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### Ph.D. Dissertation

*Loop Spaces and Higher-Dimensional Iterated Enrichment*, Virginia Tech, May 2004.  
Directed by Frank Quinn.

### Academic Appointments

- Associate Professor, University of Akron, 2014-current.
- Assistant Professor, University of Akron, 2010-2014.
- Assistant Professor, Tennessee State University, 2005-2010.
- Graduate Research Assistant, Virginia Tech, 2000-2004.
- Graduate Teaching Assistant, Virginia Tech, 1997-2002.

### Nonacademic Employment

- Framatome Technologies (Areva), Virginia, Jan. 1996 - Aug. 1997, Summer and Fall 1998.

### Education

- Ph.D. in Mathematics, from Virginia Tech  
Center for Statistical Mechanics and Mathematical Physics, May 2004.
- M.S. in Mathematics from Virginia Tech, December 2002.
- B.S. in Mathematics with Computer Science concentration, summa cum laude  
from Liberty University, May 1997.

### Grants Won

- Combinatorial Geometry of Phylogenetic Trees  
Faculty Research Committee Summer Fellowship, 2016
- *Algebraic Combinatorics and Convex Geometry*  
NSA-AMS Mathematical Sciences Program Young Researcher Grant, 2014-2015.
- *The geometry of organic chemistry: Student research opportunities*  
Faculty Research Award, Tennessee State University, Summer 2008.

### Research Interests

- Algebraic and geometric combinatorics, phylogenetics:  
Species and convex polytope sequences such as the permutohedra, associahedra  
and multiplihedra; their quotients and generalizations, and their Hopf algebras.  
Polytopes from phylogenetic trees and networks, applications to linear programming.
- Categorical homotopy theory and operad theory:  
Braided and iterated monoidal categories, enriched categories and  $n$ -categories;  
Loop spaces and  $A_n$ -spaces.
- Low dimensional topology:  
Braid groups, knot concordance, and topological quantum field theory.

### Research Publications

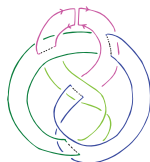
23. Split Network Polytopes and Network Spaces. (with S. Devadoss, C. Durell)  
to appear: *SLC Proceedings* 82B, FPSAC 31, 2019.

## Research Publications, cont.

22. Species substitution, graph suspension, and graded Hopf algebras of painted tree polytopes. (with L. Berry, M. Ronco, P. Showers)  
*Algebraic and Geometric Topology*, 19 (2), pp 1019-1078, 2019.
21. Optimization problems in phylogenetics: Polytopes, programming and interpretation. (with G. Hamerlinck, W. Sands)  
*Algebraic and Combinatorial Computational Biology*  
eds. R. Robeva, M. Macauley, pp 319-350, 2018.
20. Split-facets for Balanced Minimal Evolution Polytopes and the Permutoassociahedron. (with L. Keefe, W. Sands)  
*Bulletin of Mathematical Biology*, 79(5), pp 975-994, 2017.
19. Facets of the Balanced Minimal Evolution Polytope. (with L. Keefe, W. Sands)  
*Journal of Mathematical Biology*, 73(2), pp 447-468, 2016.
18. Stochastic safety radius on Neighbor-Joining method and Balanced Minimal Evolution on small trees (with J. Xi, J. Xie, and R. Yoshida).  
emphProceedings of the 10th Workshop on Uncertainty Processing., pp 217-230, 2015.
17. Convex Polytopes from Nested Posets. (with S. L. Devadoss, S. Reisdorf, P. Showers)  
*European Journal of Combinatorics* 43, pp 229248, 2015.
16. Recursive bijections for Catalan objects. (with M. Kafashan, M. Maleki and M. Strayer)  
*Journal of Integer Sequences*, 16, Article 13.5.3, pp 1-20, 2013.
15. Cofree compositions of coalgebras. (with A. Lauve, F. Sottile)  
*Annals of Combinatorics*, 17(1), pp 105-130, 2013.
14. When does compromise prevent more pollution?  
(with C. Clemons, J. Cossey, M. Ferrara, T. Norfolk, G. Obeng, D. Ricciardi, G. Young)  
*Notices of the A.M.S.*, 59(9), 1223-1234, 2012.
13. Extending the Tamari lattice to some compositions of species. *Associahedra, Tamari Lattices and Related Structures: Tamari Memorial Festschrift*.  
Progress in Mathematics, Vol. 299, pp 187-210,  
F. Müller-Hoissen, J. Pallo, J. Marcel, J. Stasheff (Eds.), 2012.
12. Pseudograph associahedra. (with M. Carr, S. Devadoss)  
*Journal of Combinatorial Theory, Series A*, 118(7), 2035-2055, 2011.
11. Cofree compositions of coalgebras (extended abstract). (with A. Lauve, F. Sottile)  
*DMTCS Proceedings, FPSAC 23 (Reykjavik, Iceland)*, 363-374, June 2011.
10. Hopf structures on the multiplihedra. (with A. Lauve, F. Sottile)  
*SIAM Journal on Discrete Mathematics*, 24(4) 1250-1271, 2010.
9. Geometric combinatorial algebras: cyclohedron and simplex. (with D. Springfield)  
*Journal of Algebraic Combinatorics*, 32 597-627, 2010.
8. New Hopf structures on binary trees. (with A. Lauve & F. Sottile)  
*DMTCS Proceedings, FPSAC 21 (Hagenberg, Austria)*, 411-420, 2009.
7. Marked tubes and the graph multiplihedron. (with S.L. Devadoss)  
*Algebraic and Geometric Topology*, 8(4) 2081-2108, 2008.
6. Quotients of the multiplihedron as categorified associahedra.  
*Homotopy, Homology and Applications*, vol. 10(2), 227-256, 2008.
5. Convex Hull Realizations of the Multiplihedra  
*Topology and its Applications*, 156, 326-347, 2008.
4. Operads in iterated monoidal categories (with J. Siehler, E. Seth Sowers)  
*Journal of Homotopy and Related Structures* 2, 1-43, 2007.
3. Classification of braids which give rise to interchange (with F. Humes)  
*Algebraic and Geometric Topology* 7, 1233-1274, 2007.
2. Enrichment over iterated monoidal categories  
*Algebraic and Geometric Topology* 4, 95-119, 2004.
1. Vertically iterated classical enrichment  
*Theory and Applications of Categories* 12, 299-325, 2004.

## Invited Presentations

20. *Clades and tubes: facets of graph associahedra and phylogenetic polytopes.*  
Geometry and combinatorics of associativity, Hamilton Mathematics Institute, Dublin 2017.
19. *Recursive Linear Programming on the Balanced Minimal Evolution Polytope.*  
Polyhedral and Combinatorial Biology,  
SIAM conference on Applied Algebraic Geometry, Atlanta 2017.
18. *Faces of Balanced Minimal Evolution Polytopes from Quotients of the Permutoassociahedron.*  
Geometric Phylogenetics, SIAM Conference on the Life Sciences, Boston 2016.
17. *Poset polytopes and some conjectured tree polytopes.*  
Enumerative Algebraic and Geometric Combinatorics,(AMS) Loyola Oct. 2015.
16. *Facets of the BME polytope.*  
The Mathematics of Evolution, Loyola Oct. 2015.
15. *Seeing in 4 dimensions.* Akron Physics Club Mar. 2014
14. *Pattern.* 1st Annual Greater Akron High School Mathematics Challenge, 2013.
13. *Tubings and polytope truncations.*  
Coxeter Groups meet Convex Geometry: Workshop at LACIM, Montreal, 2012.
12. *Composing species and composing coalgebras.*  
AMS Eastern Sectional, Species and Hopf Algebraic Combinatorics, Cornell, Sept. 2011
11. *Polytopes, phylogenetics, puddles and fractals.* REU at Kent State University,  
Applications and Ramifications of Linear Algebra, 2011.
10. *Indelible grafting: Trees and polytopes.*  
AMS Spring Eastern Sectional Meeting Worcester, April 2011.  
Special Session on Physically Inspired Higher Homotopy Algebra .
9. *Composing and covering of coalgebras..*  
SIAM conference on Discrete Math, Austin, 2010.
8. *Positrons, polytopes and antipodes.*  
AMS Spring Southeastern Section Meeting Raleigh, April 2009.  
Special Session on Homotopical Algebra with Applications to Mathematical Physics.
7. *Positrons, polytopes and antipodes.*  
Texas A&M Algebra and Combinatorics Seminar, September 2008.
6. *How to draw a multiplihedron.*  
Williams College mathematics colloquium, March 2008.
5. *Operads in iterated monoidal categories, featuring Young diagrams.*  
University of Pennsylvania Deformation Theory Seminar, September 2006.
4. *Higher categories and geometric combinatorics of free groups.*  
Topology and Group Theory Seminar Vanderbilt University, September 2005.
3. *n-fold operads in iterated monoidal categories.*  
Categories in algebra, geometry, and mathematical physics,  
Macquarie University, July 2005.
2. *Varieties of Iterated Enrichment.*  
n-categories: Foundations and Applications, IMA, Minneapolis, June 2004.
1. *Knot Cobordism Categories.*  
Virginia Tech graduate issues seminar, Nov. 2003.



## Teaching Experience

### Graduate Teaching: courses

- Advanced Combinatorics and Graph Theory.
- Topology I, point-set topology.
- Topology II, Algebraic topology.
- Structured Categories. (individual)
- Advanced Linear Algebra.
- The Associahedron: topology, combinatorics, and applications. (individual)

### Undergraduate Teaching: courses

- Ordinary Differential Equations.
- Fundamentals of Advanced Mathematics.
- Combinatorics and Graph Theory.
- Calculus I, III, and Vector Geometry.
- Linear Algebra, with Mathematica.

## Selected Contributed Presentations

- (refereed) *Compositions of cofree coalgebras: Trees and polytopes.*  
FPSAC (Formal Power Series and Algebraic Combinatorics), Reykjavik 2011.
- *Pattern MA $\Theta$*  Math Honor society  
induction ceremony guest speaker, St. Vincent St. Mary HS, Feb. 2011.
- *2-fold operads, Young diagrams, and dendritic growth.*  
University Research Symposium, Tennessee State University, April 2008.
- *Multiplihedra: polytopes, pasting, and parameterized enrichment.*  
AMS Fall Southeastern Meeting Murfreesboro, November 2007.
- *Convex hull realizations of the multiplihedra.*  
AMS Fall Central Section Meeting, Chicago, October 2007.
- (refereed) *N-fold operads: braids, Young diagrams, and dendritic growth.*  
Seminar on Categories and Applications IV,  
Universitat Autònoma de Barcelona, June 2007.
- *What is an operad and how does it act? Algebras, modules, and the multiplihedra.*  
National Assoc. of Math. Faculty conference, Tennessee State University, March 2007.
- (refereed) *A categorification of the associahedra.*  
International Category Theory Conference CT06, Nova Scotia, June 2006.
- *Finite type invariants, grope cobordisms, and grope constraints*  
AMS Special Session on Knot Theory and Its Applications, Bowling Green, March 2005.
- *Combinatoric n-fold monoidal categories from ordered semigroups*  
AMS Special Session on Semigroup Theory, Vanderbilt, Nashville, October 2004.
- *Loop spaces, enrichment, and n-categories*  
Union College Mathematics Conference, Schenectady, Nov. 2003.
- *Enrichment and Delooping of Categories with Loop Space Nerves*  
Workshop on Categorification and Higher-Order Geometry,  
Instituto Superior Técnico, Lisbon, July 2003.
- *Braids and Enrichment*  
Lehigh University Geometry and Topology Conference, June 2003.

## Selected Seminar Talks

- *Split-facets of the balanced minimal evolution polytope.*  
one lecture: U. Akron Algebra seminar, April 2016.
- *Can symmetries help solve genetic mysteries?*  
two lectures: U. Akron Algebra seminar, November 2015.
- *Routes, schedules, and genetic histories: using polytopes to find optimal solutions.*  
three lectures: U. Akron Algebra seminar, October 2014.
- *Determinants and truth values.*  
two lectures: U. Akron Algebra seminar, September 2013.
- *Tubes and Trees: When is a poset a polytope?*  
two lectures: U. Akron Algebra seminar, March 2013.
- *Addition and multiplication of Young diagrams.*  
two lectures: U. Akron Algebra seminar, 2011.
- *Introduction to the Hopf algebra of permutations.*  
two lectures: U. Akron Algebra seminar, 2010.
- *Shapes and Lattices.*  
Tennessee State U. student/faculty research seminar, October 2009.
- *Positrons, polytopes, and antipodes*  
Tennessee State U. student/faculty research seminar, September 2008.
- *What is an operad, and how does it describe a loop space of knots?*  
Tennessee State U. student/faculty research seminar, January 2007.
- *A short introduction to Geometric Combinatorics.*  
Tennessee State U. student/faculty research seminar, October 2005.
- *Twisted Ribbons and Categorical Consequences of the Yang-Baxter Equation*  
Virginia Tech graduate research seminar, Sep. 2003.
- *Introduction to Topological Quantum Field Theory*  
VT graduate research seminar, March 2002.
- *Train Tracks and Projective Laminations*  
two lectures for VT graduate research seminar, March 2002.

## Selected Refereeing

- Referee for *Discrete Optimization*, 2019.
- Referee for *Computers and Operations Research*, 2018.
- Referee for *Journal of Combinatorial Theory, Series A*, 2013, 2016.
- Referee for *Selecta Mathematica*, 2012.
- Referee for *SIAM Journal on Discrete Mathematics*, 2011.
- Referee for *Mathematical Structures in Computer Science*, 2010.
- Grant proposal review for *Fonds quebécois de la recherche sur la nature et les technologies*, 2010.
- Referee for *Journal of Homotopy and Related Structures*, 2008.
- Referee for *Theory and Applications of Categories*, 2007.

## Activities

- Co-Organizer of Special Session on Graphs and Polytopes in Algebraic Combinatorics, Fall Central Sectional AMS Meeting October 20-21, 2012.
- Organizer of Physics and Mathematics Faculty Research Seminar, Tennessee State University, 2005-2010.
- Founder and organizer of Mathematics Graduate Student Research Seminar, Virginia Tech, 2003-2004.
- “Teaching to Promote Students Intellectual Development”  
workshop by Marcia Baxter Magolda  
VT Center for Excellence in Undergraduate Teaching, May 2001.

### Advising: Thesis and Undergraduate Research

25. Cassandra Durell, MS, U. Akron  
*Facets of a Balanced Minimum Evolution Network Polytope*, 2019.
24. William Sands, MS, U. Akron  
*Phylogenetic Inference Using a Discrete-Integer Linear Programming Model*, 2017.
23. Logan Keefe, MS, U. Akron  
*New Facets of the Balanced Minimal Evolution Polytope*, 2016.
22. Matthew Hughes, MS, U. Akron  
*Price Signaling in a Two-Market Duopoly*, 2016.
21. Joseph Johnson, MS, U. Akron  
*Modeling Monitoring of An Industry In A Game-Theoretic Framework With Imperfect Information*, 2015.
20. Anthony Zunis, MS, U. Akron  
*A Game Theoretic Analysis and Simulation of Non-Incumbent Elections*, 2014.
19. Patrick Showers, Master's Thesis, U. Akron  
*Abstract Polytopes from Nested Posets*, 2013.
18. Lisa Berry, Master's Thesis, U. Akron  
*Painted trees and pterahedra*, 2013.
17. Dan Crawford, Master's Thesis, U. Akron  
*Minimizing pollution through semi-antagonistic equilibrium points*, 2013.
16. Bethany Baranyk, Master's Thesis, U. Akron  
*A Model for choosing a four-year university or a two-year community college with the presence of a government subsidy*, 2012.
15. Stephen Reisdorf, Master's Thesis, U. Akron  
*Cellohedra*, 2012.
14. George Obeng, Master's Thesis, U. Akron  
*A game theoretical model for prevention of meat contamination*, 2011.
13. Michael Knap, Research Symposium Graduate Presentation 1<sup>st</sup> place winner, TSU  
*Simple statistical results of four network topologies in the discovery problem*, 2010.
12. Kelly Jerik, Senior project, TSU  
*Finding a polytope which models the connectedness of a CW-complex*, 2010.
11. Chris White, Senior project, TSU  
*An Analysis of the Programming for Chess Computers*, 2010.
10. Fon Hunter, Senior project, TSU  
*Graded Algebra based on Polytope Faces*, 2010.
9. Shaine Walker, Senior project, TSU  
*Associahedra: Polytopes and Lattices*, 2009.
8. Derriell Springfield, Master's Thesis, TSU  
*Algebras based upon the cyclohedron*, 2009.
7. K. Walker Kelly, Master's Thesis, TSU  
*Log Jams: Napier's logarithm and its morphs*, 2008.
6. Govina M. Eyum, Master's Thesis, TSU  
*Products of Young diagrams in a 2-fold monoidal category*, 2007.
5. E. Seth Sowers, Master's Thesis, TSU  
*Operads in 2-fold monoidal categories*, 2006.
4. Felita N.C. Humes, Master's Thesis, TSU  
*Iterated monoidal categories based on a braiding*, 2006.
3. Ahmad Kheder, Senior project, TSU  
*Investigating minimal recursive growth.*, 2007.
2. Lauren Murphy, Senior project, TSU  
*Seifert surfaces, knots and braids*, 2006.
1. Jerome Lecointre, Senior project, TSU  
*Polytope structure of the composihedra*, 2006.