Cities and Complexity

Shih-Kung Lai

1. Introduction

Before starting to think about what constitutes the core of teaching and research for planning science, perhaps we should ask whether the field can be considered as a science. My answer to this question is yes, based on the knowledge of one-hundred-year efforts made by many planning scholars that are derived mostly from modern sciences. What then is the science of planning? This is a difficult question, but I think a science of planning should aim at explanations and justifications of phenomena of interest, mainly cities and plans. Such explanations and justifications must abide by the scientific standard of theorizing. On the one hand, we should explain how urban phenomena emerge and justify how they should evolve, be they transportation, land use, infrastructure, land and urban development, or other socio-economic processes, based on rigorous methodologies that can help us to gain a better understanding of how cities do and should work. For example, we could ask: Is the city solvable? That is, can the city be modeled by mathematics or computer simulations? By 'rigorous' I mean that these methodologies, whether qualitative or quantitative, must be tightly logical and aim at depth and completeness. On the other hand, we should explain how plans for urban development are made and used and interact with each other and justify how they should be made and used and interact with each other. For example, we could ask: Is the plan solvable? That is, given a plan and a set of individuals, does there exist a "policy" of price or rule setting that brings about the plan? Given this perspective, we can then identify the teaching and research scope of the science of planning as shown in Table 1.

Table 1 Teaching and research scope of the science of planning

	Urban phenomena	Planning phenomena
Explanations	How cities work	When and how plans are made and used
Justifications	How cities should evolve	When and how plans should be made and used

A planning science should aim at pursuing the scholarship of planning and therefore should conduct teaching and research that address all four questions shown in Table 1. However, in order for the science to situate itself into a particular socio-economic

context, it may focus in one or several application areas, such as transportation, land use, landscape architecture, and any other applications that the department finds important.

For the planning science research, my suggestion is that there may be a distinction between core areas and supplementary areas. The core areas should cover 1) urban economics and complexity, which address the question of how cities work, 2) urban design, land development, and urban institutions, which address the question of how cities should evolve, 3) planning theory, which addresses the question of how plans are made and used, and 4) planning analysis, which addresses the question of how plans should be made and used. Each of the core areas is described in more detail as follows.

1.1 Urban economics and complexity

This core area deals with how cities work, that is, how urban development takes place. It takes on a positive point of view on urban development. There are at least two prevailing approaches to these issues: urban economics and complexity theory. Urban economics applies economic theories to explain how urban phenomena emerge, whereas complexity theory considers cities as complex systems that evolve in an unpredictable way. These two camps of urban development theory complement, rather than contradict, each other.

1.2 Urban design, land development, and urban institutions

This core area focuses on how cities should evolve, that is, how urban development should take place. It takes on a normative view on urban development. Urban design deals with the design aspect of urban form. Land development focuses on efficient uses of land. Urban institutions propose proper formal and informal rules that regulate spatial behaviors in cities. Together, they prescribe collectively how cities should evolve.

1.3 Planning theory

This core area deals with how plans are made in real situations, that is, what behaviors we can observe when people make plans. In particular, it focuses on not only how individual plans are made, but also how these plans interact forming a web of emergent planning phenomena in cities. Sub-fields in this core area may include,

but are not limited to, sociology, game theory, organization theory, property rights, and problem solving.

1.4 Planning analysis

This core area investigates how plans should be made prescriptively. It seeks to design aids, hard or soft, to help planners to make better plans for urban development. Sub-fields in this core area may include, but are not limited to, forecasting techniques, decision analysis, operations research, and computing technologies.

2. Course Description

Given the broad framework of planning science as shown in Table 1, this course is aimed at addressing narrowly the question of how cities work through a lens of complexity theory. It is becoming widely recognized that cities are complex systems of many interacting, partially independent, agents that are far from equilibrium. This understanding has profound effects on how we make and use plans for urban development. For example, it is well known that planning problems in cities are wicked exactly because of complexity derived from interdependence, irreversibility, indivisibility, and imperfect foresights of urban development decisions. To plan cities well, we need to understand well how they work. Traditionally, cities are understood through urban economics. Recently, economic theory has been challenged for not being able to describe the dynamics of systems far from equilibrium, including cities; what we need is a theory that can depict these systems in terms of new ideas of dynamic equilibrium, that is, complexity theory. Complexity theory is a science that attempts to seek general organizational principles of systems composed of numerous interacting agents. The objective of the course is thus to provide the students with some basic understanding of how cities work and how they evolve into systems of cities or regions. In other words, the objective of this course is to provide students with an introductory understanding of how cities work through a lens of complexity theory.

3. Course Contents/Schedule

This course will cover mainly the contents of the book entitled *Urban Complexity and Planning: Theories and Computer Simulations* (2014, Ashgate) with supplementary materials distributed occasionally in the class. In each week, the instructor will introduce a chapter of the book as follows:

CHAPTER 1 From Organized Anarchy to Controlled Structure: Effects of Planning on the Garbage-Can Decision Processes

CHAPTER 2 Effects of Planning on the Garbage-Can Decision Processes: A Reformulation and Extension

CHAPTER 3 A Spatial Garbage Can Model

CHAPTER 4 An Agent-Based Approach to Comparing Institutional and Spatial Changes in the Self-Organizing City

CHAPTER 5 On Traction Rules oF Complex Structures in One-Dimensional Cellular Automata: Some Implications for Urban Change

CHAPTER 6 Applying Cellular Automata to Simulate Spatial Game Interactions to Investigate Effects of Planning

CHAPTER 7 Planning for City Safety and Creativity: Two Metaphors

CHAPTER 8 Emergent Macro-Structures of Path-Dependent Location Adoptions Processes of Firms

CHAPTER 9 The Formation of Urban Settlement Systems: Computer Experiments and Mathematical Proofs of the Increasing Returns Approach to Power Law

CHAPTER 10 Power Law Distribution of Human Settlements: An Explanation Based on Increasing Returns

CHAPTER 11 A Preliminary Exploration on Self-Organized Criticality of Urban Spatial Complex Systems

CHAPTER 12 Planning in Complex Spatial and Temporal Systems: A Simulation Framework

CHAPTER 13 Decision Network: A Planning Tool for Making Multiple, Linked Decisions

CHAPTER 14 Effectiveness of Plans in the Face of Complexity

4. Requirements

All students are required to participate in course discussions, which accounts for 20% of the final grade. Four brief essays (5-10 pages, single space, 12 points) are required by each student during the semester, which account for 80% of the final grade. The topics of the essays will be announced two weeks before the due dates.

5. Textbooks

Batty, Michael, 2005, *Cities and Complexity: Understanding Cities with Cellular Automata, Agent-Based Models, and Fractals* (Cambridge, Massachusetts: The

MIT Press).
Batty, Michael, 2014, *The New Science of Cities* (Cambridge, Massachusetts: The MIT Press).
Hopkins, Lewis D., 2001, *Urban Development: The Logic of Making Plans* (London: Island Press).
*Lai, Shih-Kung and Haoying Han, 2014, *Urban Complexity and Planning: Theories and Computer Simulations* (London: Ashgate).

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