Urban Acupuncture Through Algorithmic Zoning

Based on discussions of the smart city, zoning methods, and urban acupuncture, a theoretical framework is developed for a computational approach to city planning. Through the identification of synergistic relationships, optimized conditions are sought where public and private goals are both met. By combining top-down and bottom-up approaches to planning, new methods of governance can emerge.

Currently urban designers and architects are just beginning to explore the possibilities of data driven planning and development. Successful examples of such interventions include the real time adjustment of parking valuation based on demand, the improvement of transportation timing using mobile phone location data, and the installation of smart power and water infrastructure. These projects are mainly focused on improving the resiliency and efficiency of infrastructure or on facilitating interactions between planners and citizens to increase democratic participation and improve feedback loops. Presently, pursuit of the “smart city” is similar to sustainability in decades past. Although initially a meaningless buzzword, the concept of sustainability became useful through rigorous definition of the triple bottom line theory and the development of diagrammatic methodologies like systems thinking (figures 1 and 2). A wide variety of smart city definitions are based on the inclusion of certain technologies or use of a systematic approach to the planning process [1], but the most compelling definitions focus on the effects and interdependencies created by initiatives, rather than on the inclusion of particular systems. Claudet et al, explained this seemingly contradictory paradigm by stating “As technology
continues to dematerialize and permeate the physical environment – essentially, to disappear – it is foregrounded by the non-digital aspects of life: community, aesthetics, and nurturing environments” [2]. The real successes of computation emerge when technology seamlessly integrates into our daily lives, facilitating a focus on the more important aspects of human interaction within the built environment. Therefore, in the context of this work, the smart city is best defined: through the most effective means of data collection and analysis – a smart city is one that leverages its available resources to improve the quality of life for as many of its citizens to the greatest extent possible, in a way that enables systematic evaluation of its policy.

In the past, traditional Euclidian zoning and form-based codes provided the most effective method for regulating development to improve the well-being of citizens. The success of these methods was mainly due to their ability to simplify the complexities of urban conditions with an emphasis on application- necessitating a combination of reductionist and intuitive approaches to decision-making to achieve comprehensive design. However, there is only so much that can be quantitatively analyzed and conceptualized, even with the use of organizational methods such as systems thinking, before intuitive decision-making needs to be applied. As anyone who has worked with building codes and zoning knows, this regulatory framework has become complicated and difficult to navigate over time – resulting in the necessary specialization of consultants who deal solely with regulatory compliance for larger projects. This is so commonplace that architects such as Ted Smith have built their reputations on a detailed understanding of the regulatory framework, notable because it is so uncommon. Performance based and incentive zoning methods provide opportunities for the greater flexibility and project specificity that is necessary in our modern cities. However, these methods have been difficult to implement due to higher levels of complexity and discretionary favoritism – and a lack of transparency in the decision making process.

Urban Acupuncture is described as small interventions relative to the scale of the project context, which catalyze larger positive changes within the urban environment [3]. Popularized by former Mayor of Curitiba,
Jaime Lerner, notable projects include Rebar’s Civic Victory Garden in San Francisco (figure 3), Instant Taipei by WEAK! Architecture, and the Great Streets project in Los Angeles. Projects vary widely in their physical expression based on the specific needs of each community, but they share common themes of community-based planning and construction – often taking less than 72 hours to complete and using mostly volunteer workers. Through these projects food security is increased for vulnerable communities, informal gathering places are cemented in the urban fabric, and renovations to the streetscape transform the character of urban places.

Based on these three topics, this paper attempts to develop the role that computational design can play in facilitating human experience within the city, in the context of urban planning. This approach is informed by the concept of designing-in performance, which prioritizes the identification of ideal conditions in pre-design to create a framework within which design can take place. Algorithmic zoning is an example of this process (figures 4, 5, and 6), applied with specific goals regarding urban planning. If Urban Acupuncture is a strategy that focuses on bottom-up utilization cost-effective and community based solutions, and zoning laws focus on top-down regulation to control the nature of growth and development within the city – then the concept of algorithmic zoning finds its magic in the messy intersection of the two. Through utilizing existing and successful strategies, computational design has the ability to manage the complex relationships between different scales of information and power that drive urban planning. Through algorithmic zoning we can more effectively conceptualize these relationships and leverage processing power to optimize outcomes in a quantifiable manner.

EXAMPLES
Perhaps the best way to solidify this concept is through the short explanation of an example. This description will provide an understanding of the types of beneficial relationships that can be identified within the context of urban planning and facilitate illustration of the role that computation can play within this process. This example represents work that urban planners are, in many places, undertaking.
and any computational solution will owe a great debt to the people that developed systematic approaches to understanding the complexities of the urban environment.

The management of stormwater runoff is especially important in the context of San Diego. In the Healthy Environment chapter of the RCP SANDAG acknowledges the financial and recreational importance of water resources, and the dramatic effects of stormwater runoff on water quality in the region – stating that after just 0.2” of rainfall advisories are issued alerting the public of water contamination [4]. Efforts to address this are already underway through land-use planning that considers water quality effects within each watershed and through educational efforts to improve best management practices on each built project.

However, more specific planning of the relationship between individual projects and the larger system can be implemented using the algorithmic zoning framework. Within San Diego County there are 7 watersheds (figure 7), each of which contains collection points that can be identified by topographic analysis. When these collection points are compared to remaining developable area, there are a few areas of overlap (figure 8) that provide opportunities for reimagining the provision of public services related to the watershed and their relationship to private development.

On each of these properties allowable coverage and FAR are identified by current regulation to create development forms similar to what is shown in figure 9. However, to act as a collector for surrounding urban runoff, allowable coverage should be drastically reduced on this particular property and landscaping should be tailored to increase water infiltration and provide filtration. These types of alteration to regulations might result in a development pattern that appears closer to what is shown in figure 10.

Without careful consideration of the market context these changes would result in an unbuildable property, but through a corresponding increase in the allowable FAR the impact on landowners could be tempered. This could lead to the creation of unique development within the neighborhood that despite less buildable area, would likely be healthier and in high demand – while simultaneously providing services for the larger urban area.
Through this example we created a relatively simplistic relationship that identifies an interaction between coverage, FAR, and topographic features (figure 11). This relationship creates the basic elements for algorithmic zoning, but the truly interesting aspects of an algorithmic approach begin to emerge when information and relationships become more complex through layering multiple objectives, relationships, and databases to create a more fine-grained and specific application of the regulatory framework (figure 12).

Improvements in urban planning involve the layering of data to identify symbiotic relationships between defined parameters – then regulating to build in ways that take advantage of these relationships. By linking the many projects, data sources, and analysis methods currently engaging planners, it will be possible to evolve complex systems that can begin responding to questions of a more dynamic nature. Birkeland sees this examination of complexity as the essence of design, stating: “Design, as used here, means creating synergies, syntheses and symbioses across different dimensions: the cultural, social, psychological, economic, biophysical, climatic, and so on. Design can therefore best be described as open systems thinking: making fertile connections and adding multiple values as opposed to setting parameters and then ‘choosing’ among alternatives put forward by investors” [5].

DEFINITION
This work builds on the theoretical proposals of Erick Gardner and Alexandros Washburn, who both published brief conceptual outlines regarding algorithmic zoning. These are in turn, an extension of the writings of Christopher Alexander in “A New Theory of Urban Design” and of Andres Duany’s development of New Urbanism.

Alexander has developed a few key elements that define his approach to urban design including: a requirement to understand, respect, and seek to improve the existing conditions; incorporation of the decisions and needs of local stakeholders; a basis in generative processes to create emerging forms which are both local and unique [6]. From this work he outlines the development of a ‘generative code’ that focuses on the steps he deems necessary to facilitate urban planning.
Duany has critiqued attempts by Alexander as doomed due to an inability to scale up to deal with the larger challenges of modern urbanism [6]. Although this is valid, the protocols used in New Urbanism present their own challenges. Specifically, new urbanist developments often seem to be linked to a particular style, but without the inclusion of function. The projects often seem very artificial despite their focus on the replication of existing and successful vernacular patterns. In a sense, algorithmic zoning attempts to reconcile these two efforts by seeking the fine-grained specificity necessary for Alexander, but at a scale necessary for modern challenges as stated by Duany.

In this context it is important to note that current efforts have resulted in UrbanSim and Flux, both of which are functional urban design analysis programs upon which efforts in algorithmic zoning can be built. These systems have been highly successful in “reflecting(ing) the interdependencies in dynamic urban systems, focusing on the real estate market and the transportation system, initially, and on the effects of individual interventions, and combinations of them, on patterns of development, travel demand, and household and firm location” [7]. Although revolutionary, perhaps the main issue with these tools is that they focus largely on the analysis of design alternatives rather than on the identification of projects that will most effect the urban fabric in desired ways. This disconnect in approach is similar to an issue in architecture where we analyze already designed projects, rather than using technology to design-in performance. To achieve truly smart design of urban or architectural space, we must move away from the linear approach of design, analyze, build – to a cyclical process of analyze, optimize, test. In this way we can move beyond a preconceived notion of what an ideal outcome should be, and towards the testable evolution of smarter solutions. Anthony Townsend said this best when discussing his work predicting the future of the urban environment:

“I deliberately didn’t layout my vision for a new utopia because I think that’s the wrong way to think about it. We’ve seen any number of, sort of, poster child smart cities around the world – from Songdo in South Korea to Masdar in Abu Dhabi that really were planned utopias based on very sophisticated technology. They’ve either failed or are in the process
of failing. I think it’s because this technology is so flexible, so adaptive that there really is no single design that can capture all of its potential. I think that the tradition of good urbanism is that we should let order evolve from the bottom-up, through the investments and decisions that individuals and small groups make, and that technology really enables that.” [8]

**FURTHER DEVELOPMENT**

So far I have defined the concept of algorithmic zoning mainly through metaphor and example, speaking more about results emerging from the system than its programmed structure. This is because the idea is still a whisper around the edges of our collective consciousness. It will take some yet undefined form, driven by further study and work beyond the scope of such a short submission. However, I wanted to take this opportunity to further the development of this concept that I believe will, in the near future, irrevocably alter our world. I would like to end with a few concrete conclusions that can hopefully guide further development of the topic.

**Algorithmic zoning is about the definition of relationships**

This will take different forms in each city depending on existing logistics management, but will follow the common theme of creating a network that both defines and is altered by its pieces.

**The framework must be open-source**

The purpose of this is twofold. First, similar to performance based and incentive zoning, such a complicated decision-making process will be subject to claims of bias. By building-in transparency we can reduce the effect of this issue. Second, the open-source framework allows for cooperative development across multiple cities. This is the main benefit of the open-source framework utilized for OPUS.

**Standardization of data collection and evaluation is necessary**

To adequately compare the process of multiple cities standard metrics and measurements will be key. The ISO 37120 standard recently created for this purpose seems a fitting place to start. However, even without intervention as cities work together some standardization will naturally occur in the process.
Cross-disciplinary collaboration will be necessary

Similar to the idea that as complexity increases no one person can comprehend the entire system of relationships - no discipline contains enough knowledge to adequately address this problem. Collaboration and cross-pollination will be required.

It is through consideration of these larger questions that we prepare ourselves to tackle the challenges of tomorrow. By giving ourselves the time necessary to develop reasoned systems, we begin to address problems that we cannot yet predict. How do we find solutions to our greatest challenges when they become so complex that one person can no longer conceptually comprehend the relationships that create the larger picture? To answer these questions we must design systems rather than solutions.

ENDNOTES


