The Institute of Biological Engineering

www.ibeweb.org

Spring 2004 Volume 8.1

Highlights of IBE 2004 Annual Meeting

Jan. 8-12, 2004, Fayetteville, Arkansas

Message from the President

by IBE President, Lalit Verma

It is a pleasure to share the plans of IBE leadership in 2004. I remain firmly committed to promoting the discipline of biology-based engineering. As most of you are aware, the Institute of Biological Engineering was established in 1995 to encourage inquiry, application, and interests in Biological Engineering in the broadest and most liberal manner and to promote the professional development of its members. It promotes the view that Biological Engineering is a science-based, industry-independent discipline that is aligned with the perspective and foundation of biology. IBE espouses the view that biological engineers should possess the scientific knowledge of biology, including its philosophical views, be proficient in the principles and practices of engineering, and be capable of integrating discoveries from multiple disciplines to design sustainable solutions.

Our main goal is to continue to work with other professional societies and entities by partnering on issues of mutual interest. One critical issue is, "Identification and definition of skill-competencies for the discipline of Biological Engineering." Past-president Roy Young in his term initiated some very useful contacts with other groups having interest in Biological Engineering. I intend to work with Roy and actively to pursue this and other issues.

With ARDEL now being our executive organization, a key goal is to enhance and utilize the IBE web-site for member recruitment, partnerships with other groups, services provided by IBE, promotion of conferences, industry contacts, etc. Our plans are to increase IBE membership by providing member value. The IBE web-site will be enhanced and expanded with leadership from Jerry Gilbert and Steve Walker. I am fortunate to have the support and commitment of Brahm Verma, Roy Young, and Jerry Gilbert (President-elect) along with Judy Bourdeau, Executive Director (ARDEL), to make some significant advances in 2004.

2004 will certainly prove to be a challenging year for IBE. Recruiting members must be the primary focus. The 2004 budget calls for doubling the membership income over 2003. This will not happen without active participation from everyone. IBE should brainstorm ideas on how to recruit and maintain members, especially focusing on industry. Please feel free to provide your ideas to the leadership team.

It was a pleasure to host a very successful 2004 IBE Annual Meeting in Fayetteville. This was possible because of tremendous leadership provided by Roy Young and

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Editor, Art Johnson

The Care and Nurturing of Biological Engineering

Biological engineering is so delicate right now. I'm talking about the broad, science-based biological engineering for which IBE was founded. That concept of biological engineering has yet to be accepted by the rest of the world. Sometimes, it seems, it even gets lost within IBE.

AIChE has been dealing with a crisis of mammoth proportions over the last year. Membership was down, and finances were overwhelming. It was possible that the society would close its doors; it was that serious. Grasping for solutions, chemical engineering and chemical engineering departments have seriously begun to look at their relationships with biology (see http:/bio.aiche/org). Many have decided that Biological Engineering is the panacea that they need. So, look for many departments to change their names to Chemical and Biological Engineering over the next few years. Note when this happens, however, that there will be little, if any, corresponding curriculum changes. Sounds like agricultural engineering and ASAE a dozen years ago, doesn't it?

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ASAE is in the midst of a campaign to change its name to include Biological Engineering. Whether that is appropriate for ASAE is up to its members, but we can at least ask if ASAE is talking about the same broad and fundamental Biological Engineering that is the purpose of IBE.

Do all IBE members agree on the Biological Engineering of its founders? That is hard to answer, because, looking at the pronouncement and programs of IBE, it is difficult to discern what we stand for. Several years ago, President Norm Scott worked hard to get us to agree on a definition of Biological Engineering. It's not readily apparent that we continue to agree with it.

Then, let's look at programs from our last few meetings. We have tried very hard to include a breadth of possible applications. But, in trying to think outside the box, have we not replaced the big box with a lot of little boxes? Where is the unity in our programs?

When IBE was founded, there was a suggestion that specialty groups be allowed to form within IBE. That suggestion was rejected because we could not afford to fragment the unity of purpose of IBE.

I have written before about the tendency of IBE to look outside its ranks for experts in Biological Engineering. When it comes to keynote speakers, we look for those with established reputations in other fields to come and tell us about our own field. There must be someone in IBE who could qualify as an expert in Biological Engineering. And, if having this someone speak to us about Biological Engineering is monotonous to us old-timers, perhaps the message is needed for those who weren't around at the founding of IBE.

I strongly believe that IBE should be the bastion for broad, fundamental, Biological Engineering. We need to decide among ourselves what that really means: what are the technical areas covered and what methods are to characterize the entire field. If we are to foster different specialized applications areas, we need to focus on the common themes among them. It would be well for each paper and article published by IBE to specifically consider how its technical information relates to the entire broad and fundamental field of Biological Engineering.

Then, with that commonality of purpose, we need to sell this concept to a broader audience. We need to help chemical engineering see that they are a legitimate part of Biological Engineering, yet only a part. IBE needs to use its broad vision of biological engineering to facilitate liaisons with AIMBE, ABET, and other groups. IBE may never convolve all engineers interested in biology with all biologists interested in engineering, yet it already is serving an extremely important purpose. That purpose is a vision worthy to be nourished. Let us together keep that vision alive and never take it for granted!

Expectations for Biological Engineers

Arthur T. Johnson

Version 4.2 of Biology for Engineers is now posted on the web (www.bre.umd.edu/johnson.htm). This book is being presented as a resource for use in programs where engineers need to learn about biology, but from an engineering point of view. Because all engineers these days should know something about biology, materials such as this offer biological engineering programs the opportunity to have available an introductory course in biology for all engineers at their institutions. It's an opportunity for recognition and attraction of majors.

In Biology for Engineers, these three expectations are listed for biological engineers:

1. The knowledge of biological principles and generalizations that can lead to useful products and processes.
2. The ability to transfer information known about familiar living systems to those unfamiliar.
3. The ability to avoid or mitigate unintended consequences of dealing with any living system.

To the third expectation, we add that living systems are not passive: they move, they change, and they influence their surroundings. Thus, they cannot be used blindly without expecting other changes to happen. Anticipating these other changes can distinguish those who are experts in biological engineering from all others. Whether the process involves installing an artificial heart into a sick human patient or introducing a new law to limit harvesting of a wild food species, there will be other unrelated and perhaps unseen consequences.

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Joel Cuello and the five technical program coordinators, Joseph Irudayaraj, Evangelyn Alocilja, Jin-Woo Kim, Robert Brown, and Marty Matlock.

The theme of the 2004 Annual International Meeting of the Institute of Biological Engineering (IBE) was "Exploring Frontiers of Biological Engineering." With 130 registered attendees, the meeting opened on Friday, January 9, in Fayetteville, with an all-day Invited Plenary Session of distinguished speakers who provided cutting-edge overviews of cross-disciplinary frontiers.

The invited Plenary Session Speakers included Jeff Schloss of the National Institutes of Health for *Bionanotechnology*, William Heinemann of the University of Cincinnati for *Biosensing Engineering*, Russell Deaton of the University of Arkansas for *DNA Computing and Bioinformatics*, Michael Ladisch of Purdue University for *Bioprocessing*, and Cully Hession of the University of Vermont for *Ecological Engineering*. Following their respective presentations, the five Plenary Session speakers participated in a panel discussion exploring skill competencies for Biological Engineering graduates to function effectively in the various frontiers of opportunities.

***The first day concluded with the dinner speaker, Bob Nerem of Georgia Institute of Technology, addressing* "Bioengineering: 25 Years of Progress, But Still Only a Beginning."**

Saturday featured concurrent Technical Sessions on Bionanotechnology, Biosensing Engineering, DNA Computing and Bioinformatics, Bioprocessing, Ecological Engineering, and Poster Session. Graduate and undergraduate students in the Poster Session were automatically entered for the 2004 IBE Student Poster Competition. The poster winners were: First place**,** Ryan Pooran, a graduate student in the Department of Mechanical Engineering at the University of Arkansas, for his poster entitled: "Performance of a Flagellar Motor Based Pump;" second place, Ying Cai, a graduate student in the Department of Chemical Engineering at the University of Arkansas, for her poster entitled: "Host Cell Redesign for Simplification of Downstream Processing Via Proteome Analysis;" and third place - Matthew Campbell, a graduate student in the Department of Biological and Agricultural Engineering at Louisiana State University, for his poster entitled: "Coastal Wave Dissipation Effects of Engineered Oyster Reef Configurations."

Sunday morning provided opportunity for the Technical Session Coordinators to summarize their respective frontier areas and to provide recommendations for programming continuity at future meetings. Please check our web-site at www.ibeweb.org for details.

Action items for the coming year:

- We hope to increase our university chapter membership under the leadership of Dawn Farver.
- Another key initiative is to have an IBE publication. Alternatives are being explored under the leadership of Mark Eiteman.
- In order to increase membership, graduates of BE programs will be contacted through their respective departments. A "Welcome" package for new members including an IBE membership certificate is planned.
- A letter to survey previous members of IBE (who are not current members) inquiring about how we can get them back is also being planned.

The 2005 meeting will be in Athens, Georgia, March 4-6, 2005. IBE meetings are organized to encourage participation of scientists, engineers, and students worldwide; to present advances in engineering sciences, engineering design, technology, educational materials, and techniques and other aspects that contribute to the development of biological engineering; and to encourage the development of partnerships among academia, industry, and agencies. IBE welcomes professionals and students from all fields of science, engineering, and medicine with interest in Biological Engineering. Student participation and presentations are highly encouraged.

I plan to provide you with updates on our initiatives and progress during the year. Please feel free to let me know how we can move IBE and the Biological Engineering discipline forward.

See collage of 2004 meeting pix on page 9!

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Technological advances have made unintended consequences almost inevitable. Like a phantom in a bag that pops out in every direction that isn't held, secondary effects that are masked by primary effects assume much more importance when the primary effects are conquered (Tenner, 1996). Chronic illnesses such as cancer, silicosis, and cumulative trauma disorder probably were not recognized as important because acute illnesses such as typhoid, plague, and pneumonia killed so many. After anesthetics allowed painless surgery, the number of surgical procedures skyrocketed and the total amount of pain experienced by the total human population is higher because of it.

This message is discouraging, because it implies that unintended consequences can never be avoided. As the more acute problems affecting humans and their environment are tackled and cured, problems that had seemed inconsequential can suddenly become limiting. Nevertheless, the experienced biological engineer should be more able than others to anticipate the likely consequences of her technological fixes and to be prepared to deal with them.

IBE 2003 President's Comments at Year's End

Roy Young

At the end of Year 2003, I wish to share a few comments concerning the IBE activities of 2003 and some perspectives for where we might be going in 2004. Although I have not personally written a lot to you this year, I trust that you have been accessing our totally reworked IBE web page, www.ibeweb.org, and have seen much of what has been transpiring.

It has been a productive year with many things happening behind the scenes which we trust will lay the foundation for growth and development of our young IBE organization. IBE 2002 President Brahm Verma very ably and masterfully led the Institute in developing its October 2002 Strategic Plan around the strategic issue, *"What should IBE do to become the society of choice in the field of Biological Engineering?"* Out of this deliberate and effective process emerged the following strategy:

1. Develop Headquarters Services;
2. Organize discipline-focused meetings, conferences, and publications; and
3. Initiate a development fund.

An Implementation Plan to carry forward this strategy included the following actions:

1. Contract Headquarters Services with a private provider;
2. Form a committee of IBE Past Presidents to lead initiation of a Development Fund to support the Institute in providing member services;
3. Plan IBE Annual Meetings that deal with cross-cutting topics, are self-supporting, and generate revenues;
4. Hold "Gordon" style conferences for participants to engage in deep exchanges on relevant, single topics;
5. Expand student-focused activities at meetings;
6. Initiate IBE publications;
7. Develop industry participation;
8. Create a more effective IBE web site;
9. Increase membership recruitment activities;
10. Consider initiation of honors and awards;
11. Development Biological Engineering Textbooks; and
12. Promote accreditation practices.

2003 has seen considerable efforts to follow the Implementation Plan. As would be expected, accomplishments have varied among the listed strategic actions. After a very successful IBE 2003 Annual Meeting in Athens, GA last January, the initial and primary activity involved finalization of a contract for headquarters services with The Ardel Group in Minneapolis, MN. After her introduction to IBE through her time spent with us at the IBE 2003 Meeting, Rosealee Lee, Chief Executive Officer of Ardel, and our IBE Transition Team (Roy Young, Brahm Verma, Lalit Verma, Tim Foutz, David Jones, and Jim Dooley) successfully completed iteration of a detailed contract for headquarters services. As a young, cash-limited organization, IBE had to negotiate carefully to achieve a proper balance of professional services with volunteer efforts from our membership. A budget was created and has been followed closely this first year. We have had to make some tough choices about what IBE can now afford and what can continue to be done by volunteers. Priorities have had to be established among what we would like to do through headquarters services and what we can afford to do now and later. With her thorough and perceptive understanding of the "biological" organizations, industries, and trends and her great business and interpersonal skills, Rosealee has been a truly effective guiding counselor for our transition from a volunteers-only organization to our first-year partnership with Ardel. Many transitional activities and details had to be accomplished. Much has been accomplished to create the foundation for an IBE Headquarters in Minneapolis. In subsequent years the

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Institute through a stable headquarters infrastructure will be able to concentrate on its true potential for development and growth. By the end of 2003, Ardel was able to identify Judy Bourdeau as the Executive Director for IBE. Judy is excited about the potential for IBE. She will be present at the IBE 2004 Meeting in Fayetteville, AR, January 9–11, 2004. I hope each of you attending the meeting will get to meet Judy.

It became evident to us early in the year that an effective web site was paramount for an organization to communicate adequately and to provide suitable member value. Although it had been anticipated that the web site could be handled by volunteer efforts, reality was clearly different.

Consequently, Rosealee was very helpful and understanding in providing timely access to appropriate professional resources within Ardel. That decision has enabled IBE already to provide its members several new member benefits through www.ibeweb.org as follows: Member Update and Profile, Member Directory, Peer-to Peer Networking, and Career Resources!

The third significant activity has been planning for the IBE 2004 Meeting. As you can see from our web page and, hopefully, will experience in Fayettville, AR, this year's program focuses on "*Exploring Frontiers in Biological Engineering*." To promote attraction of a broader audience from multiple disciplines, the diverse themes of Bionanotechnology, Biosensing Engineering, DNA Computing and Bioinformatics, Bioprocessing, and Ecological Engineering were chosen as cross-cutting frontier areas. Substantial effort was made to attract invited keynote and profile presenters for the first day. These outstanding individuals come from very varied disciplines that today share significant interests in the emergence and development of biological engineering. Hopefully, this program will foster a new level of facilitation of different disciplines coming together in a single interdisciplinary forum to share their knowledge and perspectives. I believe herein lies the greatest unique capability of IBE – to be the forum for engineers and scientists to share their respective experiences and views in the development of Biological Engineering in its broadest sense across the boundaries of traditional disciplines and professions.

Other accomplishments and initial discussions have transpired during 2003 under the clear guidance now of a sound IBE Strategic Plan and a centralized headquarters. Time is being allocated with the IBE 2004 Meeting for Committees identified around our Implementation Plan to meet, to organize, to plan, and to execute their respective endeavors to make IBE a more functional and effective force in the emergence of Biological Engineering. I hope each of you will seek out how you can be involved. Achievements have been made, yet many opportunities remain for IBE to be what it can be! Now that a professional-based IBE Headquarters is in place, I feel that key efforts for 2004 should focus on *creatively expanding our membership base across multiple traditional disciplines* and on *building greater member value*. GET INVOLVED! Together we have a great opportunity and much that needs to be accomplished!

Actively Growing Membership

Roy Young

Within most major discipline societies today, subgroups are appropriately emerging that represent each respective society's interests and perspective of engineering applied to living systems. None of these groups, however, share IBE's stated objective "*to encourage inquiry, application, and interest in biological engineering in the broadest and most liberal manner ….*" IBE as the first Biological Engineering organization independent of a traditional discipline-oriented society (e.g., ASME, ASAE, AIChE, IEEE, BMES, etc.) has the unique opportunity to facilitate collaborations across multiple disciplines and industries.

With this unique opportunity in mind and with a desire to explore collaborations necessary to accomplish a diverse critical mass sufficient to achieve IBE's objective, I initiated in October 2003 letters to the chairs or presidents of several relevant organizations. Observing the recent activities within AIChE to form internally for its purposes the Society of Biological Engineering (SBE), I first sent a letter on October 9, 2003 to Dr. Dianne Dorland, President of AIChE, with a copy to Dr. Wei-Shou Hu, AIChE Division 15 Chair. Later in December 2008, I sent a similar letter to Dr. Greg Stephanopoulos, an organizer of the SBE group. I offered "*the support of IBE to AIChE and encouraged their organization to consider partnering with IBE as it seeks to facilitate a forum for exchange among engineers and scientists with biological interests from all disciplines*." I also encouraged recipients of my letter to visit the IBE web site (www.ibeweb.org), to notice the IBE 2004 Meeting program, to encourage their members with biological engineering interests to attend the IBE 2004 Meeting, and themselves to visit with IBE officers on Sunday afternoon, January 11, 2004, following the IBE 2004 Meeting to discuss potentials for collaborations that can be beneficial to our mutual purposes. Dr. Dorland has replied, "Though I am unable to attend, I would like to identify one of our leaders to represent SBE interests and (to) explore with you opportunities for collaborations." Dr. Stephanopoulos

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replied, "This is certainly an event that I would encourage SBE members to participate in during this and coming years. I am afraid I will be unable to do so personally as I will be traveling during that period, however, I look forward to similar opportunities in the future."

I also sent similar letters to Dr. Maury L. Hull, Chair of the Bioengineering Division of ASME (cc'd to Dr. Reginald I. Vachon, President of ASME); to Dr. Mark Moore, President of Surfaces in Biomaterials Foundation (cc'd to Dr. Jim Brauker, President-Elect who has now assumed office); to Dr. Kyriacos A. Athanasiou, President of BMES; to Dr. Nicholas Peppas, President of Society of Biomaterials; and to Dr. Joan Bechtold, President of ASB (American Society of Biomechanics). Reggie Vachon recommended that Rosealee and I visit ASME headquarters in New York at our earliest convenience. Mark Moore notified me that Jim Brauker assumed the presidency two weeks earlier and that he would leave it up to Jim. I have had no response from Jim. Kerry Athanasiou responded that he had discussed our letter with the BMES executive committee and recommended that we arrange to meet along with Rosealee at the AIMBE meeting in February 2004 to discuss cooperation. Drs. Peppas and Bechtold have not replied.

At this point, I am uncertain if anyone will visit with IBE officers on Sunday afternoon, January 11, 2004 in Fayetteville, AR. In 2004, I hope to arrange exploratory visits to ASME and AIChE headquarters which are both in New York. I also intend to visit with Kerry Athanasiou at the AIMBE Meeting in Washington, DC in February 2004. I will follow-up on contacts with the other recipients of my letters.

I believe one way IBE can grow the diverse and larger membership it critically needs to achieve its objective is by facilitating active collaborations with biological engineering interest groups within traditional discipline-oriented societies. These groups have an appropriate role within their respective disciplines, yet they need the opportunity through IBE to share and to grow through interactions with their counterparts in other disciplines. IBE offers just that service to a growing membership.

Tenth Institute of Biological Engineering Meeting

Brahm P. Verma

The **Tenth Meeting** of the Institute of Biological Engineering will be on **March 4-6, 2005 at the University of Georgia Continuing Education Center (Georgia Center).** The Meeting Program will focus on exploring "Biology Inspired Engineering Frontiers" in such diverse fields as bio-inspired thermodynamics and transport, cellular and tissue engineering, nanotechnology, materials, sensing and controls, systems engineering, engineering ecology, computational methods and engineering design.

Engineers and scientists interested in interfaces of engineering and biology will find the meeting an exciting opportunity to present their work and to interact with individuals who represent a wide range of disciplines. They will be bonded by common interests in creating a new engineering knowledge that draws from a greater understanding of advanced principles of biology. Promoting innovations in engineering design to capture remarkable features of living systems will be the capstone session of the meeting.

A special feature of the meeting will be presentations by the leaders of several engineering and scientific societies. They will share how their disciplines and societies have changed with the advances in biology. Forums for discussing ways of building a nexus of disciplines are being organized.

Abstracts for papers and poster presentations will be accepted until December 1, 2004. Full-length papers are optional and will be accepted until December 15, 2005 for non-refereed Meeting Proceedings. Students in science and engineering programs are especially encouraged to present papers and posters. They can also participate in the Student Poster Competition with cash prizes for the first, second and third place finishes.

The University of Georgia is located in Athens, Georgia. Athens, also known as the Classic City, offers a beautiful setting for the meeting. It is easily accessible from the Atlanta airport with regular limousine service to the Georgia Center. U.S Air has a commuter air service from Charlotte, NC. The Center has excellent guest and meeting room facilities. For meeting and program details visit the IBE website <www.ibeweb.org.>

Seeking Collaborations

During the last quarter of 2003, IBE 2003 President Roy Young sent letters to leaders of the following organizations encouraging them and their members to attend the IBE 2004 Meeting and inviting discussions of how our respective groups might collaborate through IBE:

- AIChE - Dr. Dianne Dorland, President; Dr. Wei-Shou Hu, AIChE Division 15 Chair; and Dr. Greg Stephanopoulos, MIT, instrumental in emergence of SBE (Society of Biological Engineering)
- ASME - Dr. Maury L. Hull, Chair of the Bioengineering Division; Dr. Reginald I. Vachon, President ASME
- Surfaces in Biomaterials Foundation - Dr. Mark Moore, President; Jim Brauker, President-Elect
- BMES - Dr. Kyriacos A. Athanasiou, President
- Society of Biomaterials - Dr. Nicholas Peppas, President
- American Society of Biomechanics (ASB) - Dr. Joan Bechtold, President

Follow-up communications have transpired with AIChE, ASME, Surfaces in Biomaterials Foundation, and BMES and are being continued. The content of the AIChE letter below demonstrates the nature of this contact with other groups as well as with interest in biological engineering.

Dear Dr. Dorland:

As president of the Institute of Biological Engineering (IBE), I was encouraged to observe on page 75 of the October 2003 edition of *Chemical Engineering Progress* that new interests are emerging within AIChE for engineers and applied scientists with interests in the broad area of biological engineering. Many traditional engineering disciplines have already or are recently evolving subgroups with specific interests in *Bringing Engineering to Life*. Such activities are certainly appropriate from the unique perspectives of each engineering discipline.

I would like to offer the support of IBE to AIChE and to encourage your organization to consider collaborating with IBE as it seeks to facilitate a forum for exchange among engineers with biological interests from all disciplines. Since its formation in 1995 as part of a traditional-discipline society, the Institute of Biological Engineering has existed "to encourage inquiry, application, and interest in biological engineering in the broadest and most liberal manner and to promote professional development of its members." In 1999 IBE became an incorporated organization independent of any traditional discipline-based society because of its desire to facilitate collaboration and connectivity across all corners of engineering and science with biological engineering activities. IBE's value is founded in functioning to be a forum for dialogue and exchange among groups of engineers and scientist with a need and a sincere desire to share respective experiences and perspectives in the world of engineering linked with biology. This interlinking and integration activity for the furtherance of the development of biological engineering is the heart of the member value of IBE; it is dependent on collaborations among participants with truly diverse backgrounds and perspectives. Consequently, IBE is fully supportive of biological engineering activities within all respective discipline-based organizations. Maturation of these activities is critical, yet a forum for exchange among these various interest groups is paramount for the understanding of essential common denominators important to all groups. Therein lies IBE's vision and role.

I encourage you to visit the IBE web site at www.ibeweb.org. Please note the exciting program being planned for the IBE 2004 Meeting in Fayetteville, AR on January 9-11, 2004. I extend to you and your colleagues in AIChE and SBE a special invitation to participate with presentations and/or attendance, particularly in the Bioprocessing and Biosensing technical sessions. We also would like to arrange a time on Sunday afternoon, January 11, 2004 for informal exchanges between leaders of IBE and your society to explore collaborations that can be beneficial to our mutual purposes. I believe we do share synergistic interests.

Sincerely yours,

Roy E. Young
IBE President

TRANSITION YEAR A SUCCESS!

By Judith M. Bourdeau, Executive Director

Early in 2003, the Institute of Biological Engineering (IBE) made a decision to partner with *the ARDEL group* to provide a stable infrastructure for IBE's headquarters and to promote and coordinate the Institute's growth. During this transition year and under the leadership of Rosealee Lee, President and CEO of ARDEL, IBE saw increased networking and membership benefits through the following initiatives.

Website
At the Executive Committee's request, ARDEL assumed the primary role for website development and created a basic website to serve member's needs. In 2004, the website will continue to become a valuable resource not only to IBE members but to the biological engineering community as a whole.

Peer to Peer Network
The online Peer to Peer Network provides a resource to link IBE members to the global community. By creating a virtual directory of biological engineering experts, the network enables visitors to find experts by category. Members can add their profile information to the network by visiting http://www.ibeweb.org/member/peer2peer.cgi.

Online Member Directory
The online Member Directory gives members a quick and easy way to reach other members. Additional membership services include a module that allows members to keep their contact information up to date. Members can visit https://whale.secure-host.com/ibeweb/member/memberlog.cgi to update their information in real time.

Online Job Service
An online Job Service created an opportunity for members and others to find jobs in the biological engineering field. Corporations pay a small fee to have positions available listed, and visitors to the webpage can upload their resumes as well as respond to the listings.

Visibility
ARDEL gained visibility for IBE by working with peer groups to arrange *quid pro quo* agreements for visibility opportunities. IBE received free advertising space in peer group publications, displayed meeting materials at biological engineering-related meetings, and had a linked placed on related websites.

A Marketing Prospectus was developed and mailed to potential sponsors, exhibitors, and advertisers and was placed on the website to promote IBE as a visibility option for others.

IBE saw more transition later in the year when Rosealee Lee handed over Executive Director duties to Judith Bourdeau. Judith has ten years Association Management experience and is working with volunteers to coordinate headquarters activities and marketing programs. IBE will continue to see change in 2004 as it transitions to become the primary resource for biological engineering information. With a focus on the website initiatives and membership recruitment, IBE will provide more networking opportunities and membership benefits.

Exploring Frontiers in Biological Engineering

Tenth Institute of Biological Engineering Meeting

Biology Inspired Engineering Frontiers

March 4-6, 2005
The University of Georgia, Athens, Georgia

ADVANCE NOTICE AND CALL FOR PAPERS

About IBE

The majority of engineering advances related with biology have been towards creating designs that accommodate properties and constraints of living materials. They have also been focused on specific applications, such as medicine, health and agriculture. However, learning from biology itself in ways that advances the fundamentals of engineering sciences without any regard to application needs more organized attention.

IBE was established in 1995 to promote broad inquiry in the fundamental of engineering sciences based on biology and to examine these at all scale levels - from nano to organism to landscape scales. It encourages inquiry, application and interest in biological engineering in the broadest and most liberal manner and promotes the professional development of its members.

IBE is striving to form a nexus of engineers and scientists, professional societies and industries to inspire remarkable designs that capture features of living systems.

Who should attend

Engineers and scientists interested in creating new knowledge that provides greater understanding of engineering principles founded from the understanding of biology and that promote advances in design to capture remarkable features of living systems. Students and scientists and engineers in academia, industry and agencies will find research and development in areas other than their specific discipline are catalyst for envisioning new approaches.

Program

Program committee is seeking papers and presentations on engineering topics inspired by advances in biology, such as:

· Bio-Inspired Systems Engineering
· Bio-Inspired Thermodynamics &Transport
· Bio-Inspired Engineering Ecology
· Bio-Inspired Tissue Engineering
· Bio-Inspired Cellular Mechanics
· Bio-Inspired Nanotechnology
· Bio-Inspired Materials
· Bio-Inspired Methods of Sensing & Controls
· Bio-Inspired Computational Methods
· Bio-Inspired Engineering Design

Papers

Papers and posters are sought on topics described under "Program." Submit one-page abstract of papers and posters by December 1, 2004 to contact address below. Full-length papers are optional and will be accepted for the Meeting Proceedings by December 15, 2004.Students in science and engineering programs are especially encouraged to submit papers and compete in the poster competition. Additional details <www.ibeweb.org>

Special features

The Meeting will feature panel sessions with panelists from science and engineering disciplines. The panelists will discuss ways of building a nexus of disciplines to capture remarkable features of living systems in engineering design.

Contact Information: Dr. Joel L. Cuello, Program Coordinator
University of Arizona, 403 Shantz Bldg. Tucson, AZ 85721

FOR MORE INFORMATION VISIT OUR WEBSITE: <www.ibeweb.org>
Please email abstracts to: abstracts@ibeweb.org

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IBE Has Been Heard

What are the differences among biomedical engineers, bioengineers, and biological engineers? Rob Linsenmeier (2003) explores this and other questions in his article "What Makes a Biomedical Engineer?" IEEE Engineering in Medicine and Biology Magazine v. 22(4), pp. 32-38 (July/August 2003). To compare these, he has quoted the Whitaker Foundation of biomedical engineering:

> Biomedical engineering is a discipline that advances knowledge in engineering, biology and medicine, and improves human health through cross-disciplinary activities that integrate the engineering sciences with the biomedical sciences and clinical practice. It includes: 1) The acquisition of new knowledge and understanding
> of living systems through the innovative and substantive application of experimental and analytical techniques based on the engineering sciences, and 2) The development of new devices, algorithms, processes and systems that advance biology and medicine and improve medical practice and health care delivery. As used by the foundation, the term "biomedical engineering research" is thus defined in a broad sense: It includes not only the relevant application of engineering to medicine but also to the basic life sciences.

The NIH definitions of bioengineering:

> Bioengineering integrates physical, chemical, mathematical, and computational sciences and engineering principles to study biology, medicine, behavior, and health. It advances fundamental concepts; creates knowledge from the molecular to the organ systems levels; and develops innovative biologics, materials, processes, implants, devices, and informatics approaches for the prevention, diagnosis, and treatment of disease, for patient rehabilitation, and for improving health.

The IBE definition of biological engineering:

> Biological Engineering is the biology-based engineering discipline that integrates life sciences with engineering in the advancement and application of fundamental concepts of biological systems from molecular to ecosystem levels.

and the NSF effort in Biochemical Engineering and Biotechnology (BEB):

> advances the knowledge base of basic engineering and scientific principles of bioprocessing at both the molecular level (biomolecular engineering) and the manufacturing scale (bioprocess engineering). Many proposals supported by BEB programs are involved with the development of enabling technologies for production of a wide range of biotechnology products and services by making use of enzymes, mammalian, microbial, plant, and/or insect cells to produce useful biochemicals, pharmaceuticals, cells, cellular components, or cell composites (tissues).

When compared side-by-side, Linsenmeir finds a great deal of commonality, not only in the focus of each, but also in the need to agree on common core contents, competencies, and courses.

Also in this article are industrial needs and opportunities, and processes by which a common core can be considered. He describes activities of the VanTH engineering research center for bioengineering education (www.vanth.org). This center is beginning to develop some useful materials, and this article is definitely worth reading.

Biofilms: What are they and why are they of concern?

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You may not be familiar with the term "biofilms." What are they and why are they of concern? Even if you are not familiar with this term, you have certainly encountered them on a regular basis. In nature, biofilms are found on almost every moist surface, on plant roots, leaves, and within nearly every animal. One kind of bacterial biofilm is in your mouth! The plaque that forms on your teeth, causing your teeth to decay is a biofilm. You may have gotten sick from eating biofilms on "ready-to-eat" fresh produce. Bacteria can attach to food processing materials, such as stainless steel or polyethylene bags, which may in turn contaminate your food. Biofilms, by definition, are complex microbial communities, with their cells encapsulated in a slimy matrix. Biofilms can harbor a variety of organisms including bacteria, protozoa, algae, fungi, and viruses and metazoan, such as nematodes or rotatoria1.

It is generally accepted that formation of a biofilm includes four major steps (Figure1): conditioning of a surface; adhesion of cells; formation of a microcolony; and biofilm formation2. We know that bacteria become associated with moist surfaces for a couple of reasons. One is gravity – the organism may settle out and end up resting on a surface. Another possible reason is the difference in charge between the outer membrane of a bacterium, which is often negative, and the positive charge on some inorganic surfaces, such as stainless steel. After bacteria adhere to the surface, some cells begin to excrete copious amounts of slimy, glue-like substances, which act to hold the cells to the surface. This is called extracellular polymeric substance (EPS). EPS may contain polysaccharides, proteins, nucleic acids or other polymers. All of these polymers have a high affinity for water. Therefore, biofilms are highly hydrated structures that may have a water content of up to 98%.

Biofilms may consist of monolayer of cells or they may be as thick as several hundred micrometers. At one time, most scientists thought that biofilms were a homogeneous layer of cells distributed within a uniform slimy matrix. This was shown to be incorrect by observations of intact and undisturbed biofilms by confocal laser scanning microscopy. Biofilms are now known to be complex 3-dimensional structures consisting of clusters of cells and EPS penetrated by pores and separated by channels3. Biofilms take a wide variety of forms depending on their age and growing conditions. Hermanowicz *et al.* found that the biofilms became denser and more compact with age, suggesting that the number of pores and channels inside the biofilms decreases over time4.

The time required for bacteria to attach to surfaces and form hazardous biofilms can be relatively short. It has been found that *Pseudomonas* formed attachments within 30 minutes at 25˚C and 2 hours at 4˚C in a constantly moving milk flow. *Listeria* attached within 20 minutes on a stainless steel surface. In response to these threats, President Clinton announced the Food Safety Initiative on January 25, 1997, aimed at enhancing the safety of the nation's food supply.

One significant advantage for the bacteria in biofilms over free-floating cells is their protection from antibiotics and sanitizers. One explanation for this resistance is failure of either antimicrobial to penetrate the biofilms5. Scientists have shown that a much higher concentration of these compounds is needed to kill the bacteria in biofilms than to kill planktonic (free-floating) cells 6. *In vitro* experiments have demonstrated that the bacteria inside biofilms may be 10 to 1000 times more resistant to the effects of antimicrobial agents than planktonic bacteria of the same strain. This increased resistance poses a big risk for food safety, especially for "ready-to-eat" fresh produce, such as fruit juices, lettuce and bean sprouts. In recent years, the frequency of outbreaks of foodborne illness associated with consumption of fresh fruits and vegetables has increased, partly as a result of an increased demand for minimally processed produce.

Biofilms can be removed and/or destroyed by chemical and physical treatments. Some sanitizers react with the EPS, releasing bacteria from the biofilm and killing them. Physical treatments include mechanical scrubbing and hot water. According to Mittelman (1986) "Chlorine is considered the most effective and least expensive biocide." Chlorine (usually from bleach) is particularly effective against attached biofilms. Not only are the bacteria killed, but chlorine also reacts with and destroys the EPS and its attachments to the surface, breaking up the physical integrity of the biofilm. However, due to the reaction of chlorine with other organic materials (such a residual food or other wastes) around a biofilm, the ability of chlorine to reduce contaminating pathogens has been limited7. Enzymes can also be used for breaking down the biofilm's EPS. When biofilms are treated with enzymes, the bacteria they contain become more susceptible to attack by an antibiotic or a sanitizer. Other sanitizers, such as hydrogen peroxide, ozone, and acetic acid have also been used in the food processing industry and water treatment systems8. However, their effectiveness at killing and removing biofilms needs to be further tested. Often, several sanitizers need to be used together to decontaminate the biofilms effectively.

In summary, biofilms are highly hydrated structures, which show a great resistance to antibiotics and sanitizers. Their presence in food has drawn much concern to food safety. It is clear that additional studies must be performed to further examine how and why bacteria growing in these complex communities are protected from attack. Efforts will continue to be made to find the effective sanitizers or sanitization methods to disinfect biofilms and improve food safety.

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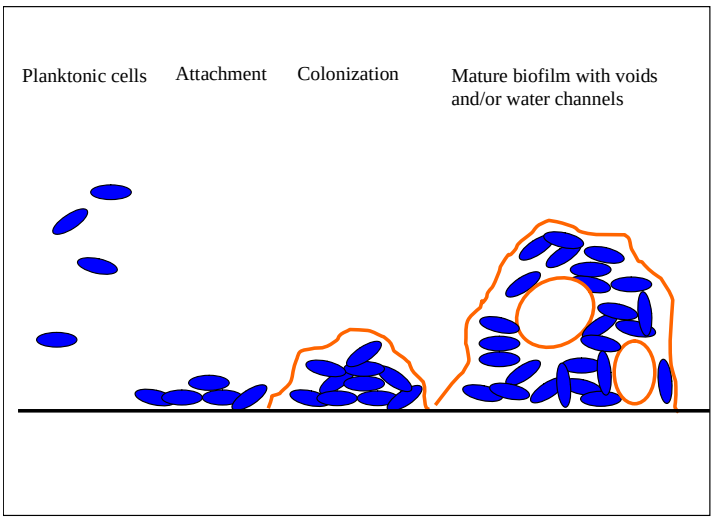

Figure 1. Process of biofilm formation. In the first step, solid surfaces will be conditioned with nutrients. Then planktonic cells attach to solid surface. If the condition favors the cells growth, microcolonies will form, and the attached cells will produce EPS to anchor cells to the surface and protect them from their environment. As the biofilm grows, it forms a complex 3-D structure with voids and/or water channels.

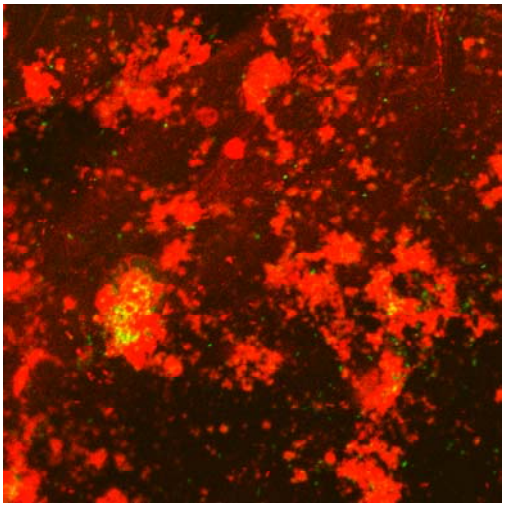

Figure 2. A biofilm of wide-type *E. coli* on lettuce. Biofilm was stained with SYTO16 and Propidium iodide. Image was captured using Zeiss confocal microscope. The yellow-green regions are living biofilm and the red regions are dead biofilm.

References

Arvin, E. 1995. Biological degradation of organic chemical pollutants in biofilm systems. *Water Sci. Technol.* 31, 1-280.

Kumar, C.G. and S.K. Anand. 1998. Significance of microbial biofilms in food industry: A review. *Int. J. Food Prot*. 58 (1), 24-28.

Decho A. W. and T. Kawaguchi. 1999. Confocal Image of In Situ Natural Microbial Communities and Their Extracellular Polymeric Secretions Using Nanoplast® Resin. *Biotechniques* 27, 1246-1252.

Hermanowicz, S. W., U. Schindler, and P.A. Wilderer. 1995. Fractal structure of biofilms – new tools for investigation of morphology. *Water. Sci. Technol*. 32, 99-105.

Thien-Fah C.M. and G.A. O'Toole. 2001. Mechanisms of biofilm resistance to antimicrobial agents. *Trends Microbiol.* 9 (1), 34-39.

Bower C.K. and M.A. Daeschel. 1999. Resistance responses of microorganisms in food environments. *Int. J. Food Microbiol.* 15, 50 (1-2), 33-44.

Seo, K.H., and J.F. Frank. 1999. Attachment of *Escherichia coli* O157:H7 to lettuce leaf surface and bacteria viability in response to chlorine treatment. *J. Food Prot*. 62: 3-9.

Mueller, R.F., 1994. Biofilm Formation in Water Systems and Their Industrial Relevance. In: *Proceedings Biological Sciences Symposium*, 195-201. Abstract 94-028.