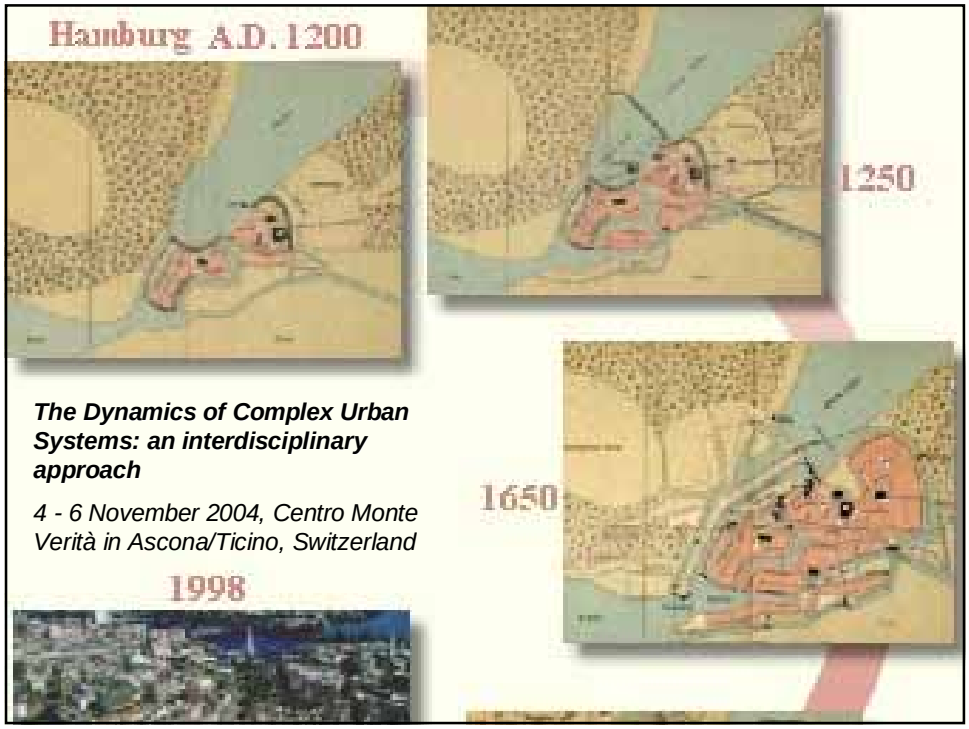

The Dynamics of Complex Urban Systems: an interdisciplinary approach

4 - 6 November 2004, Centro Monte Verità in Ascona/Ticino, Switzerland

CASA

CENTRE FOR ADVANCED SPATIAL ANALYSIS

UCL

Fifty Years of Urban Modeling:

From Macro-Statics to Micro-Dynamics

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Outline of the Talk

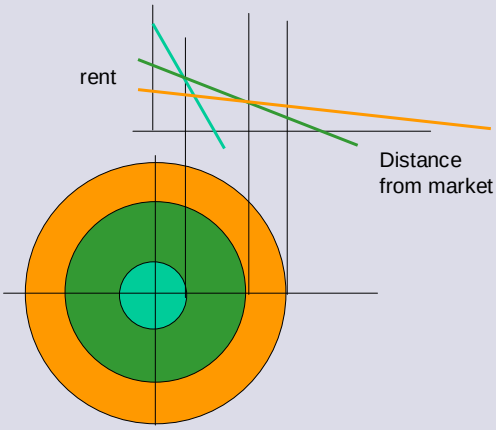
1. *Origins: Location Theory and Social Physics*
2. *The Urban Modeling TimeLine*
3. *What Kind of Cities?*
4. *1950s – 1970s : What Kinds of Models?*
   Comparative Statics – Cities in Equilibrium
5. *The Quest for Dynamics: Macro Dynamics, Catastrophe, Bifurcation, Chaos*
6. *The Move to the Micro in Space, Time and Attributes: Cells, Agents, and the New Dynamics*
7. *Some Examples: Anticipating the Rest of this Meeting and back to Social Physics in another guise*
8. *Next Steps: The Future*

1. Origins: Location Theory and Social Physics

Von Thunen 1826 ➡
The German Location Theorists from Weber to Losch
1900 - 1930
Central Place Theory and Christaller 1933
The Empiricist Americans: Reilly, Stewart & Gravitation
1920s – 1950s: Social Physics
The Urban Geographers 1920s +

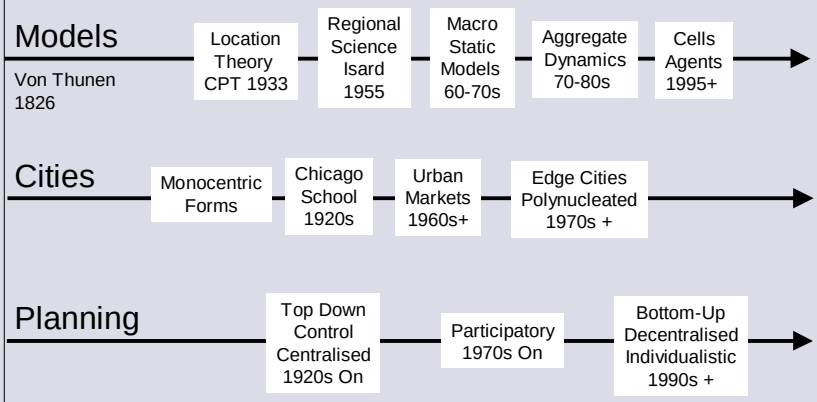
Isard and the Beginnings of Regional Science – the Urban Modeling Time Line begins here
mid 1950s ➡

Von Thunen's Model has everything that characterizes cities for the last 200 years or rather from pre the industrial revolution to around 1975.



Let me show you a simple model that illustrates how we can experiment with this kind of thinking because it characterizes many modelling strategies that came from the past

2. The Urban Modeling TimeLine



There are many time lines

3. What Kind of Cities?

Monocentric ie single centered, little choice of location – limited transport choices, strictly differentiated due to income, daily routine, homogeneous life-styles – dull !

This is the industrial city

Contrast this with cities now – heterogeneous, diverse mix, less routine, less emphasis on transport to work – much greater opportunities for different locations for living

Edge cities, polynucleated forms, more like a currant pudding than a doughnut or birthday cake for a 1 year old

4. 1950s – 1970s : What Kinds of Models? Comparative Statics – Cities in Equilibrium

The theory was locational and gravitational, the methods were eclectic – there was a focus on urban and regional economics with transport based on the journey to work – the theory was encapsulated in key books like

1956 

1964 

1968 

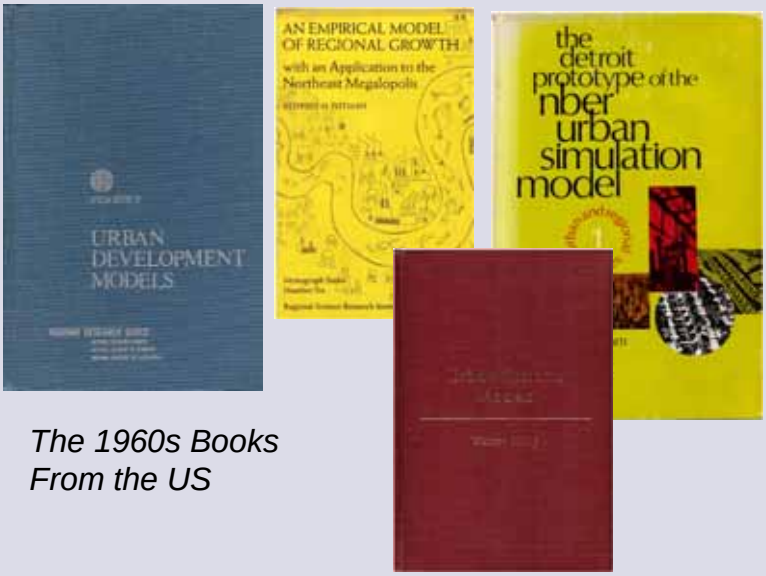
The models were cross sectional static, simulating an equilibrium based on a rudimentary systems approach which focused on physical interactions – transport and trips

Econometric – simultaneous regression – ad hoc empiricist

Gravitational – the Lowry Model which was a transport model embedded with an economic base or input output model

Simulation, not unlike CA and agent based – Chapin UNC

Optimization – LP models and economic optimization



The 1960s Books From the US

The models were strongly applied and were forced into existence through policy initiatives – by federal govt in US and by structure planning in UK

Right from the start researchers were conscious of dynamics and disaggregation – eg TOMMS model

There was massive consolidation of these styles into the Lowry model framework in the late 1960s and 1970s

Not much new innovation but a research program was put in place only to find that fashions changed

Optimization was pursued as a paradigm showing the strong top down focus of model use in planning

The largely UK contributions, the 1970s

And the contributions into the 1980s as these kinds of models began to slide out of fashion ….

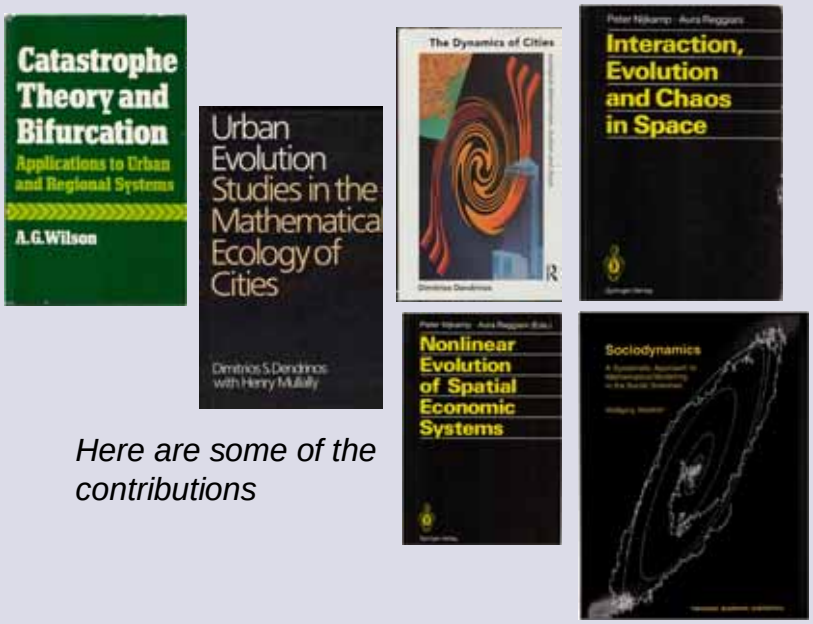
5. The Quest for Dynamics: Macro Dynamics, Catastrophe, Bifurcation, Chaos

A concern for macro-dynamics – catastrophe theory – Wilson – embedding spatial interaction models in logistic style equations, 1977 + Note it was macro not micro

The Allen-Prigogine initiatives 1977 +

The Dimitrios Dendrinos Development of Lotka Volterra Models

Later Developments of Chaos Theory – Nijkamp and Reggiani



Here are some of the contributions

6. The Move to the Micro in Space, Time and Attributes: Cells, Agents, and the New Dynamics

I must stress that there are many, many ideas and models and theories that have impacted on this field that I have not covered – all the planning techniques etc and all the urban and regional theory in economic terms.

But the wave of concern for macro dynamics also began to work itself out and there is much less focus on this now.

Essentially my own work during the 1980s was largely in reskilling myself in computer graphics and my work on fractals was not focused directly on urban models per se

The concern for detail at the micro scale has come from a sea change in the way we look at the world, from the top down, from an ordered world in equilibrium to one which is full of pulsating change driven from the bottom up

Why did we never think that way in the first place? I am not going to answer that question – at one level it can't be answered but it is having quite dramatic effects on how we think about a science of cities

Here are some reasons – <u>first</u> the focus on bottom up thinking, <u>second</u> the idea of time and change, not equilibrium – far from equilibrium, <u>third</u> better data, better computers, <u>fourth</u> heterogeneity not homogeneity, <u>fifth</u> representation as neutral objects – grids, pixels, raster, GIS

The elements of complexity theory are key to the new modes or representation which focuses on emergence

This quest began with cellular automata models as key examples of emergence which were methods to generate fractal morphologies

Recently the idea of mobile cells or agents has come onto the agenda

The biggest problems of these class of models is that they are far richer than any of their predecessors and they break the rule of parsimony – they are hard if not impossible to calibrate in their pure form

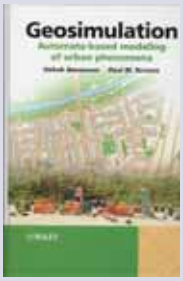
They also deal with interaction rather poorly and generally fail to grasp the appropriate notions of action at a distance

The cell size is a problem too in terms of states and land uses

They tend to be physicalist and the rules of behavior are problematic

But this is an exciting area as this meeting will show and here are some examples of what has been done so far

Some samples of what is being synthesised. Note that urban models per se is no longer the focus – it is now a science of cities or a tool box



7. Some Examples: Anticipating the Rest of this Meeting

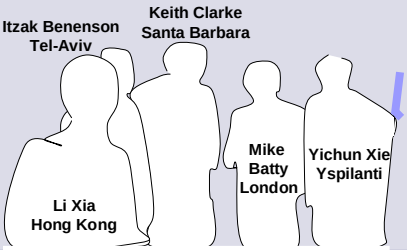
To finish let me show you an example of how far we have come and of course the rest of this meeting will be about these models – here is our DUEM model

It was developed by me, Yichun Xie from Michigan and Zhanli Sun from Urban-Champaign

Here is a reference

Batty, M., Xie, Y., and Sun, Z. (1999) Modeling Urban Dynamics Through GIS-Based Cellular Automata, ***Computers, Environments and Urban Systems****,* ***23****, 205-233.*

What some of the modelers look like



What some of the models look like

DUEM –
Dynamic Urban Evolutionary Model Applied to Ann Arbor and Detroit – purpose built software

8. Next Steps: The Future

Behavior in these models – too physicalist?

Action and interaction – perhaps we have thrown out the baby with the bath water

Policy imperatives – what are these models for?

The Resurrection of Land Use Transport Models – Fusing with CA and ABS – UrbanSim, The Wegener Models, PROPOLIS, …….