Maximilian E. Ororbia

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Brief

Research includes development of architectural, engineering, and construction (AEC) design, decision-making, and optimization processes and fabrication technologies for exploring, assessing, and generating design spaces for the smart built environment. I seek to form, mentor, and lead a highly motivated research group that will contribute to the development of approaches for sustainable and resilient infrastructure informed by modern and smart technologies, such as advanced manufacturing and artificial intelligence, as well as materials. My research goal is to enable the academic-industrial AEC community to explore new, vast and more complex design spaces, to seek out and realize creative and novel concepts, allowing designers to boldly go where no one has gone before.

Employment

University of Pennsylvania, Philadelphia, PA *2023-Present*
Postdoctoral Fellow at Polyhedral Structures Lab, Weitzman School of Design

Designing, constructing, and testing prefabricated concrete 3D-printed, carbon absorbing high-performance structures with consideration of sustainability, resiliency, and environmental impacts (`https://psl.design.upenn.edu/project/arpae/`).

Funded by U.S. Department of Energy (DOE), Advanced Research Projects Agency - Energy (ARPA-E), HESTIA Grant and U.S. National Science Foundation (NSF) Clean Energy Technology EAGER Grant

Education

Pennsylvania State University, University Park, PA *2017-2023*
Ph.D., Civil Engineering

Dissertation – "Discrete structural optimization as a sequential decision process solved using deep reinforcement learning"

Supported by Penn State College of Engineering's 2020 ROCKET Seed Grant and the U.S. NSF Resilient and Sustainable Building (RSB) Civil, Mechanical and Manufacturing Innovation (CMMI) Grant

Bucknell University, Lewisburg, PA *2013-2017*
B.S., Civil Engineering

Honors thesis – "Analysis of statically indeterminate trusses for progressive collapse using graphic statics and complexity metrics"

Publications and Conferences

2024

- **Maximilian E. Ororbia**, Hua Chai, Yefan Zhi, Jorge Huisa Chacon, Joseph R. Yost, Mathias Bernhard, Fahimeh Yavartanoo, Javier Tapia, Damon Bolhassani, Mylene Bernard, Leon Trousset, Karolina Pajak, Blaise Waligun, Paul Kassabian, and Masoud Akbarzadeh. "Experimental study of a funicular concrete beam prototype." *IASS Annual Symposium 2024: Redefining The Art Of Structural Design.* https://app.iass2024.org/files/IASS_2024_Paper_362.pdf

- **Maximilian E. Ororbia** and Gordon P. Warn. "Design synthesis of discrete structures considering topological and parametric actions solved with hierarchical-inspired deep reinforcement learning." *Journal of Mechanical Design*, 146 (9). https://doi.org/10.1115/1.4065488

- Masoud Akbarzadeh, Hua Chai, Yefan Zhi, **Maximilian E. Ororbia**, Teng Teng, Mathias Bernhard, Damon Bolhassani, Fahimeh Yavartanoo, Javier Tapia, Karolina Pajak, Mylene Bernard, Leon Trousset, Paul Kassabian, Blaise Waligun. "Design and fabrication of a 3D-printed, post-tensioned funicular concrete canopy with periodic anticlastic surfaces." *FABRICATE 2024.* https://www.uclpress.co.uk/collections/all/FABRICATE-.

- Hua Chai, **Maximilian E. Ororbia**, Ryan Welch, Billie Faircloth, Fahimeh Yacartanoo, Damon Bolhassani, and Masoud Akbarzadeh. "Design approach for a post-tensioned funicular concrete beam." *IASS Annual Symposium 2024: Redefining The Art Of Structural Design.* https://app.iass2024.org/files/IASS_2024_Paper_470.pdf

- Damon Bolhassani, Fahimeh Yavartanoo, Masoud Akbarzadeh, **Maximilian E. Ororbia**, Hua Chai, Yefan Zhi, Mylene Bernard, Leon Trousset, Karolina Pajak, Blaise Waligun, and Paul Kassabian. "The effect of post-tensioning on the behavior of small-scale 3D-printed concrete beams." *IASS Annual Symposium 2024: Redefining The Art Of Structural Design.* https://app.iass2024.org/files/IASS_2024_Paper_358.pdf

- Masoud Akbarzadeh, **Maximilian E. Ororbia**. "Broader Applications of Polyhedral Graphic Statics." Chapter in Polyhedral Graphical Statics: For Funicular Structural Form Finding. *Cambridge University Press.* (In Press)

- **Maximilian E. Ororbia** and Gordon P. Warn. "Discrete topology and sizing optimization solved with hierarchical-inspired deep reinforcement learning." *EMI/PMC24: Symposium on Topology optimization: From algorithmic developments to applications* (*Accepted talk*)

2023

- **Maximilian E. Ororbia**, Jaskanwal P. S. Chhabra, and Gordon P. Warn. "A Sequential Decision Framework to Support Tradespace Exploration of Multihazard Resilient and Sustainable Designs." Chapter in Resilient and Sustainable Designs, 121-175. *American Society of Civil Engineers.* https://ascelibrary.org/doi/10.1061/9780784485057.

- **Maximilian E. Ororbia** and Gordon P. Warn. "Design synthesis of structural systems as a Markov decision process solved with deep reinforcement learning." *Journal of Mechanical Design*, 1-19. https://doi.org/10.1115/1.4056693.

- **Maximilian E. Ororbia**. "Discrete structural optimization as a sequential decision process solved using deep reinforcement learning." Ph.D. Thesis. https://etda.libraries.psu.edu/catalog/23314meo9.

- **Maximilian E. Ororbia** and Gordon P. Warn. "Discrete topology optimization of structures through deep reinforcement learning." *EMI/PMC23: Symposium on Topology Optimization: from Algorithmic Developments to Applications.* (*Accepted talk*)

- **Maximilian E. Ororbia** and Gordon P. Warn. "Discrete optimization of structures through a sequential decision process: benchmarking and validation." *EMI/PMC23: Symposium on Probabilistic assessment, data-driven inference, and optimization for decision-making under uncertainty.* (*Accepted talk*)

2022

- **Maximilian E. Ororbia** and Gordon P. Warn. "Structural optimization as a Markov decision process and deep reinforcement learning framework." *EMI/PMC22: Symposium on Probabilistic Assessment, Inference, and Optimization Under Uncertainty.* (*Accepted talk*)

2021

- **Maximilian E. Ororbia** and Gordon P. Warn. "Design Synthesis through a Markov Decision Process and Reinforcement Learning Framework." *Journal of Computing and Information Science in Engineering*, 22:(2), 021002. American Society of Mechanical Engineers. https://doi.org/10.1115/1.4051598.

- **Maximilian E. Ororbia** and Gordon P. Warn. "Structural Design Synthesis through a Sequential Decision Process." *EMI/PMC21: Minisymposium on Advances in Artificial Intelligence for Stochastic Analysis, Control and Optimization of Structures and Infrastructure Systems.* (*Accepted talk*)

2020

- **Maximilian E. Ororbia** and Gordon P. Warn. "Structural Design Synthesis through a Sequential Decision Process." *International Design Engineering Technical Conferences and Computers and Information in Engineering Conference.* Vol. 83983. American Society of Mechanical Engineers. https://doi.org/10.1115/DETC2020-22647.

- **Maximilian E. Ororbia**, Jaskanwal P.S. Chhabra, Gordon P. Warn, Simon W. Miller, Michael A. Yukish, Tong Qiu. "Increasing the Discriminatory Power of Bounding Models using Problem Specific Knowledge When Viewing Design as a Sequential Decision Process." *Structural and Multidisciplinary Optimization:* 1-20. https://doi.org/10.1007/s00158-020-02528-0.

2019

- Vaclav Hasik, **Maximilian E. Ororbia**, Gordon P. Warn, and Melissa M. Bilec. "Whole Building Life Cycle Environmental Impacts and Costs: A Sensitivity Study of Design and Service Decisions." *Building and Environment 163: 106316.* https://doi.org/10.1016/j.buildenv.2019.106316.

2017

- **Maximilian E. Ororbia**. "Analysis of Statically Indeterminate Trusses for Progressive Collapse using Graphic Statics and Complexity Metrics." *Bucknell Digital Commons.* https://digitalcommons.bucknell.edu/honors_theses/412.

- Jeffrey Evans, **Maximilian E. Ororbia**, James Gutelius, Daniel Ruffing, Landon Barlow, Michael Malusis. "Soil-Bentonite slurry trench cutoff wall lateral deformations, consolidation, stress transfer and hyrdraulic conductivity." *Proceedings of the 2nd Symposium on Coupled Phenomena in Environmental Geotechnics (CPEG2), Leeds, UK.* https://www.geo-solutions.com/wp-content/uploads/2018/10/41_Soil_Bentonite_Slurry_Trench_Cutoff_Lateral_Deformations.pdf.

Scholarship

Alfred P. Sloan Foundation's Minority Ph.D. Fellowship *2018-2023*
SLOAN 2018-2019 match scholar cohort

Academic Experience

Research Experience

University of Pennsylvania

Postdoctoral Research Fellow *2023-Present*
Serve as project manager, working with a multi-disciplinary academic and industry team, to ensure milestones specified in DOE ARPA-E HESTIA Grant are achieved and properly communicated. Also serve as lead on structural design, printing, construction, and testing for prefabricated, modular post-tensioned funicular structures made from a carbon-absorbing mix with the overall consideration of performance, materials, recycling, and reuse.

Pennsylvania State University, University Park

Research Graduate Assistantship *2018-2023*
Doctoral researcher under Dr. Gordon P. Warn.

Summer Research Position *2017*
Research assistant for Dr. Gordon P. Warn and Dr. Aleksandra Radlinska, worked on PennDOT bridge design project.

Bucknell University

Research Position *2016-2017*
Research assistant for Dr. Stephen Buonopane, worked on a project analyzing statically indeterminate truss structures for progressive collapse utilizing graphical methods and complexity parameters.

Research Position *2015-2017*
Research assistant for Dr. Jeffrey Evans, assisted in the design, construction, and monitoring of a soil-bentonite slurry trench cutoff wall.

Teaching Experience

Pennsylvania State University, University Park

CE 341 (Design of Concrete Structures) *2023*
Teaching assistant: Held office hours and worked with Dr. Gordon Warn to design course assignments and exams.

CE 340 (Structural Analysis) *2022*
Teaching assistant: Held office hours, provided software training, and worked with Dr. Kostas Papakonstantinou to design course assignments and exams.

CE 337 (Civil Engineering Materials Laboratory) *2017*
Lecturer and teaching assistant for laboratory course investigating material physical and mechanical properties.

Bucknell University

ENGR 100 (Engineering Design Experience) *2014-2015*
Teaching assistant: Aided Dr. James Orbison with student activities related to engineering design projects.

Mentorship

University of Pennsylvania
Polyhedral Structures Lab *2023-Present*
Advising and managing a team of graduate students, research assistants, and industry collaborators on a variety of topics and tasks, including 3D concrete printing, post-tensioning, and structural testing laboratory procedures and safety protocols, computational and experimental methods, conference and journal paper writing, and general graduate career advice.

Alfred P. Sloan Foundation
Sloan Scholar Mentor *2021-2024*
Mentored a graduate student in Civil and Environmental Engineering at the University of South Florida, as part of the Sloan Scholar Engagement pilot program on the SloanConnect platform. They graduated in Spring 2024 and will begin a postdoctoral fellowship with the U.S. Forestry Service at the Ohio State University.

Pennsylvania State University, University Park
NSF Research Experiences for Undergraduates (REU) Assistant Mentor *2018*
Assisted in mentoring an undergraduate student in Civil and Environmental Engineering that participated in the Research Experiences for Undergraduate (REU) Program. Project focused on studying behavior of deep pile foundations applied to the design of a seismic force resisting structural-foundation system.

Professional Activities and Service

Greenbuild International Conference + Expo
Exhibitor *2024*
Developing and hosting a booth at the conference showcasing the recent achievements in the 3D-printed concrete carbon absorbing floor system developed through the DOE ARPA-E funded work. This work fits well with this year's theme of 'Built to Scale' reflecting both the revolutionary achievements of building sector in transforming the built world, as well as the transformative opportunities ahead.

Sustainable Engineering (SUSE) Seminar at Villanova University
Invited Speaker *2024*
Presented on research titled "3D-Printed Carbon-Absorbing Concrete Funicular Structures" showcasing how modern technologies can be used for a more sustainable practice where high-performing structural systems can be produced and material recyclability can be achieved, reducing the carbon emitted and embodied energy consumption.

Sloan Scholars Mentoring Network Academic Job Market Boot Camp
Selected Participant *2024*
Accepted to participate in the academic job market and new faculty boot camp. The Sloan Scholars Mentoring Network will host a series of technical workshops about entering academia as faculty as well as developing grant proposals.

Villanova University's NovaEdge Diversity in Engineering Program
Invited Lecturer *2024*
Lectured participants from underrepresented high school groups about contextualizing global problems within engineering design and optimization thinking frameworks and creating decision matrices (in Excel) to assess design alternatives. Also introduced concepts of sustainability, STEEP analysis framework, and broader impacts within a life cycle stage framework in which the students evaluated their project through product, construction, use, and end of life stages.

Advanced Research Projects Agency - Energy, Energy Innovation Summit
Representative *2024*
Showcased work associated with the DOE ARPA-E carbon absorbing building structure by hosting a booth. The summit brought together experts from government, academia, and industry to collaborate and advance cutting-edge energy technologies, aiming to move transformational energy technologies out of the lab and into the market.

Georgia Tech Research Institute (GTRI) Focus Fellows Program
Selected Participant *2024*
Participated in Georgia Institute of Technology (Georgia Tech) Focus Fellows Program. Attended sessions about pursuing a career in academia, networking, grant funding opportunities, and developing application packages.

RIT Future Faculty Career Exploration Program (FFCEP)
Selected Participant *2021*
Accepted into the 18th cohort of the Rochester Institute of Technology's (RIT) Future Faculty Career Exploration Program. Virtually participated in a three-day program consisting of workshops, panel discussions, and networking events focused on career development as a teaching and research faculty member.

Structural Engineering Institute (SEI) Graduate Student Chapter
Chapter President – https://sites.psu.edu/seigsc/ *2018-2023*
Served as Penn State's SEI chapter president, organized guest lectures, construction site visits, and hosted educational webinars to further SEI's mission to advance and serve the structural engineering profession.

CSATS i-STEAM Workshop: 'It's a Matter of Truss: Designing Structures'
Co-lecture & Co-organizer *2018*
Worked with Dr. Gordon Warn and Dr. Matthew Johnson from the Center for Science and the Schools (CSATS) to organize and host a K-12 educational workshop to introduce alternative teaching approaches to structural engineering.

Fundamentals of Engineering (FE) Examination
Engineer in Training (E.I.T.) Certification *2017*
Passed the FE exam and received the Commonwealth of Pennsylvania EIT Certification.

Bucknell Bridge Day Outreach Program
Engineer and Educational Assistant *2017*
Taught elementary school students about civil engineering through various hands-on design activities.

Affiliations

- PSU Structural Engineering Institute (SEI) Graduate Student Chapter, President (2018-2023)
- The Institute of Structural Engineers (ISE) at Penn State, Student Liaison Officer (2018-2023)
- American Society of Civil Engineering (ASCE), Graduate Student Member (2017-2023)
- American Society of Mechanical Engineering (ASME), Graduate Student Member (2020-2023)
- Earthquake Engineering Research Institute (EERI), Graduate Student Member (2018)
- National Action Council for Minorities in Engineering (NACME), Student Member (2016-2024)
- Bucknell Engineering Alumni Association (BEAA), Student Board Member (2015-2017)
- Society of Hispanic Professional Engineers (SHPE), Student Representative (2014-2017)
- Alpha Lambda Delta Honor Society (ALD), Student Member (2013)