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Highlights of IBE 2003 Annual Meeting Jan. 16-19, 2003, Athens Georgia

What a Meeting!

by IBE President, Roy Young

Past IBE President Brahm Verma and his colleagues in Georgia really know how to put on a meeting! Through good people, excellent programs, and an accommodating place, they presented 100 participants with a truly outstanding IBE 2003 Meeting experience in Athens, GA, January 16-19, 2003! This meeting will, no doubt, be remembered as a pivotal experience for the young Institute of Biological Engineering (IBE).

The University of Georgia faculty, students, and administrators were model hosts. Interim Senior Vice-President of Academic Affairs and Provost Arnett Mace, Jr. offered at the outset a most warm welcome and created excitement describing immediate successes at the University of GA in creatively forming a new *Faculty of Engineering*. The meetings staff at the Georgia Conference Center displayed professional confidence and efficiency in providing splendid accommodations and support throughout every part of the meeting. Their watchful eyes and quick responses averted distractions and allowed participants to focus fully on the learning and sharing opportunities. The Biological and Agricultural Engineering Department students treated all meeting participants to a superb barbeque cookout and were a solid anchor for IBE student members visiting from other campuses. Joel Cuello and his programming peers assembled a technical meeting *par excellence* from the first to the last presentation. The Department's Driftmier facilities afforded a meeting site for two highly productive Council meetings.

Keynote speaker Richard Seagrave summed it well when he said, "I have had a transforming experience! I have never felt so at home as I have these past 2-3 days in this group." Dr. Seagrave himself set the tone early with a splendidly articulated keynote presentation on *Engineering Lessons from Biology*. The

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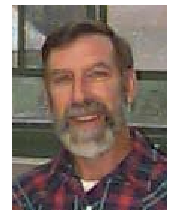

Editor, Art Johnson

Call to Arms!

They say an expert is someone who carries a briefcase and comes from more than 50 miles away. Maybe that's because the people we know from around here we know too well to admire. We know all the mistakes they've made and we know as much about any subject as they know. An expert must know more than we do, so the folks from around here can't be experts.

It seems that there are a lot of experts about biological engineering from more than 50 miles away. Jim Dooley told us about an electrical engineering professor from MIT who came to talk to the ABET council about biological engineering. His talk was supposed to stimulate thought about this new field.

And then there is the observation that, at least for a time, whenever an educational department wanted to strengthen its biological engineering efforts, faculty from chemical engineering were hired. This isn't meant to be a diatribe against chemical engineers, because they really have a lot to contribute, but do they really know more about biological engineering than we do?

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The chemical engineering definition of biological engineering is really tipped toward the subcellular, cellular, and tissue engineering side of biology. It's a definition that fits its chemical engineering roots very well. People pushing for this definition of biological engineering have, over the years, become influential in various governmental agencies and educational institutions through professional activities. Because of this, we now see their definition of biological engineering becoming the core of officially-recognized definitions.

What is missing from these definitions of biological engineering is the overall systems concepts that take into account the myriad of responses of biological units to the integrated environments in which they find themselves. Cells and tissues are treated as unit operations rather than as players in microecological complexes.

When people such as the MIT professor first become introduced to biological engineering concepts, they think they have found virgin territory. Without full appreciation for the thoughts, words, and actions taken by, for instance, members of IBE, they believe that they can contribute to the formation of this new field without extensive research.

It is time for us to realize that the experts in biological engineering do not come from (figuratively) 50 miles away. The experts are our fellow IBE members, and the society that possesses the most thoughtful, well-developed concepts about biological engineering is IBE.

It makes no sense to invite keynote speakers to the IBE meeting to speak about what is included in biological engineering if the speakers know less about the subject than we do. Also, it makes no sense to sit and listen to an electrical engineering professor talk about biological engineering as if it were an entirely new field. Additionally, it makes no sense for us to accept as definitions of biological engineering anything other than the definition that Norm Scott so painstakingly led us to agree on.

This is not meant to criticize any individual member of IBE. However, it is meant to be a call-to-arms. IBE must begin to act as the repository of biological engineering information. We should act as if we are the experts in biological engineering, and that the others have a ways to go to catch up to us. We must begin to assert that what we know about biological engineering is what needs to be known. We must be confident about this.

We must have literature that defines biological engineering and includes numerous examples from all kinds of applications. We must make sure that we don't forget the literature that we have already developed, including definitions, DNA of Biological Engineering, Proceedings of Annual Meetings, recruiting brochures, and Newsletters. And we must confidently introduce others to this literature. If it all can be archived on the IBE website, then all we need to remember is www.ibeweb.org.

So, I urge IBE members to:

1. Become involved in other circles where biological engineering topics are likely to be discussed.
2. Act confidently as <u>the</u> experts in biological engineering.
3. Use the literature that we already have developed rather than wait for new.
4. Remember that it took a lot of time, effort, and discussion to get to where we are; let's not minimize what we have accomplished.

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Members – the Heartbeat of IBE

IBE 2003 President, Roy Young

Members of IBE, you are the ***heartbeat*** of the Institute and the soul of its vision to promote Biological Engineering in its broadest sense! I thank you for your dedication, involvement, and financial support through your membership. I believe we will look back on 2003 as the year when we reached the base of the exponential growth curve and launched forward toward rapid and significant advancement. More members like you will see IBE become an organization capable of facilitating collaboration and networking among several groups sharing interests in the metamorphosis of Biological Engineering.

As an organization not promoting any particular technical application, but rather constituted of members from diverse professional backgrounds, IBE is postured to facilitate inquiry, application, and interest in Biological Engineering in its broadest and most liberal sense. Its membership can continue to expand across agricultural, food, bioprocessing, pharmaceutical, environmental, biotechnology, and biomedical interests. Together its members will be able to realize core competencies for a science-based, application-independent discipline of biological engineering that can serve diverse areas of specialized applications.

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wealth of wisdom of a full career of integrating engineering and biology was ntuitively apparent. Drs. Kenneth Diller, Bernard Patten, and Timothy Fischer stimulated thought and discourse in the first-morning plenary session on "Transport Processes across Biological Domains" from nano- to eco-scales. In an afternoon feature technical session, several presenters discussed cutting edge research on "Transport in Biological Systems." Student researchers displayed their innovative research projects in an evening poster session that was judged by a panel-of-four. Three top prizes were taken: 1st Prize – Stephen Walker, Penn State University, $300; 2nd Prize – Barbra Crompton, University of Georgia, $200; and 3rd Prize – Ennis Veale, Penn State University, $100. Eight other *magnetic* technical sessions addressed Biological Engineering Design, Biological Engineering Education, Biomaterials and Biomimetic Materials, Biosensors, Bioenvironmental Engineering (I &II), Biochemical Systems, and Microbial Systems Engineering. A Special Tutorial by Dr. John Hetling of the University of Illinois at Chicago enlightened everyone on "Neural Engineering in Medicine and Biology", stimulating us to think how possible the seemingly impossible might really be as the interface of cells and engineered sensors merge. Mark Eiteman has preserved 73 abstracts and 10 papers on a meeting CD that can be requested from him at the University of Georgia.

It was also a landmark meeting for the business and operations of IBE as well as for exchange of engineering and science. Because of Brahm Verma's leadership of the IBE Council in October 2002 to evolve and document a first IBE Strategic Plan, the Council was able to implement focused and coordinated Action Items. Moreover, crucial planning occurred throughout the Meeting to partner with the ARDEL Group, a management services company, to provide stable infrastructure for IBE's 'headquarters' functions and to coordinate growth. I believe this partnership will enable IBE to realize its mission ***to be a networking and integrating forum for promoting the development of a biologically-based engineering discipline independent of applications***. IBE may have approached this meeting as "a ripple in the pond," but it left with the potential to become "a wave in the sea" of biologically-based engineering! Let us proceed with the same *excellence* that characterized our IBE Meeting 2003!

Protecting and Assessing Primary Headwater Streams in Ohio

Dawn Farver, Graduate Student
The Ohio State University

Primary headwater streams are streams with a drainage area of one square mile or less. These streams are the origin of any great river system from the Mississippi River to the Nile. Some of these primary headwater streams are ephemeral, and only flow during large storm events. Others flow during parts of the year and are dry the other parts, and some flow year round. These streams may be small in size, but they have an immense impact on the health, efficiency and the stability of the systems they flow into. Streams, even on this small of a scale, provide habitat for a large diversity of wildlife. Salamanders and benthic macroinvertebrates flourish in the rocky, gravelly beds of these streams and play a pivotal role in tying together the land and water environments.

Primary headwater streams act as capillaries do in the body. Water flowing over land brings in nutrients in the form of organic material (eg. Fallen leaves, decomposing plant material) which shredders, a type of benthic macroinvertebrate, will break down into usable nutrients for other organisms. Primary headwater streams will then move some of these macroinvertebrates downstream, along with nutrients, where they are a food source for other macroinvertebrates and small fish. Many macroinvertebrates are insects in the larval stage which will make the transition between living in an aquatic environment to living in the terrestrial world upon maturity. Salamanders also depend heavily on this water/land interface for the survival of their species. Larvae will spend two years of life as living underwater before becoming terrestrial organisms that still must be near water for food and moisture to survive and reproduce.

Currently the Ohio Environmental Protection Agency (OEPA) depends heavily on the use of

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biological populations to be an indicator of stream health and a way to evaluate the level of protection necessary for the stream. Using a Qualitative Habitat Evaluation Index (QHEI) form, the integrity of headwater streams (streams with a drainage area of 20 square miles or less) is rated in the field on a qualitative basis examining riparian zones, bed material composition, and stream flow characteristics. The main limitation of the current system which has done an excellent job in protecting these headwater streams, is the weight put on the measurement of the maximum pool depth in the 200-foot reach studied. On the QHEI form, the value obtained for the maximum pool depth is a strong factor in determining whether or not a stream is "healthy." If the reach has a maximum pool depth of 40 cm or greater, it is considered to have sufficient habitat to support fish populations. Below 40cm, the pools are not deep enough to provide shelter and breeding ground for most fish species to survive. However, just because a stream cannot support a fish population, is that always an indicator of an unhealthy or unstable stream? Once a stream's drainage area is below a certain number, it is highly unlikely that pools meeting the QHEI minimum standard will be present, and while these streams will be inhabited by few fish as a result, they can support a broad diversity of benthic macroinvertebrates and salamanders.

Recognizing this limitation, OEPA has developed a similar evaluation form for primary headwater streams, the Headwater Habitat Evaluation Index (HHEI) form. The ultimate goal of using this form, along with the Headwater Macroinvertebrate Field Evaluation Index (HMFEI) form is to provide a means of protecting and preserving these unprotected, historically overlooked streams.
An additional limitation of both of these methods of evaluation is the lack of comprehensive geomorphological measurements being taken on the field. If the stream is stable it demonstrates a particular set of geomorphological measurements that will fall into different ranges depending on the channel type. When the stream is stable, the sediment suspended in the stream is kept constant through a suspension and deposition process along its length. More simply, the stream will neither aggrade nor degrade. As a result, the bed material will be made up of larger materials than a channel overloaded with sediment, and will then provide a better habitat for macroinvertebrates, salamanders and some small fish species.

Not only are the dimensions of the actual channel important to understanding the health and stability of the stream (eg. Bankfull depth, bankfull width, sinuosity, channel slope), another feature that stream stability is dependent on is floodplain accessibility and characteristics. This is where the ability for a stream to have active ties to the land is so important to a stream's overall stability. The role of the floodplain is to act as a place/way for a stream to release the great amount of energy of the water as it blasts down the channel during high flow events. When flow is contained within a stream's main channel, the cross section is deeper and narrow. In a stable channel with access to its floodplain, the water will overflow its banks once the flow reaches a certain volume, and the water will flow onto the floodplain. In this way, the energy of the flow is greatly reduced as the area the water flows over is increased, and the flow slows down as it contacts the floodplain. The sediment a stream may have picked up when moving quickly at high volumes, will then be deposited on the floodplain and not be transported downstream to pollute the overall drainage system.

A stream can become unstable due to a variety of outside influences, mostly human influences, and can cause a stream to become disconnected from its floodplain and the energy dispersion benefits it provides. As example of an event that can cause a stream to become entrenched and detached from its floodplain is urbanization within the drainage area of the stream. Urbanization produces a higher flow volume and a higher energy flow through the stream for each rain event due to a higher percentage of impervious surfaces in the watershed. With this higher energy, more be material is moved by the water, more erosion takes place and the stream will down-cut until a progressively larger flow event will be needed for the stream to access its previous floodplain. The issue continues to compound and the stream will enter an evolution cycle taking decades or even centuries to return to a stable geomorphology. The effect of human influences on these natural systems is an important reason for them to be carefully monitored and protected as
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much as possible so these issues never arise. Better management practices must be taken into consideration before a greater number of these natural systems are damaged beyond repair. Prevention is less expensive, less time consuming, and less invasive than restoration.

My master's research project is to look at primary headwater streams in Ohio and compare these streams in Northeast Ohio to primary headwater streams in Southeast Ohio. Measurements to be taken are channel geomorphology, a pebble count to analyze bed material properties, macroinvertebrate sampling (HMFEI), qualitative analysis of the stream reach (HHEI), and basic water quality measurements. The goal is to look at streams that have dominantly forested watersheds and have been relatively untouched and stable for a number of years to eliminate dynamically changing systems. By comparing the two areas of the state, we are hoping to see the effects of different physiographic regions, soil types, bed materials, and slopes on what type of stable streams will be found in each area. Collecting data on as many of the primary headwater streams as possible in Ohio will aid in the overall protection plan and provide valuable information to many different organizations throughout the state.

For more information please feel free to contact me at: farver.1@osu.edu.
You can also find more information on the STREAMS website at: http://www.ag.ohio-state.edu/~streams/
For more about Ohio EPA's Primary Headwater Stream Project: http://www.epa.state.oh.us/dsw/wqs/headwaters/index.html

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From the AIMBE 12th Annual Event, Washington, DC, February 20-24, 2003

As your representative for IBE to the AIMBE Council of Societies (COS), IBE President Roy Young participated on Sunday, February 24, 2003 in a half-day working session of the COS Meeting in Washington, DC. This meeting focused on results from the AIMBE National Affairs Survey which Brahm Verma had distributed to the IBE membership last summer. The number of survey responses across all 16 societies on the COS was record-breaking, approximately 450! (Special thanks to you IBE members who responded!) Summaries of survey comments were divided into 3 topic areas: (1) government issues, (2) education issues, and (3) funding for federal research programs. Breakout subgroups were formed to develop an AIMBE National Affairs Agenda for each of these topics. Roy chaired the Education subgroup. In the brief article below, Rosealee M. Lee summarizes the AIMBE National Affairs Agenda and describes activities planned around the upcoming NIH BECON meeting (June 23 and the morning of June 24, 2003).

Council of Societies Steps Up the National Affairs Agenda

By Rosealee M. Lee, CAE

National affairs considerations of the 30,000 + society members of the Council of Societies were the primary focus at the recent AIMBE annual event where participants met to draft the COS national affairs agenda. Utilizing data from the recent COS survey, three working groups developed initiatives that will guide future COS national affairs activities. The three initiatives focus on "Government" (includes issues such as FDA, medical reimbursement, certification and credentialing, etc.), "Education" (includes issues regarding educating the public and legislators, and school educational considerations), and "Funding" (focuses on federal research programs in medical and biological engineering). Following a brief period for review and comment by the working groups themselves, the agenda will be forwarded to voting representatives of the COS for comment. The complete agenda will then be forwarded to the AIMBE Board of Directors for approval. Email AIMBENationalAffairs@convenemachine.com for more information about the national affairs agenda.

On Monday, February 24, the COS organized AIMBE's first Medical and Biological Engineers Day on Capitol Hill. Participants visited Congressional representatives and represented the AIMBE community on legislative issues of interest. Thanks to the individuals who took our message to the Hill!

AIMBE is drafting plans to implement a Grants Workshop on the afternoon of June 24. Tentative plans indicate that there will be no charge for individual members of AIMBE

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Cornell University Student Branch of IBE holds it's first Annual BioEXPO … AND WHAT AN EVENT IT WAS!!!

Early in the Fall of 2002, students of the Cornell Chapter of the Institute of Biological Engineering began developing a vision to organize a bioengineering research symposium at Cornell. This spring, the vision became a reality. The *BioEngineering Research EXPO* (BioEXPO) is a student initiated and student run event that focused on fostering cohesiveness and communication among the bioengineering research community at Cornell, and promoting a campus-wide appreciation and enthusiasm for the discipline of Bioengineering. The *Bioengineering EXPO* was held on April 8th, and featured a symposium of speakers from Bioengineering disciplines presenting their cutting edge research.

The keynote speaker was Wilson Greatbatch, inventor of the first successfully implantable pacemaker and founder of Wilson Greatbatch Technologies, Inc. Dr. Greatbatch focused on the past, the present and the future of Bioengineering. He was a great speaker, extremely knowledgeable and certainly entertaining, as was evident when he began his talk by saying, "My point is to convince all of you to go into Bioengineering." Dr. Greatbatch was accompanied by four of his engineering staff, which provided students with an opportunity to interact with experienced engineers and gain an additional appreciation for life after graduation. He spoke to a standing room only crowd of over 100 students, factulty and distinguished guests.

The keynote speech was followed by two other speakers, who explained their cross cutting research and how it bridges the gap between bioengineering and technology. Dr. Andrea Turner, Ph.D. '02, discussed cell growth on different topographical structures. Her research could lead to restoring neural functions that have been paralyzed. In addition, Dr. Ruth Richardson, Civil and Environmental Engineering, discussed bioengineering in environmental issues.

Following the speakers, 25 undergraduate researchers displayed a poster of their research in the poster gallery and competed for $800 in prize money. Check the following link for the article about the BioEXPO that was in the Cornell Daily Sun on April 9, 2002 http://www.cornelldailysun.com/articles/8350/

Students at lunch with Dr. Wilson Greatbatch and his staff.

The planning and organization of the *EXPO* has provided countless opportunities for valuable interaction between Bioengineering faculty and students. Funding from Cornell University, the College of Engineering, the Department of Biological and Engineering, New York State Electric and Gas Corporation, NOCO Energy Corp. and various corporations made this event possible. The Cornell Chapter of IBE and the first annual *Bioengineering Research EXPO* are setting the standard for IBE involvement in Bioengineering at Cornell. It is our hope that University Chapters of IBE across the nation will initiate such events for further promotion of IBE and the great field of Biological Engineering.

If any IBE Student Branch would like advice on how to plan for your first BioEXPO, feel free to email Kory Reed at kbr3@cornell.edu or Rachel Ross at rr92@cornell.edu. We would be glad to help!

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COS societies to attend the Grants Workshop. One hour of the afternoon will be dedicated to preparing for AIMBE's second Medical and Biological Engineers Day on Capitol Hill which is scheduled for Wednesday, June 25. This workshop and the Hill visit are being planned in conjunction with the NIH BECON meeting (June 23 and the morning of June 24). "Talking points" given to participants of the Hill visit will incorporate the COS National Affairs Agenda. Please save the date! Watch your email and www.aimbe.org for more information as it becomes available.

Service-learning in Biological Engineering

Marybeth Lima

Service-learning is defined as "a credit-bearing, educational experience in which students participate in an organized service activity that meets identified community needs and reflect on the service activity in such a way as to gain further understanding of course content, a broader appreciation of the discipline, and an enhanced sense of civic responsibility" (Bringle and Hatcher, 1995). It is widely recognized that an integral component of engineering (and Biological Engineering) involves service to society. Service-learning can be an excellent method to explicitly demonstrate to students the link between engineering and service to society. In this article, I will discuss how to integrate a service-learning component into your Biological Engineering classroom.

A couple of things to keep in mind at the outset: (1) Service-learning is a pedagogy, or philosophy of teaching. Thus, service-learning will not add material to your course. It will change the way in which you deliver the course material. (2) There already exist some excellent resources for getting started in service-learning.

Service-Learning Course Design Workbook. Michigan Journal of Community Service Learning Special Issue. 2001. University of Michigan. *Easy to understand, step-by-step method for re-designing your course to include service-learning.*

Engineering Projects in Community Service (EPICS). 2002. http://epics.ecn.purdue.edu/ *Outstanding web site that describes service-learning projects in all disciplines of engineering.*

Heffernan, K. 2001. Fundamentals of Service-Learning Course Construction. Providence, Rhode Island: Campus Compact. *Contains an excellent cross section of service-learning methodologies described primarily through course syllabi (including those in engineering).*

E. Tsang, Editor. 2000. Projects That Matter: Concepts and Models for Service-Learning in Engineering,. American Association for Higher Education's Series on Service-Learning in the Disciplines. AAHE Press. *Excellent reference for service-learning approaches in engineering; includes advice for faculty in getting started with service-learning.*

Preparing for a service-learning course before the course term begins

- Determine learning objectives for the course. Instructors start by identifying the educational concepts they want students to master for the course. These objectives will be the same as for a non-service-learning course, but one could include additional objectives, for example, developing civic responsibility. The instructor should explicitly define service-learning for students on the syllabus and explain to students how activities for the course integrate into the service-learning project.
- Choose the project and community partners carefully and in accordance with the learning objectives. Students will (completely or in part) master the learning objectives in your course by completing the service-learning project. Choosing a project that has a scope appropriate to the length of the course and the academic level of the students is very important. Students should be able to complete the service-learning project during the course term, unless there are other means by which the students can complete the service after the course term. Engineering Projects In Community Service (EPICS, 2002) is one such model in which individual students can elect to take repeatable technical electives that require participation on a long-standing engineering design team made up of students of all ranks and engineering disciplines.

Identifying projects and community partners (agencies) to work with can be done through your university or your local contacts. Most universities have a service-learning office and/or community outreach office. Extension agents may also provide potential service-learning projects. The following list involves service-learning projects that have been completed by engineering students that may be appropriate for Biological Engineering courses:

- Students work with the university dairy farm to design and build a constructed wetland to remediate waste produced by the farm
- Students collaborate with members of a local community to develop an environmental site plan to address issues raised by the construction of a landfill in the community
- Students work with the Dean of Students

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Office to design classroom furniture for college students with physical disabilities or devices to assist students with visual or hearing impairments

- Students collaborate with Habitat for Humanity to test the strength of wood beams in new or renovated houses, and to develop floor plans and designs for new houses
- Students work with local zoos to design new habitats for captive animals, a multimedia learning/education center, and a new layout for the existing zoo space.

Community partners should be as involved as possible in the course. For example, the community partner could act as a member of an expert panel that evaluates the designs or could provide a portion of the course grade. Make sure that all ground rules for working together are determined before the course term begins. Students should know who the community partner is, how to contact this agency, when it is appropriate to contact the agency, in what capacities/contexts they will be engaging with the community partner, and the products that will be delivered to the community partner at the end of the course term. If possible, include this information in the syllabus.

The community partners should have a forum to clearly express their needs to the students, and a clear and constant means of communication with the students and the instructor. Instructors should prepare community partners for possible faux pas by students. For example, one student said, "This playground is a death trap!" in front of the executive director of a community agency for whom the student was re-designing a playground. Everyone should be clear on the deliverables involved at the outset of the project. For example, will you provide a local elementary school with a design for a playground, or will you design and actually construct the playground?

During the course term

- Communicate regularly with community partners and students to ensure smooth operation of the project. This is a useful practice, because even with the best planning, the timeline of the project may change.
- Be prepared to guide and facilitate. Some students, particularly those in the first two years of undergraduate study, can be overwhelmed by a project that requires deliverables. Students may need help with the following issues:
  - Narrowing the scope of their design to complete quality work in a limited time period
  - Sticking to a timeline (formal and informal presentations and other assignments help students stay on track)
  - Working in a group and/or with the community partner (providing rudimentary communication, teaming, and conflict resolution skills is usually invaluable)
  - Frustration with changing parameters in project scope. Sometimes community partners (or instructors) will change their minds about some aspect of the service-learning project, or a design idea pursued may not be feasible, and students must go back to the drawing board. Explaining that this is a normal part of the design process can help to alleviate students' frustration.
- Practice reflection on a regular basis. Reflection involves having the students think about the service-learning project and its impact on the community, and on themselves from an educational and personal standpoint. If well executed, this process can help students to explicitly incorporate their knowledge, thoughts, and beliefs into their personas. Service-learning projects may cause students to deal with race, class, economic, disability, and other issues; reflection is one way to help students realize and process these issues. Requiring the students to respond regularly to your questions in a journal or portfolio is an easy way to accomplish this important aspect of service-learning. Students are able to articulate the benefits of service-learning when the connection between course material and service-learning is made explicit.
- Grades should be determined using a similar rubric to your course in a non-service-learning context. Students are not graded on the number of hours they commit to the project; they are graded on the quality of the final project. Service-learning should supplement the learning opportunities for the students in your course without sacrificing academic rigor.

I believe that the advantages of incorporating

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service-learning into undergraduate education far outweigh the only disadvantage I can think of, which is intensive instructor time input. Students are very committed to projects that are real, and interacting with community partners provides a strong motivator in terms of service to the community and accountability to the agency. I have been using service-learning in a freshman level design course in Biological Engineering for five years, and the freshman-sophomore retention rate of students in the major (including women and minorities) is substantially above the national average for all engineering disciplines. I will close with two broad recommendations regarding service-learning projects.

- A service-learning approach can be easily integrated into beginning courses to give students hands-on experience in their area of study early in the curriculum. It is also useful in a capstone setting so that students can take all the knowledge they've gained throughout the curriculum and apply it in a real-world setting with guidance from instructors, community partners, and community members.

  These groups can be linked; I partnered freshmen and seniors taking the capstone design course for a service-learning project. Freshmen were very impressed by the knowledge of the seniors, and benefited from peer mentoring provided by the seniors. The seniors were grateful for help on their design project provided by the freshmen, and enjoyed sharing their knowledge with the students.

  Learning communities can be used to bring together diverse majors to work together in different aspects of a service-learning project, or students in the same major can take different classes that concentrate on distinct aspects of a service-learning project. Recently, LSU Biological Engineering students enrolled in a technical writing course wrote proposals to fund playgrounds that they were designing for community agencies in their Biological Engineering design course.
- Be cognizant of liability issues involved with students being out in the community. Discuss all issues with your campus service-learning office and/or office of risk management. Liability issues include transportation of students from the university to the community site, interactions between students and community members, and the potential for accidents during the service-learning activities, especially construction. It is fairly straightforward to adhere to a policy in which instructor, students, and the university are safe, but the instructor must make sure that s/he and the students are aware of and abide by these policies.

References

Bringle, R. and J. Hatcher. 1995. A Service-Learning curriculum for faculty. Michigan Journal of Community Service Learning 2(3): 112-122.