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BIOMEDICAL ENGINEERING SOCIETY™

A Role for Computational Modeling in Medical Practice

Moderator



- ▶ **Ben Noe**

BMES Industry Affairs Committee Chair

R&D Project Manager, Medtronic

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Announcements

- ▶ The archived recording will be available shortly after the webinar on the BMES website.
- ▶ You may submit questions throughout the webinar by using the online chat function. Your questions will be addressed after the featured speaker presentations.
- ▶ Please take a few minutes to complete the brief survey following the webinar to provide us with your feedback.

BMES/FDA

**Frontiers in Medical Devices Conference
Innovations in Modeling and Simulation:
*Advancing Translational Science***

**May 16-18 2017,
University of Maryland,
College Park Marriott Hotel and Conference Center
(Greater Washington DC)**



Conference Leadership

- Past Chairs: Tina Morrison, Jeff Bischoff
- Chairs: Anita Bestelmeyer, Leonardo Angelone
- Technical Program Chairs: Melissa L. Knothe Tate, Adam Himes
- Sponsorship coordination: Cheryl Liu
- Students Awards: Chris Basciano



Plenary talks

Urs P Wyss, Ph.D., P.Eng. - Professor Wyss has a wealth of industry and academic experience in medical devices and computational modeling. We look forward to learning from his career-long experience at the helm of a major device company and in dealing with a major recall.

Vivian Rietberg, MBA - As a former member of the NIH Clinical Center Board of Governors and the NIH Advisory Board for Clinical Research, as well as a Senior Partner at McKinsey & Company, Ms. Rietberg literally co-wrote the docket on Regulatory Excellence. We look forward to hearing her perspectives on best practices and how technology may guide the way going forward.

Gary An, M.D., Ph.D. - Professor An is one of those rare individuals who is as comfortable sharing his approach to agent-based modeling of sepsis with an audience as he is repairing the frailties of the human condition in the surgical suite. We look forward to hearing his perspectives as a consumer and creator of computational models for medical devices and therapies as well as a pundit for future uses of the technological approach.

Technical Tracks

- **Ideation**
- **Pre-Clinical**
- **Product Development**
- **Clinical Study**
- **Market Release and Post-Market**



Panels

- Academia, Industry, and FDA panels
- Use of computational modeling over the total product life cycle

Sponsors & Seminars

- GOLD: ANSYS, Dassault Systemes SIMULIA, TotalCAE, ZMT (Luncheon Seminars, booths)
- SILVER: Synopsis, Mathworks, BD, InsilicoTrialsc, CsimSoft (Morning seminars, booths)
- Exhibitor: Elemance, Siemens (booths)

Speaker

- ▶ **Ali Vahdati, PhD**



Senior Engineer

Computer–Aided Engineering (CAE)

Office of Science, Medicine and Technology

Becton Dickinson (BD)

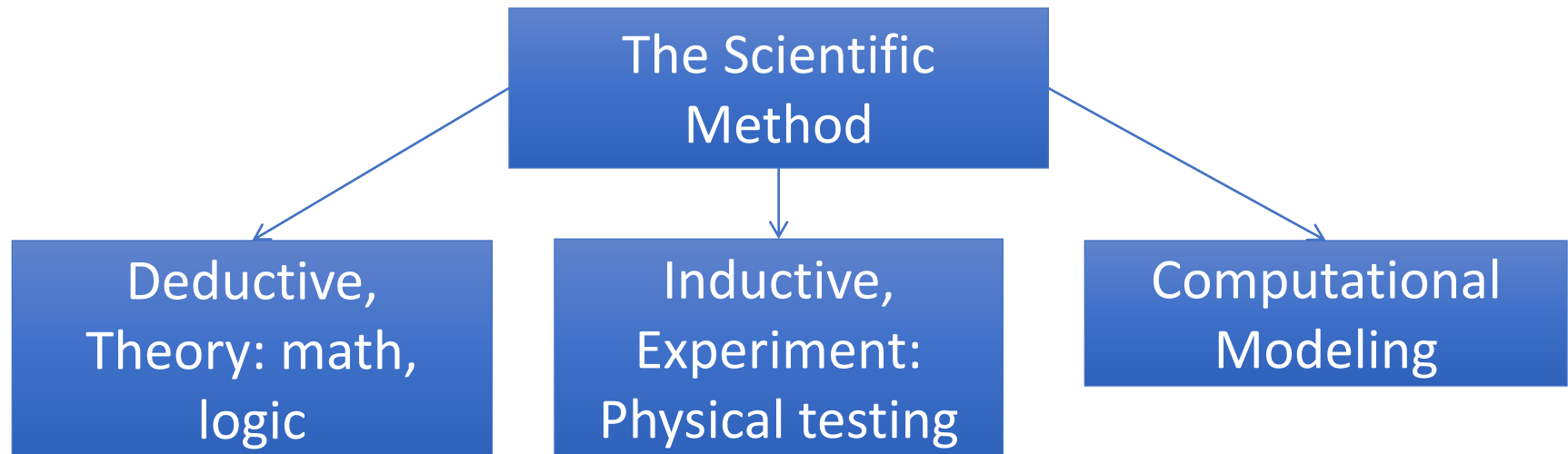
Disclaimer

- The views expressed in this presentation are my own and do not reflect those of my employer
- The presentation is based on my work experience at the Cleveland Clinic, University of Leuven and University of Notre Dame

Simulation: The third method of science

From Presidential Information Technology Advisory Committee report, 2005: "Computational Science: Ensuring America's Competitiveness,"

"Together with theory and experimentation, computational science now constitutes the 'third pillar' of scientific inquiry, enabling researchers to build and test models of complex phenomena."

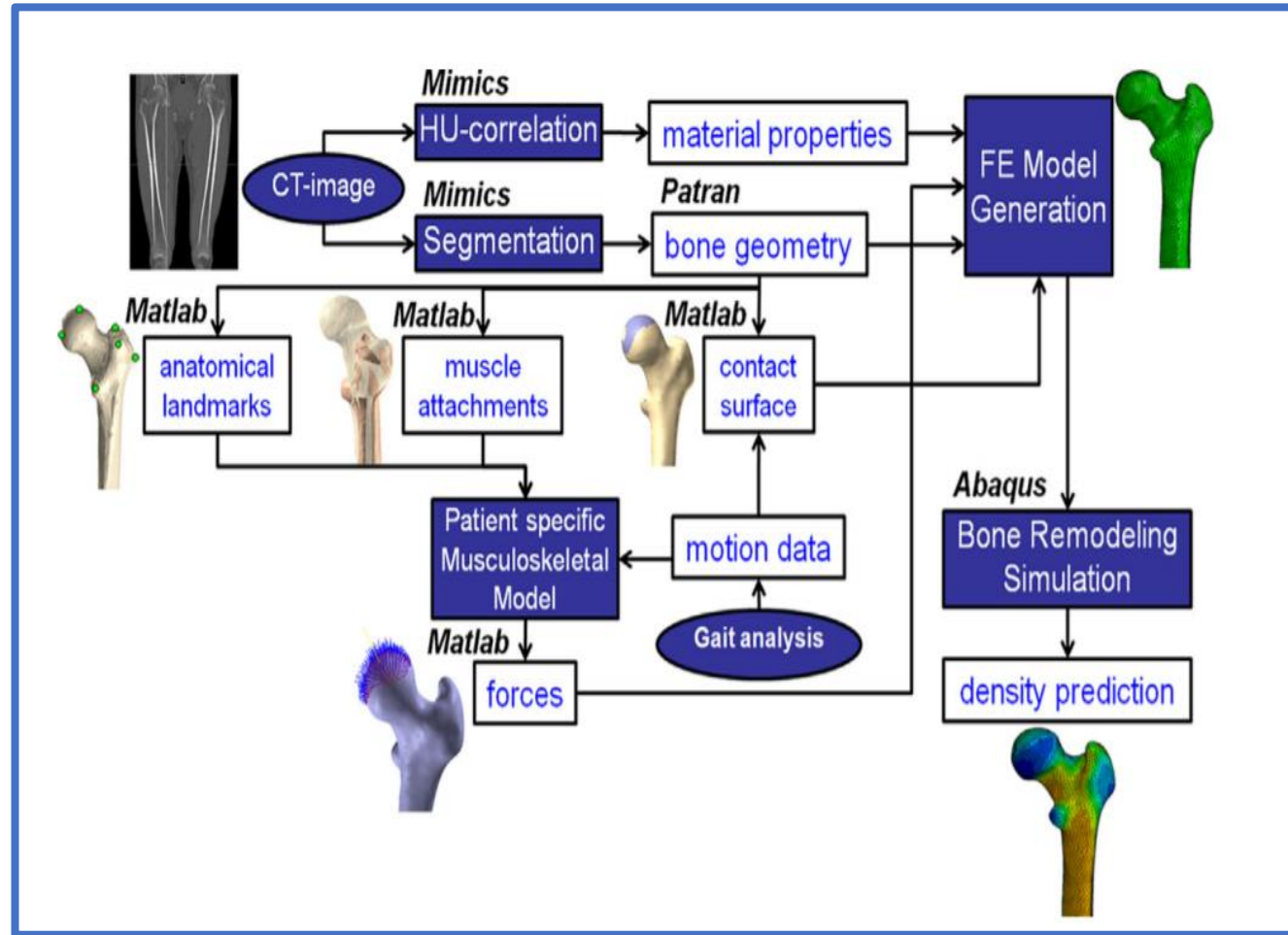
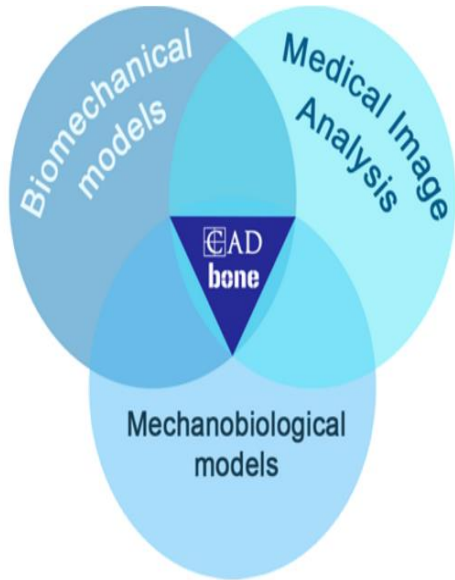


Computational modeling in clinical practice

- CM&S is emerging as a valuable tool in surgical simulation and medical device design
- Predicting the performance of medical device *in situ*
- Beneficial for virtual training of medical students and residents
- Real-time and/or patient-specific simulations achievable with increase in computational power and improved algorithms
- Understanding and predicting disease initiation and progression
- Designing drugs, in silico clinical trials and virtual patients (for example VPH framework)

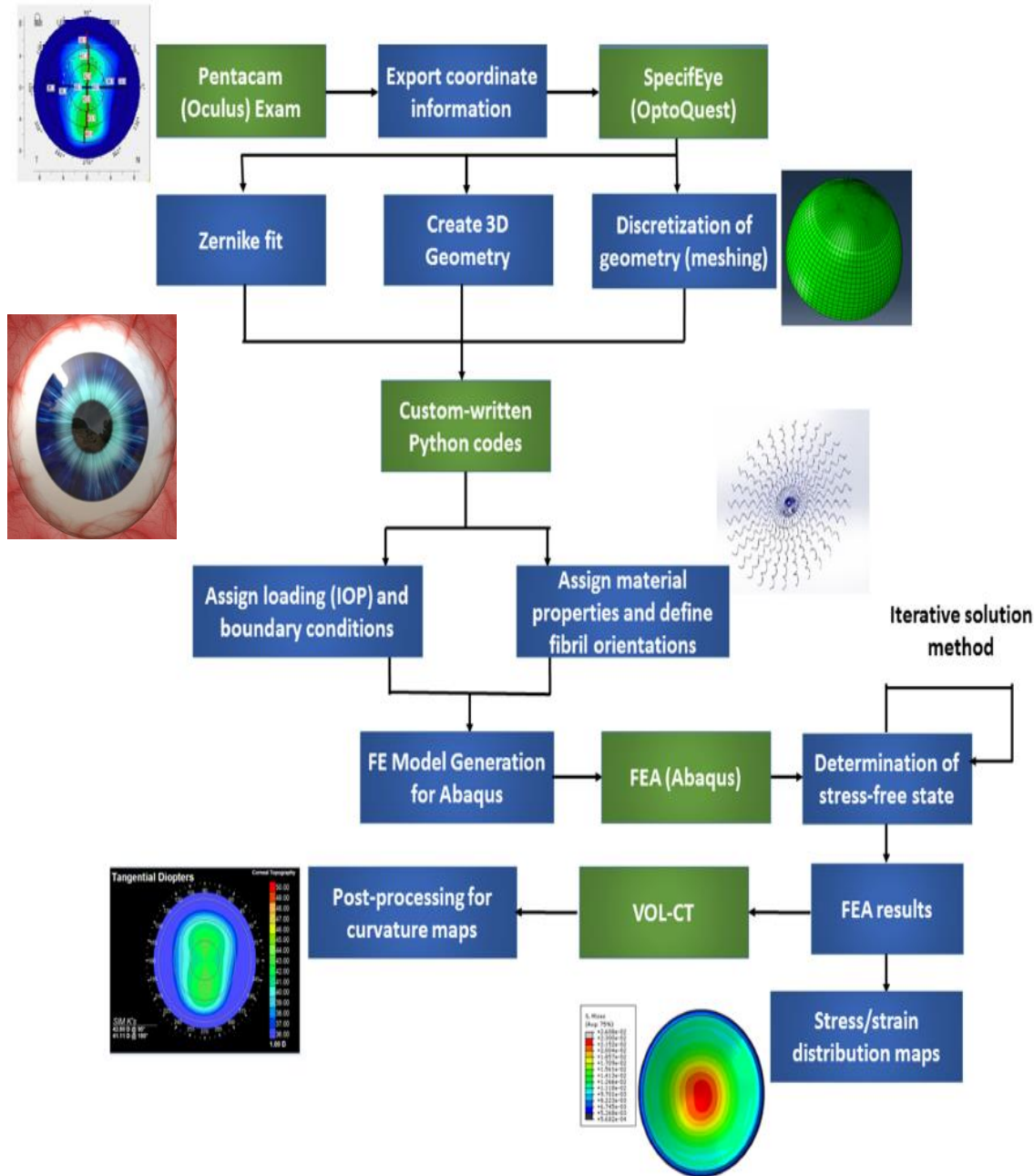


Examples



<http://cadbone.unizar.es/>

Vahdati, A., Walscharts, S., Jonkers, I., Garcia-Aznar, J. M., Vander Sloten, J., & van Lenthe, G. H. (2014). *Journal of the mechanical behavior of biomedical materials*, 30, 244-252.

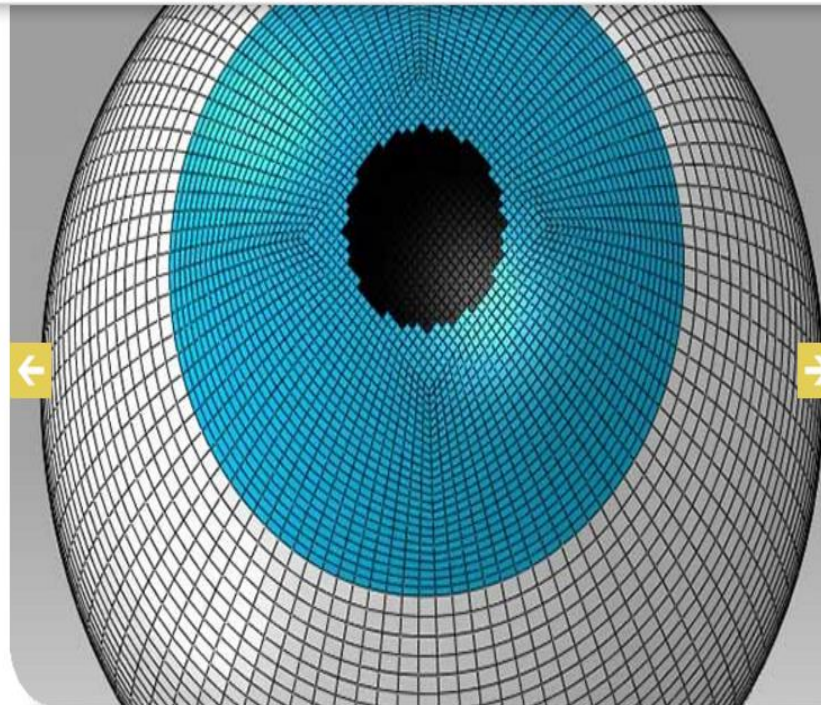


Vahdati, A., Seven, I., Mysore, N., Randleman, J. B., & Dupps, W. J. (2016). *Journal of Refractive Surgery*, 32(12), 811 -820.

Source: OptoQuest.net



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In The News

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https://www.nibib.nih.gov/science-education/science-topics/computational-modeling

The screenshot shows the NIBIB website interface. At the top left is the NIH logo and the text "National Institute of Biomedical Imaging and Bioengineering" with the tagline "Creating Biomedical Technologies to Improve Health". To the right are links for "En Español", "Site Map", "Staff Directory", and "Contact Us". A search bar with a "Search" button is located below these links. A dark blue navigation bar contains the following menu items: HOME, RESEARCH FUNDING, LABS AT NIBIB, TRAINING & CAREERS, NEWS & EVENTS, SCIENCE EDUCATION, and ABOUT NIBIB. Below the navigation bar is a breadcrumb trail: Home » Science Education » Science Topics » Computational Modeling. A teal banner with the text "SCIENCE EDUCATION" and a background image of children is positioned below the breadcrumb. The main content area is divided into three columns. The left column has a "Science Education" header and a "Science Topics" sub-header, with links for "Resource Links for General Public" and "Resource Links for Parents/Teachers". The middle column features the title "Computational Modeling" with social media icons (email, Facebook, Twitter, Google+, RSS) and a list of questions: "What is computational modeling?", "How can computational modeling accelerate discovery?", "What are some examples of computational modeling and how it can be used to study complex systems?", "How can computational modeling improve medical care and/or biomedical research?", and "What are NIBIB-funded researchers developing in the area of computational modeling?". Below these questions is a sub-header "What is computational modeling?" and a partial image of a network diagram. The right column has a "Science Education" header and a list of links: "Science Topics", "Resource Links for General Public", "Resource Links for Parents/Teachers", "Resource Links for Students", and "Glossary". At the bottom of the right column is a "Related News" section with a link to "Computational modeling is the use of".

NIH National Institute of Biomedical Imaging and Bioengineering
Creating Biomedical Technologies to Improve Health

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SCIENCE EDUCATION

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Computational Modeling

What is computational modeling?
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What is computational modeling?

Computational modeling is the use of

Science Education

Science Topics
Resource Links for General Public
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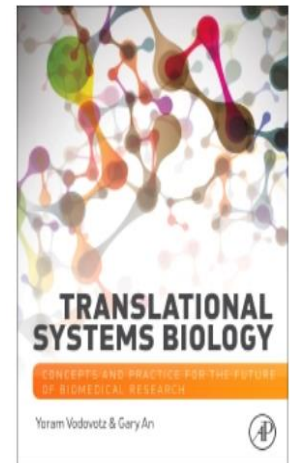
Related News

If biomedical research is a sick patient, is computational modeling the prescription?

Planning for what's beyond Big Data: Translational Systems Biology as a long-term cure for what ails biomedical research

By Gary An, MD, and Yoram Vodovotz, PhD Posted on 3 November 2014

- Translational Systems Biology: Application of CM&S based on biological knowledge and engineering principles, with the explicit goal of targeting clinical situations
- HPC, big data, multi-scale modeling and integration in personalized medicine



Vodovotz, Y., & An, G. (2014). *Translational Systems Biology: Concepts and Practice for the Future of Biomedical Research*. Elsevier.

Tips for improving communication between computational modelers and clinicians

- Scientists and engineers including computational modelers receive little or no training in effective communication of CM&S outcomes to non-experts
- Knowing your audience is key when communicating across fields
- Tailor your message to clinicians to make it easier for them to absorb CM&S results



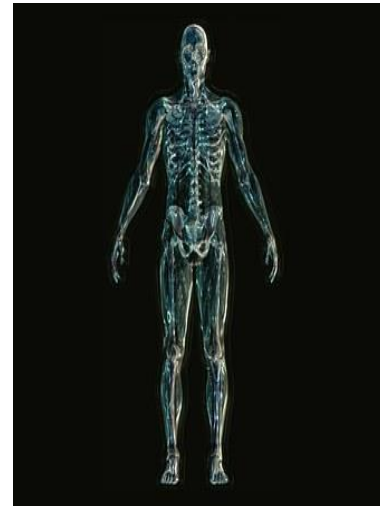
When presenting computational modeling results to clinicians and to foster collaborations:

Think about the picture. Focus on the clinical relevance and importance (i.e. how can this help your patients?)

Learn the terminology used by the clinicians. Learn about the surgical techniques. Biomedical engineering and computational biomodelling are interdisciplinary by nature

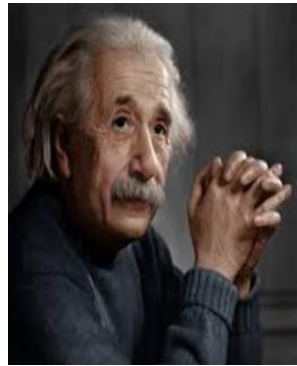
Example: spinal curvatures simulation

Kyphosis, lordosis, scoliosis



- Computational modelers and engineers can get bogged down with the details of a research project or use too much jargon to explain a simulation outcome to clinicians

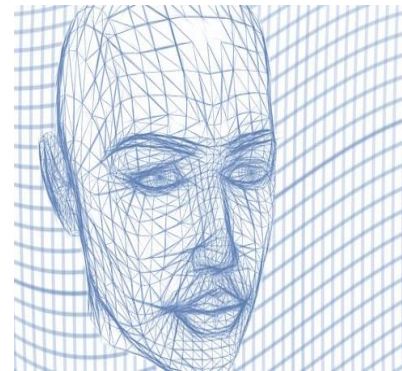
"If you can't explain it simply, you don't understand it well enough." - Albert Einstein



- Effective communication of CM&S outcomes and their importance to clinicians can make it more accessible and promote its wider use in clinical practice

<https://blogs.scientificamerican.com/guest-blog/effective-communication-better-science/>

- When presenting to clinicians or giving lectures/seminars to medical students and residents:
 - Don't assume words like stress and strain are common knowledge
 - Start with simple definitions like force, stiffness, displacement
 - It may be necessary to define terms like stress and strain (without talking about tensors and continuum mechanics)



Example scenario

- Presenting a plot of Mises stress and Maximum Principal Strain distribution in biological tissue
- The plots look pretty and interesting, but the clinicians may ask how is this helpful to my clinical practice?
- Engineer can explain how the location of maximum stress or strain may correspond to damage in the tissue
- Engineer may explain how high stress/strain can play a role in initiation of tissue pathologies



- Clinician may be skeptical of new technologies (I was lucky to work with some of the world's leading experts at the Cleveland Clinic), but not all clinicians are up to date on cutting edge research and technologies
- Clinicians may adopt technology including patient-specific simulation in their practice if the value of it is proven to them
- Technology and computational modeling should clearly demonstrate a benefit to patients



A note on limitations of CM&S

If asked about the model's limitations, for example not including some biological hormonal effect in a biomechanical simulation, remember:

"The most that can be expected from any model is that it can supply a useful approximation to reality: Essentially, **all models are wrong, but some are useful.**" - George Box, 1976

"a model might be ranked from very useful, to useful, to somewhat useful to, finally, essentially useless."
Burnham and Anderson, 2002



Summary

- CM&S is emerging as a valuable tool in medical practice
- Applications include virtual clinical trials, real-time and/or patient specific surgical simulation, virtual training
- For wider adoption of CM&S in medical practice, effective communication between computational modelers/engineers and clinicians is the key

Speaker

- ▶ **Don Anderson, PhD**



Professor and Vice Chair of Research
Department of Orthopaedics & Rehabilitation
University of Iowa



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QUESTIONS?

BMES Activities and Events

- ▶ 2017 Professional Development Webinars
<http://www.bmes.org/content.asp?contentid=147>
- ▶ 2017 BMES/FDA Frontiers in Medical Devices Conference
<http://www.bmes.org/medicaldevices>
 - May 16–18, 2017 – Washington, DC
- ▶ BMES Coulter College
<http://www.bmes.org/2017bmescoultercollege>
 - August 3–6, 2017 – Atlanta, GA
- ▶ 2017 BMES Annual Meeting
<http://www.bmes.org/annual%20meeting>
 - October 11–14, 2017 – Phoenix, AZ
 - *Abstract Submission Deadline: April 26th*
<http://submissions.mirasmart.com/BMES2017>