Gabe Cunningham

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Education

2007–2012 **Ph.D., Mathematics**, *Northeastern University*, Boston, MA.
Thesis: *Internal and External Invariance of Abstract Polytopes*. Advisor: Egon Schulte

2001–2005 **B.S., Mathematics**, *Massachusetts Institute of Technology*, Cambridge, MA.

Research interests

Discrete geometry, combinatorics, combinatorial and finite group theory. I work in the area of abstract polytopes on extremal problems ("Find the smallest abstract polyhedron with p-gonal faces meeting q at each vertex"), classification problems ("Describe all 3-orbit skeletal polyhedra"), and properties of combinatorial and algebraic constructions applied to polytopes ("Determine the structure of the smallest regular 4-polytope that covers the pyramid over a polyhedron"). I am also co-developing a software package for the computer algebra system GAP that facilitates computations with abstract polytopes and related objects.

Software

RAMP: the Research Assistant for Maniplexes and Polytopes, a GAP package available at https://github.com/SupposeNot/RAMP

Publications

24. *Cayley extensions of maniplexes and polytopes* (with Elías Mochán and Antonio Montero), Journal of Combinatorial Theory, Series A, **212** (2025).
23. *Finite 3-orbit polyhedra in ordinary space, II* (with Daniel Pellicer), Boletín de la Sociedad Matemática Mexicana, **30**, 32 (2024).
22. *Chiral polytopes whose smallest regular cover is a polytope*, Journal of Combinatorial Theory, Series A, **204** (2024).
21. *Reflexible covers of prisms* (with Mark Mixer and Gordon Williams), Contributions to Discrete Mathematics, 19(3) (2024), 196–208.
20. *Finite 3-orbit polyhedra in ordinary space I* (with Daniel Pellicer), Discrete and Computational Geometry, **70** (2023), 1785–1819.
19. *Stratified operations on maniplexes* (with Daniel Pellicer and Gordon Williams), Algebraic Combinatorics, **5** (2022), no. 2, 267–287.
18. *Tight chiral polytopes* (with Daniel Pellicer), Journal of Algebraic Combinatorics, **54** (2021), 837–878.
17. *Flat extensions of abstract polytopes*, The Art of Discrete and Applied Mathematics, **4** (2021), #P3.06.
16. *Vertex-faithful regular polyhedra* (with Mark Mixer), Discrete Mathematics, **343** (2020), no. 10.

15. *Open problems on k-orbit polytopes* (with Daniel Pellicer), Discrete Mathematics, **341** (2018), no. 6, 1645–1661.
14. *Tight chiral polyhedra*, Combinatorica **38** (2018), no. 1, 115–142.
13. *Non-flat regular polytopes and restrictions on chiral polytopes*, The Electronic Journal of Combinatorics **24** (2017), no. 3, #P3.59 .
12. *Internal and external duality in abstract polytopes* (with Mark Mixer), Contributions to Discrete Mathematics **12** (2017), no. 2.
11. *Classification of tight regular polyhedra* (with Daniel Pellicer), Journal of Algebraic Combinatorics **43** (2016), no. 3, 665–691.
10. *Tight orientably-regular polytopes* (with Marston Conder), Ars Mathematica Contemporanea **8** (2015), 68–81.
9. *Symmetry type graphs of polytopes and maniplexes* (with María Del Río Francos, Isabel Hubard, and Micael Toledo), Annals of Combinatorics **19** (2015), 243–268.
8. *Chiral extensions of chiral polytopes* (with Daniel Pellicer), Discrete Mathematics **330** (2014), no. 1, 51–60.
7. *Minimal equivelar polytopes*, Ars Mathematica Contemporanea **7** (2014), no. 2, 299–315.
6. *Variance groups and the structure of mixed polytopes*, Rigidity and Symmetry, Fields Inst. Comm., **70**, Springer, New York (2014), 97–116.
5. *Constructing self-dual chiral polytopes*, European Journal of Combinatorics **33** (2012), no. 6, 1313–1323.
4. *Self-Dual, Self-Petrie Covers of Regular Polyhedra*, Symmetry **4** (2012), no. 1, 208–218.
3. *Mixing chiral polytopes*, Journal of Algebraic Combinatorics **36** (2012), no. 2, 263–277.
2. *Mixing regular convex polytopes*, Discrete Mathematics **312** (2012), no. 6, 763–771.
1. *Discovery of patterns in LZ-78 text discrimination* (with M. Malyutov), Computational Technologies in Electrical and Electronics Engineering (SIBIRCON), 2010 IEEE Region 8 International Conference on, pp. 28–33, 11-15 July 2010.

Talks and Workshops

May 2024 **Tight polytopes**, *Department seminar*, Beijing Jiaotong University, Beijing, China.

June 2023 **Chiral polytopes whose smallest regular cover is a polytope**, *10th Slovenian International Conference in Graph Theory*, Kranjska Gora, Slovenia.

November 2022 **Skeletal polyhedra in the plane**, *Seminar in Abstract Polytopes at Northeastern University*, Boston, Massachusetts.

October 2022 **How Many Regular Polyhedra Are There?**, *Research Conversations at Wentworth*, Boston, Massachusetts.

July 2022 **Navigating data on polytopes and maps**, *Symmetries in Graphs, Polytopes and Polytopes*, Fairbanks, Alaska, (Plenary Talk).

March 2022 **Finite 3-orbit polyhedra in ordinary space**, *AMS Special Session on Symmetries of Polytopes, Maps, and Graphs*, (virtual).

January 2021 **Finite 3-orbit skeletal polyhedra**, *Algebraic Graph Theory International Webinar*, (virtual), (Invited Talk).

June 2020 **The Role of Data in Discrete Mathematics**, *Seminar for Mathematical Data*, FAU Erlangen-Nurnberg (virtual), (Invited Talk).

August 2019 **Workshop on Data in Mathematics**, part of the OpenDreamKit Project, in Cernay-la-Ville, France. (Invited Participant). See https://opendreamkit.org/2019/08/17/WorkshopOnDataInMathematics/ .

July 2018 **Open problems on k-orbit polytopes**, *Symmetries in Graphs, Maps, and Polytopes*, Morelia, Mexico, (Invited Talk).

January 2018 **Small polyhedra with prescribed symmetry**, *Northeastern University Pick My Brain Seminar*, Boston, MA, (Invited Talk).

August 2017 **Non-flat regular polytopes and restrictions on chiral polytopes**, *Symmetries of Discrete Structures in Geometry, at Casa Matemática Oaxaca*, Oaxaca, Mexico, (Invited Talk).

July 2017 **The search for small polytopes**, *2da Escuela en Simetrías de Estructuras Combinatorias (2nd Course on Symmetries in Combinatorial Structures)*, Cuernavaca, Mexico, (Invited Minicourse).

November 2015 **Tight chiral polyhedra**, *AMS Special Session on Geometry and Combinatorics of Polytopes*, New Brunswick, NJ, (Invited Talk).

October 2014 **Convex Polytopes: Symmetry and Combinatorics**, *UMass Boston presentation to visiting students from Korea*, Boston, MA.

March 2014 **The search for tight polytopes**, *Northeastern University Discrete Geometry Seminar*, Boston, MA, (Invited Talk).

April 2013 **Orbit graphs and face-transitivity of k-orbit polytopes**, *AMS Special Session on Combinatorial Geometry of Polytopes*, Boston, MA, (Invited Talk).

November 2012 **Minimal equivelar polytopes**, *MIT Combinatorics Seminar*, Cambridge, MA, (Invited Talk).

November 2012 **Minimal equivelar polytopes**, *Northeastern University Seminar in Geometry, Algebra, Singularities, and Combinatorics*, Boston, MA, (Invited Talk).

May 2012 **Constructing abstract regular polytope with external symmetries**, *UMass Boston Mathematics Colloquium*, Boston, MA.

February 2012 **Abstract polyhedra with specified face-types**, *Graduate Student Seminar at Northeastern University*, Boston, MA.

January 2012 **Constructing abstract regular polytopes with external symmetries**, *WPI Mathematics Colloquium*, Worcester, MA.

January 2012 **Constructing self-dual and self-Petrie polyhedra**, *AMS Special Session on Combinatorial Geometry of Polytopes at the Joint Meetings of the AMS*, Boston, MA, (Invited Talk).

October 2011 **Constructing self-dual chiral polytopes**, *Workshop on Symmetry in Graphs, Maps and Polytopes at the Fields Institute*, Toronto, Canada, (Invited Talk).

May 2011 **Polytopes, mixing, and self-duality**, *Tapas Seminar at Northeastern University*, Boston, MA.

February 2011 **Classical polytope constructions applied to abstract polytopes**, *Graduate Student Seminar at Northeastern University*, Boston, MA.

May 2010 **Chiral polytopes**, *Tapas Seminar at Northeastern University*, Boston, MA.

Awards and Honors

September 2024 **Finalist for the President's Award for Distinguished Scholarship**, *Wentworth Institute of Technology*.

July 2024 - June 2026 ***Maniplexes*, Grant BI-US/24-26-025**, *Slovenian Research and Innovation Agency (ARIS)*.

Summer 2020 **STEM Educational Excellence Fellowship**, *University of Massachusetts Boston*.

Fall 2019 **The Active Learning Fellowship**, *University of Massachusetts Boston*.

October 2019 **Honorary member of the Golden Key International Honour Society**, *University of Massachusetts Boston*.

May 2019 **Face-to-Face Innovation Teaching Award**, *University of Massachusetts Boston*, University Conference on Teaching, Learning and Technology.

2007–2012 **University Excellence Fellowship**, *Northeastern University*.

Summer 2011 **Ling Ma Fellowship**, *Northeastern University*.

Teaching and Course Coordination

2022–Present **Associate Professor**, *Wentworth Institute of Technology*.

Classes taught:

- Calculus 2
- Discrete Mathematics
- Foundations of Applied Mathematics
- Probability and Statistics
- Transition to Advanced Mathematics
- Abstract Algebra

Course Coordinator for Discrete Mathematics in Fall 2023 and Fall 2024.

2021–2022 **Senior Lecturer**, *University of Massachusetts Boston*.

2012–2021 **Lecturer**, *University of Massachusetts Boston*.

Classes taught:

- Precalculus
- Calculus 1, including a large lecture of 150 students Spring 2019-2022
- Calculus 2
- Multivariable and Vector Calculus
- Linear Algebra.

Course Coordinator for Calculus 1 Spring 2017-2022 and several times before. Provided support and instructional resources to roughly 10 instructors each semester, including several new instructors.

2007–2012 **Graduate Instructor**, *Northeastern University*.

Classes taught:

- Interactive Mathematics
- Calculus 1 for Business and Economics
- Calculus 1 for Science and Engineering
- Calculus 2 for Science and Engineering
- Calculus 3 for Science and Engineering
- Differential Equations & Linear Algebra.

Service

Wentworth Institute of Technology

- Member of Applied Mathematics Curriculum Committee (Fall 2022 - Present)
- Member of Bylaws Committee (Fall 2022 - Present)
- Member of Applied Mathematics Hiring Committee (Fall 2022 - Spring 2023)

University of Massachusetts Boston

- Member of the Fall Planning Academic Subcommittee. (Spring 2021)
- Member of the ERTLC (Evaluation of Remote Teaching and Learning Committee) advisory group. (Fall 2020 - Spring 2021)
- Co-organizer of Spring 2017 Math Department Colloquium
- Invited 4 speakers to Math Department Colloquium (2017-2019)

Professional

- Member of the editorial board of Mathematics Magazine (January 2024 - Present)
- Co-organizer of March 2022 AMS Special Session on Symmetries of Polytopes, Maps, and Graphs.
- Co-organizer of April 2018 AMS Special Session on Polytopes and Discrete Geometry
- Co-editor of "Polytopes and Discrete Geometry" (Contemporary Mathematics volume)
- Referee for: Ars Mathematica Contemporanea, Combinatorica, Contributions to Algebra and Geometry, Discrete Mathematics, European Journal of Combinatorics, Innovations in Incidence Geometry, Journal of Algebra, and Journal of Algebraic Combinatorics
- 20 reviews written for AMS MathReviews