

CURRICULUM VITAE

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Professor and Head

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SUMMARY STATEMENT

Dr. Billiar is dedicated to the success of the Biomedical Engineering Society. He has been a member since 1995, and he currently serves as Chair of the Membership Committee and is a member of the Education committee. He served on the Board of Directors from 2012-2015. Dr. Billiar is also a member of the Executive Board of the American Society of Mechanical Engineers (ASME) Bioengineering Division (BED), and is a Fulbright Fellow, an ASME Fellow, and an AIMBE Fellow.

The focus of Dr. Billiar's research is Tissue Mechanics and Mechanobiology. His lab studies the physical properties of biological tissues and the way in which mechanical forces regulate the development and healing of tissues and the pathogenesis of disease with applications in heart valves, skin, lung, and sternum. Dr. Billiar has been the PI of over \$1.5 million in funding of grants from The Whitaker Foundation, AHA, NIH, and NSF and co-PI of grants from AHA, NIH, NSF, and the DoD totaling over \$10.75 million. He has published over 50 peer-reviewed articles in high impact journals and book chapters with 2000 citations, and he has authored or co-authored in excess of 130 conference presentations and invited seminars including recent scientific talks in Ireland, Italy, China, Australia, and the Netherlands. He has mentored 13 postdocs and graduate students and over 35 undergraduate students in his laboratory. Dr. Billiar is an Associate Editor for the Journal of Biomechanical Engineering, reviews for over 20 journals, and regularly serves on grant panels for the NSF, and NIH and co-chairs a panel for the AHA.

Dr. Billiar has developed and taught 12 courses, advised 37 senior design team projects and 18 junior-level societal projects, and won multiple awards including the Trustees' Award for Academic Advising and the Romeo L. Moruzzi Young Faculty Award for Innovation in Undergraduate Education at WPI. Dr. Billiar has organized many educational workshops at national and international engineering conferences and regularly presents his innovative problem-based teaching methods on campus and at conferences and in peer-reviewed literature.

Dr. Billiar has served as chair of technical committees in his professional societies and is very active in Faculty governance at WPI since he started in 2002. He is currently Department Head of Biomedical Engineering and previously he was a member of the Academic Planning Committee (APC) of the WPI Board of Trustees, he served as Chair of the Committee on Governance (COG), Chair of the Undergraduate Outcomes and Assessment Committee, and currently co-chairs the search for the Dean of Engineering. He was faculty advisor to the BMES student chapter and to Lambda Chi Alpha Fraternity for over 10 years each.

BACKGROUND

EDUCATION

- 1998 Ph.D. University of Pennsylvania, Philadelphia, PA**
School of Engineering and Applied Science, Department of Bioengineering
Doctorate of Philosophy, Bioengineering
Dissertation: *A structurally guided constitutive model for aortic valve bioprostheses: Effects of glutaraldehyde treatment and mechanical fatigue.*
Advisor: Michael S. Sacks, Ph.D.
- 1992 M.S. University of Pennsylvania, Philadelphia, PA**
School of Engineering and Applied Science, Department of Bioengineering
Master of Science in Engineering, Bioengineering
Advisor: Lawrence E. Thibault, Sc.D. (deceased)
- 1991 B.S. Cornell University, Ithaca, NY**
Bachelor of Science in Engineering, Mechanical Engineering
Completed Cooperative Education Program. Graduated with Distinction.

WORK EXPERIENCE

- 2015- **Department Head**, Department of Biomedical Engineering, WPI, Worcester, MA
- 2014- **Full Professor**, Department of Biomedical Engineering, WPI, Worcester, MA
- 2002- **Affiliated Professor**, Department of Mechanical Engineering, WPI, Worcester, MA
- 2003- **Affiliated Professor**, Bioengineering Institute, WPI, Worcester, MA
- 2003- **Adjunct Professor**, Department of Surgery, University of Massachusetts Medical School, Worcester, MA
- 2005- **Adjunct Lecturer in Biomedical Engineering**, Department of Mechanical and Biomedical Engineering, National University of Ireland, Galway, Ireland
- 2008-2014 **Associate Professor with Tenure**, Department of Biomedical Engineering, WPI, Worcester, MA
- 2002-2008 **Assistant Professor**, Department of Biomedical Engineering, WPI, Worcester, MA
- 1998-2002 **Staff Engineer**, Research and Development, Organogenesis, Inc., Canton, MA
- 1995-1998 **Visiting Research Fellow**, Department of Biomedical Engineering, University of Miami, Coral Gables, FL
- 1991-1995 **Graduate Research Fellow**, Department of Bioengineering, University of Pennsylvania, Philadelphia, PA
- 1989-1990 **Research and Development Engineer**, Student CO-OP program, Hewlett-Packard, Medical Products Division, Andover, MA

SCHOLARSHIP

HIGHLIGHTS

- Elected as a Fellow of the American Society of Mechanical Engineers (ASME) in 2013
- Elected as a Fellow of the American Institute for Medical and Biological Engineering (AIMBE) in 2016
- Coleman Faculty Entrepreneurship Fellow 2013-2015
- Fulbright Fellow, 2009-2010
- Inducted into Sigma Xi, The Scientific Research Society, in 2005
- Awardee of The Whitaker Foundation 2003
- \$2.8 million in grant funding from The Whitaker Foundation, AHA, NIH, and NSF as PI; co-PI of grants from AHA, NIH, NSF, and the DoD totaling over \$11 million.
- Over 65 manuscripts (most with graduate student authors, six with undergraduate authors, many with WPI and international collaborators), and 140 conference presentations (citations available upon request).
- Manuscript selected as a 2012 Journal of Biomechanical Engineering Editors' Choice Paper
- Over 30 invited talks including Ireland, The Netherlands, Italy, China, Australia, Canada (titles and locations available upon request)
- Four patents granted.
- Citation indices from Google Scholar (as of 12/15/17)

	All	Since 2012
Citations	2733	1658
h-index	26	23
i10-index	40	38

PUBLICATIONS (In reverse chronological order. *Undergraduates in italics*, graduate students underlined.)

1. Dutta S, Mana-Capelli S, Paramasivam M, Dasgupta I, Cirka H, Billiar K, McCollum D. "TRIP6 inhibits Hippo signaling in response to tension at adherens junctions." *EMBO Rep.* 2017 Dec 8. pii: e201744777. doi: 10.15252/embr.201744777. [Epub ahead of print]
2. Hoffman AH, Teng Z, Zheng J, Wu Z, Woodard PK, Billiar KL, Wang L, Tang D. "Stiffness Properties of Adventitia, Media, and Full Thickness Human Atherosclerotic Carotid Arteries in the Axial and Circumferential Directions." *J Biomech Eng.* 2017 Dec 1;139(12). doi: 10.1115/1.4037794
3. Wang Q, Canton G, Guo J, Guo X, Hatsukami TS, Billiar KL, Yuan C, Wu Z, Tang D. "MRI-based patient-specific human carotid atherosclerotic vessel material property variations in patients, vessel location and long-term follow up." *PLoS One.* 2017 Jul 17;12(7):e0180829. doi: 10.1371/journal.pone.0180829.
4. Cirka HA, Uribe J, Liang V, Schoen FJ, Billiar KL, "Reproducible in vitro model for dystrophic calcification of cardiac valvular interstitial cells: insights into the mechanisms of calcific aortic valvular disease." *Lab Chip.* 2017 Jan 27. doi: 10.1039/c6lc01226d
5. Zuo, H., Tang, D., Yang, C., Gaudette, G., Billiar, K.L., and del Nido, P.J., "3D Fluid-Structure Interaction Canine Heart Model with Patch to Quantify Mechanical Conditions for Optimal Myocardium Stem Cell Growth and Tissue Regeneration" *in press*
6. Aghvami M, Billiar KL, Sander EA. "Fiber Network Models Predict Enhanced Cell Mechanosensing on Fibrous Gels." *J Biomech Eng.* 2016 Oct 1;138(10). doi: 10.1115/1.4034490.
7. Clyne AM, Billiar KL. Implementing problem-based learning in biomechanics courses: a practical approach. *J Biomech Eng.* 2016 May 23. doi: 10.1115/1.4033671. [Epub ahead of print] PubMed PMID: 27210616.

8. Billiar K., "Special Section: Annual Education Issue: Let the Wild Rumpus of Education Start!" (Editorial) *J Biomech Eng.* 2016 Jul 1;138(7). doi: 10.1115/1.4033584.
9. Cirka, H., Monterosso, M., Diamantides, N., Favreau, J., Wen, Q. and Billiar, K. "Active traction force response to long-term cyclic stretch is dependent upon cell prestress," *Biophysical Journal.* 2016 Apr 26;110(8):1845-57. doi: 10.1016/j.bpj.2016.02.036.
10. Tang D, Del Nido PJ, Yang C, Zuo H, Huang X, Rathod RH, Gooty V, Tang A, Wu Z, Billiar KL, Geva T., "Patient-Specific MRI-Based Right Ventricle Models Using Different Zero-Load Diastole and Systole Geometries for Better Cardiac Stress and Strain Calculations and Pulmonary Valve Replacement Surgical Outcome Predictions." *PLoS One.* 2016 Sep 14;11(9):e0162986. doi: 10.1371/journal.pone.0162986.
11. Guo X, Zhu J, Maehara A, Monoly D, Samady H, Wang L, Billiar KL, Zheng J, Yang C, Mintz GS, Giddens DP, Tang D., "Quantify patient-specific coronary material property and its impact on stress/strain calculations using in vivo IVUS data and 3D FSI models: a pilot study." *Biomech Model Mechanobiol.* 2016 Aug 25.
12. Billiar, K., Hubelbank, J., Oliva, T., Quinn, J., Rolle, M., and Camesano, T., "Participating in authentic engineering projects improves teachers' ability to teach the design process to middle school students." *ASEE Annual Meeting, New Orleans, June 2016.* (full-length, peer-reviewed manuscript accepted)
13. Liang, V., Moore, M., Rogers, J., Pfeifer, G, and Billiar, K. "Teaching Engineering Students How to Recognize and Analyze Ethical Scenarios." *ASEE Annual Meeting, New Orleans, June 2016.* (full-length, peer-reviewed manuscript accepted)
14. Zuo, H., Tang, D., Yang, C., Gaudette, G., Billiar, K.L., and del Nido, P.J., "3D Fluid-Structure Interaction Canine Heart Model with Patch to Quantify Mechanical Conditions for Optimal Myocardium Stem Cell Growth and Tissue Regeneration" *in press*
15. Jackson, X., Jasensky, Z., Liang, V., Moore, M., Rogers, J., Pfeifer, G., Billiar, K.L., "A Joint-Venture Approach in Teaching Students How to Recognize and Analyze Ethical Scenarios", *Ethics in Biology, Engineering and Medicine*, pp. 197-209 DOI: 10.1615/EthicsBiologyEngMed.2016014325
16. Kural, M.H., Billiar, K.L., "Myofibroblast persistence with real-time changes in boundary stiffness." *Acta Biomater.* 2016 Mar 1;32:223-30. doi: 10.1016/j.actbio.2015.12.031
17. Wang L., Zheng J, Maehara A, Yang C, Billiar KL, Wu Z, Bach R, Muccigrosso D, Mintz GS, Tang D., "Morphological and Stress Vulnerability Indices for Human Coronary Plaques and Their Correlations with Cap Thickness and Lipid Percent: An IVUS-Based Fluid-Structure Interaction Multi-patient Study." *PLoS Comput Biol.* 2015 Dec 9;11(12):e1004652. doi: 10.1371/journal.pcbi.100465
18. Tang D, Yang C, Del Nido PJ, Zuo H, Rathod RH, Huang X, Gooty V, Tang A, Billiar KL, Wu Z, Geva T., "Mechanical stress is associated with right ventricular response to pulmonary valve replacement in patients with repaired tetralogy of Fallot." *J Thorac Cardiovasc Surg.* 2015 Oct 3. pii: S0022-5223(15)01815-2. doi: 10.1016/j.jtcvs.2015.09.106
19. Mullen, C., Vaughan, T, Billiar, K, and McNamara, L, "The Effect of Substrate Stiffness, Thickness and Crosslinking Density on Osteogenic Cell Behaviour," *Biophysical Journal* 2015 108(7):1604-12.
20. Cirka, H.A., Kural, M.H., and Billiar, K.L., "Mechanoregulation of Aortic Valvular Interstitial Cell Life and Death" *Journal of long-term Effects of Medical Implants*, 2015;25(1-2):3-16.
21. Wang L, Wu Z, Yang C, Zheng J, Bach R, Muccigrosso D, Billiar K, Maehara A, Mintz GS, Tang D., "IVUS-Based FSI Models for Human Coronary Plaque Progression Study: Components, Correlation and Predictive Analysis," *Ann Biomed Eng.* 2014 Sep 23.
22. Zhang, W., Billiar, K.L., and Sacks, M.S., "A generalized method for the analysis of planar biaxial mechanical data," *J Biomech Eng.* 2014 Nov 1. doi: 10.1115/1.4029266.
23. Fan R., Tang D., Yang C., Zheng J., Bach R., Wang L., Muccigrosso D., Billiar K., Zhu J., Ma G., Maehara A., Mintz S G., "Human coronary plaque wall thickness correlated positively with flow shear stress and negatively

- with plaque wall stress: an IVUS-based fluid-structure interaction multi-patient study,” *BioMedical Engineering OnLine*, 13(32), 2014.
24. Kural, M.H. and Billiar, K.L., “Mechanoregulation of valvular interstitial cell phenotype in the third dimension,” *Biomaterials*, Jan;35(4):1128-37, 2014. doi: 10.1016/j.biomaterials.2013.10.047.
 25. Kural, M.H. and Billiar, K.L., “Regulating tension in three-dimensional culture environments.” (Invited review) *Experimental Cell Research*, 319(16), 2013. DOI: 0.1016/j.yexcr.2013.06.019.
 26. Billiar, K., Oliva, T., Hubelbank, J., and Camesano, T., “Teaching STEM by Design,” *Advances in Engineering Education*, V4(1) Winter 2014. *Chosen as lead article and featured in the ASEE PRISM magazine.*
 27. Rudnicki, M., Cirka, H., Aghvami, M., Sander, E.A., Wen, Q. and Billiar, K.L., “Nonlinear strain stiffening is not sufficient to explain how far cells can “feel” on fibrous protein gels,” *Biophysical Journal*, 105(1):11-20, 2013.
 28. Tang D, Yang C, Geva T, Rathod R, Yamauchi H, Gooty V, Tang A, Kural MH, Billiar KL, Gaudette G, Del Nido PJ., “A multiphysics modeling approach to develop right ventricle pulmonary valve replacement surgical procedures with a contracting band to improve ventricle ejection fraction,” *Computers and Structures* 2013 Jun 1;122:78-87.
 29. Tang D, Yang C, Zheng J, Canton G, Bach RG, Hatsukami TS, Wang L, Yang D, Billiar KL, Yuan C, “Image-Based Modeling and Precision Medicine: Patient-Specific Carotid and Coronary Plaque Assessment and Predictions,” *IEEE Transactions on Biomedical Engineering* 2013 Mar;60(3):643-51. doi: 10.1109/TBME.2013.2242891.
 30. Adebayo O, Hu JZ, Gwyther TA, Billiar KL, Rolle MW. “Self-assembled smooth muscle cell tissue rings exhibit greater tensile strength than cell-seeded fibrin or collagen gel rings.” *Journal of Biomedical Materials Research, Part A*. 2013 Feb;101(2):428-37. doi: 10.1002/jbm.a.34341.
 31. Yang, C., Tang, D., Geva, T., Rathod, R., Yamauchi, H., Gooty, V., Tang, A., Gaudette, G., Billiar, K.L., Kural, M., del Nido, P., “Using contracting band to improve right ventricle ejection fraction for patients with repaired Tetralogy of Fallot, a modeling study using patient-specific CMR-based two-layer anisotropic models of human right and left ventricles.” *The Journal of Thoracic and Cardiovascular Surgery*. 2013 Jan;145(1):285-93, 293.e1-2. doi: 10.1016/j.jtcvs.2012.03.009.
 32. Throm Quinlan, A., Billiar, K.L., “Investigating the role of stiffness in the persistence of valvular interstitial cell activation.” *Journal of Biomedical Materials Research Part A*. 2012 Sep;100(9):2474-82. doi: 10.1002/jbm.a.34162.
 33. Cirka, H., Koehler, S., Farr, W., Billiar, K.L., “Eccentric rheometry for viscoelastic characterization of small, soft, anisotropic, and irregularly shaped biopolymer gels and tissue biopsies.” *Annals of Biomedical Engineering Ann Biomed Eng*. 2012, 40 (8) PMID: 22361829.
 34. Liu, H., Canton, G., Yuan, C., Yang, C., Billiar, K.L., Teng, Z., Hoffman, H., Tang, D., “Using In Vivo Cine and 3D Multi-Contrast MRI to Determine Human Atherosclerotic Carotid Artery Material Properties and Circumferential Shrinkage Rate and Their Impact on Stress/Strain Predictions.” *Journal of Biomechanical Engineering*. 2012 Jan;134(1):011008. *Editor’s Choice Award 2012*
 35. Liu, H., Cai, M., Yang, C., Zheng, J., Bach, R., Kural, M., Billiar, K.L., Muccigrosso, D., Lu, D., Tang, D., “IVUS-Based Computational Modeling and Planar Biaxial Artery Material Properties for Human Coronary Plaque Vulnerability Assessment.” *Molecular & Cellular Biomechanics (MCB)*. *Mol Cell Biomech*. 2012 Mar;9(1):77-93.
 36. Cai, M., Yang, C., Kural, M., Bach, R., Muccigrosso, D., Yang, D., Zheng, J., Billiar, K.L., Tang, D., “Intravascular ultrasound (IVUS)-based computational modeling and planar biaxial artery material properties for human coronary plaque vulnerability assessment.” *International Conference on Computer Engineering & Systems (ICCES)*, 2012 vol.19, no.4, pp. 97-104
 37. Broderick G, McIntyre J, Noury M, Strom HM, Psinos C, *Christakas A*, Billiar K, Hurwitz ZM, Lalikos JF, Ignatz RA, Dunn RM. “Dermal Collagen Matrices for Ventral Hernia Repair: Comparative Analysis in a Rat Model Hernia,” *Hernia*. 2012, Jun;16(3):333-43. DOI: 10.1007/s10029-011-0891-0
 38. Gwyther TA, Hu JZ, Billiar, K.L., Rolle MW., “Directed Cellular Self-Assembly to Fabricate Cell-Derived Tissue Rings for Biomechanical Analysis and Tissue Engineering” *Journal of Visualized Experiments, JoVE* 2011, Issue 57 doi: 10.3791/3366, <http://www.jove.com/video/3366> .
 39. Kural, M.H., Cai, M., Tang, D., Gwyther, T., Zheng, J. and Billiar, K.L., “Planar biaxial characterization of diseased human coronary and carotid arteries for computational modeling,” *Journal of Biomechanics*, 2012 Mar 15;45(5):790-8 <http://dx.doi.org/10.1016/j.jbiomech.2011.11.019>

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