DLA 2019

Networks in Design:

Resolving Conflicts and Reaching for Optimality in City Planning

Michael Batty

m.batty@ucl.ac.uk

@jmichaelbatty

http://www.complexcity.info/
http://www.casa.ucl.ac.uk/

Let me begin by sketching what I am going to talk about

- I am going to articulate design as a process of conflict resolution – this is hardly new but my model – a 'toy' model – is purely an ideal type
- It involves setting up a scheme of conflict resolution that converges to a consensus associated with the conflicting requirements held by the actors involved in the problem
- The model is thus a kind of baseline from which most real examples will diverge

- The core of my idea is a network of actors or stakeholders or designers who come together to swap their conflicting and/or consenting views
- They reach a consensus by pooling their ideas and compromising. There are many models in this vein
- The problem I will address is one relating to the use of land – it can be anything that involves the conflict over what land is to be best used for
- There is a long history of such problem-solving from McHarg, Alexander, Steinitz … and here, the problem is one of overlay analysis where map overlays conflict or support one another

- What we will do here is generate the plan as a process of group decision-making – from the bottom up in such a way that the plan emerges from different, often conflicting individual plans
- The model is based on an old idea of pooling opinions but it has surfaced over the last 60 years in many contexts. It has strong mathematical properties (Markov-averaging) but I will not stress or develop these here.
- I will demonstrate it here for a very simple example and then point the way to how it might be generalised and used to think about design

Other Themes That Run Through this Talk

Geodesign: group decision-making:

… designing for change cannot be a solitary activity. Rather, it inevitably is a team endeavor with many participants (from the design professions and geographic sciences) …Carl Steinitz (2012) **A Framework for Geodesign**, ESRI Press, p. ix

Agents and Actors: a model of how agents combine their conflicting views of a design solution to a consensus; an agent based model (ABM)

Graphs and Networks but non-spatial networks – social networks: social power structures

The Problem Focus

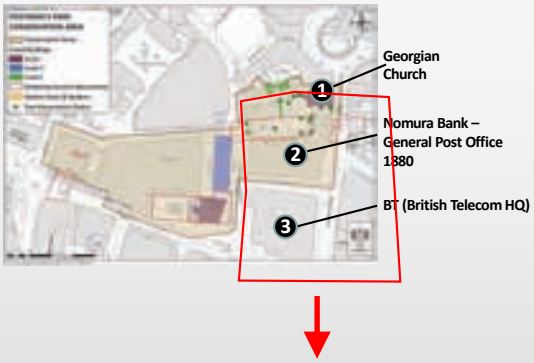
- The problem – the resolution of conflict over a change in use of land in a dense urban area – design maybe, decision certainly –
- The agents in the models – actors, stakeholders versus sites/buildings
- The way the agents interact is through the maps that represent what they think land should be used for
- The way the agents effect compromise is important and we can articulate this as two related problems which are duals of one another.

- A long preamble I know but let me begin with the problem first and then I will sketch the model
- The problem is one of reconciling **different interests in land development** in the heart of a world city: London
- It is as close to the heart of the city as possible for it centres on the postcode EC1A 1AA which is the old General Post Office and is now adjacent to the new London Stock Exchange (which is almost virtual now)
- It's a **TOY MODEL** with 6 agents or actors and 8 sites – let us see











Marconi, 1890s







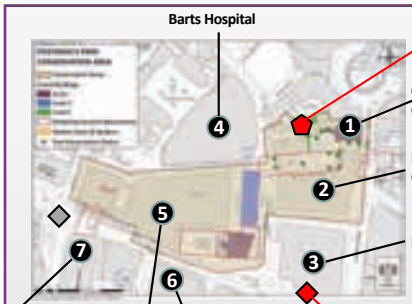
Marconi made the first public wireless transmission from the General PO Office to PO Office South in 1896







Edison's First power station – yes in London not New Jersey, 1882

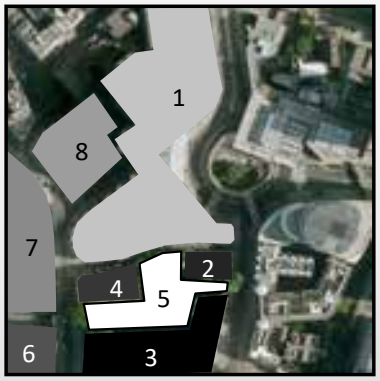


Marconi sent the first wireless signal ever in 1896

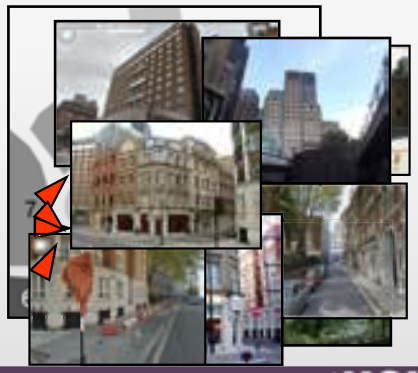








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Actors/ Stakeholders	***Sites/Buildings/ Locations***
1 City Corporation	1 Aldersgate Complex
2 Residents	2 St Botolph's
3 Hospital NHS	3 Nomura House
4 Developers	4 Milton House
5 Property Spec	5 Postmans' Park
6 Banks	6 Bank of America
	7 Barts New Building
	8 Barts Old Building

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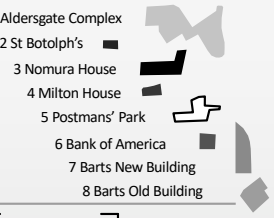
Sites/Buildings

1 2 3 4 5 6 7 8

Agents

1 City Corporation	0	0	1	0	0	1	0	1
2 Residents	0	0	0	0	0	0	0	1
3 Hospital NHS	0	0	1	0	0	1	0	1
4 Developers								
5 Property Speculators	●	●	●	●	●	●	●	●
6 Banks								

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Agents

1 City Corporation	0	0	1	0	0	1	0	1
2 Residents	0	0	0	0	0	0	0	1
3 Hospital NHS	0	0	1	0	0	1	0	1
4 Developers	0	0	1	0	1	1	1	1
5 Property Spec	1	1	1	1	1	1	0	1
6 Banks	0	0	0	0	1	1	0	0

= M(ap)

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The Primal: Interactions between actors wrt sites

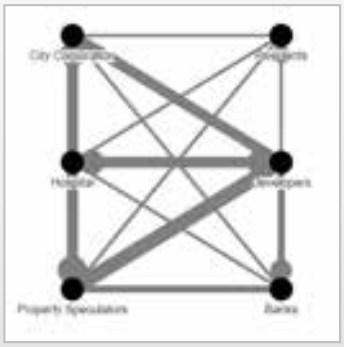
$$\begin{bmatrix} 3&1&3&3&3&1\\ 1&1&1&1&1&0\\ 3&1&3&3&3&1\\ 3&1&3&5&4&2\\ 3&1&3&4&7&2\\ 1&0&1&2&2&2 \end{bmatrix} = \begin{bmatrix} 0&0&1&0&0&1&0&1\\ 0&0&0&0&0&0&0&1\\ 0&0&1&0&0&1&0&1\\ 0&0&1&0&1&1&1&1\\ 1&1&1&1&1&1&0&1\\ 0&0&0&0&1&1&0&0 \end{bmatrix} \begin{bmatrix} 0&0&0&0&1&0\\ 0&0&0&0&1&0\\ 1&0&1&1&1&0\\ 0&0&0&0&1&0\\ 0&0&0&1&1&1\\ 1&0&1&1&1&1\\ 0&0&0&1&0&0\\ 1&1&1&1&1&0 \end{bmatrix}$$

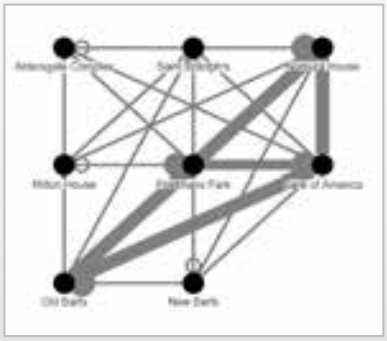
$$A = M \quad M^T$$

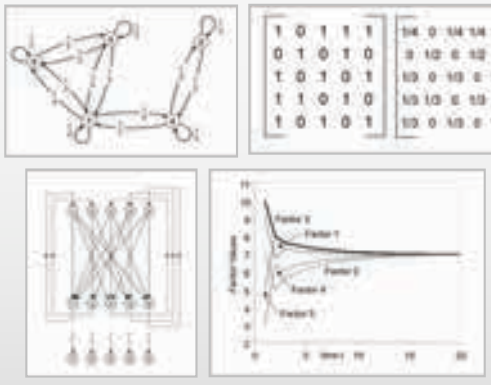
The Dual: Interactions between sites wrt actors

$$\begin{bmatrix} 1&1&1&1&1&1&0&1\\ 1&1&1&1&1&1&0&1\\ 1&1&4&1&2&4&1&4\\ 1&1&1&1&1&1&0&1\\ 1&1&2&1&3&3&1&2\\ 1&0&4&1&3&5&1&4\\ 0&0&1&0&1&1&1&1\\ 1&1&4&1&2&4&1&5 \end{bmatrix} = \begin{bmatrix} 0&0&0&0&1&0\\ 0&0&0&0&1&0\\ 1&0&1&1&1&0\\ 0&0&0&0&1&0\\ 0&0&0&1&1&1\\ 1&0&1&1&1&1\\ 0&0&0&1&0&0\\ 1&1&1&1&1&0 \end{bmatrix} \begin{bmatrix} 0&0&1&0&0&1&0&1\\ 0&0&0&0&0&0&0&1\\ 0&0&1&0&0&1&0&1\\ 0&0&1&0&1&1&1&1\\ 1&1&1&1&1&1&0&1\\ 0&0&0&0&1&1&0&0 \end{bmatrix}$$

$$S = M^T \quad M$$







The Network Averaging X Set of Maps

$$\begin{bmatrix} 3/14&1/14&3/14&3/14&3/14&1/14\\ 1/5&1/5&1/5&1/5&1/5&0\\ 3/14&1/14&3/14&3/14&3/14&1/14\\ 3/18&1/18&3/18&5/18&4/18&2/18\\ 3/20&1/20&3/10&4/20&7/20&2/20\\ 1/8&0&1/8&2/8&2/8&2/8 \end{bmatrix} \begin{bmatrix} 0&0&1&0&0&1&0&1\\ 0&0&0&0&0&0&0&1\\ 0&0&1&0&0&1&0&1\\ 0&0&1&0&1&1&1&1\\ 1&1&1&1&1&1&0&1\\ 0&0&0&0&1&1&0&0 \end{bmatrix}$$

yields

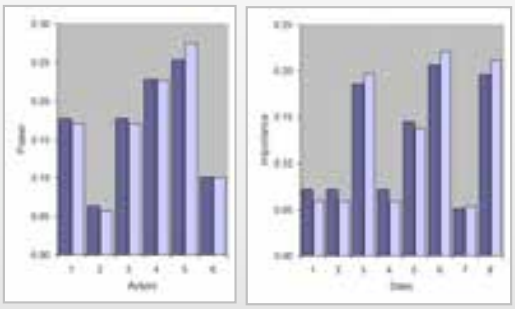
A New Averaged Set of Maps

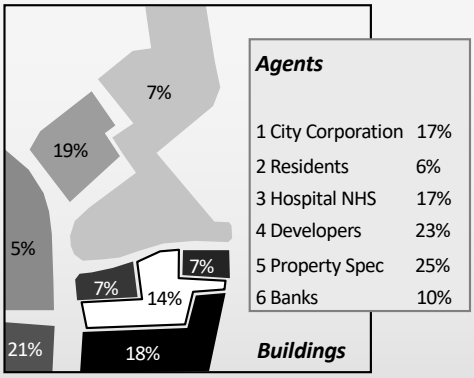
$$\begin{bmatrix} 0.21&0.21&0.86&0.21&0.50&0.93\\ 0.20&0.20&0.80&0.20&0.40&0.80\\ 0.21&0.21&0.86&0.21&0.50&0.93\\ 0.22&0.22&0.83&0.22&0.61&0.94\\ 0.35&0.35&0.85&0.35&0.65&0.95\\ 0.25&0.25&0.75&0.25&0.75&1.00 \end{bmatrix}$$

And then we average them again using the same network And this yields a new map, And so on until all the differences between the actors with respect to their maps are ironed out and we get the following map

0.25	0.25	0.84	0.25	0.58	0.94
0.25	0.25	0.84	0.25	0.58	0.94
0.25	0.25	0.84	0.25	0.58	0.94
0.25	0.25	0.84	0.25	0.58	0.94
0.25	0.25	0.84	0.25	0.58	0.94
0.25	0.25	0.84	0.25	0.58	0.94

We can do this on the dual problem, on the sites and iron out the differences between sites with respect to their actors





Agents

1 City Corporation	17%
2 Residents	6%
3 Hospital NHS	17%
4 Developers	23%
5 Property Spec	25%
6 Banks	10%

Buildings

Next Steps

- Real problems – very large networks, types of connection
- Intensity or desirability maps; spatial averaging as developed quite widely in overlay analysis in GIS
- Rational averaging, simple averaging, weighting averaging, dominance, and other strategies of compromise or not; networks that don't lead to solutions
- The model is longstanding – not new, what is new is the dual primal and the embedding of maps into it

References over Many Years

French, J. R. P. (1956) A Formal Theory of Social Power, **Psychological Review**, **63**, 181-194.

Batty, M. (1971) An Approach to Rational Design: Part 1: The Structure of Design Problems, Part 2: Design Problems as Markov Chains, **Architectural Design**, **41**, 436-439, 498-501

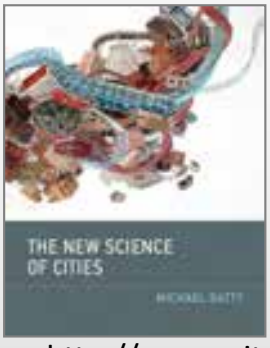
Batty, M. (1984) Plan Design and Committee Decision-Making, **Environment and Planning B**, **11**, 279-295.

Blondel, V. D., Hendrickx, J. M., Olshevsky, A., and Tsitsiklis, J. N. (2005) Convergence in Multiagent Coordination, Consensus, and Flocking, In **Proceedings of the Joint 44th IEEE Conference on Decision and Control, European Control Conference**, Seville, Spain, December 12-15, 2005,

Batty, M. (2013) **The New Science of Cities**, MIT Press, Cambridge, MA



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m.batty@ucl.ac.uk
@jmichaelbatty

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