

# PROMETHEUS: JOURNAL OF THE PHD PROGRAM IN ARCHITECTURE

## Director's Introduction: Why *Prometheus*?

*Prometheus* is a peer-reviewed journal that showcases research-in-progress presented during an international symposium organized annually by students in the Illinois Institute of Technology's PhD Program in Architecture. Each year we offer the opportunity to PhD candidates to organize the symposium and serve as guest editors for the journal. My hope is that the experience gained from these curatorial, organizational, and editorial challenges and opportunities associated with hosting a symposium and editing *Prometheus* will serve our students when they enter academia and/or professional practice.

Each issue of *Prometheus* also includes a yearly "PhD Program Overview" to showcase the achievements and activities of our community of students and affiliated faculty; this section includes academic programming highlights such as our weekly Architecture Research Forum lecture series and news about the ongoing research and accomplishments of our students and recent graduates. This academic year began with a PhD-sponsored workshop to present research for the in-progress book tentatively titled *Predicaments of Modernity: Architecture, Urbanism, and the Illinois Institute of Technology*. Dozens of speakers shared their expertise with our faculty, students, and PhD community. Also, in this issue we have included interviews with some of our recent grads, affiliated faculty members, and visiting scholars. All in all, we have had a very productive year (we even held our first virtual comprehensive exams and dissertation defenses) despite the challenges caused by the global COVID-19 crisis.

## Author

Michelangelo Sabatino, PhD, Professor  
and Director of the PhD Program in  
Architecture and Inaugural John Vinci  
Distinguished Research Fellow  
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Why did we select Prometheus as the symbol and masthead of our journal? He was the irreverent Titan who stole fire to pave the way for the advancement of humankind. From our vantage point in Chicago, we understand fire as a tool for both destruction and creation. The Great Fire of 1871 leveled our city but also provided Daniel H. Burnham and Edward H. Bennett with a reason to devise the widely influential “Plan of Chicago” (1909). Without the fire of modern blast furnaces, the fabrication of the distinctive steel girders and columns of our Ludwig Mies van der Rohe-designed S. R. Crown Hall (and many of the other buildings on the IIT campus) would not have been possible. Recently, commenting on the COVID-19 crisis, our university President Alan W. Cramb reminded us about the power of fire: “As a metallurgist, I can’t help but think of tempered steel that is made stronger by fire. When this is all over, we will be stronger.”

As a College of Architecture within a science and technology-rich university, our PhD students and faculty at IIT are committed to fostering an environment of multidisciplinary inquiry. As architects who embrace the creative potential of humanistic inquiry, we believe that collaborating with engineers is essential to advance the kind of applied research that will make our built environment more inspiring, diverse, and sustainable. Distinguished Irish structural engineer Peter Rice once stated: “I would distinguish the difference between the engineer and the architect by saying the architect’s response is primarily creative, whereas the engineer’s is essentially inventive...” (*An Engineer Imagines*, 1994). With different yet complementary skill sets, architects and engineers can ensure that complex problems are solved collaboratively.

Since the early 1940s, research aimed at advancing practice has been generated by Master of Science Program students such as Myron Goldsmith (Arch 1939, MS 1953) who was eventually appointed faculty member at IIT. Our PhD Program in Architecture was established in the late 1990s as a continuation of the research conducted by former MS students like Goldsmith in collaboration with former faculty like Dr. Fazlur Khan who went on to develop the “bundled tube” structural system first deployed in the Sears Tower (1973; currently known as the Willis Tower). In the intervening years, we have trained researchers who have made significant contributions within academia and in practice across the globe. Today, our ambitious and talented graduates are impacting professional practice as well as research and pedagogy nationally and around the globe in countries ranging from Colombia to Saudi Arabia.

We hope that as awareness of *Prometheus* builds with this fourth issue focused on “Buildings, Cities, and Performance, II,” the journal will continue to serve as a platform for emerging researchers who, like its symbol and masthead, defy the status quo by taking risks that lead to game-changing innovation in service to humankind. Above all, we hope that the exchange between contributors and readers of *Prometheus* will lead to new and unexpected collaboration among different generations of researchers across the globe.

Nota Bene: This year’s symposium was held in collaboration with the Architectural Research Centers Consortium. I would like to thank Professor Hazem Rashed-Ali, ARCC President, for his support and our extraordinary scientific committee for their efforts. Thanks also to Dr. Hamid Arastoopour, Professor and Director of the Wanger Institute for Sustainable Energy Research (WISER), for his support. Special mention goes to my colleague Assistant Professor Rahman Azari. I would like to express my gratitude to Mehdi Ashayeri

and Ezgi Bay for their efforts as editors and for organizing the symposium, together with Zahida Khan and Omar Al-Mahdy. Melinda Van Leer deserves a special thank you for her editorial review and designers Bud Rodecker and Alyssa Arnesen of Span for their continuing efforts to make *Prometheus* both easily readable and visually engaging. Funding for this publication was provided by the John Vinci Distinguished Research Fellowship and the College of Architecture.

# EDITORS' INTRODUCTION

We chose to build upon the theme of last year's symposium, *Buildings, Cities, and Performance*, because there is much research still needed in terms of data-driven and simulation-based methodologies to address urgent global and local issues related to climate change, environmental degradation, and sustainability of cities. The participants included PhD students and professors from IIT and other universities across the world representing various disciplinary expertise related to the sustainability of the built environment: architecture, engineering, environmental science, landscape, and urban planning and design. In addition to presentations by PhD students, this symposium included three keynote addresses by Dr. Andreas Wagner (Karlsruhe Institute of Technology), Dr. Larry Bank (Georgia Tech), and Dr. Elizabeth Grant (Virginia Tech). This year's symposium also included a panel discussion of PhD program directors aimed at discussing the issues and challenges facing students in PHD programs in architecture. This panel was moderated by Dr. Michelangelo Sabatino (IIT) with participants Dr. Hazem Rashed-Ali (UTSA), Dr. Peng Du (CTBUH-IIT), and Dr. Elizabeth Grant. Over the course of this two day-symposium held in the inspiring spaces of our Ludwig Mies van der Rohe-designed S. R. Crown Hall, we listened to presentations, debated, and networked. The symposium concluded with a celebration dinner to mark the launch of the first three issues of *Prometheus* at the Tadao Ando-designed Wrightwood 659 on November 16, 2019.

## Authors

Mehdi Ashayeri and Ezgi Bay  
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In this fourth issue of *Prometheus, Journal of the PhD Program in Architecture*, we gather research-in-progress presented during our fourth annual international graduate student symposium hosted on November 15–17, 2019, by IIT College of Architecture's PhD Program. The first part of this issue contains keynotes and two sections of articles by more than 50 researchers grouped thematically: A. Urban Ecology, Data-Driven Methods, and Computation; and B. Building Performance Analysis, Passive Strategies, Post-Occupancy Evaluation, and Simulation Tools. The second part includes academic programming, student life and research, interviews, and more. The primary objective in organizing our symposium and publishing *Prometheus* is to create more opportunities for PhD students, as well as professors and professionals, to share their new ideas and experiences using new methodologies for conducting research about current issues in the built environment. We hope to continue this dialogue into the future.

### **Acknowledgments**

We would like to acknowledge all who made this symposium and publication possible. We would like to thank program director Dr. Michelangelo Sabatino for initiating the annual symposium and *Prometheus*. We would like to extend our appreciation to Dr. Hazem Rashed-Ali, president of the Architectural Research Centers Consortium (ARCC), for collaborating with us this year. We also want to thank the Faculty Advisory, Scientific, and Steering Committees, the keynote speakers, and Dr. Narjes Abbasabadi, PhD Program alumna, for providing advice and sharing her experience organizing the third symposium *Buildings, Cities, and Performance* along with the third issue of *Prometheus*. Ezgi Bay would also like to thank Dr. Rahman Azari for helping organize the symposium. Additionally, we would like to thank all our colleagues in the PhD program for their hard work, contributions, and enthusiasm, especially PhD Candidates Omar Al-Mahdy and Zahida Khan.

In particular, Omar Al-Mahdy was in charge of logistics of the symposium and he created our symposium brochure. Mehdi Ashayeri developed the call for papers, managed the submission platform, oversaw the review process by assigning papers to reviewers, and interacted with authors on revisions for the required scientific standards. He also contributed in the logistics and management of the symposium event. Ezgi Bay developed a database of PhD students at other universities to be invited to submit the call for papers and managed the event registration. Also, she arranged private tours to the IIT Kaplan Institute and Chicago Architecture Biennial. Zahida Khan was responsible for all online presentations and technical arrangements. After the symposium, Mehdi and Ezgi worked on compiling and formatting the accepted papers, and communicated with the authors, copy editor, and graphic designers on formatting and graphic requirements for Part II.A and Part II.B, respectively.

# SYMPOSIUM OVERVIEW

## ***Buildings, Cities, and Performance, II: November 15–17, 2019***

The aim of this symposium is to bring together faculty, PhD students and candidates, and recent graduates whose research interests lie with building and urban performance with respect to the sustainable built environment. The symposium is shaped around a central theme about methodologies, methods, and techniques that are applied to investigate the performance of buildings and cities. The primary objective of the workshop is to create a platform for PhD students and faculty to share their ideas and experiences of using simulation-based and data-driven methodologies for solving current built environment issues, and report on complexities and challenges involved. This year's symposium will also include a panel discussion of PhD program directors and educators that aims to address current issues and challenges facing doctoral education in architecture.

Topics of interest in this symposium include, but are not limited to, the following aspects of research on performance of buildings and cities:

- Research design and methodology development
- Data-driven and optimization techniques, including machine learning and big-data approaches
- Performance-simulation tools and techniques
- Evaluating the city and building performance with respect to thermal, thermal and visual, comfort, energy consumption, indoor air quality, airflow, embodied energy, and environmental impacts
- Design solutions (building envelopes, advanced materials and components, and smart technologies)
- Lessons from the past and historical insights on performance-based evolution of the built environment
- Performances of buildings and cities beyond the environment

The IIT International PhD Symposium is an annual symposium held by the IIT College of Architecture that was initiated in 2016 and operates on an annual basis. This year's event is organized jointly with the Architectural Research Centers Consortium (ARCC). ARCC is an international

organization committed to the expansion of the research culture and a supporting infrastructure in architecture and related design disciplines.

Nota bene: Presentation information, titles and affiliations are reproduced as they appeared in the symposium program in 2019.

### **NOVEMBER 15: OPENING, S.R. CROWN HALL**

#### **Welcome and Introductions**

Michelangelo Sabatino, PhD, Professor and Director;  
Peter Kilpatrick, PhD, Provost and Senior Vice President of Academic Affairs; Reed Kroloff, Dean *Illinois Institute of Technology*

#### **Keynote 1: Energy, Comfort, Occupant Behavior: Various But Interdependent Perspectives of Building Performance Assessment**

Andreas Wagner, PhD *Karlsruhe Institute of Technology*

#### **Research in Architecture Discussion Panel**

Upper Center Core

## NOVEMBER 16: PAPER SESSIONS, S.R. CROWN HALL

### Keynote 2: How to Start a Research Program as an Architect in Academia

Larry Bank, PhD, PE *Georgia Tech*

### Overview of *Prometheus*

Mehdi Ashayeri and Ezgi Bay *Illinois Institute of Technology*

## PAPER SESSION E-1

Data, Artificial Intelligence (AI)

### Health Impacts Associated to Building Energy Consumption and Potential Response Strategies

Hamed Yassaghi, Patrick Gurian, Alison Kenner, and Simi Hoque *Drexel University*

### Improve CO<sub>2</sub>-Based Demand-Controlled Natural Ventilation—Machine Learning Perspective

Wei Zhang and Wentao Wu *Harvard University*

### A Data-Driven and Physics-Based Framework for Integrated Energy-Air Quality (iE-AQ) Modeling

Mehdi Ashayeri *Illinois Institute of Technology*

### Effectiveness of Using Predicted Solar Radiation Data in Building Performance Simulation

Hany Gaballa and Soolyeon Cho *North Carolina State University*

### How Pedestrian Wayfinding Contributes to the Smart Growth in Legacy Cities: Lessons Learned from Springfield, MA

Yanhua Lu and Michael DiPasquale *North Carolina State University, University of Massachusetts Amherst*

## PAPER SESSION W-1

Daylighting, Envelope, Simulation

### Using Parametric Energy Modeling to Design Optimal-Performance Housing Units Within an Existing Framework

Robert J. Koester and Alexander Ryan Mitchell *Ball State University*

### The Impact of Building Envelope Design Parameters on Energy and Environmental Performance: A Literature Review

Negar Badri, Getachew Assefa, and Rahman Azari *University of Calgary, Illinois Institute of Technology*

### Exploring the Performance-Based Design Process Through Integrating Designers with Daylight Parametric Algorithms Results to Find Optimal Window Size, Shading Depth, and Spacing

Helia Taheri, Sarah Wood, and Kristen M. Ambrose *North Carolina State University, Ratio Architects*

### Reducing Stormwater Runoff: A Mathematical Model of Green Roof Design

Jing Hong and Dennis Michael Utzinger *University of Wisconsin*

### Cost-Effective, Energy-Efficient Solutions for Building Envelope: A Multi-Objective Optimization Case Study

Maedeh Mohit, Elham Hasani Alavy, Mohammad Djavad Saghafi, and Behrouz Mohammad Kari *University of Tehran*

### Design and Fabrication of a Solar Collector for Daylighting Systems Based on Heliostat Layout

Elham Hasani Alavy, Mahmood Shahabadi, and Shahin Heidari *University of Tehran*

## PAPER SESSION E-2

Computational Fluid Dynamics, Passive Strategies

### The Benefits of Double-Skin Facades to Facilitate Natural Ventilation in Tall Office Buildings

Yohan Kim, Mahjoub Elnimeiri, Raymond Clark, and Mohammad Heidarinejad *Illinois Institute of Technology*

### Validation of Computational Fluid Dynamics (CFD) Platforms for the Early Stages of Architectural Design

Soo Jeong Jo, James Jones, and Francine Battaglia *Virginia Tech, University of Buffalo*

### Natural Ventilation as an Architectural Instrument: A Case Study of Gaziantep, Turkey

Ezgi Bay and Mahjoub Elnimeiri *Illinois Institute of Technology*

### What It Takes to Become a Net-Zero Development: Case Study of Serenbe, Georgia

Haleh Moghaddasi, Phillip Tabb, and Hazem Rashed Ali *Texas A&M University, The University of Texas at San Antonio*

### Typologies and Evaluation of Outdoor Public Spaces at Street Level of Tall Buildings in Chicago

Zahida Khan and Peng Du *Illinois Institute of Technology*

## PAPER SESSION W-2

Data, Post-Occupancy Evaluation

### Minor Change for Major Impact: How Can Minor Changes in the Daily Urban Environment Impact an Aspect of Psycho-Physiological Health?

Hossein Saedi and Arthur Rice *North Carolina State University*

### Developing a Multi-Agent Based Simulation Model of Users' Wayfinding as a Representation and Post-Occupancy Evaluation (POE) Tool in a Hospital

Gisou Salkhi Khasraghi *Texas Tech University*

### Windcatcher: A Passive Adaptive System for the New Climate

Reza Ramyar, Margaret Bryant, and Yao Wang *State University of New York College of Environmental Science and Forestry*

### Beyond Technical Performances—Affordances as Qualitative Building Performances

Anat Mor-Avi, Vedran Mimica, and Lennie Scott-Webber *Illinois Institute of Technology, INSYNC: Education Research + Design*

### Keynote 3: When the Rubber Meets the Roof: Building Enclosure Research Methods

Elizabeth Grant, PhD, RA *Virginia Tech*

## Closing Reception

Wrightwood 659

## NOVEMBER 17: CAMPUS AND CITY TOURS

IIT Ed Kaplan Family Institute for Innovation and Tech Entrepreneurship

Chicago Cultural Center: 2019 Chicago Architecture Biennial