The Science of Baseball II

Term: Fall 2018

About the Leader: A. Terry Bahill is Professor Emeritus of Systems Engineering and of Biomedical Engineering at the University of Arizona, (520) 742-5469, [terry@sie.arizona.edu](mailto:terry@sie.arizona.edu), http://[www.sie.arizona.edu/sysengr/](http://www.sie.arizona.edu/sysengr/)

Location: OLLI campus, 4485 N. First Ave, Saguaro room

Dates: September 18 to December 11, 2018 (Tuesdays, 1;30 – 3:30 pm)

Brief description: We will discuss models of the bat-ball collision and the flight of the ball. We will use the tools of physics, physiology and psychology. We will discuss the *Science of Baseball*: not statistics, SaberMetrics or sports analytics. Advertencia: These seminars contain equations.

Papers and slideshows are available for download from my web site.

<http://www.sie.arizona.edu/sysengr/OLLI/>

Textbook

Bahill, A. T., *The Science of Baseball: Modeling Bat-ball Collisions and the Flight of the Ball*, Springer Nature, 2018, <https://www.springer.com/us/book/9783319670317>

Reference book

Baldwin, D. *Snake Jazz*, Xlibris Corp, www.Xlibris.com, 2007.

http://www.xlibris.com/Bookstore/BookSearchResults.aspx?Title=Snake+Jazz&Author=Baldwin&

The following is an approximate schedule. You may suggest changes.

List of topics

Overview of the Pitch

Slideshows: politicalPolarization.pptx

blueDots.pptx

scienceOfBaseballChapter0.pptx located in the baseballSlides folder on my website.

Relevant papers:

Bahill, A. T. and Baldwin, D. G., [Mechanics of baseball pitching and batting,](http://www.sie.arizona.edu/sysengr/publishedPapers/GhistaChapt16.pdf) Chapter 16 *Applied Biomedical Engineering Mechanics,* Dhanjoo Ghista, CRC Press and Taylor & Francis Asia Pacific, pp. 445-488, 2008.

Bahill, A. T. and Baldwin, D. G., [Describing baseball pitch movement with right-hand rules,](http://www.sie.arizona.edu/sysengr/publishedPapers/RightHandRules.pdf) *Computers in Biology and Medicine*, **37**:1001-1008, 2007.

Bahill, A. T., D. G. Baldwin and Venkateswaran, J., [Predicting a baseball's path,](http://www.sie.arizona.edu/sysengr/publishedPapers/BaseballPath.pdf) *American Scientist,* **93**(3):218-225, May-June 2005 (cover article), with subsequent letters to the editor [letter one](http://www.americanscientist.org/issues/pub/2005/4/mastering-spin), [letter two](http://www.americanscientist.org/issues/pub/2005/5/play-ball) and [Baldwin bio](http://www.americanscientist.org/authors/detail/david-baldwin).

These papers are located in the baseballPapers folder on my website.

Bat-ball Collisions

Slideshow: scienceOfBaseballChapter1.pptx located in the baseballSlides folder on my website.

Source: Chapter 1 *The Science of Baseball*

Modeling Bat-Ball Collisions

Slideshow: scienceOfBaseballChapters234.pptx

Source: Chapters 2, 3 and 4 *The Science of Baseball*

Alternative Models for Bat-Ball Collisions

Slideshow: scienceOfBaseballChapter5.pptx

Source: Chapters 1, 5 and 6 *The Science of Baseball*

Summary of the Modeling Process

Slideshow: scienceOfBaseballChapter12.pptx

Source: Chapter 9 *The Science of Baseball*

Ball in Flight Model

Slideshow: scienceOfBaseballChapter7.pptx

Source: Chapter 7 *The Science of Baseball*

Accuracy of Simulations

Slideshow: scienceOfBaseballChapter8.pptx

Source: *The Science of Baseball*, 2nd Edition

Vertical Sweet Spot of the Bat

Slideshow: scienceOfBaseballChapter9.pptx

Source: *The Science of Baseball,* 2nd Edition

Advantage of Cross-Dominant Batters

Slideshow: scienceOfBaseballChapter10.pptx

Source: *The Science of Baseball,* 2nd Edition

What did We Learn?

Slideshow: scienceOfBaseballChapter11.pptx

Source: Chapters 8 *The Science of Baseball*

The following topics are not in

Bahill, A. T., *The Science of Baseball: Modeling Bat-ball Collisions and the Flight of the Ball*, Springer Nature, 2018, <https://www.springer.com/us/book/9783319670317>

Paradoxical Pop-ups

Slideshow: popUps.pptx

Relevant paper:

McBeath, M. K., Nathan, A. M., Bahill, A. T. and Baldwin, D. G., [Paradoxical pop-ups: Why are they difficult to catch?](http://www.sie.arizona.edu/sysengr/publishedPapers/PopUps.pdf) *American Journal of Physics,* **76**(8):723-729, August 2008.

Human Perception

Slideshow: risingFastball.pptx

Relevant papers:

Bahill, A. T. and Karnavas, W. J., [The perceptual illusion of baseball's rising fastball and breaking curve ball,](http://www.sie.arizona.edu/sysengr/publishedPapers/PerceptualIllusion.pdf) *Journal of Experimental Psychology: Human Perception and Performance,* **19**(1):3-14, 1993.

Bahill, A. T. and D. G. Baldwin, [The rising fastball and other perceptual illusions of batters,](http://www.sie.arizona.edu/sysengr/publishedPapers/RisingFastball.pdf) *Biomedical Engineering Principles in Sports,* George Hung and Jani Pallis (Eds), Kluwer Academic, pp. 257-287, 2004.

Bahill, A. T. and D. G. Baldwin, [The vertical illusions of batters,](http://www.sie.arizona.edu/sysengr/publishedPapers/VerticalIllusions.pdf) *The Baseball Research Journal,* **32**:26-30, 2003.

Slideshow: NickelAndDime.pptx

Relevant paper:

Baldwin, D. G., Bahill, A. T. and Nathan, A., [Nickel and dime pitches,](http://www.sie.arizona.edu/sysengr/publishedPapers/Nickel&Dime.pdf) *Baseball Research Journal,* **35**, 25-29, 2007 (cover article).

Eye Movements Used by Baseball Batters

Slideshow: eyeOnBall.pptx

Relevant papers:

Bahill A. T., and LaRitz T., [Why can't batters keep their eyes on the ball,](http://www.sie.arizona.edu/sysengr/publishedPapers/EyeOnBall.pdf) *American Scientist,* **72,** 249-253, May-June 1984.

McHugh, D. E. and Bahill, A. T., [Learning to track predictable target waveforms without a time delay,](http://www.sie.arizona.edu/sysengr/publishedPapers/LearningToTrack.pdf) *Investigative Ophthalmology and Visual Science,* **26,** 932-937, 1985.

The Ideal Baseball Bat

Slideshow: baseballBat.pptx

Relevant papers:

Bahill, A. T., and Karnavas, W. J., [Determining ideal baseball bat weights using muscle force-velocity relationships,](http://www.sie.arizona.edu/sysengr/publishedPapers/IdealBatWeights.pdf) *Biological Cybernetics,* **62:** 89-97, 1989.

Bahill, A. T., and Karnavas, W. J., [The ideal baseball bat,](http://www.sie.arizona.edu/sysengr/publishedPapers/NewScientist.pdf) *New Scientist,* **130**(1763):26-31, 6 April 1991.

Bahill, A. T. and Morna Freitas, M., [Two methods for recommending bat weights,](http://www.sie.arizona.edu/sysengr/publishedPapers/TwoMethods.pdf) *Annals of Biomedical Engineering,* **23/4**, 436-444, 1995.

Bahill, A. T., [The ideal moment of inertia for a baseball or softball bat,](http://www.sie.arizona.edu/sysengr/publishedPapers/MomentOfInertia.pdf) *IEEE Transactions on Systems, Man and Cybernetics,* Part A: Systems and Humans, **34**(2):197-204, 2004.

Bahill, A. T. and Baldwin, D. G., [Mechanics of baseball pitching and batting,](http://www.sie.arizona.edu/sysengr/publishedPapers/GhistaChapt16.pdf) Chapter 16 *Applied Biomedical Engineering Mechanics,* Dhanjoo Ghista, CRC Press and Taylor & Francis Asia Pacific, pp. 445-488, 2008.

Zachman Framework

Slideshow: zachman.pptx

Relevant paper:

Bahill, A. T., Botta, R., and Daniels, J., [The Zachman framework populated with baseball models,](http://www.sie.arizona.edu/sysengr/publishedPapers/ZachmanBaseball.pdf) *Journal of Enterprise Architecture,* **2**(4):50-68, 2006.

Class projects

If you want to make a presentation in class, any of the papers by Rod Cross or Al Nathan would be appropriate.

When biological systems move, the movement usually follows the two-thirds power law. It would be interesting to see if the motions of baseball players follow the two-thirds power law. See http://www.sie.arizona.edu/sysengr/OLLI/twoThirdsPower/

Three models explain the Magnus force (1) conservation of momentum (2) Bernoulli’s principle and (3) the Navier-Stokes equations,

<http://www.grc.nasa.gov/WWW/K-12/airplane/bernnew.html>.

Describe the states where each of these models is the best.

Biographical Sketch

Terry Bahill is Professor Emeritus of Systems and Industrial Engineering at the University of Arizona in Tucson. He received his Ph.D. in electrical engineering and computer science from the University of California, Berkeley, in 1975. He is the author of six engineering books and 250 scientific papers; over 100 of these are in peer-reviewed scientific journals. Bahill has worked with dozens of technical companies presenting seminars on Systems Engineering, working on system development teams and helping them to describe their Systems Engineering processes. He holds a U.S. patent for the Bat Chooser™, a system that computes the Ideal Bat Weight™ for individual baseball and softball batters. He was elected to the Omega Alpha Association, the systems engineering honor society. He received the Sandia National Laboratories Gold President's Quality Award. He is an elected Fellow of the Institute of Electrical and Electronics Engineers (IEEE), of Raytheon Missile Systems, of the International Council on Systems Engineering (INCOSE) and of the American Association for the Advancement of Science (AAAS). He is the Founding Chair Emeritus of the INCOSE Fellows Committee. His picture is in the Baseball Hall of Fame's exhibition "Baseball as America." You can view this picture at <http://www.sie.arizona.edu/sysengr/>. His research interests are in the fields of system design, modeling physiological systems, eye-hand-head coordination, human decision making, and systems engineering application and theory. He has tried to make the public appreciate engineering research by applying his scientific findings to the sport of baseball.

