PhysicsFocus

Bethel University Physics & Engineering Newsletter

Spring 2012
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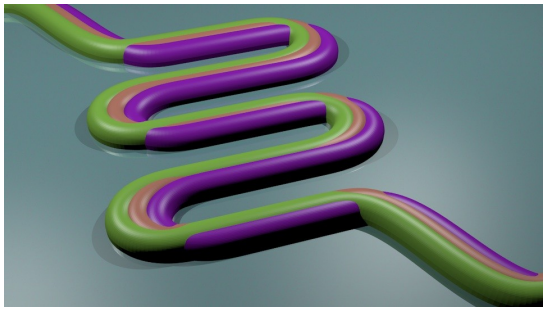
Volume 6, Issue 2

Inside this issue:

Department Plans to add Major in Biomedical Physics

During 2011, the Physics Department has worked hard at conceiving and designing a new major that builds on our strengths in engineering and applied physics and addresses an important issue facing our country today. Our goal is to help meet the growing need for people working in medicine, medical research, and biological sciences to understand physics and medical technology. As technology marches forward, a rapidly increasing number of applications are being found for health care. We have met with people in local industry, medical school, and academic research who are involved in the design and use of medical technology. As a result of these conversations and deliberations, the Physics Department is preparing to propose a new, innovative major called Biomedical Physics.

Biomedical Physics is essentially the application of physics and technology to medical and biological problems. It will prepare students for careers in physics-related health sciences. Three different emphases are envisioned:



An artistic rendition of a micro-fluidic bio-chip

Biomedical Engineering focuses on preparing students for industrial employment in the biomedical technology and health sectors.

Medical Physics prepares students for graduate study for careers in nuclear medicine, radiation oncology, and diagnostic radiology.

Clinical Medicine emphasizes preparation for medical school, with unique and outstanding academic credentials.

Our Biomedical Physics majors will be high-quality students who are confident that they can be effective in the biomedical and health care industry. Confidence for a graduating student is a key factor in getting started on a career, whether it be going directly to industry or moving on to a graduate program. Our majors will have the breadth of knowledge and learning experience that is inherent in a liberal arts education along with an outstanding background in science and technology.

Motivation

Current Student Interest

An increasing number of our students are going into health related fields. Last spring, we had seven graduates accept offers to various graduate programs in the fall of 2011. Of these, three accepted offers for Biomedical Engineering programs, two at the University of Minnesota and one at Idaho State. One of these graduates is also planning to continue on to get a medical doctorate—certainly a realistic goal. At least three current seniors have strong interests in biomedical technology—one has been taking courses like cell physiology as elective credits. Two

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Two Bethel Physics Majors Study Abroad in Europe

Recently, two of our very own physics majors, DJ Arend (‘12) and Stefan Jentoft (‘13), studied abroad in the United Kingdom. Their studies also led them to further travels in Europe, outside of the United Kingdom.

DJ traveled to the University of Edinburgh in Scotland for the fall semester of 2010. Stefan joined the England term trip with the English Department at Bethel. Both gained experiences that stretched them in new ways academically. These experiences, along with others, are found in their stories beginning on page 6.

"...the new Biomedical Physics major will provide a direct route to jobs in local industry with a firmer foundation in the sciences." -Dr. Beecken

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years ago, one physics major went straight to medical school and another went to Mayo Clinic in a biomedical doctoral program. There is already very strong current student interest., and this can be seen in four following articles in this issue related to biomedical engineering or applications.

National Trend

The emergence of biotechnology is a growing trend in the United States. Part of this is driven by the aging American population, but another important driver is the development of technological capabilities that are being applied to directly benefit human health. Now that the information technology revolution seems to be maturing, many prognosticators believe that the next new wave of growth will be in medical technology.

Local Strength in Biomedical Technology

The Twin Cities is very strong in the biomedical industry. In addition to employing a large fraction of the local engineers and scientists, companies like 3M, Medtronic, Boston Scientific, and St. Jude are world leaders. Such companies provide marvelous opportunities for collaboration in research and employment of our graduates.

Prospective Student Interest

In recent years, biomedical engineering has been one of the top interests of prospective engineering students at Bethel. The Physics Department already has a cooperative Dual-Degree Engineering program with the University of Minnesota that can lead to a Bachelor's degree in Biomedical Engineering, but the new Biomedical Physics major will provide a direct route to jobs in local industry with a firmer foundation in the sciences. In addition, there seems to be an increasing awareness that graduate work can be a significant advantage for many careers in the biomedical technology field. The Biomedical Physics major will provide a strong background for those who wish to pursue careers requiring graduates studies or medical school.

Timing and Expertise

In 2011, the Physics Department welcomed Dr. Nate Lindquist, who worked for Medtronic for a couple of years and has numerous local connections. Professor Lindquist is a tenure-track physics faculty member with a biomedical technology background. He describes his research area as "near-field optical imaging with applications in chemistry and spectroscopy and lab-on-a-chip fabrication with applications in biosensing."

Alumni

At our 2011 Spring Society of Physics Students Banquet, Dr. Melissa Terpstra was our featured speaker. Dr. Terpstra is a Bethel physics alumna with a Ph.D. in Medical Physics. As usual, the faculty set about compiling a list of local alumni to invite who would likely be interested in the speaker's topic. Very quickly the list of those who work in biomedical technology became far more than we were able to invite—causing us to realize how many students are already choosing to pursue careers for which the new major would intentionally prepare them. Additional stories from alumni working in biomedical companies follow this article.

New Courses to be Created

PHY4XX *Biomedical Devices*

The physics and engineering of biomedical devices such as implantable sensors, perfusion sensors, optical, electronic, and mechanical sensing modalities, pacing and defibrillation, materials choices and biocompatibility, as well as chemical diagnostic instrumentation, surface plasmon resonance for proteomics research and drug discovery, Raman spectroscopy for biochemical detection, and "Lab on a Chip" technologies for emerging low-cost biosensing applications. The design and implementation of simple electronic circuits, optical networks, or microfluidic chips would be incorporated as a term project.

PHY4XX *Medical Physics*

Physics of diagnostic imaging and radiation therapy. Ionizing radiations and their interactions with matter, including human tissue. X-ray, computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), single photon emission computed tomography (SPECT), fluoroscopy and nuclear medicine. Control of X-ray beams for therapy. Specification of radiation beam and image quality. Radiation dosimetry. Protection against radiation exposure. Fourier and reference frame transformations. Labs will expose students to diagnostic instruments and require them to acquire images using at least one modality.

Conclusion

The chance to offer a new major in Biomedical Physics is a prime opportunity to tap into an area of strong student interest, build on existing departmental strengths, help meet a growing need in our country, and continue to be on the cutting edge of excellence in undergraduate physics.

**A formal, tentative listing of the Biomedical Physics major course requirements is given on page 13*

Bethel Alumni Work in Biomedical Industry in Twin Cities

In recent years, a significant number of Bethel's physics graduates have continued on into a biomedical-related career. Two of these alumni, Randy Kleinman ('03) and Lance Lohstreter ('01), both spoke at Bethel events this school year.

For the fall 2011 Sigma Zeta banquet, Lance and Bethel professor Ken Rohly presented the basic science behind the numerous varieties of microscopy that they use at Medtronic. Lance shared how freshman level courses in his B.S. in Physics provided much of the necessary knowledge to understand these methods of microscopy.

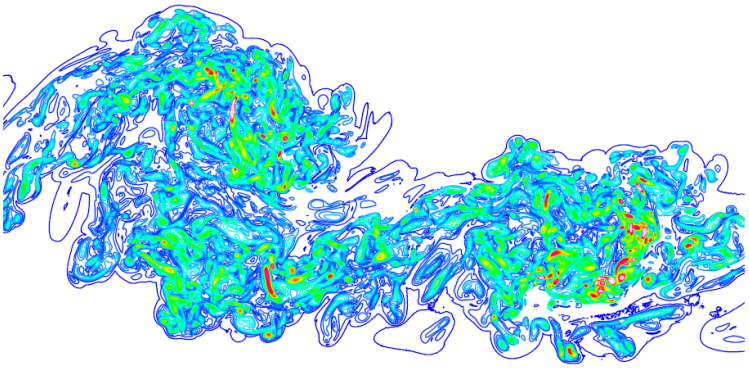
Last summer, current student Tony Burand ('13) interned with Lance's group. In addition, Randy shared his post-Bethel experiences at a luncheon event during interim. Their stories are below.

Randy Kleinman—From Bethel to Boston Scientific

I recently was invited back to the Bethel Physics department during the 2012 Interim session to talk to students about my experiences since graduating. On that day it had been 3155 days since I graduated with a B. S. in both Physics and Applied Physics ('03). It was a blessing to a part of the rich Physics tradition at Bethel, as well as have Dr. Beecken reminisce about a few of the traditions started by my classmates and me that are still a part of life around the lab (which include carving equations into pumpkins and photoshopping SPS officer campaign posters).

My journey after Bethel really began during my junior year when Dr. Stein joined as a professor. His research in parachute dynamics and introduction to computational science influenced my decision to pursue graduate studies in a very similar field. After Bethel graduation, my new wife and I moved to Champaign, Illinois, where I started the Ph.D. program in Theoretical and Applied Mechanics at the University of Illinois at Urbana-Champaign (UIUC). My research area in fluid mechanics was aeroacoustics focusing on jet noise reduction, the role of turbulence in noise generation, and numerical modeling of high-speed compressible flows. My research was entirely computational in nature. In order to study the fundamental mechanisms of jet noise generation, I developed several computer codes which computed massively-parallel fluid simulations on NASA and Department of Energy supercomputing resources around the country. My implementation of several optimization algorithms is still being used at UIUC as well as by a start-up company in Illinois. They have used it to study the jet noise from the new F-35 Joint Strike Fighter on aircraft carrier decks and for optimization of airfoil shape on windmills.

As time progressed, my interests began to include medical technology and software. Since 2009 I have been working in the medical device industry at Boston Scientific as a software engineer in St. Paul. My current position involves leading a team of engineers and being lead architect of several software testing automation tools and real-time web applications. Although I have still been able to continue work related to fluid mechanics elsewhere, I now am developing web applications with the same technologies used by the likes of Facebook, Twitter, and Apple.



Visualization of vorticity magnitude (a measure of fluid spinning) of a simulated compressible mixing layer at moderate Reynolds number. Fluid flow above the mixing region is travelling at Mach 1.3 and quiescent below. This simulation, which took 400 processors almost two weeks to compute the full time series, was part of a study of turbulence noise generation that showed that the largest flow structures in a jet generally radiate most of the noise.

While at Bethel during Interim, I was reminded of the first time I visited the Physics department. My father and I had just finished taking the tour of a different department that I was considering and decided to wander around campus afterwards. We finally ended up walking past the Physics department and were approached by a passing-by Dr. Peterson. A lab tour ensued. The depth and breadth of the Physics program that I

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Randy, his wife Karen, and their children Grace (5), Madeline (6), and Jack (2).

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saw that day and experienced in the following years at Bethel more than prepared me for graduate studies as well as a seemingly tangential career in software engineering in the medical device industry. Physics, like fluid mechanics, is a broad field with applications in many branches of science and engineering. Alongside my research in aeroacoustics, I also participated in research related to the flow of cells in arterial blood flow and the modeling of strong shock waves that are generated by a medical procedure (extracorporeal shock-wave lithotripsy) that is used to destroy stones in kidneys, bladders, and ureters. Relatively recent additions such as the Computer Methods course and the Applied Physics major were key to sufficiently preparing me for postgraduate studies outside of a traditional graduate Physics department, completing my Ph.D., and beginning a successful career in industry.

Lance Lohstreter Demonstrates Usefulness of Undergraduate Work at Medtronic

"...if a student truly understands and can apply what is in his freshman textbooks, he can go on to a successful and even distinguished career."
-Lance Lohstreter

I should have quit after my freshman year at Bethel. Or at least repeated it.

I work as an engineer/scientist at Medtronic, and after eight years on the job I have discovered something: most of the technical information that I use regularly I learned early on as an undergraduate. In fact, I contend that if a student truly understands and can apply what is in his freshman textbooks, he can go on to a successful and even distinguished career. The greatest value of going to graduate school, for me, was the chance to teach freshman Physics and, in doing so, to solidify my own understanding of that subject.

Throughout most of my time at Medtronic, I have worked in a Microscopy and Surface Analysis lab. I've been blessed to have access to state-of-the-art equipment to solve interesting problems in a noble industry. It is amazing to me that the most surface-sensitive chemical analytical technique in existence, time of flight secondary ion mass spectroscopy (TOF-SIMS), would make an entirely reasonable test problem for General Physics. A few simple equations,
KE = qV = 1/2 mv^2, provide the majority of what one needs to understand this highly sophisticated technique. I have found this to be generally true for the analytical work and overall science that goes on at Medtronic.

A director at Medtronic once told me he uses General Physics, General Chemistry, and basic statistics to a large extent, and if the work does not pass muster against those, he knows something is wrong. There is value in going on to gradu-

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ate school, but it is a different kind of value. Each year takes you further down a path of specialization. And the world needs specialists. But the undergraduate years are a chance to survey the landscape. Even if you have already chosen the map of physics or chemistry, there is much ground to cover in these broad topics.

My graduate advisor told me that you need a psychosis to get a Ph.D. He could say that as he had both the disease and the degree. I was apparently a bit too healthy, so I settled for my master's. It was a good path for me; one God had apparently laid out as I did not know any of this at the time. Undergraduates, learn well. The interesting stuff doesn't come later; it is happening now.

"The concepts I learned in my (Bethel) physics classes ... were the key to understanding how the machines work and my ability to interpret data results."

-Tony Burand

Tony Burand Interns at Medtronic with Lance Lohstreter

I started working fulltime as an intern with the Surface Analysis group at the Medtronic World Headquarters in Fridley the beginning of June. The Surface Analysis group works on many different projects, from research and development to problem solving for business units within the company. Simply said, they perform analysis on material surfaces. I was trained on the Scanning Electron Microscopes (SEM), X-ray Photoelectron Spectrometer (XPS), White Light Interferometer, Ellipsometer, and a Time of Flight Secondary Ion Mass Spectrometer. Specifically, I worked for Lance Lohstreter, but I also worked with the other members of his group. The primary goals set for me over the summer were to learn how to use the lab instruments, be able to take reliable data, problem solve, and interpret the data collected. Over the course of the summer, I learned how to operate these machines as well as how to quantize and interpret their results.

Within a few weeks after being taught how to operate the two SEMs, I was assigned my first independent project. Through this experience, I had to learn how to create a report and what to look for within my images. Another important skill I acquired was problem solving with respect to collecting data. I had to find creative ways to mount samples, test for specific physical properties of a material, and determine the best instrument to use for the task. I think the biggest help with learning these instruments and techniques was the patience and guidance Lance gave me, always pushing me towards becoming a more independent thinker and problem solver.

Medtronic's internship program also had social events planned for the interns through the summer. There were picnics and business luncheons with some of Medtronic's executives. I was also given an opportunity to represent Bethel University at the college fair sponsored by Medtronic. I had a great time with another intern from Bethel assembling a table and talking with parents and prospective high school students about Bethel and encouraging them to visit.

My background in physics had an important role in my internship. This opportunity was different from the typical internship. My internship was long term and included work on many projects, rather than only one. I also performed the same type of analysis as other physicists and chemists at Medtronic.

One of the things Lance really stressed was the importance of understanding how the machines work and how to interpret meaningful information from the data. For instance, the XPS is based on the photoelectric effect discovered by Albert Einstein. The XPS emits a beam of x-rays that hit the surface of a material and cause electrons to be ejected from the atoms in the material's surface. A detector then measures the energy of the electrons. The XPS's computer program then produces a plot of number of counts verses binding energy. From this data, the known binding energies of certain orbitals in atoms can be compared with the peaks in the spectrum to determine the elements present within the sample. If certain elements are bonded to other elements, a chemical shift will occur in the spectra. Based on the chemical shift, the compounds that are on the surface can be determined.

The concepts I learned in my physics classes, especially General Physics, Modern Physics, and Math Methods, were the key to understanding how the machines work and my ability to interpret data results.

Tony Burand, a junior double major in both Physics and Chemistry

"Bethel's Physics Department continually trains students to be adaptable learners, and studying abroad was a powerful addition to my development as an individual."
-DJ Arend

DJ Arend Studies at University of Edinburgh in Scotland

At every stage of life there are things that seem impossible right up until they actually happen. When I was in middle school, I can recall thinking "Boy, college. That seems so far away, I don't think I'll ever get there!" It wasn't until move-in day freshman year that I realized that I had really become a college student. But during those first college years I conjured up a new impossibility: "Man. Studying abroad would be sweet, but I don't think I could actually do that." The next thing I knew, I found myself in the Office of International Studies looking through brochures. And yet, even as I boarded that plane in September 2010, the implications of what I was doing hadn't even begun to set in.

Sixteen hours and three planes later, I arrived in Edinburgh, Scotland at about 10am. I hailed a taxi for the University of Edinburgh - my university and my home for the next semester. When I arrived at my dorm, I was ecstatic to find that I would be living not only with English and Scottish students, but other international students from all over the world! I had my own little room which opened into a hallway, with shared bathroom facilities for the other guys on my floor. Most of the students in the dorm were "freshers" (freshmen), but there were a handful of postgraduate students who lived on the top floor, and I ended up spending most of my time with them since they were closer to my age. I quickly got involved with the student-run Bedlam Theatre, helping with all matters behind the scenes, including lights, sound, and set building. I even had the opportunity to be the tech director of a one-act play, written and directed by a friend of mine.

DJ at a German Christmas market in Ulm while traveling with friends. The air was nippy but it was perfectly complemented by some delicious sausage and warm cider!

However, extracurricular activities weren't the only things I found fascinating. During my time there I took an international politics course, and it was enlightening to sit in a room with students from all over the world discussing the U.S. invasion of Iraq as a pivotal event of the last decade. But I suppose I should say something about Physics now: my favorite course was called Musical Acoustics. Music and Physics being two of my great interests, this course was a compelling synthesis of these two. We discussed the relationship between frequency and musical pitch, the harmonic resonances of different instruments, and the reverberation time of various acoustic spaces. We even visited several halls to measure this! Through my study abroad experience, I was able to find more specialized courses in areas that I was interested in, supplementing the things I'm learning at Bethel.

While Bethel had prepared me well for the technical knowledge I needed to jump into a completely foreign university, I have to admit that by the curriculum I was refreshingly blindsided. Usually those two words aren't used together, so let me explain. At the beginning of each course, we received a syllabus. Standard, except for one thing: in most of my courses, there were several recommended textbooks that covered the course material, but the instructor didn't lecture directly out of any one of them. Except in the math courses, there was little or no homework, and each course was treated somewhat like an independent study with the instructor as a guide. This was very different from most teaching styles in the United States, and took some time to adapt to. Although it was a stretching process, this taught me some new ways of approaching course material which have helped to make me a more flexible and efficient learner.

Sadly, it really is impossible to fit everything I experienced abroad into just a few short paragraphs. Between the friendly people and beautiful old buildings, Edinburgh quickly became one

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of my new favorite places in the world, and after three months of being there, I truly felt like it had become my home - just as my trip came to an end. This has honestly been one of the most defining experiences of my entire life, and I'm shocked to think that I once assumed it to be impossible. Now, I can't imagine where I would be without it. Bethel's Physics Department continually trains students to be adaptable learners, and studying abroad was a powerful addition to my development as an individual.

Stefan Jentoft Ventures to England to Study Abroad

An English Major I am not. Sure, I enjoy literature, and there are times when I can enjoy writing, but the fact remains. For that matter, I'm not even majoring in a subject that falls under the broad heading, "humanities." I am, in point of fact, a science major.

Now, this is not to say that science majors do no writing. Our writing, however, is radically different. Our primary literary endeavors consist of lab reports. Here are our facts, here's the process we put the facts through, here's our final data, here's our conclusion. Net result, it sounds a lot like a text book. There really isn't a terrible amount of room for literary creativity. Sure, one can throw in a joke here and there, but these are rare enough to, in one class, deserve a star sticker.

Why, then, would I be crazy enough to go on a trip designed for English majors, with writing as its core? Why would I force myself to balance writing with an attempt to appreciate England? Could it be some suppressed desire to write well, or could it have been something even deeper and darker?

Coming on this trip, I expected a challenge. Of twenty-two students, I was the only person who didn't have to do a significant amount of writing for his major. Sure, the professor's son is a physics major, but he grew up with the professor and had less banking on the writing that he did. My biggest hope was that I would be able to take advantage of the wonderful writers that I had around me to not only write well on the trip, but to improve my writing long term.

Fast-forward to the final two weeks of the trip, at Battisborough House, where I hoped to get much of the work on my final papers done. As we sit around the table, Joey reads a literary masterpiece of a profile. Now, I have fun with the assignments, and hope that I can convey what I mean fairly clearly, with a scattering of humor to keep the tone light, but when Joey reads a profile that sounds more like a transcendentalist poem than a one page essay, I begin to panic. I don't care how much editing I do or how much effort I put in, my writing will never be that clean or beautiful.

As a science major, my studies revolve around academic textbooks, not great works of literature. Is it really so surprising, then, that I think like a textbook and organize my essays accordingly? I can't help it. I love great literature for its qualities, and can recognize, to some extent, great work from shoddy work, but write a masterpiece? Not a chance.

This presents a challenge for me. People dislike science textbooks because they're dull. And they are. I'll not deny it, they make for lousy reading. I know a lot of nerds and geeks, but I don't think I know very many at all that will snuggle up and read a physics text like they would read literature. Given this, how can I make my writing that smacks so strongly of textbooks, engaging? I can add humor, and try to draw the audience on with that, but is that really enough? I don't know. You decide.

Even though there are multiple science majors that I know that love literature,

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Stefan pictured in front of the Upper Lake at Glendalough, a glacial valley in Ireland.

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trying to juggle the work load of three three-hundred level English classes isn't for every scientist. One of my very best friends, a Biomedical Engineer, loves poetry, and studies Kipling for fun. He acknowledged he would never do this trip. As a science major, one comes to somewhat expect that through sheer understanding, one can rise to the top of a class. You have to be prepared to be out-classed in both the classes and the classics. You have to accept that, at some level, you do your best, and what happens happens. This is hard for many science majors who walk on egg-shells when it comes to getting a good grade, especially since a good GPA can determine grad-school applications, and consequently, much of the rest of their lives. Not living up to the standards could be significantly narrow their career options.

For all this, there remains a lot to be said for seeing more of life than a pipet and oscilloscope. One of the self-acknowledged problems of being a science major, is that we tend to be clams: so focused on what we need to do to get the grade, that we forget to stop and smell the roses. Another good friend of mine acknowledged that he had to force himself to get out and socialize or he would spend his entire time working or gaming. Going on this kind of a trip throws one in the deep end of a pool and forces one to get outside the normal constraints.

In many ways most significantly to me, taking a trip with a group of people with such different backgrounds than my own forces me to expand my horizons. Sitting in a lab taking measurements all day, one gets a very narrow view of life. Even traveling with fellow science majors, one misses out on much of what is meaningful. By traveling with people who are interested in such different things and subjects, one sees the world through at least a dual viewpoint, a much more balanced way, especially when the second viewpoint is radically different. Even for this trip, the literature that we have studied has given me new perspectives.

I had never read many of the authors we dealt with over the course of the trip, but through studying them and hearing analysis of them from people who really cared for them and understood them, I gained a broader understanding of the works, and came to appreciate authors and books I never would have otherwise. Take Virginia Wolfe, for example. I always was slightly frightened of reading her, having had dubious experiences with post-modern literature, and being somewhat uncertain as to how to approach it. While I still remain skeptical of the post-modern world-view, I have come to appreciate the books as good writing, regardless of the reflected world-view. Wolfe's use of separate perspectives on a single event to transition between characters not only leads to the book making cohesive sense, but also allows one to gain a deeper understanding of the characters themselves by comparison and contrast.

What am I to conclude then? While I have struggled in many ways, and while I still think I probably was foolish for taking this on, the perspectives that I've gained, along with the renewed appreciation for literature and more than all the friends I've made make the entire experience incredibly worth it.

"...the perspectives that I've gained, along with the renewed appreciation for literature and more than all the friends I've made make the entire experience incredibly worth it."
-Stefan Jentoft

New Opportunity for Bethel Scientists to Study Abroad in Ireland

During the fall 2011 semester, the Office of International Studies announced a new study abroad program specially designed for science and engineering majors at Bethel.

A new partnership with Arcadia University in Ireland now enables physics and engineering students to take courses like Optics, Electricity and Magnetism, Math Methods in Physics and Engineering, Fluid Mechanics , General Physics, and even some general education courses while studying abroad. This partnership will ease the challenge of coordinating upper-level physics coursework with a study abroad experience.

In addition, the study of science in another country allows students to become more globally aware scientists and will provide them with a unique experience to apply to life, a future career, the remainder of their studies at Bethel, and possibly graduate school.

For more information about this study abroad program, please visit the Office of International Studies in CC320A.

Bethel Physics Students Hold Summer Internships and REUs

Last summer, several physics students had a summer internship or a Research Experience for Undergraduates (REU) internship. This includes Jennifer Schommer ('12), Kayse Lee ('12), Andrew Zabel ('12), DJ Arend ('12), and Lauren Otto ('12), whose stories are below. Also among students with internships or REUs are Tony Burand (page 5), Cassie Doehrmann ('13), and Jessica Doehrmann ('11) with a research fellowship.

Several students also carried 3M technical aide positions through the summer. Their stories are found in Vol. 6, Issue 1 of the *Focus.*

Jennifer Schommer Studies Frequency Spectrums of Tissues at UNL

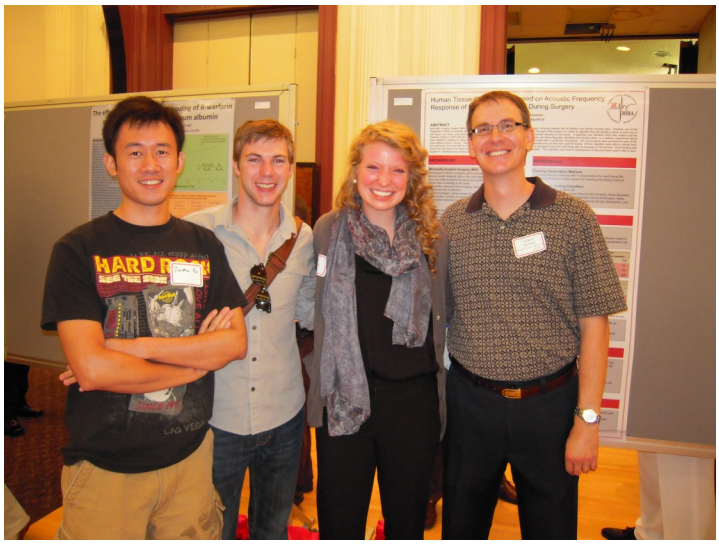
This summer, Jennifer Schommer worked in the Biomedical Imaging and Biosignal Analysis lab in the Biological Systems Engineering department at the University of Nebraska Lincoln (UNL). Her lab features equipment used for medical imaging studies and biosignal analysis, such as ultrasound mammography for breast cancer screening, and much more.

Jen contributed to two projects concurrently this summer. The first used transcranial Doppler ultrasonography (TCD ultrasound) to measure blood flow velocities within the brain. She used a device that insonates the brain bilaterally and is extremely stable. This allows the person wearing the headset to move around without disrupting the signal. They used the headset on stroke recovery patients at the local Madonna hospital. Patients would undergo a series of tasks while wearing the headset such as resting, cognitive tests and exercising. Jen has said, "This data is important because we can compare the left and the right brain... This can be used to analyze the effectiveness of stroke patients' recovery programs and seek to offer improvement."

Jen also worked on her own project while at UNL. She analyzed sound files of different tissues being tapped. A microphone was placed in a cadaver at the University of Nebraska Medical Center in Omaha, and various tissues were tapped such as the abdominal wall, bony pelvis, rib, etc. The sounds of the taps were recorded. She used a MATLAB graphical user interface (GUI) to analyze the frequency spectrum of the sounds of the different tissues. Jen worked on creating an algorithm that will classify the tissues by using the sounds they make when tapped, initially just focusing on three types: fat, bone, and tissue over bone. Hopefully this will be expanded to more specific types of tissue. The ultimate goal of this research is to assist surgeons in "blind," minimally invasive surgeries.

Jen also got connected to an awesome church there – Lincoln Berean Church. They had a college age ministry group that met on Thursdays for dinner, worship, teaching, and discussion. She also had full access to the recreation center at UNL, so she was on an intramural sand volleyball team with a few other people in her program. She even made it to the championship game and got second place. Also, through the recreation center, she went on a canoe trip. Jen, fifteen other people in the program, and four guides spent a weekend canoeing down the Platte River, which is about an hour away from Lincoln. A friend of Jen's that worked in the same building was on the football team, so she got an extensive tour of the stadium such as practice fields, academic buildings, and the top of the stadium.

"I've also tried to take advantage of the local events," Jen shared. One of her favorites was the local farmer's market every Saturday morning, which had local vendors with great produce, arts, crafts, and other foods (and amazing samples). Another of Jen's favorite events was called Jazz in June where every Tuesday night in June a live jazz band played for hundreds of people in front of a local art museum on campus.



Jennifer with two labmates and her professor, Dr. Bashford.

Kayse Lee Works to Manage Complicated Data Sets at Iowa

Kayse Lee spent her summer in the Iowa Summer Institute in Biostatistics. It was sponsored by the National Heart Lung and Blood Institute (NHLBI) and the National Center for Research Resources (NCRR) of the National Institutes of Health (NIH). The program included a graduate level biostatistics course, a lab component to the course, and individualized research with a biostatistics faculty mentor.

Kayse's research focused on methods of data quality management that are used in preparing large naturalistic data sets for analysis. The data management she worked on tends to be much more difficult than managing data typically collected in a physics or chemistry lab. In physics data collection, one would design the research, collect the data, and analyze the data; however, in the clinical trials and public health sector, those analyzing the data are often not those collecting the data. For example, a biostatistician will design the data collection procedures, but it is often up to medical doctors or other non-statistics professionals to collect the data. This results in collection methods that are often not as uniform. Another reason there are so many data quality control issues is that ethical guidelines always permit human test subjects the freedom to back out of the study whenever they choose. Thus, there may be complete data sets on some test subjects, but incomplete sets on others. Also, humans are very difficult to control; for example, although they are supposed to take a drug every three hours, humans rarely follow the "rules" and don't take the drug when they should which makes analysis harder. Kayse spent a lot of time programming and coming up with new ways to fix these problems.

Andrew Zabel Observes Neutrinos and Checks Out MINOS

Andrew Zabel worked with a physics research group at the University of Minnesota studying neutrinos as a part of the Main Injector Neutrino Oscillation Search (MINOS) project. Neutrinos are an elementary particle of three known varieties. The MINOS project searches for neutrino oscillation by measuring the number of muon neutrinos. He worked on categorizing lots of data, determining which particles were up muons and which were not up muons, which are simply neutrino induced muons, or muon neutrinos (a type of muon). These muon neutrinos then interact with the MINOS detector to create a muons, which the MINOS detector then detects. Up muons come from cosmic rays (which are mainly protons), but have high enough energy to go through the earth. Andrew only looked at the muon events that gave evidence of the particle coming from the other side of the earth and going 'up' into the detector, hence an up muon.

Andrew in front of the MINOS detector

Andrew also had another part of his summer research, in which he was looking for a sun and moon shadow of cosmic rays. This was done also using the MINOS detector, but analyzed the direction of a certain event and the position of the moon and sun.

Overall, he also really enjoyed the REU program at the University of Minnesota. He was able to go to the Science Museum of Minnesota and to the H.M.S Pinafore performance at the Guthrie. "I was also able to go up to the Soudan mine and check out the MINOS detector, and up to Ash River to check out the NOvA detector (which is a similar project to MINOS)." His time with his research group also included a trip to Washington D.C. with his adviser. There Andrew sat in on meetings with his professor, and he was able to meet Minnesota senators Al Franken and Amy Klobuchar, and another from the House of Representatives. While in Washington D.C., Andrew was able to see all of the cool sites, how research is done on the administrative side, and how important that side of research can be.

Andrew said that "It was also a great time being in Minneapolis, biking around the city, doing various fun activities, playing soccer with people, and checking out a big campus where lots of research is done. I thought it was a very good experience and I highly recommend it!"

DJ Arend Spends Second Summer with United Launch Alliance

During the summer of 2011, DJ worked at the Cape Canaveral Air Force Station in Cape Canaveral, Florida with United Launch Alliance. He was working for the Delta IV Mechanical Engineering group, which performs all of the mechanical work on the rocket. His work included receiving the rocket parts from the fabrication plant in Decatur, Alabama, processing them, putting them together, installing ordnance and other explosives, and installing the payload. No research was done, but the experience gave DJ a lot of learning and hands-on activity with rockets.

To top it all off, he was at a launch site. DJ got to help out with two rocket launches: a Delta IV Medium+ (4, 2) carrying a global positioning system (GPS) satellite and an Atlas V. He even got to look inside a Delta IV rocket. Since he was in the Delta IV group, he spent a lot of time on the pad next to the rocket. DJ was able to go into the clean room and see the GPS satellite up close before it was launched. He also got to watch a lot of other procedures, including ordnance hookups and large-scale lifting operations (moving of the rocket parts). Additionally, DJ did what is called "shooting azimuth," which uses a high-tech optical scope to measure angles between targets on the ground and on the rocket. This determines the rocket's exact GPS coordinates, so the rocket knows its starting position.

As an added bonus, DJ tells us, "Unrelated to my internship, I got to see the very last shuttle launch (STS -135)!! That was awesome."

Nanofabrication with Lauren Otto

Lauren Otto spent her summer in the National Nanotechnology Infrastructure Network (NNIN) REU program at the University of Minnesota. She worked with Professor Sang-Hyun Oh's research group in the Electrical and Computer Engineering department and was mentored by Bethel professor Dr. Nathan Lindquist and recent Bethel Physics graduate Tim Johnson ('08). Her research group works to create plasmonic biosensing devices.

Lauren worked on a few different research projects. Two of the projects involved developing biosensing devices. Another was the creation of her own microscope to be used for characterizing biosensing devices in the future. Lauren said, "I was able to use the optics laboratory skills that I had learned in Dr. Hoyt's lab for the creation of this microscope, which was really neat."

As part of the NNIN REU program, Lauren was trained on a lot of the equipment in the Nanofabrication Center at the University of Minnesota. This enabled her to create the nanostructures necessary for her devices using various forms of lithography. "My favorite was the electron beam lithography machine which uses a focused beam of electrons to pattern electron resist on our silicon wafers. It is really cool and also a spendy piece of equipment, so not many people are trained on it, which made me feel kind of special."

While at the University of Minnesota for the summer, the Electrical and Computer Engineering and NNIN REU group went to several Twin Cities events. This included Lauren's first trip to Target Field to watch the Twins, a show at the Guthrie, and time at the Science Museum of Minnesota. At the end of her program, all NNIN REU students from around the country (about 85) were gathered at the Georgia Tech campus in Atlanta, GA for the NNIN REU Convocation. There Lauren gave a talk and presented a poster about her summer work.

Lauren (left) in the clean room with Tim Johnson (middle) and Dr. Nathan Lindquist (right)

Reflecting on her time during the summer, Lauren said that, "Overall, this was a very good experience. I was able to discover a lot about what graduate school is like and what field I want to enter after graduation. I was also able to gain a lot of valuable experience and create relationships with my fellow REU students, my labmates, and my professor."

Fall 2011 SPS Events

As usual, the Society of Physics Students (SPS) officers Lauren Otto, Jennifer Schommer, Kayse Lee, Jessica Doehrmann ('11), and Tim Gustafson started the school year off with a bang hosting the N+1th (yeah, N+1th) annual ice cream social. Ice cream was served by the officers to all who came. Physics fellowshipping occurred while a slide show of pictures highlighted last year's events.

Physics students enjoy ice cream at the social

Pizza was used to lure students, especially freshmen, to a research talk night. Several students with industry internships during summer 2011 shared their experiences. These students included Tristan Boyd, Tim Peterson, Caleb Nelson, Tim Gustafson, Tony Burand, DJ Arend, and Matt Robins. Some of their stories can be found in this issue or the previous issue of the *Focus*.

Pumpkins receive equation etchings

Jessica led the way planning the second Feed My Starving Children volunteer night. Meals were packed. Children were fed. Homework was procrastinated. It was a successful night indeed.

The volunteer crew at Feed My Starving Children

The Halloween pumpkin carving actually took place on Halloween, for once, although not in the traditional electronics lab location due to an ongoing lab session. Regardless, much fun and equation-carving still occurred in the General Physics lab. Dr. Lindquist was inducted into the "Professors with Their Faces Carved into Pumpkins" hall of fame.

This was followed by a fall movie night where the film *Real Genius* was the featured presentation. This film is recommended for anyone who likes to laugh at really bad Hollywood physics.

And finally, the fall semester was completed with the Christmas party, which was hosted by the families of Dr. Hoyt and Brandon ('10) and Jessica Brunkow. Dr. Hoyt's birthday was celebrated with cake and candles, merry physics carols were sung for all to hear, and fun was had by all.

Look at the back page for Christmas Party pictures!

Tentative Requirements for Major in Biomedical Physics (B.S.)

		Semester Credit Hours
PHY290D	General Physics I	4
PHY295	General Physics II	4
PHY300	Electronics	4
PHY310	Modern Physics	4
PHY320	Math Methods in Phys. and Eng.	4
PHY350	Computer Methods in Phys. and Eng.	4
PHY360	Physics Research Seminar I	1
PHY365	Physics Research Seminar II	1
PHY400	Electricity and Magnetism	4
PHY4XX	Biomedical Devices	4
PHY4XX	Medical Physics	4
PHY490	Research	3
BIO112	Intro to Molecular and Cellular Biology	4
BIO209	Human Anatomy and Physiology	4
CHE212D	Accelerated General Chemistry	4
MAT124M	Calculus 1	4
MAT125	Calculus 2	4
MAT222	Differential Equations	3
MAT223	Multivariable Calculus	3
Choose one of the following emphases:		8
* *Medical Physics Emphasis*		
PHY440	Quantum Mechanics	
PHY410	Thermodynamics	
* *Biomedical Engineering Emphasis*		
PHY340	Mechanics	
PHY420	Fluid Mechanics	
* *Clinical Medicine Emphasis*		
CHE221	Organic Chemistry I	
CHE386	Biochemistry I	
		75
	General Education	51
		126

2009-10 Minnesota Bachelor's Degrees In Physics	
U of MN, Mpls	29
Bethel University	23
Carleton	15
St. John's	15
St. Thomas	14
Augsburg	13
St. Olaf	13
Gustavus	11
MN State Moorhead	8
Macalester	7
St. Cloud State	6
U of MN, Duluth	4
Winona State	4
Hamline	3
Bemidji State	2
Concordia	2
MN State Mankato	2
St. Mary's	2
U of MN, Morris	1
St. Catherine	0

The latest data from the American Institute of Physics, page 9 of www.aip.org/statistics/trends/reports/physrost.pdf

Spring 2011 graduates and professors. Pictured from left to right: (back) Dr. Stein, Sam Scheevel, Adam Banfield, Luke Buer, Sarah Kaiser, Brandon Peplinski, Josh Zierhut, Dr. Beecken, (front) Dr. Hoyt, Nathan Youngblood, David Swenson, Laurel Bestland, Jami Johnson, Jack Houlton, and James Benhardus. Not pictured: Jonathan Boer

Fall 2011 graduates. Pictured from left to right: Corey Lundy, Jessica Doehrmann, and Brian Clark.

Bethel University Physics & Engineering Newsletter

Newsletter article and photo submissions to Dr. Beecken (beebri@bethel.edu) or Dr. Stein (k-stein@bethel.edu) are welcome and appreciated.

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http://cas.bethel.edu/dept/physics/

Pictures taken at annual Physics Christmas Party. Dr. Hoyt extinguishes his birthday candles with air currents from his hands.