THE PROBABILISTIC GENERATION OF CHARACTERISTIC URBAN STRUCTURE
The Urban Design Agenda

- Neo-traditional urbanism now in favour
- Traditional patterns now seen as ‘models’
- But these patterns were not ‘planned’
- How to plan or design these?
‘Chaotic’
(Keeble)

‘Random’
(Mandelbrot)
Characteristic Structure

Two senses:

- Typical distinctive character
- Likely
Characteristic Structure

- Typical distinctive character
- Means the quintessential ‘street pattern shape’

Not ‘like a gridiron’
Characteristic Structure

• Typical distinctive character
• Means the quintessential ‘street pattern shape’

Not ‘like a gridiron’  Not ‘like a tree’
Characteristic Structure

- Typical distinctive character
- Means the quintessential ‘street pattern shape’

Not ‘like a gridiron’
Not ‘like a tree’
But like nothing other than a street pattern
Characteristic structure of street patterns

• a mixture of short and long routes, and more and less connective routes;
• some differentiation of routes by depth, but overall not too great a depth;
• three-way junctions are typically in the majority, but likelihood of at least some crossroads and culs-de-sac;
• a medium or ‘semi-griddy’ level of connectivity, with a relative connectivity ($X$) of around 0.35-0.45;
• a relatively high degree of irregularity and complexity, with complexity ($\Omega$);
• typically in the range 0.35 to 0.6.
DESIGN

EVOLUTION

TOP-DOWN
Pattern selection

Patterns generated by programs

BOTTOM-UP

Different kinds of program
Kit of identical parts
Kit of identical parts

(i) generation 1
Kit of identical parts

(i) generation 1

(ii) generation 2
Kit of identical parts

(i) generation 1

(ii) generation 2

or

(iii) generation 3
The T-tree program

1) Each constituent element is identical.

2) Each element is added to form structure one at a time.

3) Each new element occupies a position on the structure that is chosen at random

4) Each new element joins the existing structure at only one of its ends, to form a 3-way connection (T-junction), such that the overall structure is a ‘T-tree’.
<table>
<thead>
<tr>
<th>Case</th>
<th>Frequency</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>b_{1-6}</td>
<td>6</td>
<td>25%</td>
</tr>
<tr>
<td>c_{1-3}</td>
<td>3</td>
<td>12.5%</td>
</tr>
<tr>
<td>d_{1-4}</td>
<td>4</td>
<td>17%</td>
</tr>
<tr>
<td>e_{1-4}</td>
<td>4</td>
<td>17%</td>
</tr>
<tr>
<td>f</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>g_{1-3}</td>
<td>3</td>
<td>12.5%</td>
</tr>
<tr>
<td>h</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>i</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>
More frequent (three variants)

Typicality

Less frequent (each a singular type)

Type

Comb  Irregulars  Fractal

α  γ  δ
The ‘X-cell’ program

+ + + + + +

1) Each constituent element is identical.

2) Each element is added to form structure one at a time.

3) Each new element occupies a position on the structure that is chosen at random.

4) Each new element joins the existing structure at one or both of its ends (but not along its middle); the resulting structure can have multi-spoked nodes and form ‘circuits’.
<table>
<thead>
<tr>
<th>Stage of growth</th>
<th>Base plan</th>
<th>Structure and code</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Earliest</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
</tr>
<tr>
<td>1st generation (1 route)</td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>(b) Intermediate</td>
<td><img src="image3" alt="Image" /></td>
<td><img src="image4" alt="Image" /></td>
</tr>
<tr>
<td>2nd generation (2 routes)</td>
<td></td>
<td>II</td>
</tr>
<tr>
<td>(c) Early 12th Century</td>
<td><img src="image5" alt="Image" /></td>
<td><img src="image6" alt="Image" /></td>
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<tr>
<td>3rd generation (3 routes)</td>
<td></td>
<td>IIIa</td>
</tr>
<tr>
<td>(d) Mid 12th Century</td>
<td><img src="image7" alt="Image" /></td>
<td><img src="image8" alt="Image" /></td>
</tr>
<tr>
<td>4th generation (4 routes)</td>
<td></td>
<td>IVc2</td>
</tr>
<tr>
<td>(e) Mid to late 12th Century</td>
<td><img src="image9" alt="Image" /></td>
<td><img src="image10" alt="Image" /></td>
</tr>
<tr>
<td>4th generation (4 routes extended)</td>
<td></td>
<td>IVt</td>
</tr>
</tbody>
</table>
Deeply layered and branching structures

Meshes and spokes

Long chain structures

X
Area where actual street patterns are typically found

Grid-like street patterns

Tree-like street patterns

Intermediate
2D
3D nesting, etc.

Ziggurat of Ur
I. Direct selection of whole pattern - single act of design

II. Selection at successive stages in design, directing growth towards desired outcome
   Program $e_1$

III. Selection of programs
Conclusions and Implications

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5. Possibility of practical application through synthesis of ‘urban coding’ + ‘road hierarchy’