A Fresh Approach to City Design & Research

The City Form Lab (CFL) at the Singapore University of Technology & Design, founded in collaboration with the School of Architecture & Planning at MIT, focuses on empirical studies of city form and urban design. Our empirical work centers on two interrelated aspects: We investigate what social, economic, and environmental processes lead to particular configurations of city form, and analyze what effects these configurations, once in place, have on the social and economic potential of urban environments. Our work aims to broaden the understanding of how changes in the spatial configuration of cities impact the social and economic well-being of their users.

We recognize that the relationship between the configuration of a city’s infrastructure—the two- and three-dimensional geometry of buildings, public spaces, and streets that connect them—and the socio-economic quality of a place is still poorly understood among researchers, practitioners, and policy-makers of urban design. Our aim is to become a leading research lab to offer analytical capability in city form studies to professionals around the world. Using spatial analysis tools and statistical methods to empirically evaluate the performance of urban infrastructures in existing built environments, we explore how to better integrate descriptive research with prescriptive design practice.

Our research is focused in the following three areas:

Urban analysis software tools:
CFL develops new spatial analysis software tools for studying the formal structure and activity patterns of cities. Taking advantage of increasing computational power and availability of geographic datasets describing the forms and activity patterns of cities, CFL is currently developing an open-source Urban Network Analysis toolbox for ArcGIS. As the first freely available and open-source toolbox for urban network analysis, the software can be used to compute calculation-intensive spatial accessibility indices on urban street networks. Currently offering five different types of indices, the toolbox allows architects, urban designers and planners to accurately quantify the three-dimensional network characteristics of different buildings and neighborhood layouts. These indices have numerous practical applications, including predictions of economic establishments’ location patterns, neighborhood walking activity, and traffic patterns. We released the first version of this software in September 2011 and it has been downloaded by over 10,000 researchers from more than 100 countries worldwide.

CFL will continue the development of spatial analysis tools for urban design on an open-access basis, expanding their functionality, and improving awareness and access to architects and urban designers and policy makers. By offering cutting-edge spatial analysis of urban environments and sites, we aim to foster better informed design and policy decisions in city development.

Empirical case-studies of city form:
The aforementioned urban analysis tools are prerequisites for performing empirical analysis of existing urban development patterns. The tools allow different professionals engaged in urban analysis to share a common language about the environment under study, and to describe the social and economic effects of spatial configuration with clarity and precision.

We see Singapore as an ideal test-site for the lab’s research. Its compact size, variety of development typologies, interest in innovative planning solutions, and data resources will allow Singapore to serve as an ongoing case-study environment for the theory and tools developed at the CFL. Beyond Singapore, we are particularly interested in empirical investigations of less developed informal cities in the SE Asia, where our ability, as urban designers, to comprehend the spatial and social environment remains extremely limited. Lacking the basic infrastructure and institutions of modern cities, the structure of informal urban form remains largely opaque to both design education and practice, posing fundamental challenges to the competence of urban designers in addressing this widespread form of development in the 21st century. Forming partnerships with local NGOs, the CFL expects to engage in research in China, Malaysia, Indonesia and India to better understand the spatial and economic structure of informal settlements, exposing the opportunities and refining the role of professional involvement in such contexts.

Urban design strategies:
CFL’s work on spatial analysis tools and empirical case-studies will ultimately help inform new urban design approaches. We are particularly interested in investigating design strategies that show promise in achieving performance targets in solvability, land-use mixing, energy consumption, transit usage, and adaptability to growth and change.

The transfer of analytical knowledge to design proposals will mostly take place in the “studio” and “workshop” format. The lab will organize studio events that aim to transfer existing experimental research to contemporary design practice, the analysis tools (CFLS and SA+) researchers from different public/academic sectors to work on real-world urban design challenges with scholars and cities around the world, and in particular the rapidly developing cities of SE Asia. The studios will take students and researchers to project sites for short intensive learning experiences and operate in partnership with local sponsors and organizations. The CFL will provide technical support to the studios, help set up the partnerships, and determine the most relevant research topics for each studio site.

Current research projects:

Urban Network Analysis Toolbox
Designing for Growth & Change
Urban Density & Business Location Patterns

The City Form Lab has released a state-of-the-art toolbox for urban network analysis. The tools are aimed at urban designers, architects, planners, geographers, and spatial analysts who are interested in studying the spatial configurations of cities, and their related social, economic, and environmental processes.

Find out more at:
http://cityform.mit.edu/projects/urban-network-analysis.html

We are currently investigating architectural and urban design solutions that are well-suited to accommodate growth and change. We analyze design strategies that adapt, with ease and elegance to changes in use, and explore building and neighborhood configurations that can readily accommodate growth in demand over time.

Find out more at:
http://cityform.mit.edu/projects/designingchange.html

We have developed a unique methodology for investigating which spatial and economic factors affect the distribution of urban economic establishments. The work provides a better understanding of how urban density and configuration impact land location patterns, and thereby shape the character of urban environments. Using urban network analysis and spatial analysis, we have completed a study of retail and food-service establishments’ location choices in Cambridge and Somerville, MA. We are now expanding our focus to S.A., Singapore and other cities.

Find out more at:
http://cityform.mit.edu/projects/locationpatterns.html
Urban Network Analysis: A Toolbox for ArcGIS

The City Form Lab has created a new Urban Network Analysis (UNA) toolbox that enables urban designers and planners to describe the spatial patterns of cities using mathematical network analysis methods. While the study of spatial networks goes back to Euler and his famous solution of Königsberg’s seven bridges in the 18th century, there were, until recently, few tools available to city planners to capture computationally-invasive spatial connectivity measures on diverse networks of city streets and buildings. The new toolbox, which is developed as a free and open-source extension for ArcGIS, allows urban designers and planners to describe the spatial analyses and model potential urban network scenarios. The urban network analysis toolbox would be a valuable addition to the urban design tool kit. These analyses have numerous practical applications. They help planners, for instance, on which streets or buildings one is most likely to find local commerce, where foot or vehicular traffic is highest, and why city land values vary from one location to another. They offer a powerful tool to study spatial relationships between urban activities under the actual geometric constraints of building, pedestrian and street networks, which have been largely ignored in opioid economic models in the past.

The tools incorporate three important features that make them particularly useful for urban analysis on urban street networks. First, they can account for both geometry and topology in the input networks, using either metric distance or euclidean centroid distance on a street network. Second, unlike previous extensions that operate with two network elements (nodes and edges), the UNA toolbox is a third network element. Buildings, which are the most important urban built form and landscape, are added as a third element, allowing for the analysis of network connectivity and the identification of key nodes and edges. The analysis works by considering each building b as a candidate node and each connection between buildings as a candidate edge. The network is then used as a weighted graph, with the weights representing the strength of the connections between buildings. This approach allows for the analysis of network connectivity and the identification of key nodes and edges.

The tools are aimed at urban designers, architects, geographers, and spatial analysts who are interested in studying the spatial configurations of cities, and their impact on social, economic, and environmental outcomes. The UNA toolbox can be used for small-scale and detailed network analysis of diverse urban areas. The UNA toolbox is available as a free and open-source extension for ArcGIS and can be freely downloaded from the City Form Lab website.