

**ROBERT L. FOOTE**  
**CURRICULUM VITA**

MARCH 2008

**Address/Telephone/E-Mail**

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**Personal**

Date of Birth: December 2, 1953      Citizenship: USA

**Education**

Ph.D., Mathematics, University of Michigan, April 1983  
Dissertation: *Curvature Estimates for Monge-Ampère Foliations*  
Thesis Advisor: Daniel M. Burns Jr.  
M.A., Mathematics, University of Michigan, April 1978  
B.A., Mathematics, Kalamazoo College, June 1976  
Magna cum Laude with Honors in Mathematics, Phi Beta Kappa, Heyl Science Scholarship

**Employment**

1989–present, Wabash College  
Full Professor since 2004  
Associate Professor 1993–2004  
Department Chair, 1997–2001  
Assistant Professor 1991–1993  
Byron K. Trippet Assistant Professor 1989–1991  
1983–1989, Texas Tech University, Assistant Professor (granted tenure)  
1983, Kalamazoo College, Visiting Instructor  
1976–1982, University of Michigan, Graduate Student Teaching Assistant  
1976, 1977, The Upjohn Company, Mathematical Analyst

**Research Visits**

1996–1997, 2003–2004, Univ. of Illinois at Urbana Champaign, Visiting Scholar (sabbatical leave)  
1991, Pohang Institute of Science and Technology, Pohang, Korea  
Three months at the invitation of C. K. Han.  
1990, Texas Tech University  
Ten weeks at the invitation of Lance D. Drager.

**Current Fields of Interest**

Primary: Differential Geometry, Integral Geometry  
Secondary: Geometric Control Theory, Several Complex Variables.

**Professional Affiliations**

American Mathematical Society, Mathematical Association of America.

## Teaching Experience

### Graduate courses

Differentiable manifolds, real analysis, complex analysis.

### Undergraduate courses

Elementary analysis, advanced multivariable calculus, complex analysis, advanced linear algebra, combinatorics, differential equations, geometry (axiomatic), computational geometry, linear algebra, calculus, precalculus, geometry for liberal arts students, algebra, trigonometry, analytic geometry, business mathematics, finite mathematics, mathematics senior seminar, introductory computer science (incl. labs), methods of teaching mathematics, Cultures & Traditions, Freshman Tutorial (Science, pseudo-science, and how to tell the difference).

### Educational Software Development

*PoincaréDraw*, an interactive program for doing constructions in hyperbolic geometry in the spirit of “Geometers Sketchpad.” Original Pascal version begun in 1995. Java version begun in 2001. Work involved two student interns, the first in 1995 and 1997, the second in 2001. Student work in 1997 funded by NSF Division of Undergraduate Education grant DUE-9554636 as follow-up to “Exploring Undergraduate Algebra & Geometry with Technology” workshop (see Pedagogical Talks and Workshop Presentations below).

### Mathematics Camp

Co-directed (with E. Poffald) intensive month-long program to expose qualified undergraduates to topics and activities not usually available at undergraduate level. Camp activities included lectures, problem solving, colloquium talks, student talks, discussions about graduate school and careers in mathematics, social events. June 1992.

### Related activities

Classroom notes (articles 2, 10, and 12), service on master’s and doctoral committees, directed four summer internships, supervised teaching assistants, coach for Putnam and other contests, departmental bi-weekly contest problem, Wabash-Washington Bridge program.

## Service

### Wabash College

Academic Planning & Policy Committee (secretary), Committee on Committees, Curriculum Appeals Committee, International Students Association (co-advisor), Lecture Planning & Implementation Committee, MacLean-McTurnan-Arnold Scholarship selection committee (chair), Multicultural Concerns Committee, Off-Campus Study Committee, Pre-engineering Committee (chair), Quality of Life in Indiana Advisory Committee, Teacher Education Committee, Teaching & Learning Committee (chair), Visiting Artists Planning & Implementation Committee, ad-hoc committee for planning new science and math facilities, special faculty continuation review committees (2), organized Geometer’s Sketchpad workshop for Wabash students and local mathematics teachers, departmental colloquium organizer.

### Texas Tech University

Undergraduate Curriculum Committee, director of regional University Interscholastic League mathematics competition.

### Discipline

- MAA Visiting Lecturer 1993–97.
- Co-organized special session, “New Problems and New Techniques in Observability Theory,” MTNS Conference, Phoenix, June 1987.
- Co-organized minisymposium, “Geometric and Grassmannian Techniques in Control Theory,” SIAM Conference “Linear Algebra in Signals, Systems, and Control,” Boston, August 1986.
- Co-organized Indiana University, Purdue University, Wabash College Midsummer Student Mathematics Conference, July 2001, Wabash College.

- Refereed papers for *Indian J. of Math.*; *Circuits, Signals, and Signal Processing*; *1987 MTNS Proceedings*; *American Math. Monthly*, *College Mathematics Journal*.
- Refereed textbook for Harcourt Brace Jovanovich, 1993.
- Review Panel for NSF Young Investigators Competition, April 1993.
- Reviewed grant proposal for NSF.
- Reviewer for *Mathematical Reviews*.

## Articles

- (1) “Regularity of the Distance Function,” *Proc. Amer. Math. Soc.*, 92 (1984) 153–155.
- (2) “The Contraction Mapping Lemma and the Inverse Function Theorem in Advanced Calculus,” with L. D. Drager, *Amer. Math. Monthly*, 93 (1986) 52–54.
- (3) “Differential Geometry of Real Monge-Ampère Foliations,” *Mathematische Zeitschrift*, 194 (1987) 331–350.
- (4) “Controllability of Linear Systems, Differential Geometry of Curves in Grassmannians and Generalized Grassmannians, and Riccati Equations,” with L. D. Drager, C. F. Martin, and J. Wolper, *Acta Appl. Math.*, 16 (1989) 281–317.
- (5) “Observing Ergodic Translations on Compact Abelian Groups with Discontinuous Functions,” with L. D. Drager and D. McMahon, *IMA J. Math. Control & Info.*, 6 (1989) 441–463.
- (6) “Homogeneous Complex Monge-Ampère Equations and Algebraic Embeddings of Parabolic Manifolds,” *Indiana Univ. Math. J.*, 39 (1990) 1245–1273.
- (7) “Observing the Heat Equation on a Torus Along a Dense Geodesic,” with L. D. Drager and C. F. Martin, *Sys. Sci. and Math. Sci.*, 4 (1991) 186–192.
- (8) “Integral-Geometric Formulas for Perimeter in  $S^2$ ,  $H^2$ , and Hilbert Planes,” with R. Alexander and I. D. Berg, *Rocky Mountain Journal of Mathematics*, **35** (2005) 1825–1860.
- (9) “The Volume Swept Out by a Moving Planar Region,” *Mathematics Magazine*, **79** (2006) 289–297.
- (10) “Area Without Integration: Make Your Own Planimeter,” with Ed Sandifer, in *Hands-On History: A Resource for Teaching Mathematics*, Amy Shell-Gellasch, ed., MAA Notes Series #72, The Mathematical Association of America, Washington, D.C., 2007, pp. 71–88.
- (11) “The Dynamics of Pendulums on Surfaces of Constant Curvature,” with Patrick Coulton and Gregory Galperin, submitted.
- (12) “Elementary Proofs of the Cauchy-Santaló Perimeter Formulas,” in progress.
- (13) “Infinitesimal Isometries along Curves and Generalized Jacobi Equations,” with C.K. Han and J.W. Oh, in progress.
- (14) “Centroids and Volumes in  $S^3$  and  $H^3$ ,” in progress.

## Articles in Conference Proceedings

- (1) “Stein Manifolds that Admit Monge-Ampère Foliations,” invited paper, Varna, Bulgaria, May 1985, *Proc. Third Int’l Conf. Complex Analysis Appl.*, Bulg. Acad. Sci., 1986, 220–227.
- (2) “Controllability of Linear Systems, Differential Geometry of Curves in Grassmannians, and Riccati Equations,” with L. D. Drager and C. F. Martin, NSF Conf., San Antonio, May 1986, *Differential Geometry: The Interface Between Pure and Applied Mathematics*, Luksic, Martin, Shadwick, eds., AMS Contemp. Math., Vol. 68, 1987, 85–98.<sup>†</sup>
- (3) “Observing Ergodic Translations with Discontinuous Functions: An Example in Global Observability,” with L. D. Drager and D. McMahon, Los Angeles, December 1987, *Proc. of 26th IEEE Conf. Decision and Control*, 1987, 966–971.\*
- (4) “Global Observability of Ergodic Translations by Discontinuous Functions,” with L. D. Drager and D. McMahon, invited paper, Sp. Sess. Global Observ. Nonlin. Sys. Memory of

- D. McMahon,” MTNS, Phoenix, June 1987, *Analysis and Control of Nonlinear Systems*, Byrnes, Martin, Saeks, eds., North Holland Elsevier, Amsterdam, 1988, 411–416.<sup>†\*</sup>
- (5) “A Geometric Solution to the Cauchy Problem for the Homogeneous Monge-Ampère Equation,” Mokpo, Korea, July 1991, *Contributions to Complex Analysis and Complex Geometry*, Keem & Shim, eds., Proc. Wrkshp. Pure Math. Vol. 11, 1991, 31–39, Pure Math. Research Assoc., Korean Acad. Council; colloquium talk, Pohang Inst. Sci. Tech., June 1991; seminar talk, U. of Illinois, Oct. 1991; colloquium talk, Dartmouth C., May 1993.
  - (6) “Lie Group Calculus and Explicit Solutions of Non-Autonomous Equations,” Taejon, Korea, August 1991, *Proc. KAIST (Korean Adv. Inst. of Sci., and Tech.) Math. Workshop*, Vol. 6, Choi and Yim, eds., KAIST Math. Research Center, 1991, 199–216;<sup>†</sup> colloquium talk at Seoul Nat. Univ., August 1991.
  - (7) “Vector Bundles Over Homogeneous Spaces and Complete, Locally Symmetric Spaces,” with L. D. Drager, invited paper, AMS Summer Inst. on Diff. Geom., UCLA, July 1990, *Proc. Symp. Pure Math.*, 54 (1993), Part 2, Green and Yau, eds., 183–189.<sup>†</sup>
  - (8) “Split Trivial Bundles over Homogeneous Spaces and Locally Symmetric Spaces,” with L.D. Drager, Orono, Maine, August 1991, Conf. Honor of R.S. Palais, *Global Analysis in Modern Mathematics*, K. Uhlenbeck, ed., Publish or Perish, 1994, 107–118.<sup>†\*</sup>
  - (9) “Geometry of the Prytz Planimeter,” Proc. Conference on Non-holonomic Constraints, University of Calgary, August 1997, *Reports on Mathematical Physics*, 42 (1998) 249–271;<sup>†</sup> Diff. Geom. Seminar, U. of Illinois, March 1998; Lehigh U. Geom. & Top. Conf., June 1998;
- <sup>†</sup>Refereed.                      \*Talk presented by co-author.

### Book Review

“Close Encounters with Mathematical Cranks of the Third Kind,” review of *Mathematical Cranks and A Budget of Trisections* by Underwood Dudley, *Skeptical Inquirer*, V. 18, Winter 1994, 182–186.

### Textbook

“A Brief Introduction to Multivariable Calculus,” self-published for use at Wabash College. A nonvector-based approach for second semester calculus.

### Grant Received

ILI Grant: “An Integrated Laboratory-Classroom for Calculus and Precalculus,” Co-PI with B. Gold and E. Poffald, NSF Division of Undergraduate Education, program for Instrumentation and Laboratory Improvement DUE-#9551646, 1995.

### Research Talks<sup>†</sup>

- (1) “Monge-Ampère Foliations,” colloquium talk, Texas Tech University, March 1983.
- (2) “Differential Geometry of One-Dimensional Real Monge-Ampère Foliations,” AMS/MAA Joint Meetings, Anaheim, CA, January 1985.
- (3) “Control Theory, Differential Geometry of Curves in Grassmannians, and Riccati Equations,” with L. D. Drager and C. F. Martin, AMS special session on algebraic geometry and control theory, Claremont, CA, November 1985.\*
- (4) “Algebraic Embedding of Stein Manifolds that are Strictly Parabolic at Infinity, and of Reinhardt Type,” AMS/MAA nat’l meetings, New Orleans, January 1986.
- (5) “Geometry and Function Theory of Parabolic Manifolds of Reinhardt Type,” colloquium talk, Texas A&M Univ., March 1986.
- (6) “Differential Geometry of Riccati Flows and Controllability of Linear Systems,” with L. D. Drager and C. F. Martin, invited talk, SIAM Conference “Linear Algebra in Signals, Systems, and Control,” Boston, August 1986.

- (7) “Controllability of Linear Systems, Differential Geometry of Curves in Grassmannian and Generalized Grassmannian, and Ricatti Equations,” with L. D. Drager, C. F. Martin, and J. Wolper, AMS Nat. Conf., Atlanta, Jan. 1988; Conf. Control in 90’s, San Francisco, May 1989.
- (8) “A Characterization of Locally Symmetric Spaces,” colloq. talk, Texas Tech U., Sept. 1988.
- (9) “Observing the Heat Equation on a Torus Along a Winding Line,” with L. D. Drager and C. F. Martin, SIAM Conf. on Control in the 90’s, San Francisco, May 1989; invited talk, Ninth Southwest Symposium on Systems Theory, Texas Tech Univ., December 1989.\*
- (10) “Classifying Stein Spaces with Monge-Ampère Foliations,” sem. talk, Purdue U., Oct. 1989.
- (11) “The Gauss-Bonnet Theorem for Parallel Translation via Lie Group Calculus,” invited talk, Differential Geometry Day, Eastern Illinois Univ., November 1991.
- (12) “Lie Group Calculus with Applications to Differential Equations and Differential Geometry,” colloquium talk, Texas Tech University, March 1992.
- (13) “Planimeters and the Isoperimetric Inequality,” Geometric Potpourri Seminar, U. of Illinois, October 1996.
- (14) “Have You Seen These Theorems? Three Geometric Gems That Used to be Part of Multivariable Calculus,” Geometric Potpourri Seminar, U. of Illinois, April 1997; Indiana Section MAA meeting, Terre Haute, April 2004.
- (15) “Isoperimetric Inequalities on Constant Curvature Surfaces via Planimetry,” Differential Geometry Seminar, U. of Illinois, April 1997.
- (16) “Planimeters and Isoperimetric Inequalities on Constant Curvature Surfaces,” Lehigh Geometry & Topology Conference, June 1997. Updated version, Eleventh Midwest Geometry Conference, Wichita State Univ., April 2001; colloquium talk, Eastern Illinois Univ., January 2003; Geometry Seminar, Dartmouth College, July 2004.
- (17) “Variations on Themes by Montes and Minkowski,” with D. Berg and R. Alexander, Geometric Potpourri Seminar, U. of Illinois, November 1997.
- (18) “Holonomy of the Prytz Planimeter: More Questions Than Answers,” invited talk, Differential Geometry Day, Eastern Illinois Univ., October 1998.
- (19) “The Dynamics of Pendulum Motion on  $S^2$  and  $H^2$ ,” Geometric Potpourri, UIUC, October 2003; Lehigh Geometry & Topology Conference, October 2007.
- (20) “Integral-Geometric Formulas for Perimeter in  $S^2$ ,  $H^2$ , and Hilbert Planes,” Union College Mathematics Conference, November 2003; Lehigh University Geometry & Topology Conference, June 2004.
- (21) “An Elementary Proof of the Cauchy-Santaló Perimeter Formulas,” Geometric Potpourri Seminar, UIUC, May 2004. Expanded version, Lehigh Geometry & Topology Conference, June 2006; Geometric Potpourri Seminar, UIUC, Sept. 2006.
- (22) “Intrinsic Proofs of the Law of Sines, Concurrence of Triangle Medians, and the Jacobi Equation in Neutral Geometry,” Geometric Potpourri Seminar, UIUC, June 2004.
- (23) “Centroids and Volumes in  $S^3$  and  $H^3$ ,” UIUC Geometric Potpourri Seminar, June 2007.

† Does not include talks listed under conference proceedings.

\*Presented by co-author.

### Expository Talks and Presentations

- (1) “A Friendly Excursion into Differential Geometry,” interview talk, March 1982.
- (2) “Differential Geometry and the Theory of Relativity,” interview talk, March 1983.
- (3) “Control Theory and the Geometry of Curves in Euclidean Space,” colloquium talk, Kalamazoo College, January 1987; interview colloquium, March 1989.
- (4) “Non-Euclidean Geometry,” Texas Tech Univ., School of Arch., November 1988.
- (5) “Geometry of the Planimeter,” colloquium talk, Wabash College, April 1990; colloquium talk, Kalamazoo College, January 1991.

- (6) “What is Differential Geometry? How to Tell if Your Universe is Curved,” colloquium talk, Wabash College, January 1992.
- (7) “The Planimeter and the Pendulum,” colloquium talk, Wabash College, November 1992.
- (8) “A Plethora of Planimeters,” colloquium talk, Lake Forest College, March 1993; Indiana MAA Section Meeting, March 1995; Keynote Speaker, IIME Banquet, Rose-Hulman, May 1995; undergraduate colloquium talk, Ball State Univ., September 1995; colloquium talk, Wabash College, Sept. 2002.
- (9) “What is an Integral?,” colloquium talk, Wabash College, March 1995.
- (10) “Cruising Through Hyperbolic Space,” colloquium talk, Wabash College, with student intern Nathan Fouts, September 1995; Indiana MAA Section Meeting, March 1996; repeated as “Exploring the Hyperbolic Plane with *PoincaréDraw*,” Geometric Potpourri Seminar, U. of Illinois, February 1997.
- (11) “Planimeters and Isoperimetric Inequalities” (expository version of research talk with same title), colloquium talk, DePauw U., Feb. 1997; colloquium talk, Wabash C., Sept. 1997.
- (12) “Planimeters and Isoperimetric Inequalities on Constant Curvature Surfaces” (expository version of research talk with same title), colloquium talk, U of Cincinnati, March 1998; Indiana State U./Rose-Hulman Inst. Tech./St. Mary of the Woods C. Joint Math Colloquium, March 1998; repeated as “Planimeters and Isoperimetric Inequalities,” Indiana section meeting MAA, St. Mary’s College, November 1998; Invited opening address, Illinois Section MAA, April 1999.
- (13) “The Inverted Pendulum: Which Way Will it Fall?,” colloquium talk, Wabash College, Sept. 1998.
- (14) “Geometry of the Prytz Planimeter” (expository version of research talk with same title), colloquium talk, Wabash College, Sept. 1999, Sept. 2005; Indiana MAA Section Meeting, Oct. 1999; colloquium talk, Kalamazoo College, May 2005.
- (15) “Circumferences of Convex Regions:  $C = 2\pi r$  isn’t Just for Circles Anymore!,” colloquium talk, Wabash College, Sept. 2000.
- (16) “An Intuitive, Geometric Proof of the Isoperimetric Inequality Based on the Operation of a Planimeter,” Miami U. Annual Math Conf., Sept. 2000.
- (17) “*PoincaréDraw II*: An Interactive Program for Teaching and Learning Hyperbolic Geometry” with student intern Anand Jha, colloquium talk, Wabash College, Sept. 2001.
- (18) “How Pendulums Work in Spherical and Hyperbolic Geometry,” colloquium talk, Wabash College, November 2003.
- (19) “The Poincaré Conjecture,” colloquium talk, Wabash College, Sept. 2004.
- (20) “ $3 \leq \pi \leq 4$ ,” colloquium talk, Wabash College, April 2006.
- (21) “The Circumference of a Convex Region,” colloquium talk, Wabash College, Nov. 2006.

### **Pedagogical Talks and Workshop Presentations**

- (1) “Cruising Through Hyperbolic Space,” with student intern Nathan Fouts, NSF workshop “Exploring Undergraduate Algebra and Geometry Using Technology,” DePauw U., June 1996; repeated as “Exploring the Hyperbolic Plane with *PoincaréDraw*,” MAA Special Session on Geometry in the Classroom in the Next Millennium, AMS/MAA joint meetings, January 1999.
- (2) Invited presentation, DePauw U. *Mathematica* workshop. Presented multivariable calculus material developed for second-semester calculus, May 1999.
- (3) “(Nearly) Coordinate-Free Computational Geometry”, GLCA/Mellon Foundation workshop on computer graphics, Teaching and Research in Graphics as an Undergraduate Topic (TARGUT), Dennison University, June 2006.

## Other Presentations

- (1) Guest instructor for one class period at DePauw in their Senior Seminar talking about hyperbolic geometry, February 1997.
- (2) Guest instructor one class period at University of Illinois, Urbana-Champaign, in a graduate course on differential geometry in physics discussing planimeters as examples of geometric holonomy, November 1997.
- (3) Guest instructor for one class period at Purdue in their non-Euclidean geometry class demonstrating *PoincaréDraw* and talking about hyperbolic geometry, with student intern Anand Jha, June 2001.
- (4) Guest instructor for two class periods with the Crawfordsville High School calculus class showing the students how planimeters are used and how they work, May 2002.
- (5) Guest instructor for one class period at Kalamazoo College in their geometry course talking about a theorem common to Euclidean, spherical, and hyperbolic geometry, May 2005.

## Minicourse and Workshop Attendance

- MAA minicourse, “Teaching Problem Solving,” AMS/MAA nat’l meetings, Anaheim, Jan. 1985.
- NSF/CBMS conference, “New Constructions of Functions Holomorphic on the Unit Ball of  $\mathbb{C}^n$ ,” Michigan State University, June 1985.
- NSF/CBMS Conference, “The Method of Equivalence and Applications to Control Systems,” Texas Tech University, August 1987.
- MAA minicourse, “Chaotic Dynamical Systems,” AMS/MAA nat’l meetings, San Francisco, Jan. 1991.
- MAA Workshop on MathCad, U. of Michigan-Dearborn, November, 1992.
- MAA minicourse, “Calculus: An Active Approach with Projects,” MAA/AMS national meetings, San Antonio, January 1993.
- MAA minicourse, “Using the Computer to Teach Differential Geometry,” MAA/AMS national meetings, Cincinnati, January 1994.
- MAA minicourse, “Calculus from Graphical, Numerical, and Symbolic Points of View,” AMS/MAA Mathfest, Minneapolis, August 1994.
- MAA minicourse, “Multivariable Calculus using the Harvard Calculus Consortium Materials,” AMS/MAA Mathfest, Minneapolis, August 1994.
- U. of Minnesota Geometry Center Workshop: “Basic Issues in Computer-aided Mathematics Visualization,” August 1994.
- “Technology in Upper-Level Mathematics Courses,” St. Olaf College, November 1994.
- “Teaching Calculus with Mathematica,” Bowdoin College, August 1995.
- NSF/CBMS conference “Inverse Spectral Geometry,” Texas Tech U, July 1996.
- NSF workshop “The Geometry of Multivariable Calculus,” Bellevue C.C., Seattle, Aug. 1996.
- MAA workshop “Creating and exporting animations to the Web,” AMS/MAA National meetings, New Orleans, January 2001.
- MAA Short Course, “The History of Mathematical Technologies: Exploring the Material Culture of Mathematics,” AMS/MAA national meetings, Phoenix, January 2004.

## Other Conference Attendance Since 1996

- J. of Differential Geometry conference, Harvard, May 1996.
- Differential Geometry Day, Eastern Illinois University, November 1996.
- AMS/MAA National Meeting, Baltimore, January 1998.
- National meeting of mathematics department chairs, Washington, DC, November 1998.
- “Mathematics from Physics,” U. of Illinois, May 1999.

- AMS/MAA National Meeting, Baltimore, January 2000.
- Differential Geometry Day, Eastern Illinois University, April 2000.
- MAA section meeting, Indiana College Math. Comp., Univ. of Indianapolis, March 2001.
- MAA section meeting, Indiana College Math. Comp., Anderson Univ., March 2002.
- Differential Geometry Day, Eastern Illinois University, November 2002.
- MAA section meeting, Indiana College Math. Comp., Butler Univ., March 2003.
- Differential Geometry Day, Eastern Illinois University, November 2003.
- Bloomington Geometry Workshop, Indiana University, April 2004.
- MAA section meeting, Indiana College Math. Comp., Indiana-Purdue University, Ft. Wayne, April 2005.
- “Geometry and the Imagination,” conference in honor of Bill Thurston, Princeton U., June 2007.