

Curriculum Vita (long form) of Sean Allen Broughton

Professor Emeritus, Department of Mathematics
Rose-Hulman Institute of Technology

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1 Personal Information, Education, and Professional Experience

1.1 Personal and Contact Information

Date of Birth: November 12, 1951, Windsor, Ontario, Canada.
Address: 6 Lenox Dr., Shrewsbury, MA, 01545
Email: <mailto:brought@rose-hulman.edu>
Websites
Emeritus Website: <https://askthedoctorofmath.com/>
Rose Faculty Website: <https://wordpress.rose-hulman.edu/brought/>
Selected Works: https://works.bepress.com/allen_broughton/
Tilings of Surfaces Website: <https://tilings.org/>
Autosurf Website: <https://www.rose-hulman.edu/mapub/autosurf/home.html>

1.2 Education

B.Sc. (1975) University of Windsor, Ontario, Canada, 1971-73 & 1974-1975
Major in mathematics, minor in physics
M.Sc. (1978) Queen's University, Kingston, Ontario, 1975-78
Supervisor: O. A. Nielsen
Thesis Title: *The fundamental groups and centres of Lie groups*
Ph.D. (1982) Queen's University, 1978-82
Supervisor: A. J. Coleman
Thesis Title: *On the topology of polynomial hypersurfaces*
Languages Some fluency in spoken and written French
Reading knowledge of German

1.3 Work Experience (reverse chronological order)

2017-present Professor Emeritus of Mathematics, Rose-Hulman Institute of Technology
2014-17 Professor of Mathematics, Rose-Hulman Institute of Technology
1994-2014 Professor and Head of Mathematics, Rose-Hulman Institute of Technology
1989-94 Associate Professor, Mathematics, Cleveland State University,
1986-89 Assistant Professor, Mathematics, Cleveland State University
1983-86 Van Vleck Visiting Assistant Professor, Mathematics,
University of Wisconsin-Madison, (half-time, 9-83 to 9-85
while NSERC Postdoctoral Fellowship (Canada) concurrently held)
1981-83 Assistant Professor, Mathematics, Memorial University of
Newfoundland
1975-80 Grader, Teaching Assistant, and Lecturer while a graduate student
at Queen's University
1974-75 Sublieutenant, Canadian Armed Forces
1971-73, 74-75 Grader and Teaching Assistant, Mathematics, University of Windsor

1.4 Scholarships and Fellowships

1977-78 and 1979-80 Ontario Graduate Scholarship,
1980-81 Queen's University Scholarship,
1983-85 Natural Sciences and Engineering Research Council Postdoctoral
Fellowship (Canada)

1.5 Grants Awarded

1986-87 Research Challenge Grant, Ohio Board of Regents, \$5000
1993 Mathematical Sciences Computing Laboratory, Internal House Bill 904,
Cleveland State University, \$100,000, drafted proposal
1997 Computational Group Theory and Hyperbolic Geometry,
NSF-REU, DMS-9619714, \$30,000, P.I.
1997 Foundation Coalition Upper Division Curriculum Proposal, \$8,000, co-P.I.
1998-2001 Computational Group Theory and Hyperbolic Geometry,
NSF-REU, DMS-9619714 (extension), \$120,000, P.I.
2001-2003 Computational Group Theory, Hyperbolic Geometry, Number Theory,
and Inverse problems NSF-REU, DMS-0097804, \$144,000, P.I.
2003-2004 Sophomore Course and Ancillaries in Nanoscience
DMR-0304487 \$100,000 senior investigator
2003-2004 MAA Conference Grant supported by NSF DMS-0241090, \$2,000
2006-2007 MAA Conference Grant supported by NSF DMS-0536991, \$2,000
2014-2017 Rose Summer Undergraduate Research Program - grant administrator, \$60,000

1.6 Other Professional Activities

Summer 1983 NSERC Research Experiences for Undergraduates, Memorial U. of Newfoundland
1990-1994 reviewer, Mathematical Reviews
Summer 1992 participant, Regional Geometry Institute, Amherst, Massachusetts
Summer 1993 participant, ATLAST Linear Algebra Curriculum Workshop, U. of Michigan
March 1994 visiting scholar, Universidad Nacional de Educacion a Distancia, Madrid Spain
Summer 1996 SIAM Workshop: Mathematics of Finance
Summer 1996 consultant, Rose-Hulman NSF-REU
1996-2017 Member, Imaging Systems Faculty, RHIT
1997-2004 program director, Rose-Hulman NSF-REU
September 1999 participant, Working Conference on Undergraduate Mathematics Research,
Washington, D.C.

Winter 2000-01 TED Program Rose-Hulman
Spring 2001-02 Sabbatical, Mount Holyoke College
Spring 2007 Session on Automorphisms of Surfaces, U. of Arizona, Tucson, co-organizer
Spring 2007-08 Sabbatical, Indiana University
Spring 2007-08 visiting scholar, Universidad Nacional de Educacion a Distancia, Madrid Spain
Fall 2009 Session on Automorphisms of Surfaces, Penn State, co-organizer

Summer 2011 MAA PREP Workshop, Biomathematics - beyond Calculus,
 Sweet Briar College, participant
 Winter 2012 MAA Joint Meetings Minicourse - Computational Discrete Geometry,
 Boston, participant
 Winter 2013 MAA Joint Meetings Minicourse - Using Webwork, San Diego, participant
 Summer 2013 Riemann and Klein Surfaces, Symmetries and Moduli Spaces, Linköping Sweden
 Member of Scientific Committee and Proceedings Associate Editor
 Winter 2015 AMS Joint Meetings Short Course - Finite Frame Theory, participant
 Fall 2015 Session on Automorphisms of Surfaces, Loyola University, co-organizer
 Spring 2016 Sabbatical, Linköping University, Sweden and UNED, Madrid, Spain
 Fall 2017 Symmetries of Surfaces, Maps and Dessins - BIRS - workshop leader
 Spring 2018 Session on Automorphisms of Surfaces, Portland State University, co-organizer
 2020 Contemporary Mathematics volume - in process, co-editor

1.7 Professional Societies,

1986-present member, AMS, American Mathematical Society
 1986-2018 member, MAA, Mathematical Association of America
 1994-present member, SIAM, Society for the Industrial Applications of Mathematics

1.8 Public Service

1993 member, Technology Task Force, South Euclid - Lyndhurst School District
 1992-94 member, Adrian School PTA and Advisory Council
 1997-02 den leader and Assistant Scout Master, Boy Scouts of America
 2011-17 Terre Foods Cooperative, Recruiting and Communications Committees
 2018-19 Southgate at Shrewsbury, Resident Council - committee member
 2018- Massachusetts Life Care Residents' Association - Board member and consultant

2 Teaching Experience

2.1 Undergraduate Courses Taught

- College Algebra, Liberal Arts Mathematics, Mathematics for Teachers
- Basic and Pascal Programming
- all levels of Calculus
- Linear Algebra, Differential Equations, Statistics
- Discrete Mathematics, Probability
- Mathematical Modeling
- Euclidean, Non-Euclidean, and Differential Geometry
- Mathematics of Image Processing.
- Introduction to Parallel Computing
- Fractals and Chaotic Systems
- Lie Groups and Lie Algebras

2.2 Graduate Courses Taught

- Applied Linear Algebra
- Stochastic Methods of Operations Research
- Euclidean and Non-Euclidean Geometry
- Fractals and Chaotic Systems
- Lie Groups and Lie Algebras
- Algebraic Geometry

2.3 Graduate Student Committees

Dave Boyles	University of Wisconsin
Steve Katz	University of Wisconsin
Kay Tasuoka	University of Wisconsin
Jack Chen	Cleveland State
Todd Holthaus	Rose-Hulman
Madhulika Khare	Rose-Hulman
Siva Subramanian	Rose-Hulman
Sundershan Tirumala	Rose-Hulman
Christopher Doyle	Rose-Hulman
Lei Liu	Rose-Hulman

2.4 Undergraduate Theses and Projects

Robert Parada Gauge Theory

Jackie Preston Logistic Regression and NFL superbowl Data

3 Research Interests and Computing Activities

3.1 Research Interests

- Riemann surfaces, non-Euclidean geometry, automorphisms, tilings, group actions, moduli and Teichmüller spaces
- Lie theory, geometry and topology of manifolds and homogeneous spaces
- singularity theory, algebraic geometry
- mathematics of image and signal processing, wavelets and frames

3.2 Computing Software and Systems

- *Computer Algebra Systems:* MAPLE, MATLAB, MAGMA, MACAULAY, GAP, MATHEMATICA
- *Programming Languages:* Python, C, FORTRAN, BASIC, PASCAL
- *Other:* TeX, standard productivity tools , HTML, PHP, Contact Contact

3.3 Computing Experience and Activities

- Extensive classroom use at Cleveland State and Rose-Hulman
- Extensive research use at Cleveland State and Rose-Hulman
- Support and leadership for computer use at Cleveland State and Rose-Hulman
- Chair, Academic Software Committee, Rose-Hulman
- Equipment grant writing at Cleveland State and Rose-Hulman
- Webmaster and web site developer, RHIT Mathematics Department until August, 2014
- WeBWorK administrator, RHIT Mathematics Department
- Chair of Parallel Computing Steering Committee/Users Group
- Volunteer: Constant Contact email support for Terre Foods
- Volunteer/consultant: Webmaster, Digital archivist and Constant Contact email support for MLCRA

4 Publications, Works in Progress, and Presentations

For complete documentation and downloads of some works visit my BEpress Selected Works website: https://works.bepress.com/allen_broughton/

4.1 Theses

- T1. *The fundamental groups and centres of Lie groups*, Queen's University, M.Sc. Thesis, 1978.
- T2. *On the topology of polynomial hypersurfaces*, Queen's University, Ph.D. Thesis, 1982.

4.2 Books and Book Chapters

- B1. *The Science of Nanotechnology: An Introductory Text*, with L. Tilstra, R. Tanke, D. Jelski, V. French, G. Zhang, A. Popov, T. George, and A. Western, Nova Science Publishers, Hauppauge NY (2007).
- B2. *Discrete Fourier Analysis and Wavelets: Applications to Signal and Image Processing*, with Kurt Bryan, Wiley Interscience 2009.
- B3. *Discrete Fourier Analysis and Wavelets: Applications to Signal and Image Processing, Edition 2*, with Kurt Bryan, Wiley 2018.

4.3 Published / Accepted Papers

- P1. *A comment on unions of sigma-fields*, with B.W. Huff, Amer. Math. Monthly, **84** (7) (1977), 553-554.
- P2. *On the topology of polynomial hypersurfaces*, Proc. Symposia Pure Math., **40**, Amer. Math. Soc. (1983), 167-178.
- P3. *The height of two-dimensional cohomology classes of complex flag manifolds*, with M. Hoffman and W. Homer, Canadian Bull. Math. **26** (4) (1983), 498-502.
- P4. *A note on characters of algebraic groups*, Proc. of the AMS **89** (1) (1983), 39-40.
- P5. *The homology and higher representations of the automorphism group of a Riemann surface*, Transactions AMS **300** (1) (1987), 153-158.
- P6. *Volumes of subgroups of compact Lie groups*, Algebras, Groups and Geometries, **4** (1987), 325-364.
- P7. *Milnor numbers and the topology of polynomial hypersurfaces*, Invent. Math., **92** (1988), 217-241.

- P8. *The equisymmetric stratification of the moduli space and the Krull dimension of the mapping class group*, Topology and its Applications, **37** (1990), 101-113.
- P9. *Classifying finite group actions on surfaces of low genus*, J. of Pure & Appl. Algebra, **69** (1990), 233-270.
- P10. *The Gottlieb group of finite linear quotients of odd-dimensional spheres*, Proc. of the A.M.S., **111** (4) (1991), 1195-1197.
- P11. *Normalizers and centralizers of elementary Abelian subgroups of the mapping class group*, Topology '90, Walter de Gruyter, New York (1992), 77-89.
- P12. *Simple group actions on hyperbolic surfaces of least area*, Pacific J. of Math., **158** (1) (1993), 23-48.
- P13. *Symmetries of Riemann surfaces on which $PSL(2, q)$ acts as a Hurwitz automorphism group*, with E. Bujalance, A.F. Costa, J.M. Gamboa, and G. Gromadski, J. of Pure and Appl. Algebra. **106** (1996), 113-126, <https://www.sciencedirect.com/science/article/pii/0022404994000654>.
- P14. *Symmetries of Accola - Maclachlan and Kulkarni surfaces*, with E. Bujalance, A.F. Costa, J.M. Gamboa, and G. Gromadski, Proc. of the AMS. **127** #3 (1999), 637-646, <https://www.jstor.org/stable/118994>.
- P15. *Constructing Kaleidoscopic Tiling Polygons in the Hyperbolic Plane*, American Mathematical Monthly, **107** #8 (2000), 689-710, <https://www.jstor.org/stable/2695467>.
- P16. *Divisible tilings of the hyperbolic plane*, with D.M. Haney, L. McKeough and B. Smith, New York Journal of Mathematics, **6** (2000), 237-283, <http://nyjm.albany.edu:8000/j/2000/6-12.pdf>.
- P17. *Anharmonic Vibrational Motions in $C60$: A Potential Energy Surface Derived from Vibrational Self Consistent Field Calculations*, with Daniel Jelski and Laszlo Nemes, Journal of Cluster Science, **16** (1) (2005).
- P18. *Finite Abelian Subgroups of the Mapping Class Group*, with Aaron Wootton, Algebraic & Geometric Topology, **7** (2007), 1651-1697. <http://msp.warwick.ac.uk/agt/2007/07/p066.xhtml>.
- P19. *Topologically Unique Maximal Elementary Abelian Group Actions on Compact Oriented Surfaces*, with Aaron Wootton, Journal of Pure and Applied Algebra, **213** (2009), 557-572, <https://www.sciencedirect.com/science/article/pii/S0022404908001692>.
- P20. *Cyclic n -gonal surfaces and their automorphism groups: two talks in the UNED Geometry Seminar*, with Aaron Wootton, Disertaciones del Seminario de Matematicas Fundamentales, no. 44, UNED, <https://arxiv.org/abs/1003.3262>.

- P21. *Ellipses in Translation Surfaces*, with Chris Judge, *Geometriae Dedicata*, (2012), 1-41, <https://doi.org/10.1007/s10711-011-9602-3>.
- P22. *Superelliptic surfaces as p-gonal surfaces*, *Riemann and Klein Surfaces, Automorphisms, Symmetries and Moduli Spaces*, Contemporary Mathematics Series #629, Amer Math Soc (2014), 15-28, <http://www.ams.org/books/conm/629/>.
- P23. *Exceptional automorphisms of (generalized) super elliptic surfaces*, with Aaron Wootton, *Riemann and Klein Surfaces, Automorphisms, Symmetries and Moduli Spaces*, Contemporary Mathematics Series #629, Amer Math Soc (2014), 29-42, <http://www.ams.org/books/conm/629/>.
- P24. *Quasi-platonic $PSL(2,q)$ -actions on closed Riemann surfaces*, *Albanian Journal of Mathematics* **9** (1), (2015), 31-61, <http://albanian-j-math.com/archives/2015-02.pdf>.
- P25. *Using Strong Branching to Find Automorphisms of n-gonal Surfaces*, with C. Camacho, J. Paulhus, R. Winarski, and A. Wootton, *Albanian Journal of Mathematics* **12** (1), (2019), 89-129, <https://albanian-j-math.com/archives/2018-08.pdf>.
- P26. *Galois action on regular dessins d'enfant with simple group action*, *Higher Genus Curves in Mathematical Physics and Arithmetic Geometry*, Contemporary Mathematics Series #703, Amer Math Soc (2018), 13-32, <http://www.ams.org/books/conm/703/>.
- P27. *On Automorphisms of Algebraic Curves*, with T. Shaska and A. Wootton, *Algebraic Curves and Their Applications*, Contemporary Mathematics Series #724, Amer Math Soc (2019), <https://www.ams.org/books/conm/724/>.
- P28. *Equivalence of finite group actions on Riemann surfaces and algebraic curves*, *Automorphisms of Riemann surfaces, subgroups of mapping class groups and related topics*, Contemporary Mathematics Series, (2021), accepted.
- P29. *Future directions in automorphisms of surfaces, graphs, and other related topics*, with Jennifer Paulhus and Aaron Wootton, *Automorphisms of Riemann surfaces, subgroups of mapping class groups and related topics*, Contemporary Mathematics Series, (2021), accepted.
- P30. *One dimensional equisymmetric strata in moduli space, with Antonio F. Costa and Milagros Izquierdo*, *Automorphisms of Riemann surfaces, subgroups of mapping class groups and related topics*, Contemporary Mathematics Series, (2021), accepted.
- P31. *The engaging symmetry of Riemann surfaces: a historical perspective*, with Gareth A. Jones and David Singerman, *Automorphisms of Riemann surfaces, subgroups of mapping class groups and related topics*, Contemporary Mathematics Series, (2021), accepted.

4.4 Technical Reports and Preprints

- TR1. *Symmetries of Accola-MacLachlan and Kulkarni Surfaces*, with E. Bujalance, A F. Costa, J.M. Gamboa, and G. Gromadzki, RHIT MSTR 95-05, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/64/.
- TR2. *Counting Ovals on a Symmetric Riemann Surface*, RHIT MSTR 97-04, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/68/.
- TR3. *Constructing Kaleidoscopic Tiling Polygons in the Hyperbolic Plane*, RHIT MSTR 98-06, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/112/.
- TR4. *Divisible Tilings in the Hyperbolic Plane*, with Dawn M. Haney, Lori T. McKeough, and Brandy M. Smith, MSTR 99-04, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/60/.
- TR5. *Splitting tiled surfaces with abelian conformal tiling group*, RHIT MSTR 99-03, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/58/.
- TR6. *Triangular Surface Tiling Groups for Low Genus*: with Robert M. Dirks, Maria T. Slougher, and C. Ryan Vinroot, RHIT MSTR 01-01, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/55/.
- TR7. *The Birational Isomorphism Types of Smooth Real Elliptic Curves*, RHIT MSTR 04-05, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/44/.
- TR8. *The Barycenter of the Numerical Range of a Matrix*, with Roger Lautzenheiser and Thomas Werne, RHIT MSTR 07-04, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/39/.
- TR9. *Flattening a Cone*, RHIT MSTR 09-01, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/16/.
- TR10. *Calculation of the Killing Form of a Simple Lie Group*, RHIT MSTR 14-01, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/38/.
- TR11. *Analytical Solution of the Symmetric Circulant Tridiagonal Linear System*, with J.J. Leader, RHIT MSTR 14-02, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/103/.
- TR12. *Continuous Dependence of Solutions of Equations on Parameters*, RHIT MSTR 14-03, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/107/.

- TR13. *Quasi-platonic $PSL_2(q)$ -actions on closed Riemann surfaces*, RHIT MSTR 15-01, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/151/.
- TR14. *Topological and H^q Equivalence of Prime Cyclic p -gonal Actions on Riemann Surfaces (Corrected)*, RHIT MSTR 16-03, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/155/.
- TR15. *Branching Matrices for the Automorphism Group Lattice of a Riemann Surface*, RHIT MSTR 18-01, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/167/.
- TR16. *Topological and H^q Equivalence of Cyclic n -gonal Actions on Riemann Surfaces - Part II*, RHIT MSTR 20-03, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/175/.

4.5 Conference Proceedings (not refereed)

- C1. *Mean and standard deviation for the facilities design problem*, with V. Charumongkol, Computers in Industrial Engineering, **19**, Nos. 1-4 (1990) 313-317.
- C2. *The role of technology in enhancing learning in various disciplines*, with Sam Hulbert, Julia Williams, and Ed Doering, IHETS Purdue Conference on Technology Enhancement and Teaching and Learning.
- C3. *The Rose-Hulman NSF-REU Program*, in Working Conference on Summer Undergraduate Mathematics Research, Washington, D.C. 1999, AMS (2000) 139-145.

4.6 Unpublished Manuscripts and Notes

- U1. *Maximal finite groups of homeomorphisms of Riemann surfaces*.
- U2. *Algebraic geometry, elimination theory and factorization in exterior algebra*: notes for the Cleveland Topology Seminar.
- U3. *Symmetries of Riemann surfaces and kaleidoscopic tilings*: notes for presentation at RHIT.
- U4. *Kaleidoscopic tilings of Riemann surfaces*: problems for the RHIT - REU.

4.7 Work in Progress

- W1. *Closures of One Dimensional Strata in the Branch Locus of Moduli Space*, with Antonio Costa and Milagros Izquierdo, in preparation.
- W2. *Explicit Homology Representation for Groups Acting on Surfaces*, in preparation.

- W3. *The mirrors on a symmetric Riemann surface with quasi-platonic $PSL_2(q)$ -action*, in preparation.
- W4. *Full Automorphism Groups of Cyclic n -gonal Surfaces*, with Aaron Wootton, in preparation.
- W5. *Classification of Primitive Fuchsian Group Pairs*, in preparation.

4.8 Presentations

1. *The topology of polynomial hypersurfaces*, AMS Summer School on Singularity Theory, Arcata, California, August 1981, contributed talk.
2. *Milnor numbers and the topology of polynomial hypersurfaces*, Topology Seminar, Ohio State University, May 1984, invited lecture.
3. *The homology representation of the automorphism group of a Riemann surface*, Case-Carroll Seminar, John Carroll University, November 1986, invited lecture.
4. *The interplay between topology and singularity theory in algebraic geometry*, Case-Carroll Seminar, John Carroll University, November 1987, invited lecture.
5. *Simple groups of automorphisms of Riemann surfaces*, Mathematics Department Colloquium, Kent State University, February 1988, invited lecture; Valley Geometry Seminar, Five Colleges Inc., February 1988, invited lecture.
6. *The equisymmetric stratification of the moduli space*, AMS special session on knot theory and algebraic geometry in the large, Amer. Math. Soc. meeting, College of the Holy Cross, April 1989, invited talk.
7. *Fractal geometry: geometry, probability and computers yield pretty pictures*, Second Annual Sonya Kovalevsky High School Mathematics Day, Cleveland State University, November 1990, invited presentation.
8. *Group symmetries and partial differential equations*, Cleveland Topology Seminar, Winter-Spring 1990, 6 contributed lectures.
9. *Stratification of families of affine curves by the link at infinity*, AMS special session on affine hypersurfaces, and related number theory, Amer. Math. Soc. meeting, Dayton, Ohio, October 1992, invited talk.
10. *Algebraic geometry, elimination theory and factorization in exterior algebras*, Cleveland Topology Seminar, Fall -Winter 1992-93, 4 contributed lectures.
11. *The equisymmetric stratification of the moduli space of Riemann surfaces*, Universidad Nacional de Educacion a Distancia, Madrid, March 1994, invited lecture.

12. *Computing the finite group actions on Riemann surfaces in low genus*, Universidad Nacional de Educacion a Distancia, Madrid, March 1994, invited lecture.
13. *Symmetries of Riemann surfaces and kaleidoscopic tilings*, Rose-Hulman, January 1994, interview presentation.
14. *Lectures on wavelets*, RHIT Applied Math Seminar, Winter 1995, 4-5 contributed lectures.
15. *Tilings, finite groups, and hyperbolic geometry at the Rose-Hulman REU*, MAA Fall meeting, Wabash College, October 1997, contributed talk.
16. *The role of technology in enhancing learning in various disciplines*, with Sam Hulbert, Julia Williams, and Ed Doering, IHETS Purdue Conference on Technology Enhancement and Teaching and Learning, October 1997, contributed talk.
17. *Undergraduate research at the Rose-Hulman REU - what works for us*, AMS Annual meeting, Baltimore, January 1998, contributed talk.
18. *Wavelet based methods of image processing*, Applied Math Seminar, Winter 1998, 7 contributed lectures.
19. *Tilings, finite groups, and hyperbolic geometry at the Rose-Hulman REU*, Cleveland Topology Seminar, April 1998, invited lecture.
20. *Mathematical Methods of Image Processing, A Progress Report on Course Development*, with Ed Doering, AMS Annual Meeting, San Antonio, January 1999, contributed talk.
21. *How do I Teach with this Laptop Anyway?*, with Patsy Brackin, Julia Williams and Ed Doering, Rose-Hulman Showcase, October 1999, contributed talk.
22. *Laptop Program at Rose-Hulman*, with Dan Hatten, Aaron Klebanoff, and Julia Williams, Stevens Institute of Technology, invited presentation.
23. *Tilings, finite groups, and hyperbolic geometry at the Rose-Hulman REU*, Kanazawa Institute of Technology, July 1999, invited lecture.
24. *Higher genus Soccer Balls and Kaleidoscopic Tilings in the Hyperbolic Plane*, Rose Mathematics Seminar, April 2000, two contributed lectures.
25. *The Unreasonable Effectiveness of Mathematics*, Rose-Hulman Symposium to open 126'th school year, August 2000, invited presentation.
26. *Transform Methods in Image Processing*, Mathematics Faculty Seminar, Mount Holyoke College, Spring 2001, invited lecture series.

27. *Higher Genus Soccer Balls*, Mount Holyoke Math Club, Spring 2001, invited presentation.
28. *Signals, Images, ..., What's Next in Scientific Visualization*, Sigma Xi, Mount Holyoke College, Spring 2001, invited presentation.
29. *The Rose-Hulman Laptop Program*, with Ed Doering, Ohio Northern University, September 2001, invited presentation.
30. *Automorphisms of Riemann Surfaces, Galois Groups, and Hecke Algebras*, Rose Math Seminar, March 2002, contributed lecture.
31. *Vanishing Cycles and Kaleidoscopic Quadrilateral Tilings*, Rose Math Seminar, December 2002, contributed lecture.
32. *Kaleidoscopic Tilings on Surfaces, This Time with the Groups*, Rose Math Seminar, Spring 2003, two contributed lectures.
33. *Are the Students Competent Users of Mathematics?*, AMS Annual Meeting, Phoenix, January, 2004, contributed talk.
34. *Equivalence of Real Elliptic Curves*, Rose Math Seminar, October 2004, two contributed lectures.
35. *Fostering Undergraduate Research in Mathematics*, Showcase - Best Assessment Practices VII, Rose-Hulman, April 2005, contributed presentation.
36. *Enumeration of the Equisymmetric Strata of the Moduli Space of Surfaces of Low Genus*, AMS Regional Conference, Santa Barbara, April 2005 invited talk.
37. *Higher Genus Soccer Balls*, ISU Math Seminar, Fall 2006, invited presentation.
38. *Geometry from Chemistry*, Rose Math Seminar, Fall 2006, two contributed lectures.
39. *Geometry from Chemistry*, INMAA Spring Meeting, 2007, contributed talk.
40. *Classifying Pairs of Fuchsian Groups of Finite Type*, AMS Regional Conference, Tucson, April 2007, invited talk.
41. *Elementary Abelian Group Actions on Surfaces and the Geometry of Moduli Space*, IU Geometry Seminar, November, 2007, invited lecture.
42. *The Barycenter of the Numerical Range of an Operator*, ISU Math and CS Research Seminar, November 28, 2007, invited lecture.
43. *Billiards and Flat Surfaces, Voronoi Tessellations, Delaunay Tessellations and Flat Surfaces*, Rose Math Seminar, Fall 2008, two contributed lectures.

44. *Full Automorphism Groups of Cyclic n -gonal Surfaces*, First of two talks in the UNED Geometry Seminar, February 2009, invited presentation.
45. *Classification of Pairs of Fuchsian Groups*, Second of two talks in the UNED Geometry Seminar, March 2009, invited presentation.
46. *Cyclic n -gonal surfaces - weakly malnormal actions and computational methods*, joint with Aaron Wootton, 25th Nordic and 1st British-Nordic Congress of Mathematicians, June 2009, invited talk.
47. *Roll-ups and Differential Geometry*, Rose Math Seminar, Fall 2009, contributed lecture.
48. *Roll-ups and Differential Geometry*, INMAA section meeting, Fall 2009, contributed talk.
49. *Flat Surfaces, Teichmueller Discs, Veech Groups, and the Veech Tessellation*, AMS Regional Conference, Pennsylvania State University, University Park, PA, October 2009, invited talk.
50. *Galois actions on regular dessins and Fuchsian group covers*, Conference on Riemann Surfaces and Dessins d'Enfants On the Occasion of Jürgen Wolfart's 65'th Birthday, May 2010, invited talk.
51. *Who painted this Painting?* Rose Math Seminar, Spring 2012, contributed lecture.
52. *Pairs of Pants and the Congruence Laws of Geometry*, Rose Math Seminar, Spring 2013, contributed lecture.
53. *Exceptional Automorphisms of (Generalized) Super-elliptic Curves*, Riemann and Klein Surfaces, Symmetries and Moduli Spaces, Linköping Sweden, June 2013, invited talk.
54. *Framing the Image*, Rose Math Seminar, February 2015, contributed lecture.
55. *Quasi-platonic actions of $PSL_2(q)$ and their Dessins*, AMS Regional Conference, Michigan State University, East Lansing MI, March 2015, invited talk.
56. *Symmetric surfaces with quasi-platonic $PSL(2, q)$ action*, AMS Regional Conference, Loyola University, Chicago IL, October 2015, invited talk.
57. *Quasi-platonic actions of some simple groups on Riemann surfaces and their dessins d'enfant*, Joint Mathematics Meetings, Seattle, WA, January 2016, invited talk.
58. *Riemann Surfaces: A playground for analysis, topology, geometry, group theory, and Galois theory*, MAI seminar, Linköping University, March 2016, invited lecture.

59. *Moduli space - Geometry/Math with Letters*, Rose Math Seminar, Fall 2016, contributed lecture.
60. *Scientific Visualization and Trigonometry: Do They Mix?* New College of Florida Data Science Seminar, Sarasota FL, October 2016, invited lecture.
61. *Subgroups of the Mapping Class Group Corresponding to 1-Dimensional Strata in the Branch Locus of Moduli Space*, with A. Costa and M. Izquierdo, AMS Annual Meeting, Atlanta GA, January, 2017, invited talk.
62. *Sabbatical Travelogue: Sweden, Spain, and China*, RHIT Global Studies Faculty Seminar, May 2017, invited presentation.
63. *Defining Equations for Riemann Surfaces, BIRS Workshop on Symmetries of Surfaces, Maps and Dessins*, Banf, Alberta, September 2017, contributed lecture.
64. *Topological and \mathcal{H}^q Equivalence of Prime Cyclic p -gonal Actions on Riemann Surfaces*, AMS Regional Conference, Portland State University, Portland OR, April 2018, invited talk.
65. *Signals, Bases of Waveforms, and Frames*, College of the Holy Cross Faculty Seminar, Worcester, MA April 2019, invited lecture.

5 Undergraduate Student Research Work

I have made a considerable effort at undergraduate student research, especially at Rose-Hulman. This section lists the relevant entries from my vita as well as grants, works in progress, and student research mentored by myself.

5.1 Programs and Activities

summer 1983	NSERC Research Experiences for Undergraduates, Memorial U. of Newfoundland
summer 1996	RHIT NSF-REU, faculty consultant
1996-2000	RHIT NSF-REU, Computational Group Theory and Hyperbolic Geometry, P.I. and faculty mentor 6-8 students per year
1997-2014	developer and webmaster for RHIT NSF-REU web page, https://www.rose-hulman.edu/mathREU/
2014-2017	Rose Summer Undergraduate Research Program - program director https://www.rose-hulman.edu/mapub/RSURP/home.html https://scholar.rose-hulman.edu/undergrad_research_pubs/

5.2 Grants

1996-97	RHIT NSF-REU, Computational Group Theory and Hyperbolic Geometry, \$30,000
1997-2000	RHIT NSF-REU, Computational Group Theory and Hyperbolic Geometry, \$120,000
2001-2003	RHIT NSF-REU, Hyperbolic Geometry, Number Theory and Inverse Problems \$144,000
2003-04	MAA Undergraduate Mathematics Conference Grant \$2,000
2014-2017	Rose Summer Undergraduate Research Program - grant administrator, \$60,000

5.3 Website and Program Notes and for Tilings Program

1. *Tilings Website* <https://tilings.org/>.
2. *Symmetries of Riemann surfaces and kaleidoscopic tilings*: notes for presentation at RHIT Tilings REU (on tilings website).
3. *Kaleidoscopic tilings of Riemann surfaces*: problems for the RHIT Tilings REU (on tilings website).

5.4 Published Papers and Technical Reports (joint with students)

1. *Divisible tilings of the hyperbolic plane*, with D.M. Haney, L. McKeough and B. Smith, *New York Journal of Mathematics*, **6** (2000), 237-283
2. *Triangular Surface Tiling Groups for Low Genus*: with Robert M. Dirks, Maria T. Slougher, and C. Ryan Vinroot, RHIT Mathematical Sciences Technical Report 01-01.

5.5 Works in Progress (joint with students)

1. *Lengths of geodesics on Klein's quartic curve*, with Ryan Derby-Talbot and Kevin Woods

5.6 Presentations and Conferences attended

1. *Tilings, finite groups, and hyperbolic geometry at the Rose-Hulman REU*, MAA Fall meeting, Wabash College, October 1997, contributed lecture.
2. *Undergraduate research at the Rose-Hulman REU - what works for us*, AMS Annual Meeting, Baltimore, January 1998.
3. *Tilings, finite groups, and hyperbolic geometry at the Rose-Hulman REU*, Cleveland Topology Seminar, April 1998, invited talk.
4. *Tilings, finite groups, and hyperbolic geometry at the Rose-Hulman REU*, Kanazawa Institute of Technology, July 1999, invited presentation.
5. *The Rose-Hulman NSF-REU Program*, Working Conference on Undergraduate Mathematics Research, Washington D.C., September 1999, conference proceedings submission, participant at conference.
6. *Fostering Undergraduate Research in Mathematics*, Showcase - Best Assessment Practices VII, Rose-Hulman, April 2005, contributed presentation.

5.7 Student Research Projects Directed

All technical reports may be found here. https://scholar.rose-hulman.edu/math_mstr/

1. *Oval intersections on Riemann surfaces*, Dennis Schmidt, RHIT Mathematical Sciences Technical Report 97-03.
2. *Quadrilaterals subdivided by triangles in the hyperbolic plane*, Lori McKeough and Dawn Haney, RHIT Mathematical Sciences Technical Report 98-04.
3. *Symmetry and tiling groups in genus 4 and 5*, Ryan Vinroot, RHIT Mathematical Sciences Technical Report 98-02.
4. *Tilings and cwatsets*, Patrick Swickard and Reva Schweitzer.
5. *Symmetries which split at a mirror*, Jim Belk, RHIT Mathematical Sciences Technical Report 99-01.
6. *Quest for tilings on Riemann surfaces of genus six and seven*, Robert Dirks and Maria Slougher, RHIT Mathematical Sciences Technical Report 00-08.

7. *Lengths of geodesics on Klein's quartic curve*, Ryan Derby-Talbot, RHIT Mathematical Sciences Technical Report 00-03.
8. *Triangle tilings of quadrilaterals on the hyperbolic plane*, Brandy Smith.
9. *Separability of Tilings*, Nick Baeth, Jason Deblois, Lisa Powell, RHIT Mathematical Sciences Technical Report 00-10.
10. *Lengths of Systoles on Tileable Hyperbolic Surfaces*, Kevin Woods, RHIT Mathematical Sciences Technical Report 00-09.
11. *Oval Lengths in Tilings on Surfaces*, Shaun McCance and Sarah Weisman.
12. *Hyperbolic Billiard Paths*, Rebecca Lehman and Chad White, RHIT Mathematical Sciences Technical Report 02-02.
13. *Applications of Graph Theory to Separability*, Stephen Young, RHIT Mathematical Sciences Technical Report 02-09.
14. *Pigeon-Holing Monodromy Groups*, Niles Johnson, work in progress 02-07.
15. *Finding the Fundamental Domain of a Tiling of an n -genus Surface*, Yvonne Lai.
16. *Hecke Algebras of Low Genus Surfaces*, Matt Ong, RHIT Mathematical Sciences Technical Report 02-08.
17. *Tilings of Low-Genus Surfaces by Quadrilaterals*, John Gregoire and Isabel Averill, RHIT Mathematical Sciences Technical Report 02-13.
18. *Description of the Limiting Surfaces of Hyperbolic Surfaces Tiled by Quadrilaterals*, Michael A. Burr and Kathryn M. Zuhr.
19. *Constructing the Moduli Space of Riemann Surfaces with a G $-(k,l,m,n)$ Action*: Kathryn M. Zuhr.
20. *When Abelian Groups Split*: Robert C. Rhoades and Rachel L. Thomas RHIT Mathematical Sciences Technical Report 03-1.
21. *Divisible Tilings of Surfaces*: Aimee Kalas and Jason Saccomano.