

STEVEN R. WOODRUFF, PH.D.

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EDUCATION

Ph.D., Civil Engineering, the University of Michigan	2022
Graduate certificate in Science, Technology, and Public Policy	
M.S., Civil Engineering, the University of Michigan	2019
B.S., Civil Engineering, Tufts University	2017
Study abroad, the University of Hong Kong	

PROFESSIONAL APPOINTMENTS

Assistant professor	Aug. 2023 – Present
<i>James Madison University – Department of Engineering</i>	
Visiting assistant professor	Jul. 2022 – Jun. 2023
<i>Washington and Lee University – Department of Physics and Engineering</i>	
Graduate student research assistant	Jun. 2017 – Jun. 2022
<i>The University of Michigan – Department of Civil and Environmental Engineering</i>	
Adjunct faculty	Jan. 2022 – May 2022
<i>James Madison University – Department of Engineering</i>	
Graduate student instructor	Jan. 2021 – May 2021
<i>The University of Michigan – Department of Civil and Environmental Engineering</i>	

SELECTED AWARDS AND HONORS

Graduate research fellowship program (GRFP) fellow	2018 – 2022
National Science Foundation (NSF)	
Honored Instructor Award	2021
The University of Michigan	
AISC/GLFEA scholarship	2017
American Institute of Steel Construction and Great Lakes Fabricators and Erectors Association	
SEAMASS scholarship	2017
Structural Engineering Association of Massachusetts	
Max O. Urbahn scholarship	2016
Society of American Military Engineers, New York City Post	

INSTRUCTIONAL EXPERIENCE

Statics and dynamics (ENGR 212)

Spring 2024

James Madison University

- Instructor of record
- Taught rigid-body statics and dynamics for applications in engineering
- Reinforced lessons with hands-on laboratory experiments conducted by the students

Fluid mechanics (ENGR 311)

Fall 2023

James Madison University

- Instructor of record
- Introduced students to introductory fluid mechanics with an emphasis on civil and mechanical applications
- Reinforced lessons with hands-on laboratory experiments conducted by the students

Introduction to engineering design (ENGN 250)

Spring 2023

Washington and Lee University

- Instructor of record
- Project-based course on design processes
- Advised students on origami-inspired acoustic panel design, analysis, and prototyping

Capstone design (ENGN 379)

Winter 2023

Washington and Lee University

- Instructor of record
- Continuation of ENGN 378
- Advised students as they completed prototyping and presentation of capstone projects

Mathematical methods for physics & engineering (ENGN/PHYS 225)

Winter 2023

Washington and Lee University

- Instructor of record
- Taught mathematical concepts with applications in engineering and physics
- Flipped-classroom model with high-level- Bloom's-taxonomy, project-based assignments
- Emphasis on using Python for numerical, symbolic, and graphical solution verification

Capstone design (ENGN 378)

Fall 2022

Washington and Lee University

- Instructor of record
- Advised students in self-directed capstone projects for local non-profits
- Heavily emphasized effective community outreach into curriculum
- Instructed students on project management, design planning, and technical communication

Introduction to engineering (ENGN 178)

Fall 2022

Washington and Lee University

- Instructor of record
- Introduced students to engineering fields, design processes, ethics, policy, and skills
- Implemented a flipped-classroom model to teach coding (MATLAB) and CAD (Inventor)
- Designed and implemented individual and group term projects to demonstrate learned skills
- Emphasized critical thinking, societal impact, technical communication, and continued learning
- Supervised an undergraduate teaching assistant

Engineering decisions (ENGR 112)

Spring 2022 & 2024

James Madison University

- Instructor of record
- Conducted in-person lectures and hands-on class activities
- Designed and implemented projects involving CAD (SolidWorks) and data analysis (MATLAB)
- Collaborated with a teaching team and supervised an undergraduate student instructor
- Incorporated community impact of engineering and critical thinking into the curriculum

Computational methods (CEE 303)

Winter 2021

The University of Michigan

- Graduate student instructor (GSI) supervised by Professor Ann Jeffers
- Designed, implemented, and graded weekly labs
- Created videos, codes, and Jupyter Notebook files to aid student learning
- Hosted office hours and discussion pages to help students with the labs and course material
- Labs focused on applications of numerical methods in civil and environmental engineering
- Recipient of Honored Instructor Award for having made a significant impact on students

RESEARCH MENTORING EXPERIENCE

Hardik Patil (graduate)

Jan. 2021 – Aug. 2022

Deployable, rapid-assembly ship hulls using curved-crease origami

Guided Hardik in using bar and hinge models for curved-crease origami with advice on curved-crease origami design and analysis.

Jack Riley (undergraduate)

Jan. 2019 – Aug. 2019

Redistributing corrugation stiffness using curved creases

Aided Jack in the design of different parabolic origami corrugations, trained him on the use of a ULS laser cutting machine, and advised him on the use of a Mark-10 load-deformation testing apparatus.

Bolivar Perez (undergraduate)

Jun. 2018 – Aug. 2018

Large-scale origami prototype

Mentored Bolivar in choice of materials, fold connection design, and geometric design of a large-scale, curved-crease model.

Ella Yazbeck (undergraduate)

Jun. 2017 – Apr. 2018

Curved-crease origami arches

Advised Ella on the geometric design of curved-crease origami arch tubes and trained her on the use of a ULS laser cutting machine.

RESEARCH EXPERIENCE

Research interests:

- Promoting and improving relationships between engineers and communities
- Expanding engineering student awareness of social issues related to STEM
- Integrating non-expert knowledge with engineering design processes
- Simple and rapid modeling of dynamic and adaptive structures
- Exploration of novel and interdisciplinary applications of curved-crease origami
- Computational modeling of highly nonlinear solids and structures

Acoustic control using adaptive, curved-crease origami metamaterials **May 2023 – Present**

Visiting assistant professor, assistant professor

PI: Steven Woodruff

- Constructed, validated, and implemented a 2D acoustic waveguide to test origami samples
- Implemented acoustic simulations in ANSYS

Complex shape morphing in origami with simple actuation **Sep. 2020 – Present**

Graduate research assistant, NSF GRFP fellow, visiting assistant professor

PI: Evgueni Filipov (University of Michigan)

- Identified a unique property of curved-crease origami where local, simple actuations can result in global, complex deformations for use in dynamic deployment or shape morphing.
- Improved the bar and hinge model to accommodate local actuations with greater ability to measure torsional and bending deformations.

Deployable, rapid-assembly ship hulls using curved-crease origami **Jan. 2021 – Aug. 2022**

Graduate research assistant and NSF GRFP fellow

PI: Evgueni Filipov *Collaborators:* Zhongyuan Wo and Hardik Patil (University of Michigan)

- Collaborated with a team of origami engineers and the Office of Naval Research to design ship hulls that could be assembled on-site from flat sheets.
- Provided expertise on rapid modeling of curved-crease origami using the bar and hinge model for use alongside fluid-structure analysis in Ansys.

Bar and hinge modeling of curved-crease origami **Jun. 2018 – Aug. 2020**

Graduate research assistant and NSF GRFP fellow

PI: Evgueni Filipov

- Developed a rapid and accurate method of modeling the deformations of thin sheets folded about curved creases for both folding and post-fold loading.
- Calibrated the model stiffness to match theoretical and experimental solutions.
- Explored the stiffness response of curved-crease origami under highly nonlinear, post-fold loading to understand how folding increases global stiffness.

Redistributing corrugation stiffness using curved creases **Jan. 2019 – Jun. 2020**

Graduate research assistant and NSF GRFP fellow

PI: Evgueni Filipov *Collaborator:* Jack Riley (University of Michigan)

- Introduced novel, curved-crease origami designs that give isotropic bending stiffness in corrugated sheets without additional stiffeners or supports.
- Developed two second-moment-of-area-based methods for predicting the bending stiffness anisotropy using deformed shapes from the bar and hinge model.
- Performed load-deflection experiments on polyester sheet prototypes to assess stiffness anisotropy in bending to confirm the prediction methods.

Finite element analysis of curved-crease origami

Jun. 2017 – Apr. 2018

Graduate research assistant

PI: Evgueni Filipov

- Developed a method for modeling curved-crease origami folding and post-fold loading in Abaqus using shell elements for sheets and a connector scheme to model creases.
- Performed strain energy analysis to compare theoretical, geometry-based predictions for curved-crease origami deformations.
- Identified limitations to existing kinematic theories and unique behaviors of curved-crease origami after folding.

GRANT PROPOSAL WRITING EXPERIENCE

1. **JMU CISE Faculty Development Grant.** “Development of an origami-inspired metamaterial for active acoustic control.” \$3,200 (**funded**). Jan. 2024 - May 2024. PI: Steven Woodruff.
2. **Washington and Lee University Lenfest Grant.** “Characterization of curved folding using digital image correlation.” \$6,500 (**funded**), May 2023 - Jul. 2023. PI: Steven Woodruff.
3. **Washington and Lee University Spring Term Course Enhancement Funding.** “Origami-inspired, acoustic panel design course.” \$2,027 (**funded**), May 2023. PI: Steven Woodruff.
4. **Washington and Lee University Dean’s Office.** “Prototyping materials for capstone projects.” \$750 (**funded**), Jan. 2023 - Apr. 2023. PI: Steven Woodruff.
5. **Washington and Lee University Dean’s Office.** “Arduino board and environmental sensor kits for hands-on education.” \$750 (**funded**), Sep. 2022 - Dec. 2022. PI: Steven Woodruff.
6. **Office of Naval Research.** “Rapid assembly of continuous surfaces by adhesion of curved-crease origami.” \$120,000 (**funded**), Jan. 2021 - Dec. 2021. PI: Evgueni Filipov.
7. **National Science Foundation.** “A multi-physical framework for curved-crease deployable structures,” \$138,000 (**funded**), May 2018 - May 2023. PI: Evgueni Filipov.
8. **Office of Naval Research.** “Curved folded sheets for stiff, anisotropic, and adaptable structures,” \$322,181 (**funded**), Jan. 2018 - Dec. 2020. PI: Evgueni Filipov.

PUBLICATIONS

Peer-reviewed journal articles

1. Woodruff, S. R. & Filipov, E. T. (2022). Bending and twisting with a pinch: Shape morphing of creased sheets. *Extreme Mechanics Letters*, 52, 101656. <https://doi.org/10.1016/j.eml.2022.101656>.
2. Woodruff, S. R. & Filipov, E. T. (2020). Bar and hinge model formulation for structural analysis of curved-crease origami. *International Journal of Solids and Structures*, 204-205, 114-127. <https://doi.org/10.1016/j.ijsolstr.2020.08.010>
3. Woodruff, S. R. & Filipov, E. T. (2020). Curved creases redistribute global bending stiffness in corrugations: Theory and experimentation. *Meccanica*, 56(6), 1613-1634. <https://doi.org/10.1007/s11012-020-01200-7>

Peer-reviewed conference proceedings

1. Woodruff, S. R. & Filipov, E. T. (2018). Structural analysis of curved folded developables. *16th Biennial International Conference on Engineering, Science, Construction, and Operations in Challenging Environments*, 9780784481899, 793-803. <https://doi.org/10.1061/9780784481899.075>

PRESENTATIONS

Plenary presentations

1. Woodruff, S. R. & Filipov, E. T. (2018, April). *Structural analysis of curved folded developables* [Conference presentation]. ASCE International Conference on Engineering, Science, Construction, and Operations in Challenging Environments, Cleveland, OH, United States. ***Student paper award finalist.***

Symposium presentations

1. Woodruff, S. R. (2024, February). *The power of Excel in engineering* [Conference presentation]. 2024 KEEN National Conference, Austin, TX, United States.
2. Filipov, E. T., Woodruff, S. R. & Patil, H. (2022, August). *Functional shape-morphing origami* [Conference presentation]. 16th International Symposium on Functionally Graded Materials, Hartford, CT, United States.
3. Woodruff, S. R. & Filipov, E. T. (2022, May). *Shape-fitting origami with curved creases and pinches* [Conference presentation]. ASCE Engineering Mechanics Institute Conference, Baltimore, MD, United States.
4. Woodruff, S. R. & Filipov, E. T. (2021, March). *Torsion and bending of curved-crease origami: Linking crease pattern geometry to behavior* [Conference presentation]. ASCE Engineering Mechanics Institute International Conference (online).
5. Filipov, E. T. & Woodruff, S. R. (2020, October). *Curved creases enhance the bending rigidity of folded sheets* [Conference presentation]. Society of Engineering Science Conference (online).
6. Woodruff, S. R. & Filipov, E. T. (2020, April). *Curved creases redistribute global bending stiffness in corrugations* [Conference presentation]. ASCE Engineering Mechanics Institute International Conference (online).
7. Woodruff, S. R. & Filipov, E. T. (2019, June). *Functional anisotropy: Exploiting the mechanics of curved-crease origami systems* [Conference presentation]. ASCE Engineering Mechanics Institute Conference, Pasadena, CA, United States.
8. Filipov, E. T. & Woodruff, S. R. (2019, May). *Mechanics and dynamics of reconfigurable curved-crease origami arrays* [Conference presentation]. Acoustical Society of America Annual Meeting, Louisville, KY, United States.
9. Filipov, E. T. & Woodruff, S. R. (2019, March). *Exploring the mechanics of curved-crease origami with a discrete bar and hinge* [Conference presentation]. Bulletin of the American Physical Society, Boston, MA, United States.
10. Filipov, E. T. & Woodruff, S. R. (2018, May). *The mechanics of folding curved-crease origami* [Conference presentation]. ASCE Engineering Mechanics Institute Conference, Cambridge, MA, United States.

Poster presentations

1. Woodruff, S. R. & Filipov, E. T. (2021, October). *Twisting flat surfaces using curved creases and local pinching* [Conference poster]. Society of Engineering Science Annual Conference (online).

UNIVERSITY SERVICE ACTIVITIES

Community-Based Learning Collaborative Fellow **2022 – 2023**
Office of Community-Based Learning, Washington and Lee University

Graduate student association committee member **2018 – 2020**
CEE Department, the University of Michigan

Graduate student townhall organizer CEE Department, the University of Michigan	2020
Graduate student mentorship committee member CEE Department, the University of Michigan	2019
Undergraduate research mentor Summer Research Opportunity Program, the University of Michigan	2018; 2019
NSF GRFP workshop panelist College of Engineering, the University of Michigan	2018; 2019
Student visit weekend committee member College of Engineering, the University of Michigan	2018

EXTERNAL SERVICE ACTIVITIES

ACCESS (formerly XSEDE) Allocation Review Committee member National Science Foundation, Advanced Cyberinfrastructure Coordination Ecosystem: Services & Support (ACCESS) program	2022 – Present
Civil and Environmental Engineering Panel reviewer National Science Foundation	2023; 2024
Ad hoc journal reviewer Thin-Walled Structures; Mechanics Research Communications; Cellulose; Scientific Reports; International Journal of Solids and Structures	2022 – Present

COMMUNITY INVOLVEMENT/OUTREACH

Energy efficiency improvement proposal – Capstone advisor Rockbridge Area Relief Association, Lexington, VA	2022 – 2023
Pond development proposal – Capstone advisor Kendal Senior Living Community, Lexington, VA	2022 – 2023
Truss bridge educational program assistant Beacon Elementary School, Dexter, MI	2018; 2019
“How much will your bridge hold?” program assistant MConnex Xplore program, the University of Michigan	2018
Civil engineering program leader and organizer Girls in Science and Engineering Camp, the University of Michigan	2018
“Structural origami for kids” program assistant Ann Arbor District Library, Ann Arbor, MI	2017

PROFESSIONAL MEMBERSHIPS AND AFFILIATIONS

American Society for Engineering Education (ASEE) Member	2023
Society of Engineering Science (SES) Member	2021
Engineering Mechanics Institute (EMI) Member	2019
Sigma Xi Honor Society Associate member	2018
Out in Science, Technology, Engineering, and Mathematics (oSTEM) Member	2017
American Society of Civil Engineers (ASCE) Member	2014

PROFESSIONAL TRAINING

Safe Zone Ally LGBTQ+ training The Safe Zone Project, Washington & Lee University	2022
Developing competitive grant proposals Hanover Research, the University of Michigan	2021
Teaching for equity and inclusion from an international perspective Center for Research on Learning and Teaching, the University of Michigan	2020
Effective science advocacy The Ford School of Public Policy, the University of Michigan	2019
Leadership style and personal strengths workshop Sanger Leadership Center, the University of Michigan	2019
Broad science communication Michigan Communicating Science Conference, Ann Arbor, MI	2018
Responsible conduct of research and scholarship The University of Michigan	2017
Fundamentals of engineering exam (engineer in training) The National Council of Examiners for Engineering and Surveying	2017

NON-ACADEMIC WORK EXPERIENCE

Infrasense, Inc.

2016 – 2018

Woburn, MA - Junior staff engineer/GIS specialist

- Worked as the GIS expert in a team within a nondestructive testing (NDT) company.
- Designed and managed a database on NDT data for roads and bridges within the Idaho Transportation Department, District 6.
- Worked at the vanguard of a new type of project for both the company and the Idaho state government.
- Aided in decision making about how to represent data for effective use.

Structural Integrity Engineering Group, Inc.

2014 – 2015

Medford, MA - Engineer's assistant/drafter

- Drafted and checked technical drawings and met with clients.
- Conducted field work investigations of structural projects.
- Experienced in residential and commercial environments on a variety of project sizes.

(Last updated on April 1, 2024)