

Lloyd V. Smith

Washington State University
School of Mechanical and Materials Engineering
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Education

University of Utah, Salt Lake City, Utah

Ph.D. in Mechanical Engineering, June 1994

Dissertation: Multiaxial characterization of two dimensionally braided composite materials

Advisor: Stephen R. Swanson

M.S. in Mechanical Engineering, December 1991

Thesis: Synergistic effects of environment and stress on coated polymeric fibers

Advisor: K. Lawrence DeVries

B.S. in Mechanical Engineering, June 1988

Minor: Math

Positions

Professor	Washington State University, Washington	2011 to present
Visiting scholar	École Polytechnique Fédérale de Lausanne, Switzerland	2013
Visiting scholar	Royal Melbourne Institute of Technology, Australia	2006
Associate professor	Washington State University, Washington	2002-11
Assistant professor	Washington State University, Washington	1996-02
Research assistant professor	Oak Ridge National Laboratory, Tennessee	1995-96
Post-doctoral fellow	Oak Ridge National Laboratory, Tennessee	1994-95

Ph.D. Research Supervised (5 total)

Preetam Mohapatra	Modelling the effect of bondline thickness	8/12 to present
Arghavan Talebanpour	Describing human injury in sport	5/14 to present
Yi Chen	Viscoelastic modelling of adhesive joints	5/17 to present

M.S. Research Supervised (41 total)

Nitish Dhawan	Modelling oblique helmet impacts	8/16 to present
Rajat Srivastava	Durability of wood baseball bats	8/16 to present
Phillip Petersen	Drop tower oblique helmet impacts	8/16 to present
Taylor Tosaya	Drag measurements of sports balls	8/17 to present
Mark Fung	Changes in aluminum bat performance	8/17 to present

Fulltime Laboratory Staff (6 current)

Awards and Honors

Invited presentation, Harvard Engineering & Applied Science, December 15, 2004

Amateur Softball Association Advisor, 2003 to present

Major League Baseball Panelist, 2002, 2005, 2017

NCAA Baseball Panelist, May 2007 to present

USA Baseball Bat Advisory Committee, 2008 to present
 NFHS Baseball Advisor, 2010 to present
 Trackman Advisory Panelist, August 2012
 Invited Paper, Sports Engineering, 2013
 Excellence as an Academic Advisor award, 2013
 Fellow, International Sports Engineering Association (ISEA), 2018

Popular Press (last 5 years)

Baseball America, Bat Guide 2.0, March, 2011
 Harvard Health Publications, March 31, 2011
 KLEW TV, April 3, 2011
 Smithsonian.com, June 24, 2011
 Redbull Ball Park Cranks, Longest Batted Ball Attempt, June 27, 2011
 Popular Mechanics, July 5, 2011
 ESPN, July 9, 2011
 Washington Post, April 19, 2012
 Instron Community Blog, May 23, 2012
 PAC-12 Network, March 2013
 Sporttechie, September 23, 2013
 Baseball America, October 2, 2013
 NCAA Champion Magazine, April 2014
 WUOT 91.9 FM, NPR, February 27, 2015
 HBO, Real Sports, April 19, 2016 (episode 229)
 Chemical and Engineering news, Vol 95, Issue 26, 6/26/17

Courses Taught

Introduction to Finite Elements (U. Utah)
 Dynamics, ME 212
 Manufacturing Processes, ME 310
 Manufacturing Processes Laboratory, ME 311
 Systems Design, ME 316
 Materials Laboratory, ME 320
 Experimental Design, ME 406
 Machine Design, ME 414
 Finite Element Methods in Design, ME 472
 Continuum Mechanics, ME 501
 Mechanics of Composite Materials, ME 534
 Engineering in Sport, ME 483

Professional Service

Reviewed papers for:
 Journal of Composite Materials
 Journal of Engineering Materials and Technology
 Polymer Engineering and Science
 Journal of Thermoplastic Composite Materials

Composite Structures
 Experimental Mechanics
 Sports Engineering
 Sports Technology
 Journal of Sports Engineering and Technology
 Journal of Applied Biomechanics

Proposal Reviewer

Clean Washington Center, 1997
 SIRTI, 1999
 NOCSAE, 2003
 NSF, 2009, 2016

Secretary, SEM Composites TD, 1998-99

Vice Chair, SEM Composites TD, 2000-01

Chair, SEM Composite TD, 2002-03

Chair, ASTM Ball task force 2005-07

Chair, ASTM Committee F08.26 on Baseball and Softball Equipment, 2007-14

Editorial Board of the Int'l J of Sports Technology, 2007-16

Co-Organizer, Asia-Pacific Congress on Sports Technology, 2009

Executive Board Member, ISEA, 2010 to 2013

Editorial Board of the Sports Engineering Journal, 2012-13

Editor in Chief, Sports Engineering, 2013 to present

University Service

Member of Undergraduate Studies Committee, 1999, 2004-06

Member of Laboratory Equipment Committee, 1999-02

Chair of Laboratory Equipment Committee, 2003

Member of Graduate Studies Committee, 1996-98, 2008-17

Undergraduate Academic Advisor, 1997 to present

Member of Safety Committee, 2000, 2017 to present

SAE Student Club Advisor, 2002-06, 2008-12

ASME Student Club Advisor, 2007-09

SAMPE Club Advisor, 2011-13, 2017

Chair Graduate Studies Committee, 2011-17

Chair MME Website Committee, 2016-17

Extramural Support

1. Federal: ONR, FAA, USDA
2. State: WTCF, SIRTI, JCATI
3. Industry: Albarrie, Boeing, Toray, Cytec, 3M, Intel, Sporting Goods Manufacturers
4. Federations: ASA, NCAA, MLB, USABaseball

Professional Memberships

ASME, SAMPE, SEM, ASTM, ISEA

Journal Publications

- J1. Smith, L. V., DeVries, K. L., 1993. "Mechanical Properties of Polymeric Fibers Exposed to Stress in a NO_x environment," *Polymer*, 34.3:546-550.
- J2. Smith, L. V., Swanson, S. R., 1993. "Response of Braided Composites Under Compressive Loading," *Journal of Composites Engineering*, 3.12:1165-1184.
- J3. Smith, L. V., Swanson, S. R., 1994. "Failure of Braided Carbon/Epoxy Composites Under Biaxial Compression," *Journal Composite Materials*, 28.12:1158-1178.
- J4. Smith, L. V., Swanson, S. R., 1995. "Failure of Braided Composite Cylinders under Biaxial Tension," *Journal of Composite Materials*, 29.6:766-784.
- J5. Smith, L. V., Swanson, S. R., 1995. "Micro-mechanics Parameters Controlling the Strength of Braided Composites," *Composites Science and Technology*, 54.2:177-184.
- J6. Smith, L. V., Swanson, S. R., 1996. "Effect of Architecture on the Strength of Braided Tubes under Biaxial Tension and Compression," *ASME Journal of Engineering Materials and Technology*, 118.4:478-484.
- J7. Swanson, S. R., Smith, L. V., 1996. "Comparison of the Biaxial Strength Properties of Braided and Laminated Carbon Fiber Composites," *Composites*, 27B.1:71-77.
- J8. Smith, L. V., Swanson, S. R., 1996. "Strength Design with 2-D Triaxial Braid Textile Composites," *Composites Science and Technology*, 56:359-365.
- J9. Smith, L. V., and Weitsman, Y. J., 1996. "The Immersed Fatigue Response of Polymer Composites," *International Journal of Fracture*, 82:31-42.
- J10. Smith, L. V., Swanson, S. R., 1997. "Design of a Cylindrical Specimen for Biaxial Testing of Composite Materials," *Journal of Reinforced Plastics and Composites*, 16:550-565.
- J11. Smith, L. V. and Weitsman, Y. J., 1998. "Inelastic Behavior of Randomly Reinforced Polymeric Composites Under Cyclic Loading," *Mechanics of Time-Dependent Materials*, 1.3:293-305.
- J12. Smith, L. V., and Weitsman, Y. J., 1999. "The Visco-Damage Mechanical Response of Swirl-Mat Composites," *International Journal of Fracture*, 97:301-319.
- J13. Rangaraj, S. V., and Smith, L. V., 1999. "The Non-Linear Viscoelastic Response of a Wood-Thermoplastic Composite," *Mechanics of Time-Dependent Materials*, 3.2:125-139.
- J14. Rangaraj, S. V., and Smith, L. V., 2000. "The Effects of Moisture on the Durability of a Wood-Thermoplastic Composite," *Journal of Thermoplastic Composite Materials*, 13.2:140-161.
- J15. Shenoy, M. M., Smith, L. V., Axtell, J. T., 2001. "Performance Assessment of Wood, Metal and Composite Baseball Bats," *Composite Structures*, 52:397-404.
- J16. Smith, L. V., 2001. "Evaluating Baseball Bat Performance," *Sports Engineering*, 4:205-214.
- J17. Smith, L. V. 2001, "Method and Apparatus for Molding Composite Materials," US Patent 6533985.
- J18. Darrow, D. A., Smith, L. V., 2002. "Isolating Components of Processing Induced Warpage in Laminated Composites," *Journal of Composite Materials*, 36.21:2407-2419.
- J19. Smith, L. V., Axtell, J. T., 2003. "Mechanical Testing of Baseball Bats," *Journal of Testing and Evaluation*, 31.3:210-214.
- J20. Pooler, D. J., Smith, L. V., 2004. "Non-linear Viscoelastic Response of a Wood-Plastic Composite Including Temperature Effects," *Journal of Thermoplastic Composites*, 17.5:427-445.
- J21. Bapanapalli, S. K., and Smith, L. V., 2005. "A Linear Finite Element Model to Predict

- Processing-Induced Distortion in FRP Laminates,” *Composites Part A: Applied Science and Manufacturing*, 36:1666-1674.
- J22. Yadama, V., Wolcott, M., Smith, L. V., 2006. “Elastic Properties of Wood-Strand Composites with Undulating Strands,” *Composites Part A: Applied Science and Manufacturing*, 37:385-392.
- J23. Ramachandran, M., Smith, L. V., 2007. “A Mechanistic Model Describing the Degradation of Polymers,” *Journal of Polymers and the Environment*, 15.2:75-80.
- J24. Biesen, E., Smith, L. 2007. “Describing the Plastic Deformation of Aluminum Softball Bats,” *Sports Engineering*, 10:185-194.
- J25. Smith, L. V., Cruz, C. M., 2008. “Identifying Altered Softball Bats and Their Effect on Performance,” *Sports Technology*, 1.4-5:196-201.
- J26. Smith, L. V., Duris, J. G., 2009. “Progress and Challenges in Numerically Modeling Solid Sports Balls With Application to Softballs,” *Journal of Sports Sciences*, 27.4:353-360.
- J27. Bigford, R. L., Smith, L. V., 2009. “Experimental Characterization of Ice Hockey Sticks and Pucks,” *ASTM STP 1516:186-197 & Journal of ASTM International*, 6.7:
- J28. Smith, L. V., 2009. “Progress in Measuring the Performance of Baseball and Softball Bats,” *Sports Technology*, 1.6:291-299.
- J29. Pilli, S. P., Simmons, K. L., Holbery, J. D., Shutthanandan, V., Stickler, P. B. Smith, L. V., 2009. “A Novel Accelerated Moisture Absorption Test and Characterization,” *Composites Part A*, 40.9: 1501-1505.
- J30. Smith, L. V., Duris, J. G., Nathan, A. M., 2009. “A Determination of the Dynamic Response of Softballs,” *Sports Engineering*, 12.4:163-169.
- J31. F. Alam, L. V. Smith, A. Subic, F. K. Fuss, S. Ujihashi, (eds) 2009. “The Impact of Technology on Sport III,” RMIT University, ISBN 13: 978-1-921426-39-1.
- J32. Smith, L., Sherwood, J. 2010. “Engineering our Favorite Pastime,” *Mechanical Engineering, the Magazine of ASME*, 132.4:44-48.
- J33. Nathan, A. M., Crisco, J. J., Greenwald, R. M., Russell, D. A., Smith, L. V., 2011, “A Comparative Study of Baseball Bat Performance, *Sports Engineering*, 13.4:153-162.
- J34. Nathan, A. L., Smith, L. V., Faber, W. L., Russell, D. A., 2011. Corked Bats, Juiced Balls, and Humidors: The Physics of Cheating in Baseball, *American Journal of Physics*, 79.6:575-580.
- J35. Nathan, A. M., Smith, L. V., Faber, W. L., 2011. “Reducing the effect of the ball on bat performance measurements, *Sports Technology*, 4:1-2:19-28.
- J36. Pilli, S., Smith, L., 2012. “The Effect of Pressure on Moisture Diffusion in Polymer Matrix Composites,” *International Journal of Thermophysics*, 33.8-9:1715-1725.
- J37. Salavatian M., Smith L.V, 2012. “Matrix damage in composite pressure vessels with a bias fiber orientation,” *Journal of Composite Materials*, 46.22:2793-2802.
- J38. Burbank, S. D., Smith, L. V., 2012. “Dynamic Characterization of Rigid Polyurethane Foam Used in Sports Balls,” *Sports Engineering and Technology*, 226:77-85.
- J39. Smith, L. V., Kensrud, J., 2013, “Mechanical and Aerodynamic Behavior of Baseballs and Softballs” *Routledge Handbook of Sports Technology and Engineering* (Eds: Fuss/Subic/Strangwood/Mehta), *part VII, ch. 24, pp. 386-398*.
- J40. Smith, L. V., 2013. “Mechanical Behavior of Baseball and Softball Bats” *Routledge Handbook of Sports Technology and Engineering* (Eds: Fuss/Subic/Strangwood/Mehta), *part VI, ch. 20, pp. 325-338*.
- J41. Smith, L. V., 2013. “The Physics of Baseball Bat Performance Measurements,” *Sports*

- Physics, Paris MMXII, Ecole Polytechnique, Christophe Clanet, editor, *pp*:372-382.
- J42. Smith, L. V., 2013. "Another Chapter for Sports Engineering," *Sports Engineering*, 17.1:1.
- J43. Siva P. Pilli, Lloyd V. Smith, Shutthanandan Vaithiyalingam, 2014. "MEASURING TIME DEPENDENT DIFFUSION IN POLYMER MATRIX COMPOSITES," *Mechanics of Time Dependent Materials*, 18.4:633-641.
- J44. Salavatian, M., Smith, L. V. 2013. "The effect of transverse damage on the shear response of fiber reinforced laminates," *Composites Science and Technology*, 95:44-49.
- J45. Smith, L. V., Kensrud, J. 2014. "Field and Laboratory Measurements of Softball Player Swing Speed," *Sports Engineering*, 17.2:75-82.
- J46. Smith, L. V., 2014. "Hygrothermal Effects of Baseballs and Softballs," *Sports Engineering*, 17.3:123-130.
- J47. Salavatian, M., Smith, L. V. 2014. "*An improved analytical model of shear modulus of fiber reinforced laminates with damage*," *Composites Science and Technology*, 105:9-14.
- J48. Salavatian, M., Smith, L. V. 2015. "*An investigation of matrix damage in composite laminates using continuum damage mechanics*," *Composites Structures*, 6.12:565-573.
- J49. Salavatian, M., Smith, L. V. 2016. "*A NOVEL EXPERIMENTAL TECHNIQUE FOR BIAXIAL TESTING OF A COMPOSITE LAMINATE WITH MATRIX DAMAGE*," *Journal of Composite Materials*, 50:2783-2792.
- J50. Smith, L. V., Kensrud, J. 2016. "Chapter 26: Impact performance of sports composites," *Dynamic Deformation, Damage and Fracture in Composite Materials and Structures*, edited by V. V. Silberschmidt, Elsevier, Woodhead Publishing, 18:545-557.
- J51. Lloyd Smith, Derek Nevins, Ngo Tien Dat, Pascal Fua. 2016. "Measuring the accuracy of solid sport ball impact simulations", *Sports Engineering*, 19.4:265-272.
- J52. Patrick Schwizer, Marc Demierre, Lloyd V. Smith. 2017, "An Experimental and Numerical Study of Softball to Facemask Impacts," *Sports Engineering and Technology*, 231.4:336-343.
- J53. Brendan Kays, Lloyd Smith. 2017 "Analysis of Ice Hockey Stick Performance", *Sports Engineering*, 20.4:245-254.
- J54. Jeffrey Kensrud, Alan Nathan, and Lloyd Smith, 2017. "Oblique Collisions of Baseballs and Softballs with a Bat" *American Journal of Physics*, 85.7: 503-509.
- J55. Lyu, Bin, Smith, Lloyd, 2016. "Evaluation of wireless bat swing speed sensors," *Sports Engineering*, *accepted*.
- J56. Jeffrey Kensrud, Lloyd Smith, 2016. "Drag and lift measurements of solid sports balls in still air," *Sports Engineering and Technology*, *accepted*.
- J57. Nevins, D., Hildenbrand, K., Kensrud, J., Vasavada, A., & Smith, L. (2017). "Laboratory and field evaluation of a small form factor head impact sensor in un-helmeted play." *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology*, 1754337117739458, *accepted*.
- J58. D. Nevins, K. Hildenbrand, A. Vasavada, J. Kensrud, L. Smith, 2017. "In-Game Head Impact Exposure of Boy and Girl High School Soccer Players," *Athletic Training and Sports Health Care*, *submitted*.
- J59. D. Lemme, L. Smith, 2017. "Ratcheting in a Nonlinear Viscoelastic Adhesive" *Mechanics of Time-Dependent Materials*, *accepted*.
- J60. P. Mohapatra, L. Smith, 2017. "A comparison of plastic hardening rules in adhesive joints" *Intl JI of Adh & Adh*, *submitted*.

- J61. Derek Nevins, Jeffrey Kensrud, Lloyd Smith. 2017. "Influence of bat inertia on fast-pitch softball player swing speed," *Journal of Sports Sciences*, *submitted*.
- J62. Derek Nevins, Jeffrey Kensrud, Lloyd Smith. 2017. "Effect of Warm-Up Bat Moment of Inertia on Swing Speed and Accuracy," *Journal of Strength and Conditioning Research*, *submitted*.
- J63. Arghavan Talebanpour, Lloyd Smith, 2018. "Assessment of Head Impact Reconstruction Using Numerical Analysis Corresponding Author," *Journal of Biomechanics*, *submitted*.

Conference Proceedings

- P1. Smith, L. V., DeVries, K. L., 1992. "Mechanical Properties of Polymeric Fibers Exposed to Stress in an NO_x Environment," *Bulletin of The American Physical Society*, Vol. 37, No. 1, p. 676, Indianapolis, Indiana.
- P2. Smith, L. V., Swanson, S. R., 1993. "Effect of Architecture on the Strength of Braided Tubes Under Biaxial Compression," *ASME WAM, Composite Materials and Structures*, AD-Vol.37/AMD-Vol. 179, pp. 285-296, New Orleans, Louisiana.
- P3. Smith, L. V., Swanson, S. R., 1994. "Strength Design with 2-d Braid Textile Composites," *Proc. of the American Society for Composites, Ninth Technical Conference*, pp. 727-734, Newark, Delaware.
- P4. Swanson, S. R., Smith, L. V., 1994. "Comparison of the Biaxial Strength Properties of Braided and Laminated Carbon Fiber Composites," *Proc. of International Conference on Composites Engineering, ICCE/1*, Ed. D. Hui, pp. 511-512, New Orleans, Louisiana.
- P5. Smith, L. V., Swanson, S. R., 1994. "Selection of Carbon Fiber 2D Braid Preform Parameters for Biaxial Loading," *Composites: Design and Manufacture for Cost Effectiveness*, MD-Vol 48, *Proc. ASME WAM*, pp. 33-44, Chicago, Illinois.
- P6. Smith, L. V., Weitsman, Y. J., 1995. "Seawater Effects on Fatigue Response of Polymeric Composites," *Proc. International Conference DURACOSYS 95*, 16-21 July, pp. 217-223, Belgium.
- P7. Swanson, S. R., Smith, L. V., 1995. "Multiaxial Stiffness and Strength Characterization of 2-D Braid Carbon/Epoxy Fiber Composites," *Mechanics of Textile Composites Conference, NASA Conf. Pub. 3311, Part 1*, pp. 175-249, Hampton, Virginia.
- P8. Smith, L. V., Weitsman, Y. J., 1995. "Damage-Based Deformation Modeling," *Durability of Lightweight Composite Structures for Automotive Applications: Progress Report for Period Ending September 30, 1995*, ORNL/TM-13176, pp. 6-1 - 6-14, Oak Ridge, Tennessee.
- P9. Smith, L. V., Weitsman, Y. J., 1996. "Visco-Damage in Swirl-Mat Fiberglass Composites," *Proc. First International Conference on Composites Science and Technology, ICCST/1*, 18-20 June, Durban, South Africa.
- P10. Abdel-Tawab, KH., Smith, L. V., Weitsman, Y. J., 1996. "The Inelastic/Damage Response of Swirl-Mat Polymeric Composites: Experiments and Theory," *Proceedings of the symposium on Inelasticity and Damage in Solids Subject to Microstructural Change in honor of the late Professor L. M. Kachanov*, September 25-27, pp. 291-300, St. John's, Newfoundland, Canada.
- P11. Smith, L. V., Weitsman, Y. J., 1996. "Damage-Based Deformation Modeling," *Durability of Lightweight Composite Structures for Automotive Applications: Progress Report for Period Ending September 30, 1996*, pp. 5-1 - 5-14, Oak Ridge, Tennessee.
- P12. Weitsman, Y. J., Smith, L. V., 1997. "The Mechanical Behavior of Swirl-Mat

- Composites,” Proceedings of the 30th International Symposium on Automotive Technology and Automation, ISATA, Florence, Italy, June 16-19, pp. 399-406.
- P13. Smith, L. V. Weitsman, Y. J., 1997. “Characterization of Damage in Viscoelastic Materials,” Abstract Proc. of the Society for Experimental Mechanics, Spring Conference, pp. 47-48, Bellevue, Washington.
- P14. Smith, L. V., 1998. “Examination of Factors That Influence the Strength of Textile Composites,” Abstract Proc. of the Society for Experimental Mechanics, Spring Conference, pp. 11-13, Houston, Texas.
- P15. Smith, L. V., 1998. “The Effects of Moisture on the Fatigue Response of Polymeric Composite Materials,” Proc. Of the 35th Annual Technical Meeting of the Society of Engineering Science, p. 98, Pullman, Washington.
- P16. Rangaraj, S. V., Smith, L. V., 1999. “Durability of a Wood-Thermoplastic Composites in a Simulated Marine Environment,” Abstract Proc. of the Society for Experimental Mechanics, Spring Conference, pp. 814-816, Cincinnati, Ohio.
- P17. Smith, L. V., Hermanson, J. C., Rangaraj, S. V., Bender, D. A., 1999. “A Dynamic Finite Element Analysis of Wood Baseball Bats,” Proceedings of the Summer Bioengineering Conference, pp. 629-630, Big Sky, Montana.
- P18. Smith, L. V., Shenoy, M., Axtell, J. T., 2000. “Simulated Composite Baseball Bat Impacts Using Numerical and Experimental Techniques,” Abstract Proc. of the Society for Experimental Mechanics, Spring Conference, pp. 5-8, Orlando, FL.
- P19. Axtell, J. T., Smith, L. V., Shenoy, M., 2000. “Effect of Composite Reinforcement On The Durability of Wood Baseball Bats,” Proceedings of the 32nd International SAMPE Technical Conference, pp. 687-698, Boston, MA.
- P20. Campbell, B. D., Smith, L. V., Peterson, K., 2001. “Environmental Degradation of Fiber Reinforced Thermoplastic Composites,” Proceedings of the 2001 SEM Annual Conference and Exposition of Experimental and Applied Mechanics, pp. 344-347, Portland, OR.
- P21. Pooler, D. J., Smith, L. V., 2001. “Temperature Dependent Response of a Wood Plastic Composite,” Proceedings of the 2001 SEM Annual Conference and Exposition of Experimental and Applied Mechanics, pp. 628-630, Portland, OR.
- P22. Darrow, D. A., Smith, L. V., 2001. “Evaluating the Spring-In Phenomenon of Polymer Matrix Composites,” Proceedings of the 33rd International SAMPE Technical Conference, pp. 326-337, Seattle, WA.
- P23. Smith, L. V., Campbell, B. D., Peterson, K., 2001. “A Comparative Study of the Environmental Durability of Thermoplastic Composites,” Proceedings of the 33rd International SAMPE Technical Conference, pp. 998-1008, Seattle, WA.
- P24. Briggs, KK; Martinez, SA; Smith, LV; Carroll, WJ; Zimmermann, JA; Shih, MS; Feldman, R; Lincoln, JD. Comparison of the osteogenic effects between two surface interferential stimulation devices to enhance surgically based spinal fusion. *Veterinary-and-Comparative-Orthopaedics-and-Traumatology*. 2004; 17(1): 41-47.
- P25. Smith, L. V., Hanson, J. D., Hermanson, J. C., 2002. “A Numerical Investigation of Shear Testing of Composite Materials,” Proceedings of the 2002 SEM Annual Conference and Exposition of Experimental and Applied Mechanics, pp. 178-181, Milwaukee, WI.
- P26. Bapanapalli, S. K., Smith, L. V., 2003. “The Effect of Tool-Part Interaction on the Geometry of Laminated Composites,” Proceedings of the 2003 SEM Annual Conference and Exposition of Experimental and Applied Mechanics, pp. 139-146, Charlotte, NC.

- P27. Smith, L. V., Broker, J., Nathan, A., 2003. "A Study of Softball Player Swing Speed," Sports Dynamics Discovery and Application, Subic, Trivailo, Alam, eds., pp. 12-17, Melbourne, Australia.
- P28. Shultz, M., Smith, L. V., 2004, "Optimal Fiber Orientation for Fiber Reinforced Pressure Vessels," 2004 SEM Annual Conference and Exposition of Experimental and Applied Mechanics, pp. 1-7, Costa Mesa, CA.
- P29. Duris, J., Smith, L. V., 2004, "Evaluating Test Methods Used to Characterize Softballs," The Engineering of Sport 5th International Conference, Vol. 2, pp. 80-86, Davis, CA.
- P30. Nathan, A. M., Russell, D. A., Smith, L., 2004, "The Physics of the Trampoline Effect in Baseball and Softball Bats," The Engineering of Sport 5th International Conference, Vol 2, pp. 38-44, Davis, CA.
- P31. Mahadevan, R., Smith, L. V., 2005. "Describing the Degradation of Polymers," SEM Annual Conference and Exposition of Experimental and Applied Mechanics, Portland, OR
- P32. Smith, L. V., 2005. "Describing Polymeric Degradation through Weight Measurements," ICCE-12, Tenerife, Spain
- P33. Smith, L. V., Cruz, C. M., Nathan, A. M., Russell, D. A., 2005. "How Bat Modifications Can Affect Their Response," APCST 2005, Tokyo, Japan, The Impact of Technology on Sport, (Subic & Ujihashi, Eds) pp. 33-38.
- P34. Smith, L. V., 2005. "Describing Polymer Degradation Using Simplified Experimental Measurements," SAMPE Fall Technical Conference, Seattle, WA
- P35. Smith, L. V., Duris, J. 2006. "The Dependence of Bat Performance on Ball Properties," IMAC-XXIV, St. Louis, MO.
- P36. Gillespie BW, Martinez SA, Smith LV, Treece BR., 2006. "Comparison of The Tensile Strength Between Two Intradermal Suture Patterns: Buried-knot and "Pulley Knot-free" Techniques in the Dog," American College of Veterinary Surgeons Symposium, October 5-7, Washington, DC.
- P37. Smith, L. V., Ison, A. 2006. "Rigid Wall Effects on Softball Coefficient of Restitution Measurements," The Engineering of Sport 6, Volume 1, Developments for Sports, (Moritz & Haake, eds) Munich, Germany, pp. 29-34.
- P38. Biesen, E., Smith, L. V., 2007. "Describing the Plastic Deformation of Aluminum Softball Bats," The Impact of Technology on Sport, F. K. Fuss, A. Subic, S. Ujihashi, eds., Taylor & Francis, pp. 351-356.
- P39. Smith, L. V., 2007. "Accelerating Degradation in Composites and Their Adhesives," Proceedings of ASC, Seattle, WA.
- P40. Stone, D. P., Smith, L. V., Kothidar, A., 2007. "The Influence of Non-Traditional Composite Laminates on Open-Hole Tension Strength," Proceedings of IMECE2007, 2007 ASME Mechanical Engineering Congress and Exposition, November 11-15, 2007, Seattle, Washington, USA.
- P41. Smith, L. V., 2008. "Measuring the Hardness of Softballs," IMAC-XXVI, Orlando, FL.
- P42. Singh, H., Smith, L. V., 2008. "Describing the Performance of Cricket Bats and Balls," IMAC-XXVI, Orlando, FL.
- P43. Anderson, R., Smith, L. V., 2008. "Experimental Characterization of Ice Hockey Sticks and Pucks," IMAC-XXVI, Orlando, FL.
- P44. Smith, L. V., Singh, H., 2008. "An Examination of Cricket Bat Performance," The Engineering of Sport 7, Estivalet, M., Brisson, P, (eds.) pp. 475-482.

- P45. Stone, D. P., Smith, L. V., Kothidar, A., 2008. "The effect of laminate fiber orientation on open-hole tension strength," 49th AIAA/ASME/ASCE/ AHS/ASC Structures, Structural Dynamics, and Materials Conference
- P46. Smith, L. V., 2009. "REDUCING DAMAGE NEAR CIRCULAR HOLES IN COMPOSITE LAMINATES," 17 International Conference on Composite Materials, Edinburgh, Scotland.
- P47. NATHAN, A. M. AND SMITH, L. V., 2009 "EFFECT OF BALL PROPERTIES ON THE BALL-BAT COEFFICIENT OF RESTITUTION," 4th Asia-Pacific Congress on Sports Technology, Honolulu, Hawaii, The Impact of Technology on Sport III, pp. 257-262.
- P48. Smith, L. V., 2009. "The effect of experimental error on bat performance measurements," 4th Asia-Pacific Congress on Sports Technology, Honolulu, Hawaii, The Impact of Technology on Sport III, pp. 269-273.
- P49. SMITH, L. V., BIGFORD, R. L. 2009. "Laboratory Measurements of Ice Hockey Stick Performance," 4th Asia-Pacific Congress on Sports Technology, Honolulu, Hawaii, The Impact of Technology on Sport III, pp. 341-345.
- P50. Pilli, S., Shutthanandan, V., Smith, L., 2010. "MEASURING TIME DEPENDENT DIFFUSION IN POLYMER MATRIX COMPOSITES," SEM, Indianapolis, Indiana.
- P51. Smith, L., Salavatian, M. 2010. "Describing the Strength of Fiber Reinforced Pressure Vessels," SAMPE, Seattle, WA
- P52. Pilli, S., Smith, L., Shutthanandan, V., 2010. "ORTHOTROPIC DIFFUSION MEASUREMENTS IN POLYMER MATRIX COMPOSITES USING NRA," SAMPE, Seattle, WA.
- P53. Kensrud, J., Smith, L. 2010. "In situ drag measurements of sports balls," The Engineering of Sport 8, Vol. 2, Issue 2, ISEA, Vienna, Austria, pp. 2437-2442.
- P54. Bryson, A., Smith, L., 2010. "Impact response of sports materials," The Engineering of Sport 8, Vol. 2, Issue 2, ISEA, Vienna, Austria, pp. 2961-2966.
- P55. Smith, L., Faber, W., 2011. "The effect of temperature and humidity on the performance of baseballs and softballs," The Impact of Technology on Sport, 5th Asia-Pacific Congress on Sports Technology, Melbourne, Australia, pp. 200-206.
- P56. Kensrud, J., Smith, L. 2011. "In situ lift measurements of sports balls," The Impact of Technology on Sport, 5th Asia-Pacific Congress on Sports Technology, Melbourne, Australia, pp. 278-283.
- P57. Salavatian, M., Smith, L. 2011. "Matrix damage in laminated composites under biaxial stress," 18th International Conference on Composite Materials, Jeju, South Korea, pp. 1-4.
- P58. Salavatian, M., Smith, L. 2011. "Gradual failure in composite pressure vessels after first ply failure," SAMPE Tech 2011 Conference and Exhibition, Fort Worth, Texas, pp. 1-14.
- P59. Smith, L. V., Burbank, S., Kensrud, J., Martin J., 2012. "Field Measurements of Softball Player Swing Speed," ISEA Sports Engineering Conference 9, Procedia Engineering, Volume 34, pp. 538-543.
- P60. Martin, J., Smith, L., Kensrud, J. 2012. "Drag on sports balls using Doppler radar," ISEA Sports Engineering Conference 9, Procedia Engineering, Volume 34, pp. 134-139.
- P61. Salavatian, M., Smith, L. 2012. "Nonlinear shear response of fiber reinforced composites using continuum damage mechanics" SAMPE Tech 2012 Conference and Exhibition, Charleston, SC.
- P62. Nelson, G., Smith, L., Salavatian, M. 2012. "APPLICATION OF IMPROVED FREE

- EDGE DIGITAL IMAGE CORRELATION,” SAMPE Tech 2012 Conference and Exhibition, Charleston, SC.
- P63. Alam, F., Ho, H., Smith, F., Subic, A., Chowdhury, H., Kumar, A. 2012. “A study of baseball and softball aerodynamics” ISEA Sports Engineering Conference 9, Procedia Engineering, Volume 34, pp. 86-91.
- P64. Alam, F., Djamovski, V., Chowdhury, H., Smith, L., Watkins, S., Subic A., 2012. “A Comparative Study of Baseball and Softball Aerodynamics” 18th Australasian Fluid Mechanics Conference, Launceston, Australia, 3-7 December 2012, vol 34:86-91.
- P65. Salavatian, M., Smith, L., 2013. “Experimental Study of Matrix Damage Evolution in Fiber Reinforced Composites,” SAMPE.
- P66. Smith, L., Salavatian, M., 2013. “The Mutual Effects of Shear and Transverse Damage in Polymeric Composites,” ICCM19, Montreal Canada.
- P67. Nevins, D., Smith, L., 2013. “Influence of ball properties on simulated ball-to-head impacts,” 6th Asia-Pacific Conference on Sports Technology, The Impact of Technology on Sports, Hong Kong, 18-20 September 2013, vol 60:4-9.
- P68. Smith, L., Burbank, S., 2013. “Simulating sport ball impact through material characterization,” 6th Asia-Pacific Conference on Sports Technology, The Impact of Technology on Sports, Hong Kong, 18-20 September 2013, vol 60:73-78.
- P69. Kensrud, J., Smith, L., 2013. “Spin from oblique impact of batted sports balls,” 6th Asia-Pacific Conference on Sports Technology, The Impact of Technology on Sports, Hong Kong, 18-20 September 2013, vol 60:130-135.
- P70. Alam, F., Chowdhury, H., Husni, N., Smith, L., 2013. “An experimental study of baseballs and softballs,” 6th Asia-Pacific Conference on Sports Technology, The Impact of Technology on Sports, Hong Kong, 18-20 September 2013, vol 60:467-472.
- P71. Salavatian, M., Smith, L., 2013. “Shear Modulus Degradation in Fiber Reinforced Laminates,” ASME.
- P72. Salavatian, M., Smith, L., 2013. “Analysis of the Shear Modulus Reduction of a Cracked Composite Laminate Including Crack Surfaces Friction,” Proceedings of the American Society for Composites 2013-Twenty-Eighth Technical Conference
- P73. Alan Nathan, Jeff Kensrud, Lloyd Smith, Eric Lang, 2014, “Testing TrackMan Just How Well Does TrackMan Work?,”
<http://www.baseballprospectus.com/article.php?articleid=23202>
- P74. Nevins, D., Smith, L., 2014. “Head Impact Response to Simulated Ball-to-head Collisions,” ISEA 10, Sheffield, UK, Procedia Engineering, Volume 72, 2014, Pages 545-550
- P75. Kays, B., Smith, L., 2014. “Field Measurements of Ice Hockey Stick Performance and Player Motion,” ISEA 10, Sheffield, UK, Procedia Engineering, Volume 72, 2014, Pages 563-568
- P76. Gupta, V., Mohapatra, P., Smith, L., 2014. “The Effect of Adhesive Bondline Thickness on Joint Strength,” Composites and Advanced Materials Expo, Orlando, FL.
- P77. Jeffrey R. Kensrud, Lloyd V. Smith, Alan Nathan, Derek Nevins, 2015. “Relating baseball seam height to carry distance,” 7th Asia-Pacific Congress on Sports Technology, APCST 2015.
- P78. Brendan Kays, Lloyd Smith, 2015. “Numerical Simulation of the Ice Hockey Slap Shot,” 7th Asia-Pacific Congress on Sports Technology, APCST 2015.
- P79. Derek Nevins, Lloyd Smith, Jeff Kensrud, 2015. “Laboratory Evaluation of Wireless

- Head Impact Sensor,” 7th Asia-Pacific Congress on Sports Technology, APCST 2015.
- P80. L.V. Smith and M. Salavatian, 2015. A PROGRESSIVE FAILURE MODEL FOR COMPOSITE LAMINATES INCLUDING MATRIX CRACKS INTERNAL TRACTION, 20th International Conference on Composite Materials, Copenhagen.
- P81. M. Salavatian, L.V. Smith, 2015. Investigation of the fiber reinforced laminates stiffness reduction due to internal defects and matrix cracks, American Society of Composites-30th Technical Conference
- P82. Salavatian M., Smith L.V, 2015. BIAXIAL TESTING OF A COMPOSITE LAMINATE WITH MATRIX DAMAGE USING IOSEPESCU FIXTURE, Proceedings of the 2015 SAMPE conference, Baltimore, MD
- P83. K Hildenbrand, A Vasavada, D Nevins, J Kensrud, L Smith, 2016. On-field Head Impact Exposure in Boys and Girls High School Soccer, *Medicine and science in sports and exercise* 48 (5 Suppl 1), 18
- P84. D Nevins, K Hildenbrand, J Kensrud, A Vasavada, L Smith, 2016. Field Evaluation of a Small Form-factor Head Impact Sensor for use in Soccer, *Procedia Engineering* 147, 186-190
- P85. P Schwizer, M Demierre, LV Smith, 2016. Evaluation of Catcher Mask Impacts, *Procedia Engineering* 147, 228-233
- P86. Preetam C. Mohapatra, Harrison Scarborough, Lloyd V. Smith, 2016. A Comparison of Hydrostatic And Plastic Yield Criteria for A Toughened Adhesive, SAMPE Conference Proceedings. Long Beach, CA, May 23-26, 2016, LB15--0260
- P87. David A. Lemme, Lloyd V. Smith, 2016. A Time Dependent Nonlinear Model of Bulk Adhesive Under Static and Cyclic Stress, SAMPE Conference Proceedings. Long Beach, CA, May 23-26, 2016, LB15—0343
- P88. Preetam C. Mohapatra, Lloyd V. Smith, 2017. EFFECT OF BOND QUALITY ON CRACK GROWTH RESISTANCE OF ADHESIVELY BONDED COMPOSITE JOINTS UNDER STATIC AND CYCLIC LOADING, SAMPE Conference Proceedings
- P89. Arghavan Talebanpour, Lloyd Smith, 2017. A comparison between simulated and measured human brain response under mild acceleration, IRCOBI, Antwerp Belgium.
- P90. Jeff Kensrud, Derek Nevins, Lloyd Smith, 2017. Impact Response of Association Footballs, APCST, Tel Aviv, Israel.
- P91. Derek Nevins, Jeff Kensrud, Lloyd Smith, 2017. Effect of warm-up bat inertia on swing speed, APCST, Tel Aviv, Israel.
- P92. Bin Lyu, Jeff Kensrud, Lloyd Smith and Taylor Tosaya, 2018. Aerodynamics of Golf Balls in Still Air, ISEA 2018, Brisbane, Australia.
- P93. Derek Nevins, Phillip Petersen and Lloyd Smith, 2018. Evaluation of a Differentiation Scheme for Estimating Angular Acceleration from Angular Velocity, ISEA 2018, Brisbane, Australia.
- P94. Preetam C. Mohapatra, Lloyd V. Smith, 2018. Examination of adhesive yield criteria using mixed mode loading of adhesive joints, SAMPE Conference Proceedings