The **Master of Science in Computational Design** (MSCD) is a post-disciplinary research program at the School of Architecture at Carnegie Mellon University investigating critical questions and creative opportunities at the intersection of design, computation, and the built environment.

### mscd (pre) thesis

#### fall 2021

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<td>Rodger Luo (Autodesk); Athina Papadopolou (MIT); Jordan Geiger (ghek, CMU CodeLab); Nik Martelaro (CMU HCII); Paul Pangaro (CMU HCII);</td>
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<th><strong>MSCD Track Chair</strong></th>
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<td>- Dec 9, 9-12:30 pm (CodeLab - MMCH 403)</td>
<td>Daniel Cardoso Llach (<a href="mailto:dcardoso@cmu.edu">dcardoso@cmu.edu</a>)</td>
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* Candidate for December graduation
Course Description

Through readings, discussions, written assignments, and presentations this seminar cultivates the skills to identify a research question, situate it within a wider scholarly conversation, state its relevance to the field, and clearly formulate its methods and key proposition. The seminar will consider different approaches to method and end with a thesis proposal presentation open to all CD faculty and students, including students’ advisory committees. Across the different modules, two themes will be emphasized:

1) Inclusion in citational and scholarly practice — e.g. politics of citations in regards to intellectual-racial-gender-socioeconomic vectors; and
2) Sociotechnical/political dimensions of design-technological systems.

Pre-requisites: 48-727 and 48-716a.

Schedule: Thursdays, 4:40 - 6:00 pm (Zoom)
Units: 6

Instructor: Prof. Daniel Cardoso Llach
Office: MMCH 412 | Email: dcardoso@cmu.edu
Office hours: By appointment.

Course Objectives

By the end of the seminar students will be able to write about and verbally describe their research highlighting its relevance and contributions to the field, while situating it within broader historical, cultural, and technical contexts. Students will have the elements to articulate in writing and orally present a Thesis Proposal. In particular, students will have articulated the following components of their thesis:
- A well-defined research question;
- Relevance of the research (to CD and broader);
- State of the art;
- Methods statement;
- Thesis committee.
Visualizing Public Spaces for Exploring the City

Author
Chengyu Chen

Abstract
The project explores a new method of finding points of interest, especially public spaces, by using data visualization in Augmented Reality. This project will be located at the streets and public spaces, visualizing the information of public open spaces through AR hardware to guide the people to explore the city public spaces and find their destinations. The data includes different aspects of a public space: such as it's type, amount of users, type of activities happening there and the public arts established there.

Advisory Committee
Daragh Byrne, Daniel Cardoso Llach, Eddy Man Kim
Deep Vernacular

Author
Michael Hasey

Abstract
My research proposes an end-to-end pipeline for collecting and encoding the rules and parameters that drive exterior architectural forms for integration and use within new designs. Though similar proposals and techniques have existed before, they often rely on restrictive manual or parametric based techniques that have difficulty capturing high-resolution complexities, nuanced aesthetic relationships, and other ambiguous physical characteristics resultant of local cultures, history, beliefs, and so on. As an alternative, my research explores how deep neural network (DNN) technologies, which have the ability to capture fine-grained data relationships and patterns, may be used to capture and make accessible these nuances and complexities for new designs via a proposed design tool. To apply this pipeline to a case study, the author has chosen the Carpathian Wooden Churches of Ukraine as a potential target typology and style.

Committee
Daniel Cardoso Llach, Jinmo Rhee
Information Up Close: Interactive Objects to Bridge Perceptual Distance

Author
Malika Khurana

Abstract
Our globalized, connected, and climate change world constantly pushes us to interact with ideas outside of what we can immediately perceive or conceptualize. We find ourselves preoccupied with people and events on the other side of the world, digesting steady streams of media in endless feeds, and trying to wrestle with the consequences of our consumption. Through a series of interactive objects and devices, this thesis interrogates how to make such information that is difficult to perceive more legible. The goal of these experiments is to communicate information that is abstract, complex, or distant in tangible forms, to engender moments that alleviate the pressures of stretching our perception to its limits.

Advisors
Daragh Byrne, Golan Levin, Mark Baskinger
Creating Multisensory Experience Through Interactive Installations in Public Spaces

Author
Yanwen Dong

Abstract
Public spaces are created to be shared and accessible to the general public. Being spaces that connect social lives and activities, public spaces act as the platform for spontaneous events to connect people temporarily. With the five basic senses sight, sound, smell, taste, and touch, and additional full body senses of proprioception and kinesthesia, we are able to learn and experience environments to successfully navigate through those spaces. While we rely heavily on the usage of the senses, the actual actions and interactions often-time are overlooked. This thesis takes a closer look at the sensorial and multi sensorial experiences that happen in public spaces, and intends to utilize computational methods and sensory design to develop a digital interactive installation for public spaces. Through emphasizing, amplifying, and revealing those sensorial events, the installation aims to bring people's attention to how their senses are actively engaged in everyday life experiences.

Advisors
Daragh Byrne, Dina El Zanfaly
Representational Gap: Data Abstraction in Urban Transit Simulation

Author
Ariadne Bai

Abstract
The construction of design software is a mapping process of a real-world design domain getting abstracted into code and data. The schemes chosen in this process deeply affects the design, implementation, and ultimately, the user experience of a piece of design software. The issue of representational gap, is the gap between a common mental understanding of the domain and its data abstraction in a computer system. Urban transit simulation is a study case where designers may use software's aid for decision making where information is limited and optimized solutions are not realistic. By analyzing existing projects and proposing a prototype, this thesis opens a discussion about where representational gap comes and whether bridging the gap may help build better software, in terms of data storage, simulation scheme, and object ownership in coding.

Advisors
Daniel Cardoso Llach, Eddy Man Kim
Acoustic Sensing: Using Sound as Input for Tangible Interaction

Author
Zhenfang Chen

Abstract
I want to explore how we can involve non-human sound in interaction design. Beyond human voice, I think the sound that is generated by the vibration of an object or through the interaction between human body activity and an object can work as a material, full of potential, in interaction design. No matter through the form of audible or inaudible sound, high-frequency or low-frequency vibration, the non-human sound increases interaction capability.

Committee
Daragh Byrne, Dina El Zafaly
Tangible Design of Metamaterials

Author
Willa Yang

Abstract
Tangibility is important when designing physical experiences, and this holds particularly true when designing materials. Metamaterials as artificial materials can be used for a diverse range of functionalities and materialities. However, tangible design with metamaterials has been constrained due to 1) the lack of room for direct material manipulation and 2) limited material choices due to incompatibility between different metamaterials. In this work, we propose a physical construction kit that contains modules of major types of metamaterials. Modules are designed to be compatible and easily assemblable with each other. Our kit allows end users to touch and feel different metamaterials and broaden the design space by combining various motions. In order to allow end users to transform motions of different modules more efficiently, for example, rotational to linear, we also built a computational design tool that generates models for force propagation and transformation. We demonstrate the design possibilities of metamaterial combinations and complex assemblies with customized connections generated by our computational tool.

Committee
Josh Bard, Alexandra Ion, Daniel Cardoso Llach
Technologically Enhanced Human-Plant Interaction

Author
Stella Shen

Abstract
Current technologies have made it possible for human beings to sense and respond to our environment in a real-time fashion. Natural systems that used to be considered as operating at the scale of years, seasons and days are now capable of giving instantaneous and dynamic feedback, which more prominently reveals the parallel evolution of the ecological environment and human interactions with it. Our built environment now is understood as a synthetic expression of direct and indirect human interventions upon ecological systems and their processes. Thus, designing our constructed environment hinges around designing the interactions between us and the natural environment.

The research seeks to create both virtual and physical computer-mediated interfaces and systems to enhance the interaction between humans and plants. The proposed interactions seek ways to better indulge people with nature, cultivating curiosity, appreciation and empathy. Sensed data derived from contextualized interactions is processed and embodied to provide knowledge that leads to new assessment of the constructed environment - an engineered matrix that we've created, which guides our future city/urban design that challenges a static solution and dualistic views.

Committee
Daragh Byrne, Lining Yao
Discrete Control of Functional Knitted Textiles Using Computational Design Tools

Author
Jamaal Tribune

Abstract
I am collaborating with digital knitting software that is not as user friendly to computationally devise complex knit topologies that may ultimately allow more complex functionalities in knitted textiles and apparel.

Committee
Josh Bard, Jim McCann, Golan Levin
Thermal Cubic: Virtual Reality Based Thermal Data Visualization Engine for the Early Stage of Compact Residential Design

Author
Shuyi Shao*

Abstract
Nowadays, thermal comfort has become an important concern in the building industry due to its great impact on the living environment, especially in compact urban space. This thesis research proposes a prototyping system to combine the rising Virtual Reality technology with modeling and thermal analysis tools to provide dynamic and immersive thermal analysis and visualization experience inside the virtual environment to enable better design iteration experience during the early stage of urban residential design and to raise attention of professionals to evaluate building thermal comfort during the initiation of a design project.

Committee
Daragh Byrne, Daniel Cardoso Llach