Grant Deliverables and Reporting Requirements for UTC Grants

UTC Project Information	
Project Title	URBANO: A computational tool-kit for integrated urban design incorporating active transportation, pollution, and outdoor comfort models to facilitate the design of healthy and sustainable urban habitats
University	Cornell University
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Funding Source(s) and Amounts Provided (by each agency or organization)	USDOT: $65,349 Cornell: $33,375
Total Project Cost	$98,724
Agency ID or Contract Number	Sponsor Source: Federal Government CFDA #: 20.701 Agreement ID: 69A3551747119
Start and End Dates	Start date: 10/01/18 End date: 12/31/19
Brief Description of Research Project	Rapid urbanization and new construction estimated to be 250 times NYC by 2050, is increasing traffic congestion, pollution and related health threats. Understanding consequences of urban design choices on mobility, sustainability and health is hence a necessity and requires development of a new design toolkit that allows non-specialized urban designers to quantify performance of mobility solutions, sustainability, public health impacts, pedestrian thermal comfort and pollution exposure during the earliest stages of a design process. Embedded in a generative, performance driven design process, such a tool can significantly facilitate the design of healthy and sustainable urban habitats that promote active mobility.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	The Urbano.io software was expanded to address the following high-level questions: How does a specific design choice influence active mobility and transit use, and what kind of health and sustainability impacts will stem from that? We made four major novel contributions:

	Improvements to the Urbano simulation tool. We made a series of improvements to the Urbano tool. This includes new methods to consume urban data sets for urban site analysis and new features to conduct mobility analysis in urban design have been added. These include: • Automated model setup process using OSM and other urban data sources for parametric urban design. • A data-driven metric called Amenity Demand Profiles (ADP) that describe the needs and preferences of different demographic groups. • A trip-sending simulation process that is mainly driven by the ADP and the shortest-path algorithm. • An advanced Walkscore that can apply customized weighting according to the local ADP. • Amenity utilization metric called Amenityscore that describes the demand for services at a specific amenity. • Street utilization metric called Streetscore that indicates the pedestrian density on particular street segments. • A mobility toolkit inside a visual scripting environment that includes the ability to customize workflows and define custom performance metrics. • A series of test studies demonstrating the capability and applicability of the new modeling framework. A detailed description the new methods and has been published in the Technology, Architecture and Design Journal: *Dogan, T., Yang, Y., Samaranayake, S., & Saraf, N. (2020). Urbano: A tool to promote active mobility modeling and amenity analysis in urban design. Technology| Architecture+ Design, 4(1), 92-105. https://doi.org/10.1080/24751448.2020.1705716* *Yang, Y., Samaranayake, S., & Dogan, T. (2019). Using Open Data to Derive Local Amenity Demand Patterns for Walkability Simulations and Amenity Utilization Analysis. Proceedings of ECAADe 37/SIGraDi, 23. DOI: 10.5151/proceedings-ecaadesigradi2019_627*

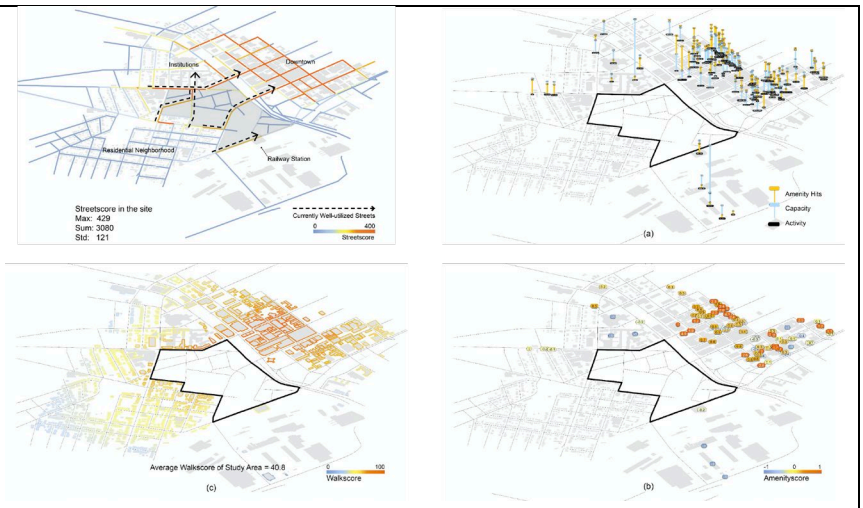


Figure1: Site analysis using Urbano.io. Street utilization, Amenity utilization, Walkscore per building.

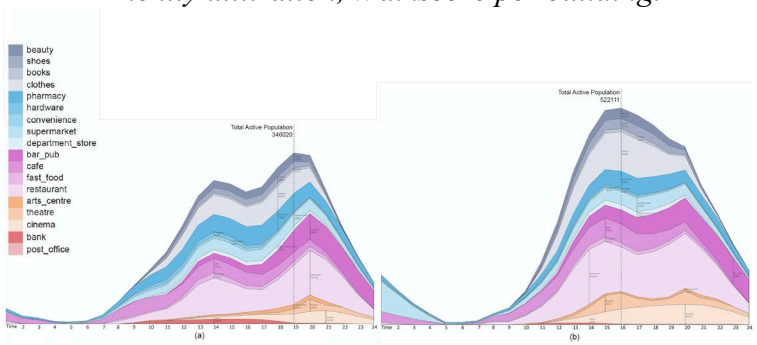
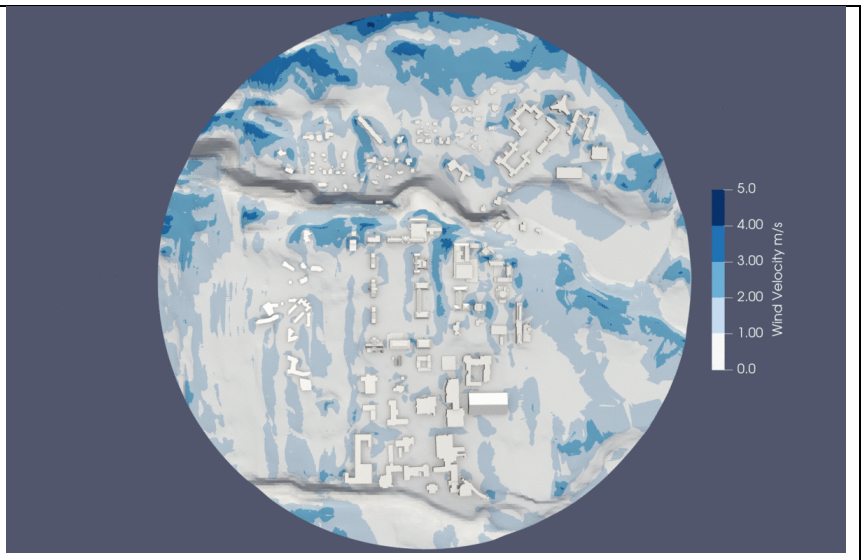


Figure2: Google Places "Popular Times" is used to extract activity profiles for neighborhoods.

Validation of outdoor comfort simulations using field measurements in Ithaca.

To facilitate urban scale CFD simulations for outdoor thermal comfort predictions we introduced a novel a routine to create a cylindrical mesh that expedites the simulation of arbitrary wind directions using OpenFOAM. Results computed with the cylindrical domain are validated against wind tunnel data. We report that the cylindrical method yields comparable results in terms of accuracy and convergence behavior. Further, run time comparisons in a real-world scenario are conducted to discuss its advantages and limitations. Based on the findings, we recommend using the cylindrical approach if at least eight wind directions are analyzed for which we report 18% run time savings.

Kastner, P., & Dogan, T. (2020). A cylindrical meshing methodology for annual urban computational fluid dynamics simulations. Journal of Building Performance Simulation, 13(1), 59-68. https://doi.org/10.1080/19401493.2019.1692906

	 *Figure 3: Multi-directional CFD (RANS) analysis predicting local wind velocities.* To validate micro climate simulation workflows we began collection of sub-hourly microclimate data on the Cornell campus. This data is used to validate microclimate simulation model. A comprehensive validation publication that juxtaposes simulation-based predictions and long term measurements for all relevant microclimate variables is progress. Preliminary validation results show satisfactory accuracy and have been published at the IBPSA Building Simulation conference: *Kastner, P., & Dogan, T. (2019, September). Towards High-Resolution Annual Outdoor Thermal Comfort Mapping In Urban Design. In Proceedings of the 16th International IBPSA Conference, Rome, Italy (pp. 2-4).* **Raw data will be available at:** https://github.com/EnvironmentalSystemsLab/CampusMicroclimateAndWeather
Impacts/Benefits of Implementation (actual, not anticipated)	**Impacts:** Urbano provides urban designers, and other stakeholders of the built environment, with the ability to quantify and understand the impacts of new site design choices on active mobility and access to urban amenities. The software developed as part of this research generates specific design feedbacks which can lead to actionable design solutions for enhanced urban walkability. The proposed scores can be further related to higher-level metrics on

	sustainability, public health, economics, and quality of life to understand the broader impacts of urban design. **Facilitate the design of healthy and sustainable cities:** This research advanced the understanding of the mobility systems during the urban design process through user-friendly computational modeling, visualization interfaces that can cope with spatial and temporal data sets. The software implementation in Rhino3D provides increased accessibility to optimization and machine learning workflows for designers. Urbano.io was publicly released and announced in November 2019 and has been downloaded over a thousand times by practitioners, students and educators in the urban design profession. **Rhino News:** http://blog.rhino3d.com/2019/11/urbano-for-urban-mobility-simulations.html **Forbes:** https://www.forbes.com/sites/juliabrenner/2019/11/13/new-free-software-helps-architects--city-planners-create-walkable-cities-of-the-future/#33edcaf098b8 **Trackable number of downloads:** https://www.food4rhino.com/app/urbano **Improved STEM Education:** The outcomes of this research are actively used in classes thought at Cornell Architecture and thus is growing the scientific workforce capable of studying and managing mobility systems. Urbano.io is popular among designers because it lowers the barrier of entry to complex mobility simulations. **Collaboration with design practitioners:** We closely collaborated with design practitioners at KPF to solicit their feedback and to test research outcomes on real-world projects and problems. The KPF and Cornell collaboration lead to several implementations of Urban in design and a joint project conducted with Sidewalk Labs in Toronto.
Web Links • Reports • Project website	Project Page: www.urbano.io Lab Page: www.es.aap.cornell.edu http://ctech.cee.cornell.edu/final-project-reports/