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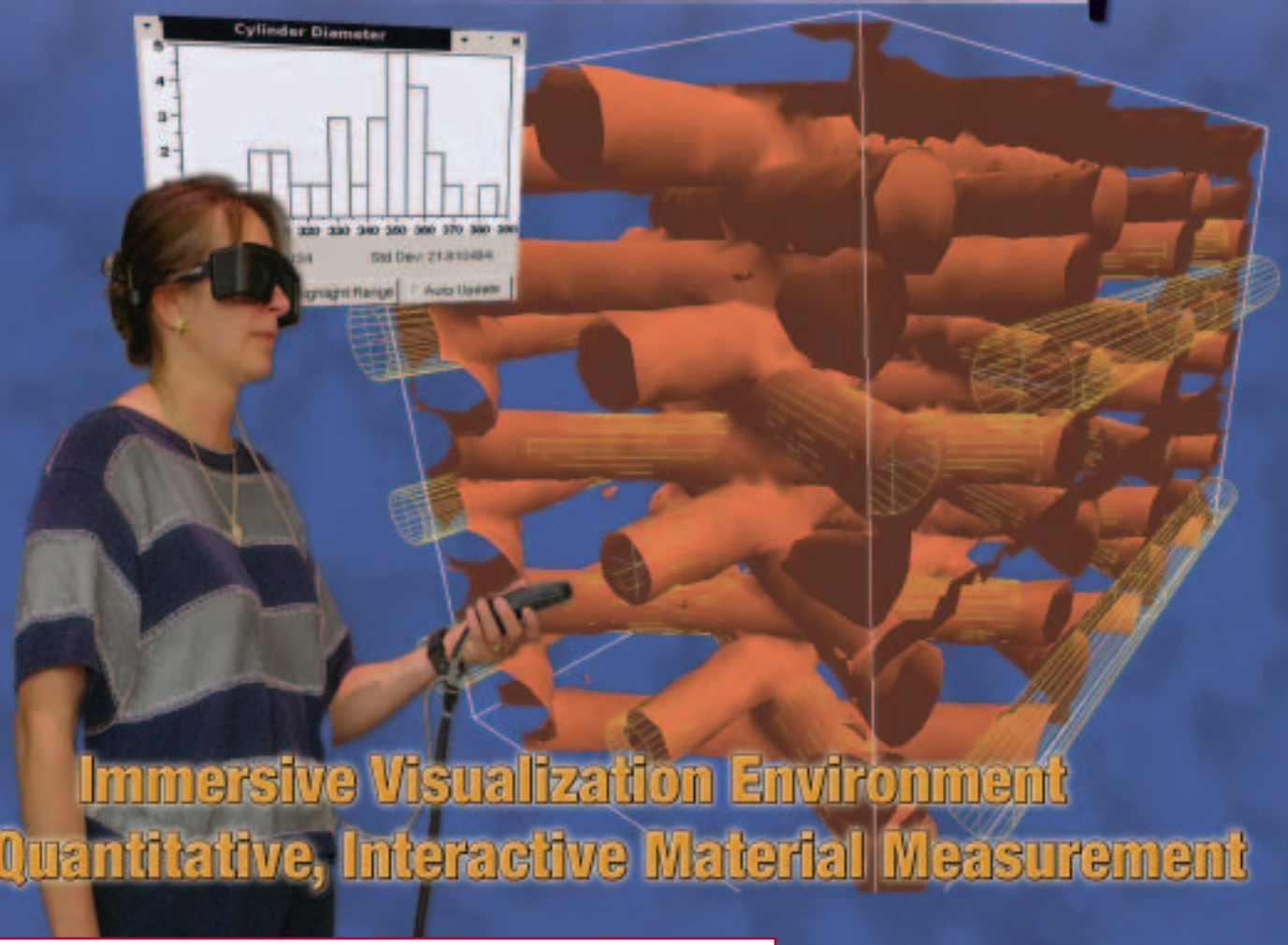

Immersive Visualization Environment for Quantitative, Interactive Material Measurement

Staff Updates From Headquarters

Step Outside Your Comfort Zone and Think Cross-Discipline

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BIOMATERIALS FORUM

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Fourth Quarter 2006 • Volume 28, Issue 4

Features

A user in the NIST immersive visualization environment.

Departments

From the Editor

By Karen J.L. Burg

I attended the recent Rising Above the Gathering Storm Convocation in Washington, D.C., which focused on the key areas identified in the National Academies report: *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. The event, attended by many administrators and legislators, caused me to ponder the attention given to higher education and to question how these concerns should affect readers of *Biomaterials Forum*. For example, as clinicians, students, educators, and industrialists, how might we answer the call to create a more competitive workforce? It has been pointed out on numerous occasions, and in a variety of venues, that higher education has become very product focused and the "customer" expects us to be extremely accountable to their expectations. Clearly, we can relate to this as biomaterialists, as the public is a consumer of biomedical devices and expects transparency and accountability in our development and marketing of products.

The Convocation discussion was perfectly timed as I sought to better understand the "Spellings Report," the product of a federal initiative on higher education to "radically reform higher education." This report was developed by the Commission on the Future of Higher Education in response to a charge by Education Secretary Margaret Spellings in September 2005. The Commission explored four issues—access, affordability, accountability and quality—to determine whether postsecondary education adequately prepares students to compete in a global economy; the Commission compiled its thoughts in what has been termed the Spellings Report.

The Spellings Report claims that "too many decisions about higher education—from those made by policymakers to those made by students and families—rely too heavily on reputation and rankings derived to a large extent from inputs such as financial resources rather than outcomes. Better data about real performance and lifelong working and learning ability is absolutely essential if we are to meet national needs and improve institutional performance." This means the breadth and depth of skills important to research and industry are not necessarily correlated to the ranking of an institution. In concert with the Rising Storm report, the Spellings Report emphasizes the importance of innovation, both in research and education, in globally positioning and optimizing U.S. institutions. Both reports concern themselves with the low numbers of American students pursuing degrees in science, technology, engineering and mathematics and point to multi-disciplinary fields, e.g. the field of biomaterials, as reactors for innovation. The Spellings Report insists that student success must be based on "value added" and not in the traditional manner of subjective rankings and opinion polls, and the Commission emphasizes that transparency in accountability is the key to institutional success.

"It seems fitting that as institutions of higher education wrestle with issues regarding mission, quality, and accountability, we should consider how these same metrics might be used to judge the contributions of SFB to biomaterials education."

It is obvious from the Spellings and the *Rising Above the Gathering Storm* reports that we are in a world of increased challenges. It seems fitting that as institutions of higher education wrestle with issues regarding mission, quality, and accountability, we should consider how these same metrics might be used to judge the contributions of SFB to biomaterials education. SFB must be considered a source of continuing education and a path for feedback to adjust the focus of activities in higher education. In these roles, how do we grade ourselves against the Spellings criteria? Access—are we reaching out to a diverse technical and cultural population that is representative of our field and that allows us optimal teamwork and innovation? Are we only interested in recruiting into the field those with the best looking pedigree or are we willing to admit that other traits and experiences are equally important? Affordability—is access assured to all who can benefit from our journals and meetings? Accountability—are we seeking new methods of reaching the public, are we actively engaging our students in service learning and community outreach projects and are we preparing them to communicate with persons of varied technical backgrounds? And quality—how indeed do we define a "quality" education in a biomaterials related field? Does "quality" mean our colleagues opinion of us or does it mean tangible value-added? The questions are endless, but the opportunity is real—to chart a course that will serve as a model for interdisciplinary programs elsewhere. Is SFB ready for the gathering storm?

Karen J.L. Burg
Hunter Endowed Chair & Professor of Bioengineering
Clemson University

From the President

By C. Mauli Agrawal

Time appears to be flying by so fast! It seems only yesterday when we had our Spring 2006 annual meeting in Pittsburgh and here it is Fall already. The Board, Council and the various committees have been busy on different initiatives during this time. The most important, in my opinion, is one that was started last year when several task forces were established to assess and evaluate how our Society functions and what could be done better. These tasks forces looked at several core aspects such as society governance, special interest groups, and the annual meeting among others, and submitted detailed reports. These reports were given to the Long Range Planning Committee, which under the leadership of President-elect Martine LaBerge, worked diligently to take the recommendations of the task forces and convert them into actions items. We hope to start implementing these after their approval by the Council. As a result, I think that during the next year or two you will see the SFB evolve into a better and more efficient society.

Under the direction of Kinam Park, scientific program chair, the 2007 annual meeting in Chicago is fast taking form and promises to be an exciting event. In 2008, which will be a World Congress year, we will hold a smaller, more topical meeting in the United States. Plans for this meeting are still in development. The 2009 annual meeting will be held in San Antonio. If you have suggestions for locale for future meetings, please send them to the SFB office.

As part of an initiative to get exposure for SFB and its members at meetings more likely to be attended by clinicians, we will be holding a joint workshop with the Orthopedic Research Society at their annual meeting in 2007. Thanks are due to the Liaison Committee, and in particular Warren Haggard, for arranging this at short notice. In the future we hope to hold similar joint events with groups in the cardiovascular, dental and other areas. Suggestions regarding these are highly welcome.

Lastly, the efforts described above are just a small example of the overall work that is needed to run an organization such as SFB. Critical to all of this are volunteers. I encourage you to get more involved and serve on committees, task forces, etc. Membership in our Society can only be as exciting and rewarding as we collectively make it.

Staff Updates from Headquarters

By Dan Lemyre, Executive Director

Throughout the 3rd quarter of 2006, SFB Headquarter staff has been working to support each of the following committee activities:

Awards Ceremonies and Nominations Committee – The nomination period for SFB Officer positions and the 2007 Awards is now closed. More than 20 award nominations and a plethora of well-qualified candidates for the Board of Directors positions were received. The Awards Ceremonies and Nominations Committee will begin its deliberations shortly to present the membership with an election ballot for the officer positions, and to present Council with award candidates.

Bylaws Committee – Working with the Membership Committee, strategic task forces, and Long Range Planning Committee, the Bylaws Committee will be introducing a number of proposed amendments to the Bylaws at the 2007 Annual Meeting. Watch your mail in the first quarter of 2007 for notification of these proposals!

Education and Professional Development Committee –The E&PD Committee presented the Board with three endorsement requests for ratification in the last quarter: The 8th New Jersey Symposium on Biomaterials Science; UVA's Orthopaedic Biomaterials and Tissue Engineering Symposium, and the International Congress on Bio-Hydrogels. More information on each of these SFB-endorsed meetings can be found on the calendar on the SFB website.

Headquarters is also working with the E&PD Committee and the National Student Section to reorganize and re-invigorate the National Student Section, in addition to planning a career building workshop for Chicago. Students are encouraged to contact SFB headquarters to update their chapter officers and website information.

Finance Committee – The Finance Committee has reviewed proposals from several investment firms, and will be making a recommendation to the board of directors for selection of the Society's investment advisor.

Liaison Committee – The SFB is working with the Orthopaedic Research Society to cosponsor a workshop at the 53rd Annual Meeting of the ORS, February 11-14, 2007. The workshop, titled Xenografts: Biomaterials, Clinical and Regulatory Issues, is organized by Warren Haggard, PhD, University of Memphis, and Babara Boyan, PhD, Georgia Institute of Technology. The goal of the workshop is to summarize the current technologies and clinical uses of xenograft scaffolds.

Long Range Planning Committee – Each of the task forces that were initiated in last year's strategic planning session has provided reports to the Long Range Planning Committee:

- Annual Meeting Programmatic Vision
- Branding
- Governance
- Non-Dues Revenue
- SIGs

The Long Range Planning Committee is working to distill these reports into an action plan with short-term and longer-term objectives. This action plan will be submitted to the board and Council for discussion and implementation.

Meetings Committee – The committee is exploring options for holding the 2009 Annual Meeting in San Antonio, and is also considering Phoenix as an alternate location. Plans for holding a smaller meeting in Fall 2008 on translational research are also underway. That meeting is being planned in cooperation with the Society's Special Interest Groups.

Membership Committee – More than half of the Society's current membership has opted for the new electronic subscription option to JBMR. The Membership Committee continues in its work to streamline the membership application process and increase membership. As a result, a few bylaws changes are being considered, and will be presented for the membership's approval in April 2007. SFB also exhibited at the 8th New Jersey Symposium on Biomaterials Science, November 8-10.

Program Committee – The 2007 Program Committee has outlined the program for next year's meeting, themed A Multi-Dimensional, Multi-Disciplinary Approach to Biomaterials Science. Next year's meeting will be held April 18-21, 2007, at the Sheraton Chicago Hotel & Towers. Please visit the SFB website for more information about the preliminary program, www.biomaterials.org.

Publications Committee – SFB has launched three new features of the website recently, including SIG & Committee web pages, a "Biomaterial of the Week" homepage feature, and an enhanced Surgical Video Library. Any suggestions for additional web content should be sent to the SFB website editor, Dr. Thomas Webster.

Special Interest Groups – Newly elected SIG officers submitted their 2007 budget proposals and are preparing to participate in review of the 2007 abstract submissions.

Additionally, SFB was a proud sponsor of the American Institute for Medical and Biological Engineering's (AIMBE) Council of Societies' Federal Symposium. Held September 13, 2006, the symposium focused on trends in funding and the future outlook for bioengineering throughout various federal agencies. According to AIMBE, "This symposium and subsequent 'storming' of Capitol Hill has the potential to be a major determining factor in the final FY2007 funding of major agencies such as the Department of Defense, National Institutes of Health, National Science Foundation and other key research programs." SFB leaders in attendance included President C. Mauli Agrawal, PhD, 2nd Past President Anne Meyer, PhD, Secretary-Treasurer Lynne Jones, PhD, and Bylaws Chairman Tim Topoleski, PhD.

If you are interested in knowing more about a particular issue or committee activity, please contact the SFB headquarters office:

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Step Outside Your Comfort Zone and Think Cross-Discipline

We often dream of striking it rich, rich in grant money, I mean. It appears that to realize such a dream we need to step outside our comfort zone and seek cross-disciplinary collaborations. This seems to be the message the National Science Foundation (NSF) is sending in its recent awards of $75.3 million for five new Engineering Research Centers. These five new centers will develop cross-disciplinary research programs to advance technologies that address major societal problems and provide the basis for new industries, and educate a competitive U.S. workforce for leadership in an increasingly "flat" world.

Four of these five centers are related to the fields of bioengineering, biomaterials, and healthcare. At the Synthetic Biology Engineering Research Center (based at UC Berkeley), the focus is on synthetic biology — the design and construction of new biological entities such as enzymes, genetic circuits and cells, or the redesign of existing biological systems. The center will construct the biological components that will allow engineers to build biological solutions to important societal problems, such as the environmentally-friendly production of chemicals using microbes or replacing damaged or malfunctioning genetic circuits inside human cells to cure disease.

"These [Engineering Research] centers are the results of multi-institutional collaborations, and they bring people of diverse expertise together to work on complex problems of societal importance. So keep dreaming, and dare to leave the comfort zone and interact with people in different fields."

The Quality of Life Technology Engineering Research Center (based at Carnegie Mellon University and the University of Pittsburgh) will develop a range of technologies that will allow people with limited mobility or other physical and mental restrictions to live more independent and productive lives. Research at the center will build upon recent advances in intelligent system technologies, including machine perception, robotics, learning, communication and miniaturization, which until now have been used primarily in industrial, military or entertainment settings.

The objective of the Mid-Infrared Technologies for Health and the Environment Center (based at Princeton University) is to develop technologies that use mid-infrared quantum cascade lasers as the backbone for a wide range of next-generation air-monitoring sensors to revolutionize sensor technology and construct devices that have a unique ability to detect minute amounts of chemicals found in the atmosphere, emitted from factories or exhaled in human breath. The center will produce devices that are so low in cost and easy to use that they can transform aspects of the way doctors care for patients, local agencies monitor air quality, governments guard against attack and scientists understand the evolution of greenhouse gases in the atmosphere.

The Engineering Research Center for Structured Organic Composites (based at Rutgers University) is studying the nature of finely ground granular materials and other substances that form the core of drug tablets, processed foods, agricultural chemicals and other "composite organic" products in order to improve the quality and consistency of such materials. Research will focus on the structure of component materials, including particle shapes and sizes and forces that bind them together, and study how to efficiently produce structured materials in large quantity. These efforts will provide a foundation for new manufacturing processes that are more predictable, consistent and cost-effective such that the end products can benefit more people around the world.

These centers are the results of multi-institutional collaborations, and they bring people of diverse expertise together to work on complex problems of societal importance. So keep dreaming, and dare to leave the comfort zone and interact with people in different fields.

Quantitative, Interactive Measurement of Tissue Engineering Scaffold Structure in an Immersive Visualization Environment

Feature

By John Hagedorn[1], Joy Dunkers[2], Adele Peskin[1], John Kelso[1], Judith Devaney Terrill[1]

Abstract

We describe a software system that enables the measurement and analysis of tissue engineering scaffold materials from three dimensional images that were generated with X-ray micro-computed tomography (μCT), segmented and converted to a polygonal representation. We use this system to compare an 'as designed' scaffold with a manufactured scaffold to determine differences in strut properties. Essential to this work is the use of an immersive visualization (virtual reality) system that gives the researcher the ability to interact directly with data representations in ways that are not possible with desktop systems. Structures can be inspected and measurements can be made and analyzed during the immersive session. Using these measurements, researchers can assess the fidelity of actual scaffolds to the design model and evaluate scaffold manufacturing processes. We describe future directions for more automatic measurement techniques for three dimensional images, and the role of immersive visualization in understanding and evaluating these techniques.

Introduction

Tissue engineering is an emerging interdisciplinary field that has evolved because of the dire need for compatible, replacement organs and tissues in light of the shortages of transplantable organs and the problems associated with biomaterial implants. Four issues critical to the success of tissue engineering were identified in a recent review.[1] One of the issues is the optimization of the matrix, or scaffold, for cell proliferation, differentiation and tissue remodeling. It is widely recognized that factors that influence cell response to scaffolds include chemistry, surface roughness, elastic modulus and structure. The structure also influences media transport through the scaffold. In order to understand how the structure influences cell response, structural descriptors such as porosity, pore size distribution, tortuosity, and connectivity are generated through analytical or computational means.

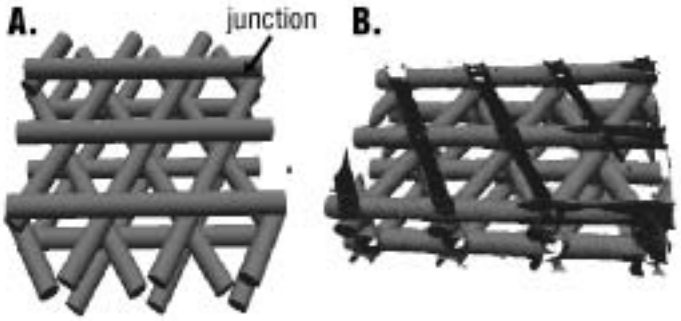

Figure 2. As-designed scaffold, synthetically constructed based on the design specifications (A.), 3D reconstruction of the scaffold made by SFF (B.).

Figure 1. A user in the NIST immersive visualization environment.

We are pursuing the processing of 3D images of scaffold materials in the context of an immersive (virtual reality) visualization environment (IVE). We use the IVE to measure scaffold descriptors and to present them in a clear and interactive manner.

An immersive visualization environment provides the researcher with the illusion that visual data representations are present in a volume of space within which the user can move. The user has the experience of being immersed in a virtual scene where he or she can view and manipulate elements of the virtual world. We prefer to use the term immersive visualization (IV) rather than virtual reality in order to emphasize our use of the technology for data visualization and to highlight the user's sense of being present in the midst of the data space. At the National Institute of Standards and Technology (NIST), we have created an IV environment which is shown in Figure 1.

The user can move around, look in different directions, and even interact with the data representations as if they were present. Interactions are often accomplished with a hand-held device (a wand) that is also motion-tracked. This environment provides the user with three dimensional (3D) visual and kinesthetic cues that are impossible to achieve with desktop displays. The IV environment provides perceptual cues (both visual and kinesthetic) that are extremely advantageous in understanding, measuring, and analyzing 3D structures.

Previous work applied measurement and 3D image analysis in an immersive environment to the understanding of microscopic biological structures.[2,3]

We are pursuing the use of the IV environment as a framework for more easily measuring scaffold descriptors, for support in developing consensus definitions of scaffold descriptors, for understanding automatic descriptor measurement methods, and for qualitatively evaluating and validating scaffold manufacturing techniques.

In this initial effort, we apply IV techniques to a straightforward manual linear measurement task to derive quantitative structural information from a digital 3D image of a tissue engineering scaffold.

3D Image Generation and Processing

The poly(E-caprolactone) (PCL) scaffold examined in this work was manufactured by a process called solid freeform fabrication (SFF).[4] The struts are designed to be 400 µm in diameter and are laid down in a 0o-60o-120o layer pattern. The gap width is 1.0 mm.

The µ-CT images of the scaffold were generated by a Skyscan 1072 micro-computed tomography scanner with voxel spacing of 12.9 µm in each direction. The images were output as bitmap files.

These bitmap files were processed by custom software in conjunction with open source software to produce files suitable for input to the IVE. Segmentation was performed by applying a threshold, and a 3D polygonal representation was generated based on the threshold.

Image Measurement and Analysis

While the initial processing of the image data was relatively straightforward, the analysis and measurement of geometric descriptors was more challenging. The latter motivated the use of IV. We do not have algorithms for the automatic three-dimensional measurement and analysis of the image data, so we used the IVE to interactively measure the desired features.

Our objective was to build a software system within the IV environment that integrated the following tasks: 1. measurement of scaffold characteristics; 2. analysis of the collected measurements; 3. display of the analysis; 4. interactions with the data and analyses that will enable grouping of results. The goal of these tasks was to achieve greater understanding of the structural characteristics of the scaffold material.

The initial measurement task that we undertook was the manual measurement of linear distances. It was felt that this step would enable the understanding of several important scaffold characteristics, one of which is strut diameter distribution and any associated anisotropy. We decided that the specific scenario for this first implementation would be: 1. The user collects a set of linear measurements; 2. A simple statistical analysis is made; 3. The analysis, including the distribution of measurements, is presented to the user; 4. The user can interact with the measurement distribution in order to highlight measurements that fall within any selected range of values. All of these tasks are to be performed in real-time during the IV session.

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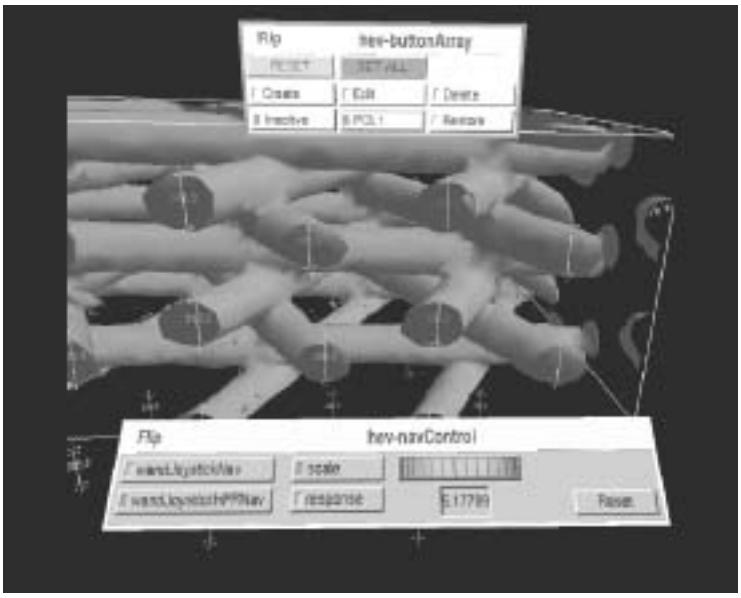

Figure 3. Cross-section of PCL scaffold with measurements of strut diameter.

The underlying software on which our immersive system is built is DIVERSE,[5] which provides a portable, modular, open source software platform that manages all aspects of the IVE. For the presentation of the data analyses and for some aspects of the user interaction, we used VEWL[6] which enables the use of standard desktop user interfaces within the IV environment. VEWL is a software subsystem that operates within the DIVERSE framework.

There are two main components to our implementation. The first component allows the user to manually make a series of linear measurements in the IV environment. The other component is a standard 2D user interface (displayed with VEWL) for displaying the measurement statistics and distribution in tabular and histogram form.

Our main objective in designing the user interface was to make the 3D measurement task direct and natural. The user makes a linear measurement simply by moving the hand-held wand to a point in the 3D virtual environment, pressing a button on the device, then moving to a second point and pressing the button again. Visual feedback is given at each step of the process and the user is able to adjust each end point simply by grabbing it with the wand and repositioning it. The process is fast, simple, and direct.

As a first demonstration of the quantitative IV, we compare the strut dimensions of the manufactured scaffold in Figure (2B) to the as-designed scaffold shown Figure (2A). We examine in detail the diameters at the strut junctions as compared to the inter-junction diameters.

We made two types of measurements: strut diameters and strut layer thickness. Strut diameters were measured directly at several points on each strut in a vertical direction in between the junctions (Figure 2). Strut layer thickness was found by measuring the vertical distance between the bottoms of struts on adjacent layers. We made layer thickness measurements at several junctions for each layer.

These two types of measurements were made on the "as-designed" scaffold model (generated synthetically from the design) and on the image of the actual manufactured scaffold material. The measurements of the "as-designed" scaffold are intended to validate the measurement method. The measurements of the experimental data will be used to understand the scaffold structural characteristics and fabrication method.

Figure 3 shows the PCL scaffold as it appears within the IVE, including several menus that allow the user to control the system. The box around the image data enables the researcher to interactively access features of interest for measurement throughout the volume of the 3D image. The IVE also enables the scientist to inspect various features and size ranges within the dataset. In Figure 4, the scientist has specified a range in the histogram. The corresponding measurements are highlighted in the display, providing additional visual feedback on scaffold uniformity.

Results and Discussion

As mentioned above, the as-designed scaffold model was made with 400 µm diameter struts arranged in layers that contacted. This configuration results, of course, in strut layer thickness of 400 µm. Our measurements resulted in these statistics:

Strut diameter: mean 399.3 µm std dev 1.3 µm n=63
Layer thickness: mean 399.8 µm std dev 1.6 µm n=24

The numbers clearly indicate that the measurement procedure is capable of producing valid results. During the collection of these data, we noticed that the distribution of diameter measurements was skewed slightly to the low side of 400 µm, likely because the cylindrical struts were being represented by polygonal approximations.

The measurements of the data representing the actual scaffold material yielded these results:

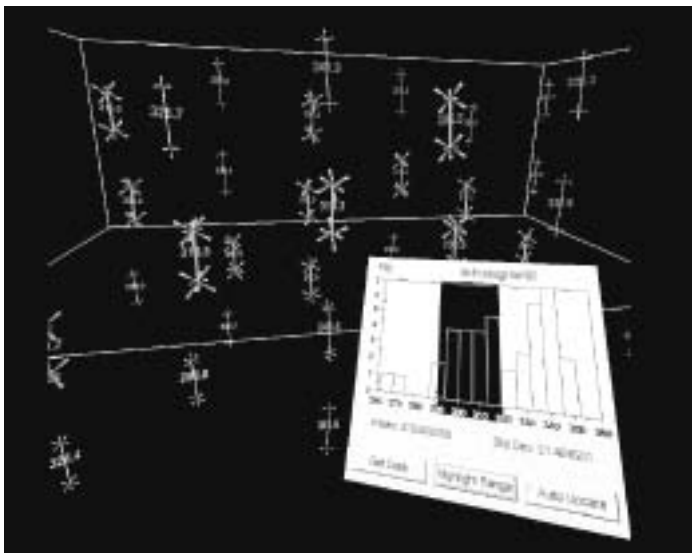

Figure 4. Selected histogram bins are highlighted in visualization showing distribution of strut diameters in the range of 200 to 320 Ìm. The struts have been removed from the scene in order to make the measurements more visible.

Strut diameter: mean 325.2 µm std dev 31.2 µm n=82
Layer thickness: mean 271.1 µm std dev 22.2 µm n=33

These manual measurements required the user to exercise judgment in selecting the measurement end points. Also note that, just as with the as-designed model, we perform our measurements using polygonal representations that are, inherently, approximations to the true form of the scaffold.

We see from the measurements of the actual scaffold that the mean inter-junction strut diameter is significantly more than the mean layer thickness (strut diameter) at the junctions. A qualitative sense of this effect can be seen in the IV environment; the struts appear to be fused and somewhat overlapping at the junctions. We also note, of course, that the actual strut diameter differs significantly from the as-designed model. The effect of these differences on the function of the scaffold is unclear and is the subject of future study. It is clear, however, that the IV environment has provided us with a way of making a meaningful quantitative characterization of scaffold structure. From this analysis, we find no anisotropy or gradients in inter-junction or at junction strut diameters.

Conclusion and Future Directions

We have found that IV is a technology that enables both qualitative and quantitative understanding of 3D structure of tissue engineering scaffolds that was not otherwise possible. The measurements made within the virtual environment would have been very difficult to make with typical desktop visualization techniques. We also plan to use the immersive environment in conjunction with automatic measurement techniques that we are developing to aid in understanding the action of the automatic algorithms and as a way of validating those methods.

The measurements and analyses enabled comparison of key scaffold descriptors across images. We have found that the inter-junction strut diameter is about 19% smaller than the as-designed model. The at-junction strut diameter (or layer thickness) is about 33% smaller than the as-designed model. IV measurement of these descriptors should be implemented for a further evaluation of the SFF manufactured scaffold: layer planarity, strut diameter uniformity, strut circularity, and strut location.

Disclaimer

Certain commercial products may be identified in this paper in order to adequately describe the subject matter of this work. Such identification is not intended to imply recommendation or endorsement by the National Institute of Standards and Technology, nor is it intended to imply that the identified products are necessarily the best available for the purpose.

[1] Scientific Applications and Visualization Group, Mathematical and Computational Sciences Division, National Institute of Standards and Technology (NIST), Gaithersburg, MD
[2] Biomaterials Group, Polymers Division, NIST, Gaithersburg, MD

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Members in the News

Congratulations to:

SFB President **Mauli Agrawal**, who has been appointed as Dean of the College of Engineering of the University of Texas at San Antonio.

Dr. Tony Mikos, the J.W. Cox Professor of Bioengineering and Professor of Chemical and Biomolecular Engineering at Rice University, who is the recipient of the 2007 BMES Distinguished Scientist and Lecturer Award. Tony will be recognized in next year's BMES meeting in Los Angeles.

Dr. Linda Griffith, who is the recipient of a 2006 MacArthur Fellowship, given by the John D. and Catherine T. MacArthur Foundation. The MacArthur Fellowship is a five-year grant to individuals who show exceptional creativity in their work and the prospect for important future advances. Linda is a Professor in the Departments of Biological and Mechanical Engineering and Director of the Biotechnology Process Engineering Center at the Massachusetts Institute of Technology.

Dr. Kinam Park, Professor of Pharmaceutics and Biomedical Engineering at Purdue University, who was recently named Showalter Distinguished Professor of Biomedical Engineering. Kinam is the Program Chair for the 2007 SFB Annual Meeting.

Orthopaedic Issues in Osteoporosis

Book Review

By Liisa Kuhn, Assistant Professor, University of Connecticut Health Center, Center for Biomaterials

Edited by Yuehuei H. An

Copyright 2003, CRC Press, Boca Raton, FL. 597 pages.
New or Used for: $120-$160.

Description

Dr. An, Editor of the well-known book *Animal Models in Orthopedic Research*, has succeeded again in assembling another "best in its field" book, this time on orthopedic issues in osteoporosis. This is not a brand new book, but I recently became aware of it and wanted to highlight it for SFB members who are interested in osteoporosis, particularly the clinical management of it. This was the first, and is still the only, inclusive book on orthopaedic aspects of the research and repair of osteoporotic conditions arising from metabolic bone diseases. The book has an introductory section on basic science and clinical essentials of osteoporosis, but focuses mainly on osteoporotic fractures and diagnosis and surgical management of them. The book ends with a section on prevention and non-surgical management of osteoporosis, including exercise and pharmacologic management of osteoporotic conditions.

Measurements of bone mineral content of the skeleton constitute an important aspect of the detection and follow-up of metabolic bone diseases. The book provides a critical review of the many methods currently available and those under development. The complexities of structural analysis of cancellous bone degraded by disease are well described. Radiographs of patients with osteoporosis that have failed traditional orthopaedic interventions illustrate graphically the difficulty of stabilizing and repairing weakened osteoporotic bone. The book therefore focuses heavily on providing descriptions of successful surgical techniques that a clinician can use to meet the challenges of treating osteoporotic bone fractures. The prevention chapters provide material for the clinician to educate his/her patients and for self-education of other readers.

The book is so successful at describing the difficulties of repairing osteoporotic bone, that I immediately took a calcium pill after reading this book! Truly a valuable resource.

Audience

This book will be of interest to anyone working in the fields of clinical orthopaedics, orthopaedic research, or implant manufacture. Potential readers include orthopaedic surgeons, orthopaedic residents, orthopaedic researchers, fellows, graduate students, implant designers, as well as patients with a scientific/medical background interested in self-education. This book would make a valuable addition to medical school libraries, hospital libraries, biomedical engineering libraries, and the libraries of companies with a focus on orthopaedic research.

Contents

BioInk

Steve T. Lin, Industrial News Contributing Editor
From Press Releases

The American Diabetes Association (ADA) and **Entelos** (Foster City, Calif.), a leader in predictive biosimulation, are working together to establish an in silico research facility to support basic research in type 1 diabetes—a plan announced during ADA's 66th Scientific Sessions in June. The facility, which will initially be located at Entelos' Foster City headquarters, is expected to provide researchers with "an unparalleled ability to investigate the onset, progression, and treatment of diabetes." The first research projects will use Entelos' Type 1 Diabetes PhysioLab platform, a computer simulation model of the non-obese diabetic (NOD) mouse, the primary animal model used to study type 1 diabetes.

Applied Biosystems (Norwalk, Conn.) announced that the U.S. Department of Defense has awarded the company a $24.5 million contract to accelerate the development of a prototype instrument system that is intended to improve the way infectious diseases are identified for epidemiological and biosecurity purposes. Upon successful completion of this project, this new system is expected to yield precise, reproducible results in less than one hour following sample processing by providing a streamlined workflow and the ability to simultaneously analyze multiple pathogen targets in a single test.

Geomagic (Research Triangle Park, N.C.), a worldwide software and services firm, announced it has signed an exclusive, joint worldwide agreement with **Z Corporation** (Burlington, Mass.). As part of the deal, Geomagic will provide Geomagic Studio software in a comprehensive bundle with the new Z Corporation ZScanner 700. The ZScanner 700 is the first self-positioning 3D laser scanner. The lightweight, handheld device is ready to use in minutes and free of traditional mechanical arms, making it ideal for scanning hard-to-reach places. It offers real-time surfacing, captures 3D data in one continuous process to reduce post-processing, and uniquely allows objects to be moved during scanning.

Invitrogen Corp. (Carlsbad, Calif.), a provider of essential life science technologies for disease research and drug discovery, announced a collaborative agreement with **Signalomics** (Steinfurt, Germany) to develop nanocrystal reagents with the ability to enhance the identification of tumors in in vivo patient tissue by detecting the presence of a single cancerous cell—improving the ability to excise the tumor more rapidly and completely. The initial goal of the collaboration is to develop an imaging agent that can be used to identify colon carcinomas requiring surgical intervention.

Johnson & Johnson Corporate Office of Science and Technology (New Brunswick, N.J.) has formed a partnership with The Petit Institute for Bioengineering and Bioscience (IBB) at the Georgia Institute of Technology. The partnership is designed to stimulate cross-disciplinary, collaborative research that will have a major impact on healthcare and biomedical research. Through the partnership, called the "Johnson & Johnson/Georgia Institute of Technology Healthcare Innovation Awards," each organization will provide funding for innovative research initiatives around the development of new health care technologies. The collaboration with Johnson & Johnson's COSAT represents the maturation of the long-standing relationship with IBB that was initiated through its Industrial Partners Program through the institute in 1994.

Life Sciences Corp., a majority-owned subsidiary of **CuraGen** Corp. (Branford, Conn.), in collaboration with scientists at the Max Planck Institute for Evolutionary Anthropology, announced in Leipzig, Germany, the launch of a project to sequence the complete Neandertal genome. Neandertal is the closest relative to humans and knowledge of its genetic composition will significantly enhance the understanding of human biology. The project is estimated to take two years and is made possible by 454 Sequencing™ technology and a grant from the Max Planck Society.

Orthofix International NV (Netherlands) announced that it has signed an agreement to acquire independent spinal implant developer **Blackstone Medical** Inc. The $333 million acquisition allows Orthofix to leverage Blackstone's engineering vitality, established Breakthrough Thinking™ brand identity, and their market strength in the fusion, motion preservation and biologics categories. Blackstone has experienced profitable revenue growth of more than 25 percent in each of the last three years, and total revenue increased 39 percent during the first half of this year. Combining both companies' strengths into a synergistic powerhouse will bring greater innovation to orthopedics on a global level.

Scientists from **Pfizer Global R&D** (New London, Conn.) presented the results of Phase IIb studies of maraviroc, one of a new class of anti-HIV drugs called CCR5 antagonists. Unlike the predominant retroviral inhibitors, which largely target the virus after it has entered white cells, CCR5 antagonists prevent the virus from entering the cells by blocking its interaction with CCR5, its predominant route of entry. The 24-week study of 186 late-stage patients examined whether maraviroc, when used in combination with a combination therapy, would increase the incidence of HIV infection via another cell receptor (CxCR4) and lead to more rapid diminishing of CD4 cell counts. The scientists found that although viral load reduction was similar between maraviroc and placebo, the CD4 increase was greater in the treatment group, with no indication of further toxicities.

Stem Cell Sciences (Edinburgh, United Kingdom) announced that it will participate in the European Commission approved "ESTOOLS" program, a world leading human embryonic stem cell research initiative involving both academic and commercial researchers. Stem Cell Sciences is one of three commercial partners taking part in this program. The overall goal of ESTOOLS is to develop the tools and biological understanding required to control expansion, lineage commitment and terminal differentiation of human embryonic stem cells ("hES") for bio-industrial and medical applications.

Synthes Spine (West Chester, Pa.) received a letter from the FDA indicating that its PRODISC lumbar total disc replacement device PMA has been approved with specific indications and restrictions.

Community Calendar

OARSI 2006 World Congress on Osteoarthritis
December 7-10, 2006
Hilton-Prague
Prague, Czech Republic
www.oarsi.org

53rd Annual Meeting of the Orthopaedic Research Society
February 11-14, 2007
San Diego Convention Center
San Diego, CA
www.ors.org

13th International Symposium on Recent Advances in Drug Delivery Systems
February 26-28, 2007
Little American Hotel
Salt Lake City, UT
www.drugdeliverysymposium.utah.edu

Society For Biomaterials 2007 Annual Meeting and Exposition
April 18-21, 2007
Chicago, IL
Sheraton Chicago Hotel & Towers
www.biomaterials.org

International Congress on BioHydrogels
November 14-18, 2007
Viareggio (Lucca), Italy
Congress Centre 'Principe di Piemonte'
www.biohydrogels2007.it

3rd International Conference on Tissue Engineering
September 21-26, 2008
Aldemar Paradise Village
Rhodes, Greece


SOCIETY FOR BIOMATERIALS 2007 ANNUAL MEETING
CHICAGO
SOCIETY FOR BIOMATERIALS
April 18-21, 2007
Chicago, Illinois
Please visit the SFB website or contact SFB headquarters at info@biomaterials.org for more information about the 2007 Annual Meeting.

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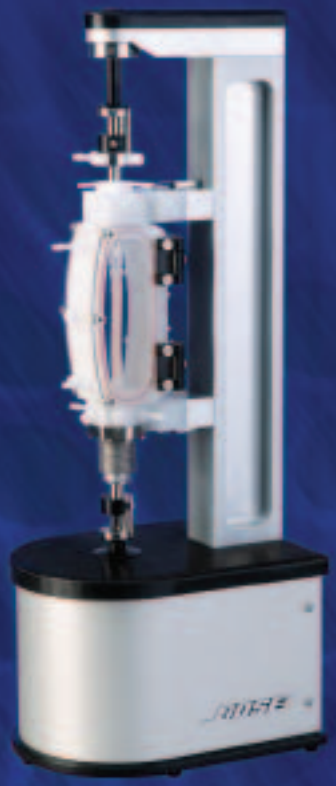

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