

Nathan Brown

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Research Interests

conceptual design, sustainable design, structural and multi-objective optimization, computational design applications of artificial intelligence, data science, and engineering knowledge to building design

Education

Massachusetts Institute of Technology | *Ph.D. in Building Technology* 2016-2019
Research Group Affiliations: MIT Digital Structures

Massachusetts Institute of Technology | *S.M. in Building Technology* 2014-2016

Princeton University | *B.S.E. in Civil and Environmental Engineering* 2008-2012
Certificate in Architecture and Engineering | Certificate in Urban Studies

Professional Experience

The Pennsylvania State University | *Assistant Professor* | University Park, PA 2019-Present
Department of Architectural Engineering
Department of Architecture (Affiliate Assistant Professor, 2022-present)

BuroHappold | *Structures* | Boston, MA 2017-2019 (part time)
Created workflows for performance-based conceptual design studies
Implemented structural optimization and interoperability within traditional project work

Ochsendorf DeJong & Block, LLC | *Structural Design Consultant* | Cambridge, MA Summer 15
Curragh Racecourse, County Kildare, Ireland | for Grimshaw Architects
Developed a custom multi-objective optimization tool for generating performance feedback and managing interactions between design objectives in the early-stage design phase

Elevate Energy | *Senior Energy Analyst (2014) / Energy Analyst (2012-13)* | Chicago, IL 2012-2014
Executed or organized all phases of energy efficiency retrofit projects in multifamily buildings
Led the effort to integrate water efficiency into the energy audit and analysis process

Water Mission | *Research and Development Intern* | Charleston, SC Summer 11
Designed and built a water recycling system for in-house filter production wastewater
Developed a working 3D CAD model of WM's water filtration system for future design upgrades

International Water Management Institute | *Science Communications Intern* | Gujarat, India Summer 10
Evaluated the impact of IWMI research using interviews with policymakers and other stakeholders
Made recommendations on how to best disseminate technical research to varied audiences

Nittany Engineering and Associates LLC | *Engineering Support Intern* | Centre Hall, PA Summer 09
Assisted engineers in structural and MEP design calculations
Prepared site maps, structural detailing, spec sheets, and drawing revisions

**Peer-reviewed
Journal
Publications**

- Bunt S., Berdanier C., & **Brown N.**, 2023. 'Observing architectural engineering graduate students' digital parametric design behaviors using eyetracking methods.' *Journal of Civil Engineering Education*, 149(4): 04023005.
- Moeini M., **Brown N.**, & Memari, A., 2023. 'Estimating hurricane-induced vertical surge and wave loads on elevated coastal buildings based on CFD simulations and ensemble learning.' *Coastal Engineering*, 183: 104325.
- Fang D., **Brown N.**, De Wolf C., & Mueller C., 2023. 'Reducing embodied carbon in structural systems: a review of early-stage design strategies.' *Journal of Building Engineering*, 76: 107054.
- Bunt S. & **Brown N.**, 2023. 'Design efficacy and exploration behavior of student architect-engineer design teams in shared parametric environments.' *Buildings*, 13(5): 1296.
- Broyles J., Shepherd M., & **Brown N.**, 2023. 'Evaluation of the dynamic response for scaled models of shaped concrete floor slabs.' *Building Acoustics*, 30(2): 143-163.
- Hens I., Solnosky R., & **Brown N.**, 2023. 'A parametric framework for early evaluation of fire design and structural feasibility in tall timber.' *Journal of Architectural Engineering*, 29(1): 04022040.
- Duarte G., Duarte J., Memari A., **Brown N.**, & Gevaudan J.P. 2023. 'Towards a model for structural performance in concrete printing based on buildability and toolpath design.' *Journal of Building Engineering*, 69: 106325.
- Zargar, H., Sadeghi, J., & **Brown N.**, 2022. 'Agent-based modeling for early-stage optimization of spatial structures.' *International Journal of Architectural Computing*, 21(1): 84-99.
- Lima F., **Brown N.**, & Duarte J., 2022. 'A grammar-based optimization approach for designing urban fabrics and locating amenities for 15-minute cities.' *Buildings*, 12(8): 1157.
- Hinkle L., Wang J., & **Brown N.** 2022. 'Quantifying potential dynamic façade energy savings in early design using constrained optimization.' *Building and Environment*, 221: 109265.
- Broyles J., Shepherd M., & **Brown N.**, 2022. 'Modified acoustic transmission metrics for early-stage design exploration using a computational case study of heavyweight floors.' *Applied Acoustics*, 196: 108865.
- Lima F., **Brown N.**, & Duarte J., 2022. 'A grammar-based optimization approach for walkable urban fabrics considering pedestrian accessibility and infrastructure cost.' *Environment and Planning B: Urban Analytics and City Science*.
- Broyles J., Shepherd M., & **Brown N.**, 2022. 'Design optimization of structural-acoustic spanning concrete elements in buildings.' *Journal of Architectural Engineering*, 28(1).
- Lima F., **Brown N.**, & Duarte J., 2021. 'Understanding the impact of walkability, population density, and population size on COVID-19 spread: A pilot study of the early contagion in the United States.' *Entropy*, 23(11): 1512.
- Duarte G., **Brown N.**, Memari A., & Duarte J., 2021. 'Learning from historical structures under compression for concrete 3D printing construction.' *Journal of Building Engineering*, 103009.
- Taylor M., **Brown N.**, & Rim D., 2021. 'Optimizing thermal comfort and energy use for learning environments.' *Energy and Buildings*, 111181.
- Hens I., Solnosky R., & **Brown N.**, 2021. 'Design space exploration for comparing embodied carbon in tall timber structural systems.' *Energy and Buildings*, 244: 110983.
- Brown N.**, Jusiega V., & Mueller C., 2020. 'Implementing data-driven parametric building design with a flexible toolbox.' *Automation in Construction*, 118: 103252.
- Brown N.**, 2020. 'Design performance and designer preference in an interactive, data-driven conceptual building design scenario.' *Design Studies*, 68: 1-33.
- Brown N.**, & Mueller C., 2019. 'Design variable analysis and generation for performance-based parametric modeling in architecture.' *International Journal of Architectural Computing*, 17(1): 36-52.

Brown N., & Mueller C., 2019. 'Quantifying diversity in parametric design: a comparison of possible metrics.' *Artificial Intelligence for Engineering Design, Analysis, and Manufacturing*, 33(1): 40-53.

Brown N., & Mueller C., 2016. 'Design for structural and energy performance of long span buildings using geometric multi-objective optimization.' *Energy and Buildings*, 127: 748-761.

Tseranidis S., **Brown N.**, & Mueller C., 2016. 'Data-driven approximation algorithms for rapid performance evaluation and optimization of civil structures.' *Automation in Construction*, 72: 279-293.

Adriaenssens S., **Brown N.**, Lowinger R., & Hernandez J., 2014. 'Structural analysis of reinforced concrete folded hyperbolic paraboloid: a case study of the Miami Marine Stadium.' *International Journal of Architectural Heritage*, 8(4): 498-516.

Conference Presentations & Publications

Duarte G., Duarte J., **Brown N.**, Memari A. M., & Nazarian S., 2023. 'Design Optimization Workflow for 3D Concrete Printing of Roof Structures.' *Proceedings of the IASS Annual Symposium 2023*. Melbourne, Australia.

Bunt, S., Berdanier C., & **Brown N.**, 2023. 'Optimization strategies of architecture and engineering graduate students: responding to data during design.' *Computer-Aided Architectural Design. INTERCONNECTIONS: Co-computing Beyond Boundaries*, 1819, Delft, Netherlands.

Hinkle L., & **Brown N.**, 2023. 'Expanding performance-driven parametric design spaces through data streams.' *Computer-Aided Architectural Design. INTERCONNECTIONS: Co-computing Beyond Boundaries*, 1819, Delft, Netherlands.

Zargar H., Uarac P., Barbosa A., Sinha A., Simpson B., van de Lindt, J., & **Brown N.**, 2023. 'Comparing optimization approaches in OpenSees-based direct displacement design of tall timber lateral systems.' *ASCE International Conference on Computing in Civil Engineering*, Corvallis, OR.

Kontra S., Uarac P., Araujo G., Furley J., Mensah F., Orozco G., Ho, T., Zargar S., Barbosa A., Simpson B., van de Lindt J., Sinha A., & **Brown N.**, 2023. 'Design and Cradle-to-Grave Life Cycle Assessment of a full-scale six-story shake table test building.' *World Conference on Timber Engineering 2023*, Oslo, Norway.

Bunt S., Hinkle L., Walton A., & **Brown N.** 2023. 'Relationship between high school STEM self-competency and behavior in a parametric building design activity.' *2023 Annual Conference and Exposition of the American Society for Engineering Education*, Baltimore, MD.

Alhussain A., Kurdi Y., Asadi S., & **Brown N.**, 2023. 'Shaping urban block building form to correlate PV production with electricity demand.' *ASCE International Conference on Computing in Civil Engineering*. Corvallis, OR.

Leonard S., Eddin M., Prichard M., Broyles J., Menard S., & **Brown N.**, 2023. 'Trade-offs between embodied carbon and acoustic insulation for mass timber floor structures.' *World Conference on Timber Engineering 2023*, Oslo, Norway.

Broyles J., Self I., & **Brown N.**, 2022. 'Revisiting the Viipuri Library: Assessing performance and design trade-offs in custom ceiling geometry.' *Proceedings of the IASS Symposium 2022*, Beijing, China (online).

Zargar L., Ghorbani Z., Wang Z., Messner J., & **Brown N.**, 2022. 'Data-driven design exploration with immersive visualization.' *Proceedings of the 22nd International Conference on Construction Applications of Virtual Reality (CONVR2022)*. Seoul, South Korea.

Hinkle L., Pavlak G., Curtis L., & **Brown N.**, 2022. 'Dynamic subset sensitivity analysis for design exploration.' *Proceedings of ANNSIM (SimAUD track)*, San Diego, CA.

Bunt S., & **Brown N.**, 2022. 'Evaluating profession-based vocabulary in terms of architecture and engineering designers.' *Proceedings of the 5th International Conference on Structures and Architecture*, Aalborg, Denmark.

Broyles J., Hartwell A., Gascon Alvarez E., Ismail M., Norford L., Mueller CI, & **Brown N.**, 2022. 'Shape optimization of concrete floor systems for sustainability, acoustical, and thermal objective.' *Proceedings of the 5th International Conference on Structures and Architecture*, Aalborg, Denmark.

- Brown N.** & Bunt S., 2022. 'Optimization tools as a platform for latent qualitative design education of technical designers.' *Proceedings of the National Conference on the Beginning Design Student 37*, Muncie, IN.
- Oghazian F., **Brown N.**, & Davis F., 2022. 'Calibrating a formfinding algorithm for simulation of tensioned knitted textile architectural models.' *Proceedings of CAADRIA 2022*, Volume 1, 111-120.
- Kore R., **Brown N.**, & Durmus D., 2021. 'Damage reduction with maintained colour quality of artwork under RGB projector.' *CIE 2021 Midterm Meeting Light for Life-Living with Light*, International Commission on Illumination.
- Bunt S., & **Brown N.**, 2021. 'Homogeneity versus heterogeneity in architect-engineer design teams.' *Proceedings of the IASS Symposium 2021*, Surrey, U.K. (online).
- Zargar H., & **Brown N.**, 2021. 'Deep learning in early-stage structural performance prediction: assessing morphological parameters for buildings.' *Proceedings of the IASS Symposium 2021*, Surrey, U.K. (online).
- Broyles J., Shepherd M., & **Brown N.**, 2021. 'Evaluation of shaped concrete floor slabs for structure-borne and airborne acoustic performance.' *Proceedings of the IASS Symposium 2021*, Surrey, U.K. (online).
- Boothby T., **Brown N.**, & Annalisa Crannell, 2021. 'Saving appearances: treatment of anomalies in the projective geometry – graphic statics analogy.' *Proceedings of the IASS Symposium 2021*, Surrey, U.K. (online).
- Broyles J., Shepherd M., & **Brown N.**, 2021. 'Quantifying sound transmission of building structures for optimization in early-stage design.' *INTER-NOISE and NOISE-CON Congress and Conference Proceedings 265(5)*: 1215-1226.
- Solnosky R., **Brown N.**, & Napolitano R., 2021. 'Teaching structures in an (almost) empty room: an assessment of strategies for student engagement in mixed-mode and remote classes.' *2021 ASEE Virtual Annual Conference*, online.
- Lima F., **Brown N.**, & Duarte J., 2021. 'Urban design optimization: generative approaches towards urban fabrics with improved transit accessibility and walkability.' *Proceedings of CAADRIA 2021*, Hong Kong.
- Broyles J., Shepherd M., & **Brown N.**, 2020. 'Investigation of optimization techniques on structural-acoustic shaped concrete slabs in buildings.' *Proceedings of Meetings on Acoustics*, online.
- Brown N.**, 2020. 'Suggesting design directions: early examples of simulation-based guidance for common model types.' *Proceedings of SimAUD 2020*, online.
- Brown N.**, 2019. 'Interactive optimization: understanding how designers engage with live performance feedback from multiple surrogate models.' *Proceedings of the IASS Symposium 2019*, Barcelona, Spain.
- Fang, D., Arsano, A., **Brown N.**, Reinhart, C., & Mueller C., 2018. 'Design space exploration for high-performance greenhouse design.' *Proceedings of the IASS Symposium 2019*, Barcelona, Spain.
- Brown N.**, & Mueller C., 2018. 'Gradient-based guidance for controlling performance in early design exploration.' *Proceedings of the IASS Symposium 2018*, Cambridge, MA.
- Stephen C., **Brown N.**, Mayencourt P., & Mueller C., 2018. 'Clustering analysis of structural loading for post-disaster housing design.' *Proceedings of the IASS Symposium 2018*, Cambridge, MA.
- Brown N.**, & Mueller C., 2017. 'Designing with data: moving beyond the design space catalog.' *Disciplines and Disruption, ACADIA 2017*. Cambridge, MA.
- Brown N.**, & Mueller C., 2017. 'Automated performance-based design space simplification for parametric structural design.' *Proceedings of the IASS Symposium 2017*, Hamburg.
- Mayencourt P., **Brown N.**, Wald S., Sumini V., Danhaive R., Hayashi K., and Mueller C., 2017. 'Hängemattenbrücke.' *Proceedings of the 6th International Footbridge Conference*, Berlin.
- Brown N.**, & Mueller C., 2016. 'The effect of performance feedback and optimization on the conceptual design process.' *Proceedings of the IASS Symposium 2016*, Tokyo.

Brown N., de Oliveira, J., Ochsendorf, J., & Mueller C., 2016. 'Early-stage integration of architectural and structural performance in a parametric multi-objective design tool.' *The International Conference on Structures and Architecture*, Guimarães, Portugal.

Mueller C., **Brown N.**, & Danhaive R., 2015. 'Digital brainstorming: new computational tools for creative data-driven design.' *Boston Society of Architects Conference, ABX 2015*, Boston.

Brown N., Tseranidis S., & Mueller C., 2015. 'Multi-objective optimization for diversity and performance in conceptual structural design.' *Proceedings of the IASS Symposium 2015: Future Visions*, Amsterdam.

Brown N., & Mueller C., 2015. 'Optimization for structural performance and energy usage in conceptual building design.' *Engineering Mechanics Institute Conference*, Stanford University.

Adriaenssens S., Lowinger R., Hernandez J., **Brown N.**, Halpern A., Aye Z.M., Prier M., 2012. 'The shells of the Miami Marine Stadium: synergy between form, force, and energy'. *IASS-IACM 2012: 7th International Conference on Computational Mechanics of Spatial Structures*, Sarajevo, Bosnia and Herzegovina.

**Theses
& Other**

Brown N., 2019. 'Early building design using multi-objective data approaches.' *MIT PhD Thesis*. Cambridge, MA. Committee: Caitlin Mueller, Christoph Reinhart, John Ochsendorf.

Brown N., 2017. 'Integrating secondary goals into structural design.' *SOM Structural Engineering Travel Fellowship Report*. Chicago, IL.

Brown N., 2016. 'Multi-objective optimization for the conceptual design of structures.' *MIT SMBT Thesis*. Cambridge, MA. Advisor: Caitlin Mueller.

Brown N., 2012. 'Form, use, and sustainability: A geometric and structural feasibility study of hyper shells.' *Princeton University Undergraduate Thesis*. Princeton, NJ. Advisor: Sigrid Adriaenssens.

Teaching	The Pennsylvania State University <i>Instructor</i> State College, PA	2019-present
	Fall/Spring 2020-24 AE 481W/482 – AE Senior Project	
	Fall 2021 & Spring 2024 AE 397 – Parametric Thinking and Modeling for Design	
	Fall 2020-2023 AE404 – Building Structural Systems in Steel and Concrete	
	Spring 2020-2024 AE 540 – Computational Design & Optimization for Buildings	
	Fall 2019 AE124 001 – Imagining a New Design for Beaver Stadium (First Year Seminar)	
	Fall 2019 AE124 002 – Robots Building Buildings (First Year Seminar)	
	Fall 2019 AE124 003 – Additive Construction: 3D Printed Buildings (First Year Seminar)	
	Massachusetts Institute of Technology <i>Teaching Assistant</i> Cambridge, MA	2014-2019
	4.461 Architectural Building Systems – Carl Solander, AIA	
	4.462 Building Structural Systems I – Prof. John Ochsendorf	
	4.463 Building Technology Systems: Structures and Envelopes – Prof. Caitlin Mueller / Andrea Love, AIA	
	4.464 Environmental Technology in Buildings – Prof. Christoph Reinhart	
	4.432 Modeling Urban Energy Flows – Carlos Cerezo Davila	
	Class Lecture Topics:	
	Reinforced Concrete Design, Building Systems Interactions, Climate Data Visualization (MIT 4.461/4.463)	
	Multi-Objective Optimization in Design (MIT 4.463 and MIT 4.450J – Comp. Structural Design and Optimization)	
	Structural Systems, Structural Design Tools (MIT 4.463) Parametric Design (MIT CEE M.Eng. Program)	
	Kaufman Teaching Certificate Program MIT Teaching preparation seminar	
	UROP Advisor MIT Advised 4 undergraduate research assistants	
	Invited Design Reviewer	
	MIT 4.462, 4.463, 4.450J, Core 3 Studio (design crits)	
	UNC Charlotte Building Systems Integration (design crits)	
	Hofstra Civil Engineering Design (design crits)	
	Penn State Additive Manufacturing of Concrete Structures Studio; MycoKnit Studio; Irregular Lacing Structural Networks Studio	



**Research
Advising**

Graduate Thesis (completed)

- 2023 | Stephanie Bunt | Ph.D. in Architectural Engineering, Penn State
- 2023 | Ali Alhussain | M.S. in Architectural Engineering, Penn State
- 2020 | Isabelle Hens | M.S. in Architectural Engineering, Penn State | Co-advised with Dr. Ryan Solnosky
- 2020 | Jonathan Broyles | M.S. in Architectural Engineering, Penn State

Graduate Thesis (ongoing)

- 2023-present | Amir Shargh Ghasem | Ph.D. in Architectural Engineering, Penn State
- 2023-present | Ian Self | M.S. in Architectural Engineering, Penn State
- 2021-present | Hossein Zargar | Ph.D. in Architectural Engineering, Penn State
- 2020-present | Jonathan Broyles | Ph.D. in Architectural Engineering, Penn State
- 2020-present | Laura Hinkle | Ph.D. in Architectural Engineering, Penn State | Co-advised with Dr. Julian Wang
- 2020-present | Committee member for 15 PhD / 5 MS theses across Architectural Engineering / Architecture

Undergraduate Advising

- 2020-present | 5 AE Building Engineering-Seminal Undergraduate Research Experience (BE-SURE) Students
- 2020-present | 17 AE Senior Thesis Students
- 2023-present | 1 Schreyer Honors College Student

Awards

- Best Overall Paper** | Annual Modeling and Simulation Conference + SimAUD 2022
- TODA Award** | MIT | Research Excellence in Building Technology 2019
- Presidential Fellowship** | MIT 2013
- Structural Engineering Travel Fellowship** | Skidmore, Owings and Merrill Foundation 2019
- Hyzen Fellowship** | MIT 2019
- W Mack Angas Prize** | Princeton | Highest undergraduate award in CEE department 2012
- Sigma Xi Book Award** | Princeton | Most outstanding thesis in CEE department 2012

**Invited Talks
&
Research
Symposia**

- Foster + Partners (London) | 2016
- Block Research Group (ETH Zurich) | 2016
- Spatial Architecture Information Lab (RMIT) | 2016
- Boston Society of Architects (Boston) | 2016
- Dimella Shaffer (Boston) | 2016
- SOM (Chicago) | 2017
- Boston Architectural College (Course Guest Lecture, Jamie Farrell) | 2017
- Stanford University (Course Guest Lecture, CEE183, Gregory Deierlein) | 2017
- Stuckeman Center for Design Computing (Penn State) | 2018
- HOK (New York) | 2018
- Partnership for Achieving Construction Excellence (PACE) Roundtable | 2019
- Hope College (Holland, Michigan) | 2020
- Harvard Graduate School of Design (Course Guest Lecture, SCI 6484, Ellie Jungmin Han) | 2022
- Packhunt (Industry Lecture, Amsterdam, NL) | 2023

Professional Activities & Special Projects	building design group Director	2019-Present
	Director of an interdisciplinary research group focused on understanding, improving, and applying advanced computational techniques related to early building design	
	Research Experience for Teachers (RET) Research Supervisor	2020-2021
	Integrated a high school science teacher into my research group for a summer; developed research agenda and activities for high schoolers to learn about sustainable design	
	Design Space Exploration Software Developer	2015-Present
	Set of open-source Grasshopper tools for performance-based design space exploration created along with other researchers at MIT and Penn State	
	Graduate Resident Tutor Maseeh Hall, MIT	2017-2019
	Live-in mentor and educator who works to foster a supportive, safe, and positive living environment for all undergraduate residential students	
	MIT Museum Idea Hub Cambridge, MA	2017-2019
	Collaboration with the Idea Hub to develop an educational exercise that exposes young students to digital design, structural behavior, and 3D printing	
Peer Reviewer	2017-Present	
<i>Sustainable Cities and Society, Applied Thermal Engineering, Buildings and Environment, International Journal of Architectural Computing, Journal of Architectural Engineering, TAD Architectural Engineering and Design Management, Journal of Computational Design and Engineering Energy and Buildings, Engineering Structures, Journal of Building Engineering</i>		
Journal of Architectural Engineering Associate Editor	2021-Present	
IEEE Intern. Conference on Human-Machine Systems Program Committee Member	2020	
Penn State Institute for Computational and Data Sciences Associate	2019-Present	
Stuckeman Center for Design Computing Affiliate Researcher	2019-Present	
American Society of Civil Engineers Member	2019-Present	
Architectural Engineering Institute Member	2019-Present	
Structural Engineering Institute Member	2019-Present	
IASS Symposium 2019 Scientific Committee Member	2018-2019	
International Association of Shell and Spatial Structures Member	2018-Present	
Building Technology Educators' Society Member	2015-Present	
Engineer Intern (E.I.T.) NCEES, State of Illinois	2013	