GSD DESIGN LABS

Annual Report 2015 - 2016

CITY FORM LAB
Professor Andres Sevtsuk

ENERGY, ENVIRONMENTS AND DESIGN LAB
Professor Jane Hutton & Professor Kiel Moe

GEOMETRY LAB
Professor Preston Scott Cohen

THE JUST CITY LAB
Professor Toni Griffin

MATERIALS PROCESSES AND SYSTEMS GROUP
Professor Martin Bechthold

RESPONSIVE ENVIRONMENTS AND ARTIFACTS LAB
Professor Allen Sayegh

SOCIAL AGENCY LAB
Professor Michael Hooper

The City Form Lab focuses on empirical investigations of the physical forms of cities using state of the art technologies and spatial analysis techniques. It addresses an important emerging agenda at the intersection of city planning and technology by developing new analytic software tools for planners and urban designers, and by examining relationships between city design, social and economic development through empirical analysis of realworld case studies. By establishing the lab to GSD, we aim to build upon the school's growing international role and exposure in the areas of spatial planning, technology and urban analytics.

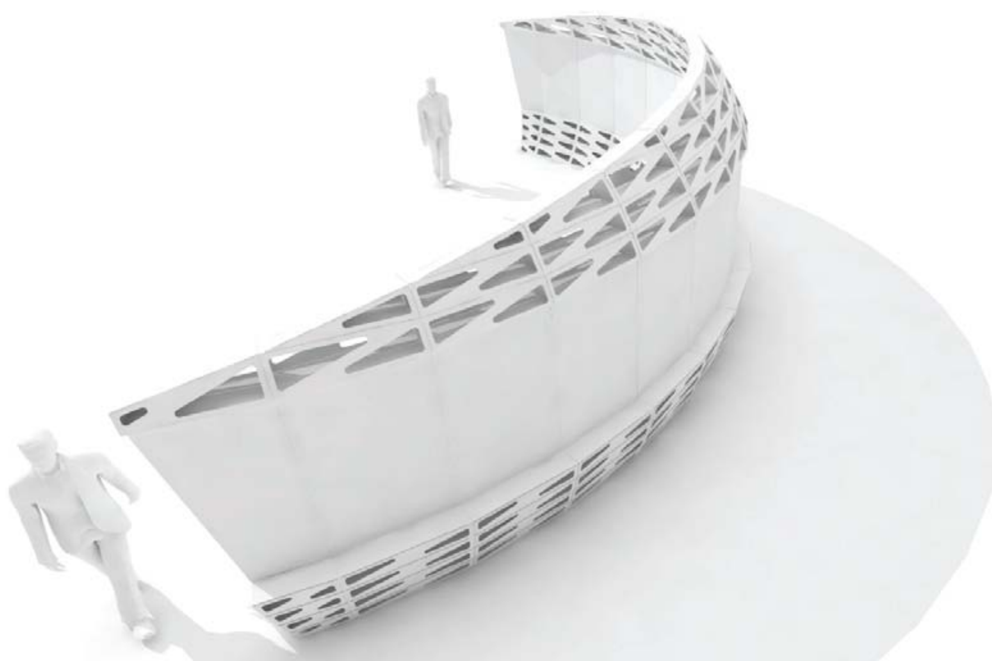
The lab, originally founded as a research group at MIT in 2010, was established at the Harvard Graduate School of Design in January 2016. During its first semester at the GSD, the lab has started work on three parallel research projects.

Urbanization in Indonesia Exhibit

This exhibition is a collaboration with World Bank Indonesia. It tells a visual story about the state of urbanization in Indonesia using data visualizations and photographs taken in a number of Indonesian cities in the fall of 2015. The exhibit was developed in conjunction with a World Bank publication "Indonesia's Urban Story" (2016).

The exhibition will be shown in Jakarta in the summer 2016 and subsequently shipped back to the US, where it will be re-mounted at the Harvard Plaza and potentially shown at the World Bank headquarters in Washington DC.

The design of the exhibit involves two tasks -- a structure to carry the exhibit and the graphic contents applied on the structure. The first builds on the lab's related research on grid-structures – double-curvature shell structures that can be made out of flat-sheet materials using only 2D cutters. The exhibit structure uses light gray 4mm Alucobond panels that are CNC cut and folded into shape to form a double-curved stand. Graphic contents are mounted on A0 plexi-glass panels, which are backlit with tube lights hosted inside the structure. The graphic component uses text, original photos taken throughout Indonesia during summer 2015, as well as info-graphic data illustration, describing urban and economic trends observed in the present urbanization of the country.



Structure of Indonesia's Urban Story Exhibit, made of light gray Allucobond pandels and fabricated on CNC cutting machine using CGL grid-structures technology.

Urban Commerce

Andres Sevtsuk, the director of the lab, is working on a book titled "Urban Commerce: The Hidden Logic of Retail Location Patterns and Vibrant Streets".

Urban centers are witnessing a revival across America. The millennial generation appears to prefer density, diversity and walkability to suburban office-parks, single-family housing and driving. Cities are competing to offer the most livable and attractive urban environments to lure both residents and companies with public space improvements, bike-lanes and public transit investments. Street-front commerce–publicly accessible retail, food and personal service establishments – play a central role in signaling the return of the urban life-style. Being able to conduct errands on foot or walk to restaurants and shops offers patrons more than accessible opportunities of consumption – mixed-use commercial streets generate social interaction, lively public spaces, and multiplier effects for a local economy. Attraction to urban commerce is demonstrated, among others, by ballooning housing values and office rents around commercial districts. From planners' perspective, the availability of shops, eateries and walk-in type service establishments near places of work or residence reduces patrons' reliance on automobiles and decreases urban energy consumption, enhances patrons' health through walking, and fosters a sense of community and social cohesion. Urban designers envision streets rich in retail and food service establishments, often rather idealistically, as constituent parts of vibrant urban environments.

Yet despite widespread enthusiasm for streets rich in commerce, both scholarly and professional knowledge about the spatial and economic mechanisms that sustain urban commerce remains scarce. Commerce formed an integral part of urban renewal schemes in American downtowns following the Second World War, but the disappointing outcomes of these projects, and the following shift towards a privatist model of urban development, distributed the responsibility of commercial planning to the private sector. Planning education lost interest in commercial spaces, focusing instead on urban problems that the private market would not deliver – affordable housing, public transit and public spaces. It was believed that the private sector would be far more efficient in creating successful retail environments. The preferred commercial typology that emerged in the privatist developments of the 1970s was the shopping mall. Centralized ownership, combined with financial lease incentives to attract only desirable tenants and a management structure that coordinates the operations of stores, made the mall a huge success. The typology was adopted by cities around the world.

This book argues that the revitalization of inner-city commercial clusters requires learning from the innovations that enabled the mall's success. Planning successful commercial clusters in inner city neighborhoods requires much more than zoning spaces for commercial uses. Rather than encouraging uninterrupted bidding for the highest rent among stores, business associations and municipal oversight is needed to coordinate the operations of stores and to ensure that both business and community interests are upheld. Spatial planning plays an important role in determining where customers are most readily accessed and where the supply of commercial space can grow over time. Spatial analysis tools and data on existing retail developments can help planners determine whether a location is suitable for regeneration, prioritize appropriate types of businesses and predict the patronage of clusters given the presence of competing destinations, customer density and income levels in surrounding areas. Public transit and parking availability both play a decisive role in affecting accessibility. Building typologies and urban design regulations affect the suitability of ground floors for business and determine their capacity to expand over time. The distribution of commerce also depends on agglomeration effects and customer spillovers between stores, which at times, can be a more important for choosing a location than the physical environment around them. Exploring these levers and their limitations, the book explains what it takes for different types of stores and establishments to remain economically viable, how to evaluate whether particular locations provide sufficient access and visibility, how agglomeration effects and inter-store externalities affect patronage, why shopping malls have been able to overtake so many main-streets, and how building types and urban design regulations affect the opportunities for commercial mixed-use ground floors to grow over time.

Grid Structures

Architectural design of complex structures has made a quantum leap in the last two decades. Computer aided design and analysis tools have expanded the horizons of architectural form, similar to the way in which descriptive geometry expanded the possibilities of masonry during the Enlightenment. But construction technology that enables the fabrication and assembly of new architectural geometries has not kept pace. Complex forms of most contemporary buildings rely on relatively traditional column-beam support systems, infill and cladding. More advanced structural solutions require complex fabrication, such as three-dimensional CNC milling and highly skilled assembly labor on site – requirements that are well beyond reach for most architectural projects.

The City Form Lab's research on grid structures has developed a novel building technology solution, which enables prefabricated double-curvature structures to be built with nonspecialized labor at a very low cost. This is made possible by using standardized flat-sheet materials, limiting all fabrication to only two-dimensional cutting and relying on structural folding to achieve desired geometric forms. Constraining all structural elements to strictly flat material sheets, using shape outlines that are cut only at a perpendicular angle, reduces fabrication costs and makes complex spatial structures available to a wider audience. A custom RhinoPython library was developed at CFL to automate the generation of double-walled flat-panel structures from a user-provided line network. The geometries of all structural elements are jointly controlled by adjusting the underlying line-network and associated material parameters. The RhinoPython library regenerates the geometric solution when the network is altered, complete with fabrication-ready unfolded panel drawings, marked with unique IDs on each element. The developed solution allows full-scale grid structures to be generated freeform curved line networks using very flexible structural patterns, ranging from triangles, quads, pentagons, hexagons or any regular or irregular n-gons.

The solution has been previously tested in four full-scale architectural / exhibition projects and a series of scale models:

- Singapore University of Technology and Design's (SUTD) Gridshell (in collaboration with ARUP)
- Re:imagining Cities exhibit at the Singapore Urban Redevelopment Authority gallery (in collaboration with the ETH Future Cities Lab)
- Tallinn Architecture Biennale main exhibition structure. Indonesia's Urban Story exhibition structure.

A detailed description of the technology solution is available in two related papers:

Sevtsuk, A., Kalvo, R., 2014. "A Freeform Surface Fabrication Method with 2D Cutting". Proceedings of the Simulation for Architecture and Urban Design (SimAUD) 2014 conference, Tampa, FL.

Sevtsuk, A., & Kalvo, R. (2014). Geometrical Solution Space for Grid Structures with Double-Walled Edges. In P. Block, J. Knippers, N. J. Mitra, & W. Wang (Eds.), Advances in Architectural Geometry (pp. 215–231). Springer.

Grid-structure exhibited at the Tallinn Architecture Biennale, September 2015.

PUBLICATIONS

Peer reviewed papers
Sevtsuk, A. (2016). Bugis: A Model for Singapore 100. FCL Magazine, Special Is(Urban Breeding Grounds), 62.

Sevtsuk, A., Kalvo, R., & Ekmekci, O. (2016). Pedestrian accessibility in grid layouts: the role of block, parcel and street dimensions. Urban Morphology 20(2), accepted, upcoming in September.

Sevtsuk, A., & Kalvo, R. (2016). Urban Network Analysis Toolbox for Rhinoceros 3D. Planning and Technology Today, (issue no. 112), 4–5.

Accepted abstracts
Sevtsuk, A. (2016) Patronage of urban commercial clusters. Environment and Planning B, Special issue on integrating spatial and social network analyses of the built environment. 2016/2017.

Submitted articles in review
Sevtsuk, A. (2016). Mapping the Elastic Public Realm. Journal of Planning Education and Research. In review.

Sevtsuk, A., Amindarbari, R. (2016) Measuring Metropolitan Form. Canadian Geographer. In review.

Scholarly Press Articles
Grabar, H. (2015, July 10). New Mapping Tool Helps Planners Judge Pedestrians, Public Space. Next City. Science of Cities. http://nextcity.org/daily/entry/newplanning- tool-mit-city-form-lab-unarhino-3d

Sitler, B., King, M., Sevtsuk, A., & Kalvo, R. (2016). SUTD Library Extension. Kenchiku Gijutsu, March, 1–4.

Sevtsuk, A. (2016). Ask A Planner. Quarterly Planner. A Free Newspaper Covering the Cambridge Citywide Plan., p. 6.

Journal Editing
Andres Sevtsuk is serving as guest editor for the Journal of Design Science Journal for the special issue on Design and Mobility in 2016. Cambridge University Press. http://www.designsciencejournal.org

EXHIBITS

The CFL was invited to participate in the main exhibit “Body Building”, as part of the Tallinn Architecture Biennale in September 2015. We produced and exhibited a full-scale prototype of a grid-structure, using technology developed in the lab (Figure 5). http://www.tab.ee/programme/mainexhibition

[Project]: Turtle Mountain Band of Chippewa Indians Housing Research and Prototype Design
Started summer 2015, completed Spring 2016: Report to donor

Funding: $30,000 (Turtle Mountain Band of Chippewa Indians)

This project is a six-month research project aimed at developing a site-, and need-specific housing prototype for the Turtle Mountain Band of Chippewa Indians, with particular focus on minimizing reliance on off-site energy sources and expensive heating and cooling technologies, and maximizing energy-effective spatial and material solutions. During the initial phase of the project, the research group will analyze the residential needs of the Turtle Mountain community, while identifying material and energetic resources available within the immediate proximity of the reservation, in order to determine the guiding strategies for the design of the prototype.

Principal Investigator: Kiel Moe; Project Leader: Aleksandra Jaeschke, Doctor of Design Candidate ’16; Project Team: Sean Connelly, MDes ’15, Benjamin Peek, MDes Candidate ’16, Oliver Curtis, MDes Candidate ‘17

[Publication]: Empire, State & Building
Started 2012, completed Spring 2016: Book Publication, published by Actar

Funding: $25,000 (American Institute of Architects UPJOHN Research Grant Program)
$12,000 (Harvard Graduate School of Design Dean’s Junior Faculty Research Grant)

This book documents a 4 year research project on architecture and urbanization. The research plotted every building material that has flowed over the past two hundred years through the site currently occupied by the Empire State Building. From farm, to rowhouse, to the original Waldorf-Astoria Hotel, to the Empire State building. This data is the basis of three primary chapters. The first, Empire, focuses on the otherwise unconsidered material geography of building: an empire without rule. The second, State, focuses on the ecological dynamics of this material flow in thermodynamic terms, articulating buildings in terms of their thermodynamic states and as political states. The third chapter, Building, uses the first two chapters to question what constitutes building and thus challenges the autonomous object building as the constitution of architecture.

Principal Investigator: Kiel Moe; Project Team: Carlos Cerezo MDes ‘12, Tom Sherman MDes ‘14, Arta Yazdanseta MDes ‘14, Saurabh Shrestha MDes ‘14, Manuel Colon-Amador MLA ‘14, Hector Tarrido-Picart MLA ‘15, and Christine Min March ’15

[Project & Publication] Wood Urbanism: From The Molecular to the Territorial
Started 2014, ongoing 2016: Book Publication

Funding: $60,157 (Softwood Lumber Board 2016)
$25,000 (David Rockefeller Center for Latin American Studies Faculty Grants Program 2014)

This book will document recent transscalar design research focused on wood conducted in the Energy, Environments & Design Research lab at Harvard University’s Graduate School of Design. From small-scale thermal properties to large scale forestry, territorial, and carbon cycle issues, wood has latent propensities not well addressed in the current discourse on wood construction. These propensities and implications of wood construction will be presented in this book through a range of design research formats: from testing to in-situ documentation to speculative projects. The aim is to help articulate and illustrate future architectural and ecological potentials of wood.

Principal Investigator: Kiel Moe & Jane Hutton; Project Team: Daniel Ibanez DDes Candidate, Jacob Mans MDes ’16, Ben Peek MDes ’16, David Kennedy MDes ’16, Tom Sherman MDes ‘14

[Publication]: The Hierarchy of Energy in Architecture: Emergy Analysis
Completed Fall 2015: Book publication

Srinivasan, Ravi, and Kiel Moe. 2015. The Hierarchy of Energy in Architecture: Emergy Analysis. Abingdon, UK; New York, NY: Routledge.

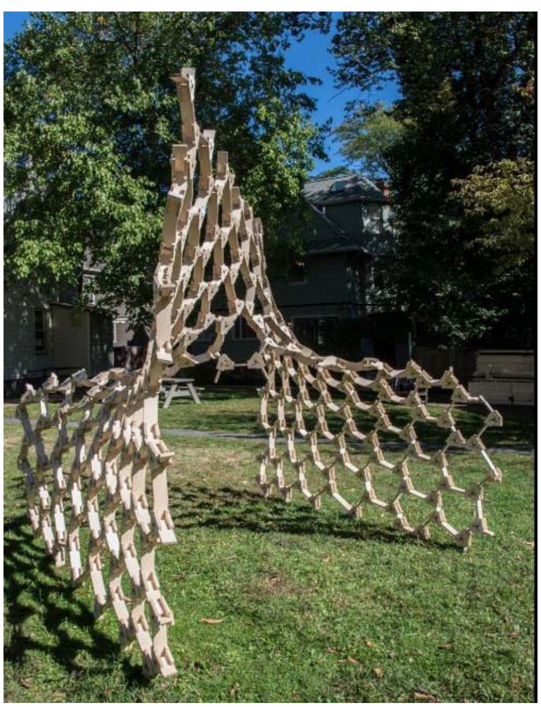
The laws of thermodynamics—and their implications for architecture—have not been fully integrated into architectural design. Architecture and building science too often remain constrained by linear concepts and methodologies regarding energy that occlude significant quantities and qualities of energy. The Hierarchy of Energy in Architecture addresses this situation by providing a clear overview of what energy is and what architects can do with it. Building on the emergy method pioneered by systems ecologist Howard T. Odum, the authors situate the energy practices of architecture within the hierarchies of energy and the thermodynamics of the large, non-equilibrium, non-linear energy systems that drive buildings, cities, the planet and universe. The book is divided into a fundamentals section, which introduces key topics and the emergy methodology, and an applications section, which features case studies applying emergy to various architectural systems. The book provides a concise but rigorous exposure to the system boundaries of the energy systems related to buildings and as such will appeal to professional architects and architecture students.

Note: Jane Hutton will be stepping down as Lab Co-Director at the end of the ’15-’16 year, as part of her move to the University of Waterloo.

The Computational Geometry Lab researches the intersection of design and science of shape, aided by computational tools and design intuition. The Lab is unique at the School in the sense that it combines computational, formal, architectural, and historical research into a single synthetic program. The projects pursued in the Lab, highlighted below, attest to the variety and depth of this work. In addition to active research projects, the members of the Lab pursue its research topics through seminars that use the facilities of the Lab, including Mechatronic Optics, Conic and Developable Surfaces, and Structural Surfaces.

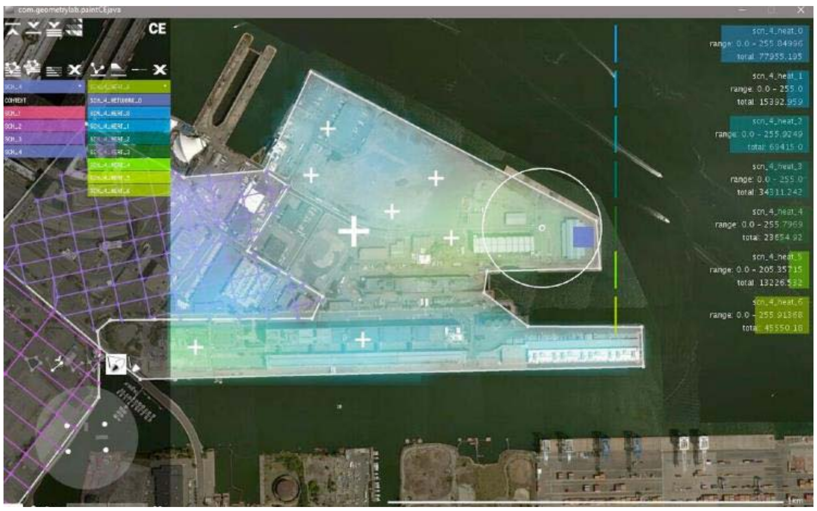
Spanning and Developable Surfaces

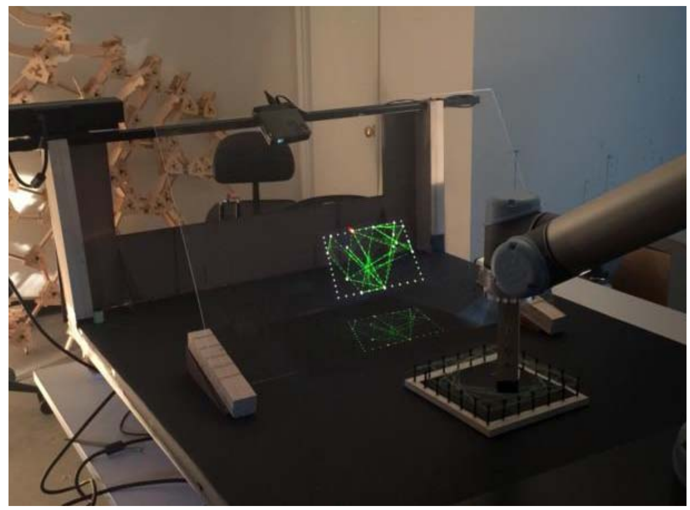
The lab continues to investigate and demonstrate large-scale construction systems for spanning and minimal surfaces, primarily unitized assembly systems or methods of material deformation which may accommodate these geometries. One example is the proof-of-concept installation below, from Fall 2015, which demonstrates the construction of a spanning surface through the use of an adaptable, flatcutable hexoganalization/triangulation.



Procedural Urban Modeling

With the support of a grant from ESRI, the lab has been actively researching methods and implications of procedural modeling in the city. While centering on the use of generative urban tools such as City Engine, the research attempts to go beyond proscriptive methods of design toward more open-ended and flexible uses of data-informed formmaking. The current product of this work is a new software tool developed in the lab called PaintCE. A kind of Photoshop for statistical spatial data, PaintCE allows the user to design heatmaps with desired urban qualities, import external data as heatmaps, create differential and sequential maps, and generate cities which have the desired differential qualities. Highly visual, it combines the power of procedural modeling with the simplicity of Photoshop.





Haptic Robotic Interfaces

An ongoing challenge in design robotics is the latency that often occurs between design and robotic execution. In part as an extension of our work on robotic spaceframe assembly, we have taken on a number of initiatives around computer vision, projection, and realtime robot interaction. The Lab has acquired two Universal robots, the industry standard for co-working interactive technology. We have also developed tools that allow the realtime feedback and response of the robots, which can lead to a range of applications, including augmented construction and realtime assembly interfaces. Some student projects in the last year have demonstrated the power of these new tools, including the holographic realtime interaction interface above.

Publications

The publications of the Lab in the past year have focused on both morphological and historical issues.

Andrew Witt, “Cartogramic Metamorphologies; or, Enter the RoweBot” (Log 36, Winter 2016) The paper summarizes Witt’s recent work on seeing and classifying machines, specifically bots that scan urban form to generate metamorphological trees.

Andrew Witt, “Landscapes, Spaces, Meshes: A Cultural Narrative of Design Technics” (Forthcoming, in anthology Architecture is All Over). This paper considers the historical development of meshes as both tools of landscape and spatial measurement.

Witt also continues to collaborate with the Canadian Center for Architecture around the world’s first archive of digitally-native projects. He has been invited to contribute an essay on the critical digital projects of 1970 to a forthcoming volume of digital design histories compiled by the CCA.

THE JUST CITY LAB

Professor Toni Griffin

The Just City Lab investigates the definition of urban justice and the just city and examines how design and planning contribute to the conditions of justice and injustice in cities, neighborhoods and the public realm.

Would we design better places if we put the values of equality, inclusion or equity first? If a community articulated what it stood for, what it believed in, what it aspired to be - as a city; as a neighborhood - would it have a better chance of creating and sustaining more healthy, vibrant place with positive, economic, health, civic, cultural and environmental conditions. Imagine that the issues of race, income, education and unemployment inequality, and the resulting segregation, isolation and fear, could be addressed by planning and designing for greater access, agency, ownership, beauty, diversity or empowerment. Now imagine the Just City - the cities, neighborhoods and public spaces that thrive using a value-based approach to urban stabilization, revitalization and transformation. Imagine a set of values that would define a community's aspiration for the Just City, and imagine that we can assign metrics to measure design's impact on justice, and imagine we can use these findings to design interventions that minimize the conditions of injustice.

Just City Essay Publication

Volume 1 was released in 2015 featuring 26 authors from 9 different countries. A second volume is planned to further the discussion and debate about whether a truly just city is achievable. A series of forums will also be planned, featuring best practices.

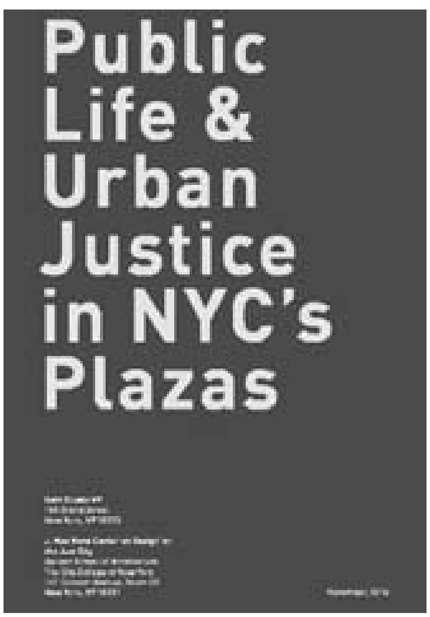
Just City Participatory Planning Approaches

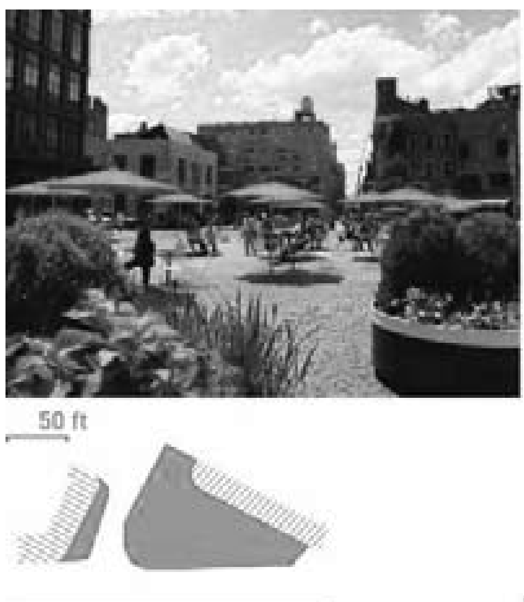
As part of the Just City Indicator Project, the lab will research and develop unique participatory tools that enable a community to define the values necessary to achieve their just city or just community. The tools will also equip communities with the ability to collect and analyze neighborhood data to be entered into the indicator framework for evaluation of the presence of just and unjust conditions.

Just City Indicator Project

Over the last decade, indicator frameworks around sustainability, livability and resiliency have been incorporated into many municipal governance structures as a way to monitor progress on achieving healthier environments, growing economies and improving operating efficiencies. These frameworks also aim to address the provision of "equity", and balance the need to tackle place-based and people-centric issues. This lab operates from the opinion that many of these frameworks fall short on truly measuring the presence of equity and often lose sight of other critical social justice values. In fact, the lab questions whether striving for equity alone is enough to address the challenges of exclusion, disrespect, intolerance, and marginalization in the space of the city. The Just City Indicator Project is developing an indicator framework tool including an elaborate menu of urban values, indicators and metrics, both spatial and social, designed to evaluate how design of the built environment contributes to health, economic, civic, cultural, aesthetic and environmental design wellbeing. The initial pilot project, "Public Life and Urban Justice in NYC's Public Plaza's" was completed in 2015 by Professor Griffin, with the J. Max Bond Center, Gehl Studios and Transportation Alternatives. The second pilot project to create an indicator framework for the neighborhood scale is under development. These issues are also explored through the GSD spring seminar, Design for the Just City.

Just City publications and indicator studies dated 2015 were developed by Professor Griffin at the J. Max Bond Center on Design for the Just City at the City College of New York, Spitzer School of Architecture.





Meatpacking Plaza

Flatiron Plaza

Concrete 3D Printing: Evaluation Framework and Process Model
Sponsor: Industry

The study included a comprehensive literature review on existing and emerging printing technologies for concrete, including interviews with all major research groups. The key parameters that influence speed and quality of printing along with related mechanical and other properties of the cured concrete were identified. Several applications were modeled in terms of cost and process parameters with the goal to identify the most promising applications, and understand the challenges which need to be overcome before advancing the technology from its current state of emerging into a feasible delivery process for construction components and elements.

Status: Completed, paper in preparation

3D Printing of Ceramics
Sponsors: ASCER Tile of Spain, AutoDesk BUILD Grant

The project develops various technical capabilities for printing clay-based and cementitious ceramic materials, with a special interest in expanding the control of material properties in ways as to allow for functionally graded materiality to be become a reality. Structural as well as thermal applications are being investigated. A related workshop offered as part of the 2016 RobArch in Sydney won the best workshop award.

Status: in progress

Fig. 1: Interactive 3D printing at RobArch 2016. Collaboration with Alexandre Dubois (IAAC Barcelona), Dagmar Reinhart (University of Sydney) and Kate Dunn (University of New South Wales)

Extruded Wall: Tessellated Tectonics
Sponsor: ASCER Tile of Spain, Cevisama Valencia

The tessellated wall explores the design space of a novel ceramic customization strategy developed by MaP+S researchers and students. The initial process idea was developed by Stefano Andreani, Jose Luis Garcia del Castillo Lopez, and Aurgho Jyoti in a course taught by M. Bechthold. The technique involves the automated cutting of clay extrusions that are industrially produced on a state of the art extrusion line. The approach is based on extruding pieces from a single die, thus minimizing tooling costs while at the same time maximizing the scope for varied design expressions.

The tessellated wall investigates the design space of this approach with a module design that features interlocking, ornamental patterns which allow for novel structural use of ceramic blocks in planar, folding and curved wall assemblies. The modules are produced with a complex extrusion die developed for project. Robotic manipulators equipped with wire-cutters can be integrated into the production system to trim off the end surfaces at custom angles and lengths as the wet clay is extruded. Alternatively, CNC saws can perform automated cutting operations after the large ceramic extrusions have been fired. Both approaches allow for low-cost customization of the ceramic modules to achieve a unique three-dimensional expression, control views and light, as well as address different structural needs in the wall. The modules can be bonded with cement for permanent installations, or be dry stacked and clipped together for easy assembly and disassembly, as was the case for CEVISAMA 2016.

The two walls displayed at the 2016 Cevisama consist of approximate 700 elements with lengths ranging from 15 to 60 cm. Variations in length and cutoff angle lead to 38 unique elements for the installation. These pieces are used to create a unique surface texture on every wall surface, but maintain the overall consistency of a strongly ornamental expression of the tectonic system.

Status: Completed

Fig. 2: Finished Walls at the 2016 Cevisama in Valencia.

Adaptive Living Environments (ALivE) Collaboration
Sponsor: Wyss Institute for Biologically Inspired Engineering

The ALivE group is a collaboration between MaP+S, Harvard GSD REAL (Prof. Allen Sayegh), and scientists from the Wyss Institute's Adaptive Materials Platform led by Prof. Joanna Aizenberg. The 2015 research focused on transformable material formations based on elastic deformations, challenging the paradigm of mechanical gears and linkages of traditional kinetic systems. Among these, auxetic material patterns offer the opportunity to transform larger surfaces that are subdivided into smaller units into visually and acoustically active materials. Recent research by the Bertoldi group at the Harvard University Paulson School of Engineering and Applied Science (SEAS) developed non-linear finite element analysis methods that have allowed the rapid design of novel auxetic patterns for transformable material systems in sheet form as well as volume configuration. The physical production of prototypes, however, was cumbersome, and their actuation remained difficult. The 2015 ALivE project researched issues involved in scaling up transformable patterns into an architectural scale prototype that was presented at the 2015 retreat of the Wyss Institute for Biologically Inspired Engineering. The research produced strategies for blending and scaling patterns and presents strategies for adapting patterns to irregular boundary conditions. During the course of the study several actuation systems were developed. Prototypes were generated using multi-axis robotic fabrication methods that further broaden design scope of transformative auxetic material systems.

Status: Completed, Publication in preparation

Fig. 3: Wyss retreat exhibition by the ALivE group.

Composite Constructions
Sponsor: Industry

The study investigates novel opportunities for composite material systems in architecture, leveraging design computation, robotics and material exploration.

Status: ongoing

The Responsive Environments and Artifacts Lab (REAL) at Harvard Graduate School of Design is a research lab that pursues the design of digital, virtual, and physical worlds as an indivisible whole. It recognizes the all-pervasive nature of digital information and interaction at scales ranging from our bodies to the larger urban contexts we occupy and the infrastructures that support them.

REAL takes an interdisciplinary look at the design of the built environment from the lens of technologically-augmented experiences, with a strong focus on the sustainability and longevity of technology. Putting the human being at the center and forefront, researchers at REAL examine the emerging ways in which technology fuses into the ways we live, work, and play – from the micro (bodily sensors, smart product design, augmented interfaces) to the macro (interactive buildings, information infrastructures, communication frameworks).

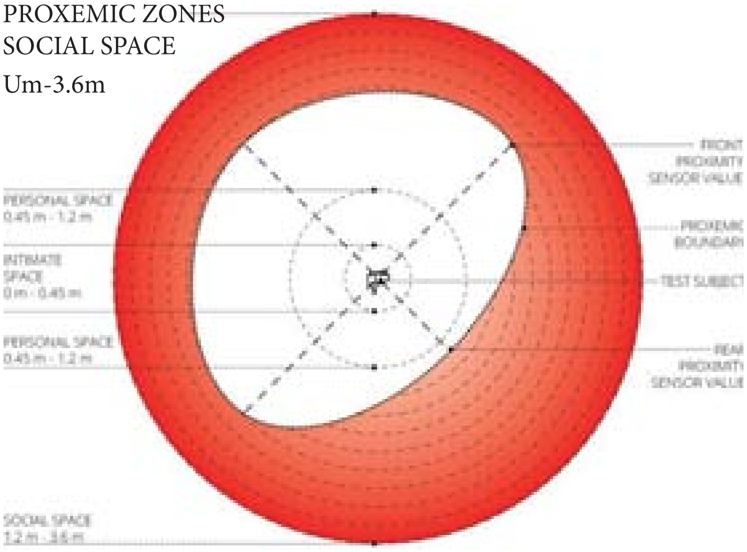
What kind of interfaces embrace our social, cultural, and natural landscapes? How does mediated matter permeate our environments, our surroundings, and our personal space? What experiences are truly physical, and what are truly digital today? How can we design for an audience that is rapidly adopting new technologies and what approaches can we take to embody responsiveness in our design decisions?
REAL pursues a design-led approach for the development of alternative models, technologies, and processes to be applied to artifacts and buildings as well as to cities and landscapes, with the ultimate objective of mediating and augmenting the relationship between the individual and the urban environment.

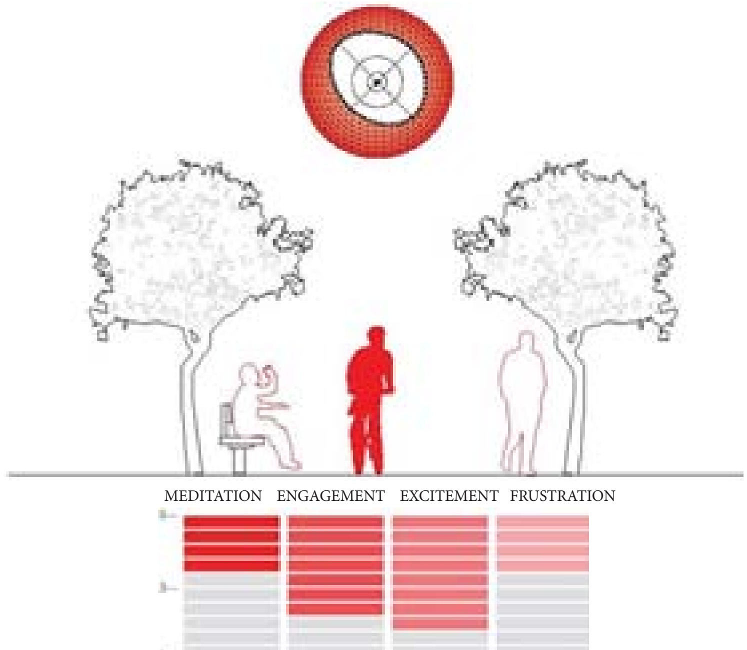
PROJECTS

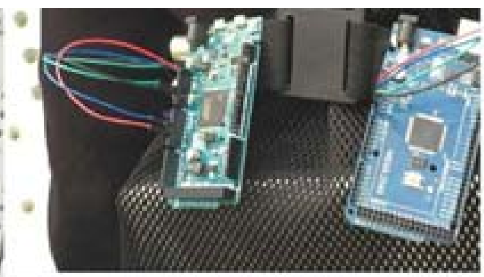
Genome of the Built Environment

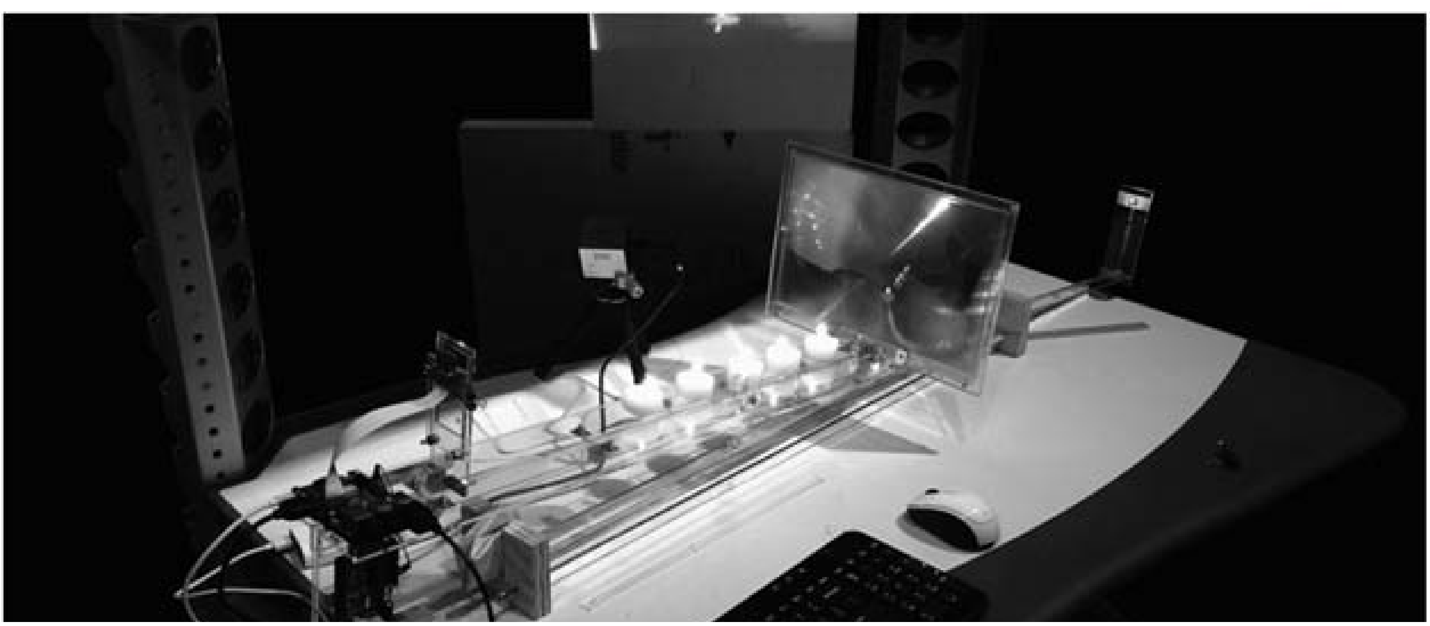
The built environment is one of the most fascinating yet enigmatic artifacts of the human being. We perceive it as a complex entity resulting from the juxtaposition of spaces, flows, experiences, objects, and events. Each environment has certain qualities, and – even though shared characteristics do exist – those qualities vary from place to place. Articulating criteria of investigation and speculating on the role of design technology, this project introduces a new paradigm of how we might understand the built environment. How we might perceive it, and thus evolve it. The research attempts to answer some basic but fundamental questions, such as: What makes built environments differ from one another? What creates consistencies between different places? What is the impact of certain elements of cities in our state of mind?

The “Genome of the Built Environment” investigates the role of new augmenting and responsive technologies in articulating, mapping, and exploiting the specificities of places through a multi-sensory approach. The ‘beat’ or the pace is one characteristic that has been established trying to uniquely characterize cities by identifying a distinct pace to each of them. But what are the other new qualities that are measurable that help us understand cities in new and perhaps previously unexplored ways? This project aims to measure and elaborate on quantitative descriptions of ‘hidden’ characteristics, attempting to build correlations between different unseen but detectable qualities of the built environment – in addition to the pace, the colors and tones, the mood of places, the agitation levels, the micro-climate, etc.


PROXEMIC ZONES
SOCIAL SPACE
Um-3.6m
FRONT PROXIMITY SENSOR VALUE
PERSONAL SPACE 0.45 m - 1.2 m
PROXEMIC BOUNDARY
INTIMATE SPACE 0 m - 0.45 m
TEST SUBJECT
PERSONAL SPACE 0.45 m - 1.2 m
REAR PROXIMITY SENSOR VALUE
SOCIAL SPACE 1.2 m - 3.6 m


MEDITATION
ENGAGEMENT
EXCITEMENT
FRUSTRATION

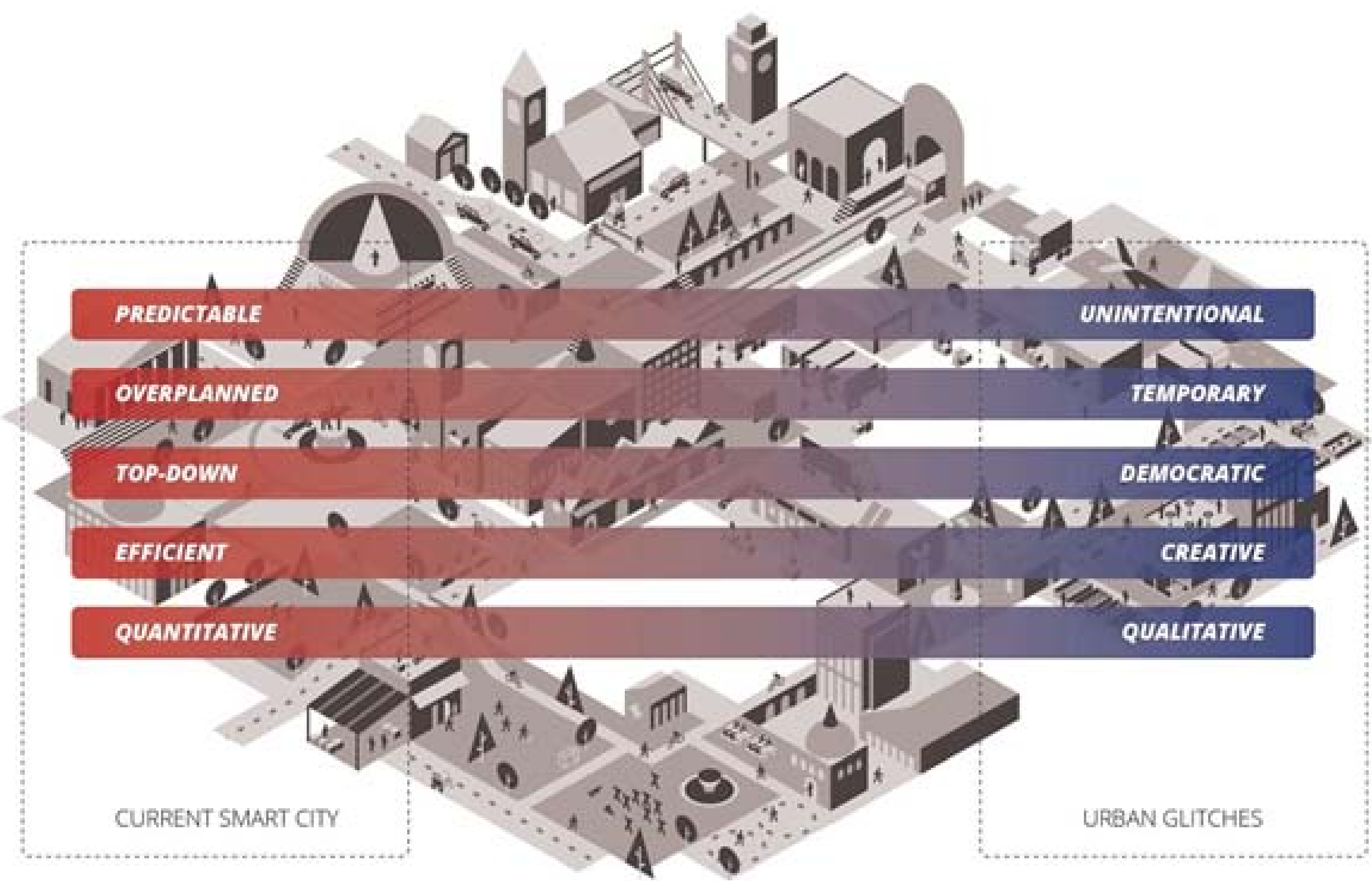




Creative Glitches in Cities

Drawing from an ongoing research initiative at REAL in collaboration with the University of Bergamo, this project introduces a new take on the framing and creative potentials of situated and connected environmental technologies. In particular, it proposes the concept of Urban Glitches as a trigger for creativity and how these can translate to the urban space of the city. As a reaction to the digitally driven, routine inducing built environments depicted by current smart city concepts, this project proposes the urban glitches as important elements to help create technologically driven conditions other than efficiency, which is widely the driver in the approach to smart cities.

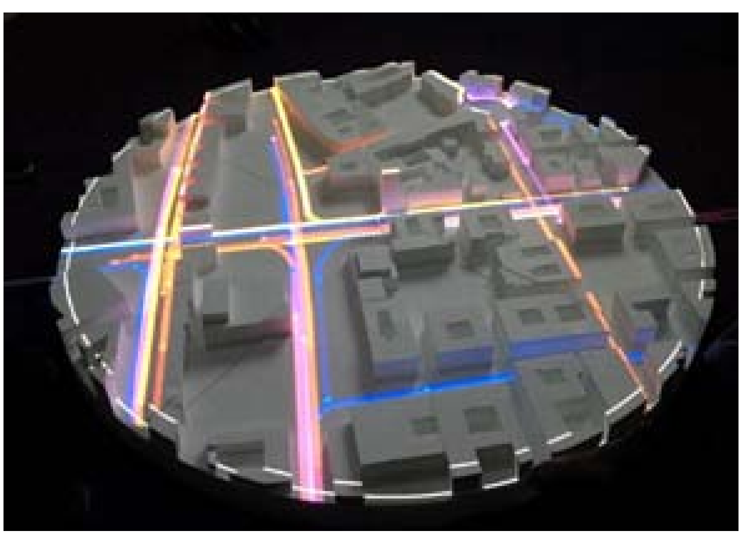
Urban glitches – that are unintentional, temporary, democratic, creative, and qualitative – ultimately become a recipe for the design of technologically augmented or 'smart' cities, developing environments that foster creativity, have a better ambiance, and lead to pleasant and unexpected repercussions throughout the whole city. Using the glitch as a metaphor in the context of food systems, this research developed alternative design strategies to augment food experiences. Such strategies include: adopting the concept of 'portals' as a way to test the uncanny ability of food to transcend space and time; using interactive technologies for augmenting the experiential qualities of food to activate and to revitalize abandoned and unused spaces in cities; creating new opportunities for people to engage with food by digitally augmenting the user/dish connection and embracing the whole food system.

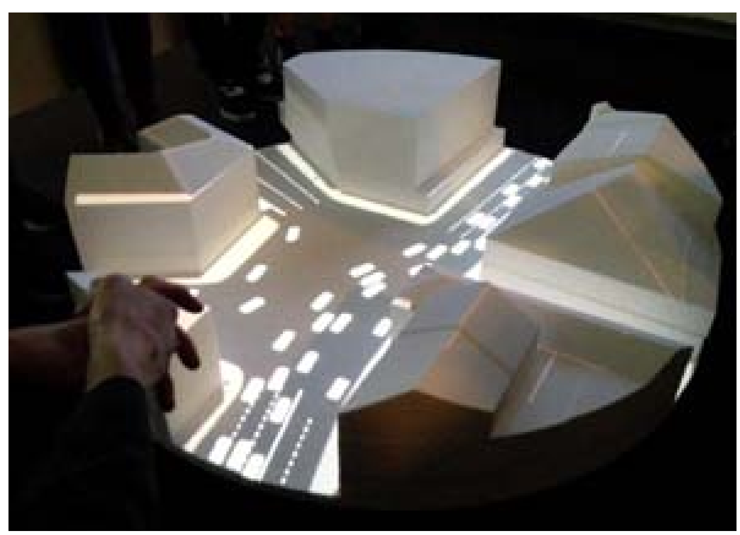


Motion and Emotion

With a focus on urban mobility, this project addresses the question of how the built environment and its infrastructures will integrate emerging technologies and trends for evolving mobility patterns and systems, and how users will adapt to – and in some cases drive – those changes. The research, in collaborations with the University of Bergamo, ultimately aims to investigate the complex interplay of people's behaviors and new modes of transportation in future urban scenarios, opening up unexpected research and design opportunities as well as generating impulses and solutions for cities at different scales.

This project is part of a research initiative with the University of Bergamo ("REAL Cities | Bergamo w2035") and will create alternative urban scenarios and new experiences in the city 20 years from now. Using the City of Bergamo – a typical mid-size European city – as a case study, the research employs technological-longevity design strategies in order for the adopted technologies to be still valid in 2035. The research and design work is pursued through the engagement of local stakeholders – from municipality representatives to industry experts – with the aim of developing prototypical interventions that address specific issues of Bergamo and yet can be replicated in other contexts as well.





RECENT PAPERS

Bechthold, M, Sayegh, A. “Hacking Science: The ALivE Group’s Material Design Methods for Interdisciplinary Environments,” in Material Synthesis: Fusing the Physical and the Computational, Architectural Design 237, Wiley, 2015.

Andreani, S., Sayegh, A., Responsive Environments and Artifacts: Answers to the Future of Technology, Cities and the Human Being (in preparation).

Sayegh, A., Andreani, S., et al, “Experiencing the Built Environment: Strategies to Measure Objective and Subjective Qualities of Places,” ACADIA - POSTHUMAN FRONTIERS: DATA, DESIGNERS AND COGNITIVE MACHINES, University of Michigan, 2016 (submitted).

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Sayegh, A., Andreani, S., et. al. “A New Method for Urban Spatial Analysis: Measuring Gaze, Attention, and Memory in the Built Environment,” in Proceedings of UrbanGIS 2015: The First International Workshop on Smart Cities and Urban Informatics, Seattle, 2015.

Over this academic year, the GSD Social Agency Lab concluded several long-standing projects and began several new projects to be implemented over the coming two years. The lab's completed projects focused on the urban impacts of oil exploration in Ghana, rapid urbanization in Mongolia, post-disaster reconstruction in Haiti and experimental approaches to perceptions of urban density (Figure 1). These projects were financially supported with by a Milton Fund Grant, the American Planning Associate, a GSD Dean's Research Grant, the Joint Center for Housing Studies and the Harvard Academy for International and Area Studies. These projects all involved multiple GSD students and recent graduates as research and fieldwork assistants (Appendix 1). Each of the projects resulted in at least one peer-reviewed journal article, which are summarized in the following section.

The lab hosted and participated in several events over the academic year. Most notably, the lab organized and hosted a symposium and panel discussion on the future of urban planning in Havana. The event, held at the GSD on September 24, 2015, was entitled "The challenge of change: The future of Havana." It brought seven of the most dynamic young planners and architects from Havana to Harvard for several days of discussion and presentations regarding the future of Cuba's capital.

Fig 1. Research assistants Allie Tuvshinbat (MUP '15), Batjin Boldbat and Anji Clubb (MUP '14) conducting interviews in Ulaanbaatar, Mongolia (left), and the research team, including Raven Anderson (MUP '14), Batjin Boldbat and Allie Tuvshinbat (MUP '15) posing after a day of fieldwork.

Research Outputs: Published and Under Review

Pym, M. and M. Hooper. 2016. "Humanitarian standards in urban, post---disaster contexts: A study of Sphere shelter standards in Haiti." *Humanitarian Exchange* [Under Review]

Hooper, M. 2016. "Flatulence, filth and urban form: Do hygiene and sanitation cues influence perceptions of urban density?" *PLOS One* [Under Review]

Hooper, M. 2016. “When diverse norms meet weak plans: The organizational dynamics of rubble clearance in post-disaster Port-au-Prince, Haiti.” *Natural Hazards Review* [Under Review]

Anderson, R. and M. Hooper. 2016. “Competing organizational perspectives on rapid urbanization and its management: A case study of Ulaanbaatar, Mongolia.” *International Development Planning Review* [In Press]

Anderson, R. and M. Hooper and A. Tuvshinbat. 2016 “Towers on the steppe: Compact city plans and local perceptions of urban densification in Ulaanbaatar, Mongolia.” *Journal of Urbanism* [In Press]

Hooper, M. 2015. “Will the city rise again? The contested geography of housing reconstruction in post-disaster Haiti.” *Housing Studies,* 30[7]: 1016-1035.

Eduful, A. and M. Hooper. 2015. “Urban impacts of resource booms: The emergence of oil-led gentrification in Sekondi-Takoradi, Ghana.” *Urban Forum,* 26[3]: 283-302.