individual research disciplines to create true interdisciplinary teams and ventures.

As a junior faculty member at my previous workplace, the University of California, San Francisco, I followed closely the development of a joint graduate program in bioengineering between UC San Francisco and UC Berkeley that ultimately led to a world class program. Subsequently, I had the privilege of actually being involved in the establishment of the Department of Bioengineering centered in the College of Engineering at UC Berkeley but functionally operated as a joint program with UC San Francisco to take advantage of its strong biomedical programs.

During the eighties and nineties, UCSF had a number of faculty eager to improve the diagnostic tools in Medicine, as well as identifying a means to improve tissue regeneration and prostheses. Individual departments at UCSF started to hire research



Dean Øie

engineers to help with these endeavors. The combined groups of basic science faculty in molecular biology, and biophysics together with the new engineers and clinical scientists quickly realized their potential, as well as the need to engage additional engineering faculty in biomechanics and robotics at UC Berkeley. This synergy resulted in the creation of the first bioengineering interest group that spanned not

“biology, medicine, chemistry, materials science, computer technology and engineering... poised to revolutionize medicine and technology.”

just different schools but two universities. What quickly followed, through faculty initiatives, was a joint graduate program in bioengineering. The bioengineering graduate program currently involves 142 faculty members with 54 members at Berkeley and 88 in San Francisco ranging from such diverse

fields as dentistry, medicine, pharmacy, vision sciences, molecular biology, engineering and chemistry. The program currently has 60 graduate students divided between the two universities. Research areas cover computational biology (bioinformatics), biomaterials, biomechanics, biomedical imaging, biomedical instrumentation, bioMEMS and nanotechnology, robotics, drug delivery systems, neural system analysis, tissue engineering and vision.

I believe that similar collaborative opportunities exist here at UGA, and Pharmacy is looking forward to becoming an active partner in such a development. With the recent approval of two jointly funded positions in pharmaceutical bioengineering, between engineering and pharmacy, we are taking the first step in making this a reality.

Pharmacy is focusing its research along the lines of drug discovery, drug development, experimental therapeutics and pharmacy care administration. In the area of drug discovery and drug development, significant opportunities exist for collaboration with engineering. Development of new screening methods of drugs; new automated methods for developing chemical libraries using a non-traditional scaffold; development of genetically modified cell culture for screening; using biosensors and intelligent delivery methods for new dosage forms, and the use of nanotechnology and structures for specific targeting at the tissue, cellular and subcellular level are potential interest areas. In addition, biological engineering of new approaches to produce complex pharmaceutically active compounds, processing of pharmaceuticals and the development of new methods for rapid screening of metabolic and kinetic behaviors are also areas that offer great potential. Success in these areas will depend upon the successful incorporation of genetics and proteomics, molecular engineering, structural biology, material sciences, pharmacology, electronics, polymeric sciences and nanotechnology.

To help build these interdisciplinary activities, Pharmacy is not only developing a joint program with engineering, but it is also getting ready to launch a drug discovery center that will facilitate opportunities for faculty at UGA, MCG and elsewhere having an interest



in drug discovery to interact. Engineering is a key component to the success of this endeavor.

To be successful we must also develop better accessibility to medical centers and biomedical research centers. As a first step, Pharmacy has worked to strengthen the link with medicine through the placement of clinical and research faculty at MCG, clinical faculty at Albany State University and Phoebe Putney Hospital in Albany and clinical faculty at Memorial and St Joseph/Candler hospitals in Savannah. We believe these connections will enhance the opportunities for exciting research and training for engineers in the biomedical field with a special focus on pharmaceuticals. We are extremely enthusiastic about all the possibilities this new endeavor provides and look forward to your participation.

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To observers of the UGA Faculty of Engineering, this approach is not a new one – but its acknowledgement does lend credence and momentum to the shift. That our physicists, biologists, engineers and ecologists see themselves as part of something larger going on at the University of Georgia is as integral to the future success of the institution as new buildings and a diversified student body. An engaged, forward-looking approach such as that defined by the Faculty of Engineering – highlighted in these pages – affects every aspect of an institution from curriculum to development to public relations to research and licensing. As it gains currency with the larger education community, political obstacles in its path will begin to fade; with the whim of fashion, some may even seek to become its champions. But hiring the men and women, integrating the courses, leveraging strengths with ingenuity that ultimately results in proffering degrees in vital new fields and bridging interminable chasms with new discoveries must continue. New labs, new professors and new courses – the new engineering approach is seeping into and around the entire campus. It's happening; and it's happening because of your involvement with this unique approach.

ABET Conference Considers Emerging Technologies, Blurring Disciplines

The Accreditation Board for Engineering and Technology (ABET) held its annual meeting in Minneapolis the last two days of October. The conference was fittingly titled Face the Future as its subtexts were the future of engineering education and the ambiguities of the changes occurring therein that are the accreditation Board's most complex challenges as it looks toward 2020. ABET's international eminence attracted attendees from Europe and the Far East. The lead speaker of the Emerging Disciplines/Blurring Boundaries session, Brahm Verma from the UGA Faculty of Engineering, presented a case study for re-organizing ABET, framed around the evolution of biological engineering.

ABET is going through a reassessment of how to evaluate academic programs in the fast-changing disciplines as they find it more difficult to identify what determines the quality of individual programs. In the past, controlling professional societies like ASME provided

and other attendees to make sense of the issue and the ramifications of potential solutions.

Verma offered his own particular insights from within the evolution of biological engineering over the last sixty years, concentrating on the especially fluid period between 1985 and the present. "The idea of emerging disciplines and blurring boundaries sounds like an oxymoron. But what appears to be contradictory is not, at a higher level of thinking," he recalled later. In his talk he introduced the idea of fluency – the transfer of mass, energy and information among entities – and creating a network similar to what happens in living systems. "A network is what creates the organism, so we have to mimic these principles in our own design," he said.

Using the Faculty of Engineering as an example, Verma urged the usage of the network analogy to suggest the Board's direction. What are the outcomes sought by a particular institution? By answering, ABET can then assess whether the desired education is of sufficient content and rigor to warrant a B.S. degree. Determining who will make these assessments lays in the fabric of building a

Building a network based on fluency

benchmarks as per how mechanical engineering programs and institutions should be assessed. But a dearth of controlling societies for emerging disciplines – which do not have conventional boundaries – is presenting the Board with new challenges of cross-disciplinary instruction. ABET, a federation of 31 professional and technical societies, is the recognized accreditor of not only engineering disciplines but also non-engineering disciplines, whose educational parameters, much less their professional societies, have yet to be fully formulated.

The complex multi-dimensionality of Nanotechnology, mechatronics, geomatics and bioinformatics, just to name a few, was posited at the conference as "the greatest challenge ABET has ever faced". Historical considerations, technological nuances, linguistic facets and sociological factors all contribute to the enormity of the challenge. Topical experts conferred with ABET leaders

network and presents a clearer path for the Board to reorganize without rendering the present system obsolete. The goals and concepts of the Faculty of Engineering are certainly out in front of its governing body; that is to be expected. But it should also be the reason that institutions like it be the primary resources for making sure accreditation keeps up with innovation and change at the leading edge of research and instruction.

In early October, a team from ABET spent a week at UGA. The team interviewed faculty, students and administrators to provide a comprehensive review of the engineering programs that comprise the degrees offered at UGA.

The extent to which ABET is taking these changes seriously and engaging experienced faculty for constructive input is a good sign. When he asked in his presentation, "Biological Engineering – what will it be?" Verma could just as well have been reflecting on the future of the accrediting board itself.

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But those who can envision the future challenges of technology, politics and human progress have realized that specialized pedigrees will be particularly ill-suited to meet those challenges.

In an example of research where mathematics informs engineering, Sornborger is involved in a particular type of correlation analysis that will enhance brain imaging experiments that he is undertaking. "It's a good way of de-noising your data, and it's applicable to spectroscopic imaging in general. The new brain imaging we're developing involves imaging two fluorophores, which have correlated activity," he says, explaining that understanding the correlated aspects of that activity helps give a better estimation of what is actually going on. "The same thing happens in some imaging data that has been collected of the heart; they look at the same fluorescent dye at two different wavelengths, and the interesting information is anti-correlated from these two movies - one gets light while the other gets dark."

Developing a method to extract this anti-correlation and leave everything else behind, Andrew admits, would be a very effective way of doing analysis. And as he describes the nature of applying the same method to two completely different subfields of biology, the nuances of collaborations and exposure to cross-disciplinary research become clear. He likely would not have been investigating these fluorometric methods for imaging the brain if not for working with others on imaging the heart. "Math ties everything together," he says, "it allows you to take something and abstract it down to the raw material, whatever the important logical pieces of a problem are."

Certainly, if there is an analogy between two systems, it will become obvious with a mathematical analysis of each. And just as mathematics finds applications in very disparate, even unexpected places, the mathematics of analyzing data is effectively an engineering discipline. "The kinds of methods we use in this work were developed in Bell labs for communications," Sornborger explains. "They focus on problems that people who care

about designing good systems, good engineering systems, have to worry about." He arrives knowing that UGA has established strengths in biological sciences and biological engineering, which he sees as an open avenue to connect his knowledge and intellectual curiosity to real scientific impact.

Progress for the Faculty of Engineering may be closely tracked by the faculty it is able to attract and the developments and discoveries that, through their work, become a part of its accomplishments. With this most recent hire, the UGA Faculty of Engineering demonstrates a commitment to the high standards of collaboration, networking and life-long learning put forth in initially seeking campus support. The search committee has expressed a preference toward these higher concepts and in doing so, perhaps Dr. Sornborger has found a home that hopefully will continue to challenge him for years to come.



THE FACULTY OF ENGINEERING
DRIFTMIR ENGINEERING CENTER
THE UNIVERSITY OF GEORGIA
ATHENS, GA 30602-4435
PHONE (866) ENGR.UGA / FAX (706) 542.8806
WWW.ENGINEERING.UGA.EDU

