

# Biomechanics Working Group Breakout Session Summary

*Ahmet Erdemir, Jay Humphrey*

1:00 PM – 2:30 PM

Building 45, Room H

September 3, 2014

*2014 MSM Consortium Meeting*

National Institutes of Health

## Attendees:

1. Victor Barocas, University of Minnesota
2. Silvia Blemker, University of Virginia
3. Yasin Dhaher, Northwestern University
4. Scott Diamond, University of Pennsylvania
5. Ahmet Erdemir, Cleveland Clinic
6. Jay Humphrey, Yale University
7. Peter Laz, University of Denver
8. Yaling Liu, Lehigh University
9. Michael Mak, Boston University
10. Mohammad Mofrad, UC Berkeley
11. Jimmy Moore, Imperial College
12. Kevin Shelburne, University of Denver
13. Darryl Thelen, University of Wisconsin-Madison
14. Beth Winkelstein, University of Pennsylvania

## Notes:

1. **Introductions.** Attendees briefly introduced themselves including their interests.
  - (a) Victor Barocas – soft tissue; collagen; Winkelstein collaborator, MSM Grantee
  - (b) Silvia Blemker – biomechanics of muscle and tendon
  - (c) Yasin Dhaher – surgical simulation
  - (d) Scott Diamond – blood platelets; clotting; bleeding
  - (e) Ahmet Erdemir – multiscale musculoskeletal and tissue mechanics
  - (f) Jay Humphrey - vascular mechanobiology
  - (g) Peter Laz – probabilistic mechanics; implant
  - (h) Yaling Liu – biofluids; microfluidics
  - (i) Michael Mak – intercellular mechanics of cancer cells
  - (j) Mohammad Mofrad – protein to cells
  - (k) Jimmy Moore – lymphatic biomechanics
  - (l) Kevin Shelburne – musculoskeletal simulation
  - (m) Darryl Thelen – ACL reconstruction; MSM grantee
  - (n) Beth Winkelstein – Barocas collaborator; MSM Grantee
2. **Transitioning of Working Group Leadership.** Muhammad Zaman has taken over the co-leadership in the working group during 2014. The working group is looking for another co-lead to work with Muhammad, interested parties should contact Jay, Ahmet, or Muhammad. Both Jay and Ahmet will continue being part of the working group and help transitioning process.

3. **History.** Ahmet provided a brief history of the working group starting with Working Group 6 days; continuing with Tissue Mechanics Working Group and later more inclusive Biomechanics Working Group. Summary of accomplishment to promote visibility of biomechanics in the multiscale modeling and simulation arena were noted, including white papers, invited articles, organization of sessions in conferences.
4. **Past Year Activities.** Jay noted the requirement giving webinars. Yet, in the past year the working group focused on increasing visibility of multiscale modeling and simulation in the World Congress of Biomechanics (WCB) 2014. Jay summarized the WCB 2014 activities; 13 MSM sessions resulted in more than 60 podium presentations. A mini-symposium on multiscale modeling and simulation was opened by a keynote from Grace Peng and was followed by additional sessions on computational challenges in multiscale modeling in biomechanics. Selected work from these sessions will form an upcoming special issue in Journal of the Royal Society Interface. Ahmet also mentioned online breakout session that was held last year in lieu of the canceled MSM meeting. The minutes of this session is available in the IMAG wiki.
5. **Upcoming Activities.** Ahmet noted involvement of the working group in the upcoming meeting on Computer Methods in Biomechanics and Biomedical Engineering (to be held in October 2014 in the Netherlands). Yasin noted the possibility to involve the working group in Summer Biomechanics, Bioengineering & Biotransport Conference (in June 2015 in Utah). Yasin also noted that Jeff Weiss and Wendy Murray will be organizing a multiscale session in the Biomedical Engineering Society conference. It will be good to get the working group involved to promote multiscale biomechanics, possibly by contacting Jeff.
6. **New Directions.** The group explored what can be done to keep biomechanics (specifically multiscale biomechanics) high on the list in terms of visibility.
  - (a) **Ideas.** The attendees shared their ideas that can be adapted as working group activities.
    1. **Constitutive modeling challenge** (Victor). Provide some data, e.g. from biaxial testing, hold the remainder to see how community can predict measured (yet not disclosed) biomechanical outcome.
    2. **Virtual T32 for training in multiscale biomechanics** (Yasin). The working group can provide the critical mass of experts to provide comprehensive training in multiscale biomechanics, online and across institutes. A T32 grant application can be submitted for this purpose.
    3. **Virtual courses** (Scott). Related to education, the group can develop training material, e.g. books, Coursera like courses, where individual members can provide chapters integrated into an overall theme.
    4. **Benchmark problems** (Yaling, Victor). In the spirit of FDA benchmark problems, the working group can generate benchmark cases, e.g. to evaluate validation process of a multiscale problem using combined computational approach. FDA is pushing towards simulation as part of regulation process. The working group can promote incorporation of multiscale modeling to devices/implants, e.g. in anything that goes to the approval process.
    5. **ASME V&V** (Yasin, Jimmy, Peter). The working group may want to have an active role in ASME V&V meeting, in particular to emphasize the our discipline in that community. Efforts in ASME to come up with standards were noted along with ASTM's work and FDA's initiatives with ASME V&V.
    6. **Success stories** (Silvia). The group can emphasize the importance of biomechanics by identify success stories (when a model has changed the clinical practice) and ways to convey such stories to non-modeling community, including clinicians and possibly the general public.
    7. **Presentation to the President** (Silvia). Similar to BRAIN Initiative, can the working

group provide a poster child problem and how biomechanics can be leveraged to address it? This can catch the imagination of society as a whole.

8. **Model sharing** (Darryl). Model sharing in biomechanics is still lagging. Not having pressure from the journals lessens the priority of model sharing. If done, such approaches can enhance reproducibility. The working group can engage to MSM Consortium wide activities to promote model sharing within the biomechanics discipline.

(b) **Prioritization.** The group prioritized the aforementioned ideas by voting; each member had a maximum of 3 votes to cast to inform others about their preference.

1. Constitutive modeling challenge – 9 (if broadened)
2. Virtual T32 for training in multiscale biomechanics - 8
3. Virtual courses - 7
4. Benchmark problems - 1
5. ASME V&V – 3 (including medical device design related V&V)
6. Success stories - 10
7. Presentation to the President - 1
8. Model sharing – It was decided that this activity has been conducted through MSM wide initiatives, where the working group can participate.

As a result, the group noted the following activities as potential new directions for the working group and discussed implementation pathways:

**Success stories.** When identified, success stories can be distributed through social media (e.g. Twitter), where we can advocate for each other. To reach clinicians specifically the information can be fed to WebMD and working group members can be involved in clinicians' conferences.

**Modeling challenge.** This activity can be implemented as a constitutive modeling challenge also incorporating data from multiple scales (structure & function).

Alternatively a more applied problem can be devised, e.g. brain trauma. The challenge should be tractable and exciting to encourage participation. The “biomechanics challenge” can also have a promotional value. Implementation of the modeling challenge can be incorporated into an existing grant as a supplement.

**Virtual T32 for training.** A grant application can be drafted. The activity can be combined with virtual course development (see above). The book or a course can be one of the deliverables of the proposal. The wiki can be used as an undergraduate training tool. NSF Reshaping the Engineering Program may be another venue to fund education activities.

(c) **Leadership.** Yasin (with help from Yaling and Victor) is interested in leading virtual T32 for training. Victor (with help from Mohammad) can lead modeling challenge.

7. **Other.** Victor and Beth are co-editors of Journal of Biomechanical Engineering (JBME). JBME is open to new ideas to foster the biomechanics community, e.g. commentaries, editorials.