Introduction: *Environment and Planning B* – Perspectives on the Development of an Idea

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In the Beginning

Ten years before **Environment and Planning** was first published in 1969, the disciplines and professions of architecture, planning, geography and urban studies began to change. The optimism of a better future following half a century of war and depression, and a deep seated belief in the power of science and the magic of technology combined to fuel a sea change in the way societies might be understood, managed and planned. The Quantitative Revolution in geography began quite distinctly in North America marked by the publication of *Studies of Highway Development and Geographic Change* (Garrison, Berry, Marble, Nystuen, and Morrill, 1959). In city planning, Jane Jacobs (1960) published her *Death and Life of Great American Cities* in which she railed against the blind bureaucracy of City Hall and the relentless march of modernism from the top down, while in design, a new sense of how we might go about systematically planning a better future through design methods was forcing the field into new ways, as portrayed in books such as Christopher Alexander's (1964) *Notes on the Synthesis of Form*. That there were tensions in these movements there is little doubt, for the notion of using science to manage human affairs has always raised the mantra of social engineering and the blindness of technocracy but fifty years ago, the evident optimism of using science in social science swept all before it. The 1960s, the space program, and the prospect of mass consumption in the West all beckoned.

It was into this milieu that this series of journals was born. In the mid 1960s, the geographer Peter Haggett (1965) produced his great synthesis of methods that were coming from the Quantitative Revolution in his book *Locational Analysis in Human Geography* while at the same time in North America, the regional science movement through the work and writings of Walter Isard was impressing the same kinds of message in the domain of urban and regional economics. In planning, various computer models were being developed and applied as reported in the special issue of the *Journal of the American Institute of Planners* in 1965 guest edited by Britton Harris, and various attempts at seeing the city as a system and planning its cybernetic controller were explored by Chadwick (1971) and McLoughlin (1969) in their treatises on the systems approach. These changes were not only influencing academia, public policy

and the commercial world, but the curriculum in high schools was being fast affected, certainly by the new geography, and a generation of students were being exposed to ideas that would change these cognate fields out of all recognition.

In 1968, John Ashby, one of the founder publishers of Pion who produce this series of journals, attended a parent-teacher meeting at his son's grammar school in North London. Being a physical chemist by background, it was there that he learnt and was intrigued by what was happening in high school geography. He recognised that here was a publishing opportunity that could not be missed for a relatively young scientific publishing house such as Pion. He was advised to seek the help of Peter Haggett who in turn referred him to Alan Wilson who had just joined the Centre for Environmental Studies, a government think tank for planning in London and who was assembling a team of mathematicians, economists, physicists as well as architects and planners to develop new tools and methods suitable for the scientific understanding of cities and their application to generate better city plans.

And so, *Environment and Planning* was born. In fact at the beginning, the journal was called *Environment*. John Ashby was keen that it have a generic title like *Nature*, so Alan Wilson recalls, so that it might encompass as wide a range of material as possible, but of course in the new domain of more formal approaches. But when Pion did a search of journal titles, they discovered one by that name had already been registered. Planning was an obvious extension given the focus of Alan Wilson's research and the momentum of those times. In fact the first issues of *Environment and Planning* were dominated by urban and regional models and by methods in regional science, and the . . . the focus only subsequently moved to . . . . . moved towards urban and regional research *per se*. This is significant for at that time, John Ashby was keen to extend the remit of Pion's new found interest in planning to architecture. Lionel March who led the Centre for Land Use and Built Form Studies at Cambridge University, was developing similar theories and methods to those at the urban and regional scale but for smaller scale environments at the level of buildings. Combined with a strong interest in design methods, it appeared that an equivalent journal focusing on formal methods in architecture would provide a serious complement. Much of the logic for this was contained in the book *The Geometry of Environment* which Lionel March and Philip Steadman published in 1971. It was here that they laid out formal methods for representing the geometry of buildings in much the same way that William Bunge, a decade earlier had fashioned a geometry of geography in his book, *Theoretical Geography*. The scene was thus set for a second journal and in 1974, *Environment and Planning B* was first published.

At this point, *Environment and Planning* became the flagship in the series donning the mantel of *A*. Many people ask why we use the series designation in such obvious alphabetic form. The reason relates to the fact that in physics and chemistry, this was the original differentiation as these fields grew larger

and wider and John Ashby assumed this was the right way to grow the series. *A* was already subtitled from the start as the *International Journal of Urban and Regional Research* but this was dropped in 1993 as it was felt by then the series had enough identity. *Environment and Planning B* adopted the subtitle, *International Journal of Architecture and Building Research* in 1974, moving to *International Journal for the Science of Architecture and Design* in 1980. In 1983, it took on its current title, *Planning and Design*. Starting at 2 issues a year and expanding in 1979 to 4, *B* published 120 pages an issue. It has gradually increased in the number of issues and size since these early days. In the beginning, the focus was on geometry and design in architecture but the focus on buildings was not exclusive. The Cambridge group that was the inspiration behind *B* also worked on urban and regional methods and models and were strongly involved in physical planning. The book, *Urban Space and Structures* edited by Leslie Martin and Lionel March which was published in 1972, dramatically illustrated the synergy between *A* and *B*. Indeed, it is *B* of all the members of the family which has had the most common authors – those who have published in other journals in the series, mainly *A*.

Some excellent articles were produced in those early years, some in design methods but most in new geometrical models of building and city form. Design has always been an issue but less so in the narrower sense of design methods, more in the tradition of formal analysis of organic and planned structures, of buildings produced in their vernacular as well as those designed by well-known architects from Palladio to Frank Lloyd-Wright. In a sense, the dictum of modern architecture that form follows function – or its original equivalent ascribed to Louis Sullivan who in 1896 said, "That form ever follows function. This is the law" – has provided a guiding light for the journal. Many of the articles assume this dictum implicitly in their quest to explain geometrical and other organizational forms as diagrams of forces, of functions and processes that underpin the way buildings and cities are articulated and designed. But once the journal moved to 4 issues a year in 1979, it was felt by Lionel March and John Ashby that the genesis of articles in this field was not deep and broad enough to sustain the journal in its early focus. To architectural design, physical planning was added, in recognition of the fact that by focusing on design in the domain of city planning but keeping this to the development of formal methods, this would enhance the synergy between architecture and planning yet, at the same time keep the focus on geometry and configuration and its relationship to geography at larger scales.

In 1981, one of us (Michael Batty) joined the editor Lionel March as co-editor (thence as editor from 1985) and the journal was re-badged in terms of its subtitle as "Planning and Design". The mission of the journal slowly broadened to embrace formal methods in planning but the editors steered clear of soliciting or encouraging articles in the areas of urban and regional modeling and regional science which were the traditional domain of *A*. This stricture has gradually relaxed as the scope of *A* has broadened but as we will

see in the cross-section of articles included in this volume, there is still some sense in which articles in those areas are more likely to be submitted to *A*. Many of the issues published in the 1980s were special and theme issues that originated from conferences but as the journal became more established, so the number of themes has been reduced. Moreover, special issues were abandoned in favor of themes in 1988 and in 1992, the journal went to 6 issues a year. In 1997, the number of pages in the journal was increased from 120 an issue to 160 and then to 190 pages a year in 2007. This additional space for articles has followed a massive increase in the number and breadth of submissions, although we as editors are continually stretched to keep the focus of the journal to its original mission.

Of course, in 1983, *Environment and Planning C* and *D* were founded and were immediately seen as complementary to *A* and *B*. Proposals for *E* have been made from time to time but, at the time of writing, there are no firm plans. The existing range of the journal provides a wonderful sense of the scope of environment and planning where the focus is very much on the human and social sciences, on the way we use the built environment, and the way we articulate key spatial problems of the times in which we live. The series does not deal with the construction of the built environment per se or indeed a detailed understanding of the physical environment of cities and regions, although enormous thought is given to the interface between them and the core fields. In *Environment and Planning B*, this is of especial concern with respect to buildings.

Dominant Themes

Theory and Practice, Science and Design

Architecture and planning unlike geography and the more eclectic disciplinary domain of urban studies are still regarded as professions where their dominant focus in universities is on enabling students to acquire skills through controlled practice in studio environments. The notion of having to understand the system of interest, be it at the scale of the building or the city, has equal billing with the process of design, and this changes the emphasis in this field with respect to research. Until a decade or so ago, the amount of research into the systematic understanding of buildings and cities was small, and thus the gulf between theory and practice, research and application has tended to be quite wide. This distinction is also writ large in the gap between science and design (Batty, 1980). It is no accident that when architectural research was first established, design as much as science was the focus for systematic inquiry: hence design methods, as well as methods for understanding the built environment became the key source of publications for the journal.

In fact, design also extends to planning processes and policy analysis in *B* for in physical planning, design has always been significant notwithstanding the fact that design merges into policy analysis and is inevitably a more collective activity than architecture. We have tried to encourage articles that deal with planning theory in the journal but planning theory stands across the divide between the rather instrumental problem solving focus of plan-making and policy analysis and the stronger ideological basis of planning in social theory, which we have always felt is more suited to the temperament of our sister journals *A* and *D*. We have included articles on positive planning theory which deal with technical as well as administrative processes and of late, we have published articles on the administrative structure of planning and government, but these we believe are more the domain of *C*. In planning theory, Faludi (1973) once made the distinction between 'theories in planning' and 'theories of planning' with the former being concerned with the city systems and the latter with the planning system, including processes of problem-solving and implementation. In fact, ideological concerns stand astride these foci but readers will find all these concerns reflected in our journal and a close analysis of what we have published over the last 37 years illustrates how fuzzy these boundaries have become.

During the journal's history, our focus on design has covered a range of planning processes that move from planning theory to problem-solving processes through to urban and building design, where there has been a strong focus on formal methods drawn from artificial intelligence and operations research as well as computer science. Of late, there has been resurgence in such methods under the guise of planning support systems, which encapsulate a range of new methods which have emerged from computer applications in planning and design. Over the years of the journal, optimisation methods have formally figured in many of these contributions, thus focusing our field on more formal methods of design that complement more intuitive and participatory methods.

Models, Methods and Machines

In the 1950s, the term "model" was not widely used. In so far as methods of analysis in architecture and planning were formalized, it was theory that ruled the day. It took the development of digital computation to establish the term as an abstraction that now has widespread currency. In the early twentieth century, most scholars used the word model to refer to iconic representations, images rather than theories or abstractions, although there have been associations between the term model and pattern for at least one thousand years. Its reference to an icon has been particularly germane to its use in architecture and city planning where the term has literally meant a physical representation of form without function, a scaled down replica of the real thing, useful for

fixing ideas but not useful to experimentation or formal reasoning of any kind. It was not until the 1930s that the term really entered the lexicon as abstraction. Albert Einstein (1930) in his book, *The World As I See It* said: "I still believe in the possibility of a model of the reality, i.e. a theory which represents the things themselves and not only the probability of their occurrence". By the mid 1950s, the word was becoming popular and Herbert Simon even used it to entitle his first collection of articles that he published in 1957 as *Models of Man*.

The 1960s saw a great growth in the idea of models and modeling. In geography, Richard Chorley and Peter Haggett (1967) edited an enormous compilation of articles entitled *Models in Geography*, while David Clark (1972), a contemporary of theirs at Cambridge University, edited *Models in Archaeology*. It was, therefore, of little surprise that the idea of a model should find itself dominant in both *Environment and Planning A* and *B* in their early years. Models of course find their way into methods and tools and to an extent, the journal is now dominated more by methods than by models. Many of these represent tools for inquiring into the geometry of the built environment and urban form as well as articulating processes which lead to spatial change. But in the journal there has always been an uneasy tension between representing cities in terms of geometry and geography and their relationships to people and places. Many of the models that are articulated in the pages of the journal treat the city more as a machine than as a social organism but there is, we believe, a strong recognition of these tensions amongst our advocates and supporters, a tension that is essential if our field is to progress and refine its ideas and methods.

Technological Imperatives

Throughout the time this journal has been published, there have been major changes in information technology which underpin many of the methods used to develop the ideas presented in its pages. In 1974, the integrated circuit had only just been invented and it would take another 5 years before the first personal computers appeared. By the late 1980s, graphics had firmly taken hold and many of the articles in the journal were generating visualizations from the methods and models that were being reported based on these new technologies. By the late 1990s, much of the desktop technology of the 1980s began to move online and currently, the focus has moved to online systems that enable us to build models and methods *in situ*. This is having a major impact on those who use these techniques and there is a new-found interest in theory and practice but in the online world.

Two things that emerge from these developments in ICT involve concerns that were not present when the journal was first started. These new technologies are increasingly being embedded into buildings-plural and cities

themselves, developing an alternative universe of wired buildings and wired cities whose management and control raises very different possibilities from those available in the material world. When this embedding extends to software itself, the nature of the built environment and the social relations that define it are changing the nature of the system that we are attempting to understand, control and design. We have had a number of articles on these issues that we are bound to encourage and we sense that this is an area of increasing importance to the journal.

A second theme that in a sense we are only now able to grasp in hindsight involves the increasing complexity of the systems that form our subject matter. There is absolutely no doubt if you look at the pages of this journal since its inception, that you would be forgiven for thinking the subject matter had changed completely. An even better indicator of this is to examine the index up until 2004, before the journal moved online when indexes were replaced by search engines within pdfs. Comparing the index in 1989 with that in 2005, only about 10 percent of the key words are common. Quite remarkable changes in style and fashion appear to pervade the content. This is as much due to the lack of convergence in the field as more and more complexity is added to city systems and the built environment and as more and more researchers develop their own approaches. In fact, this is a salutary reminder that the role of fashion pervades our field but it is also a reminder that we do not have and may never have a core set of theories and models that will remain stable through time. It is in this area of technology that the greatest change is manifest.

Representation and Processes, Aggregate and Disaggregate Conceptions

There has been a major shift too in the way we represent our subject matter. Right from the beginning, authors have developed methods and models that allude to digital representation but within this there have been highly differentiated developments. Process-based models of building form have been firmly rooted in geometry and in linguistic representations such as those involving building morphology and shape grammars. There have been developments in computer-aided design (CAD) and in computer graphics but these tend to have been absorbed in the mainstream with some ease and have not produced any disruptive force in research into architectural form. In contrast, the development of geographic information systems (GIS) has had a major impact on the way spatial systems can be represented. Combined with developments in spatial analysis, there has been a tendency for the journal to attract more and more articles in these areas, notwithstanding the fact that there are other major outlets for such material. One of our constraints has been to draw a fine line between new representations of building and city systems and their development for specific purposes of planning and design.

A more difficult area has been the concern for cognition and learning in spatial systems. Explicit models of behaviors are now being developed for urban systems and some of this has been attracted to the journal. Our focus on visual fields in cities and their formal representation through space syntax has extended this concern and extensions into way-finding are important advances. A concern for space and landscape in cities is now generating more formal approaches through GIS and these too have found a place in the journal of late. This we expect will also become a more significant area in time and it relates directly to new forms of urban and spatial models that have emerged during the last two decades.

These new models extend those that were a main focus in *Environment and Planning A* some 40 years ago. Urban models in the social physics tradition which were very well represented in the early issues of *A* were aggregate in form, static in terms of the structures that they simulated, and parsimonious in that they were highly abstracted from the systems in question. Through the 1970s, a critique of these structures led to various attempts to make such models dynamic and combined with the need for disaggregation, a new class of models based on notions of systems dynamics and agent-based behaviors has emerged. Cellular versions of these models are the geographical equivalents of shape grammars at least at one level of representation with many articles being published in this area in the journal in the last 15 years. Agent-based equivalents have also found favor and in the sample of articles that we show here, such process orientated models are significant in defining the scope of the journal.

We could extend the themes we have defined here many times over by building layer upon layer of detail into this content. But at this point, we need to guide the reader to the material we consider representative of the journal and its history. In our selection, we have been at pains to select not only what we consider good articles, but also articles that represent the best of many, excluding those that we have been personally concerned with. The four themes we have chosen that reflect these more cross-cutting themes we have just described relate to *Building Morphologies* where shape and grammars and layout dominate, *Urban Flows, Forms and Fields* that largely pertain to movement at the urban design scale in streets and buildings, *Urban Simulation* which reflects developments in modeling urban systems at more disaggregate spatial scales, and last but not least, *Planning and Design Processes* that reflect a range of approaches to the design as a process and activity that link both architecture and planning.

Building Morphologies

Morphology is the study of form through the relations that determine how such a form is created and evolves. In short, models of form generate morphologies and any systematic study of buildings or cities is almost inevitably

bound up with the question of form. The great tension in our field is between forms which are created from the bottom up, through the actions of many individuals or agents, and forms that are created from the top down by the few. The latter are sometimes said to be 'planned' whereas the former are regarded as evolving organically. It is axiomatic that a good model of form should generate any variant across this spectrum from organic to planned but in practice, planned forms are often seen as being imposed on an organically evolving system.

In architecture, this distinction between different kinds of forms is often thought of in terms of the vernacular or unself-conscious design versus self-conscious design or machine architecture as it has been called in the modernist movement. In examining form in building using systematic approaches, the focus began on 2-dimensional structures, on plan forms whose relationships could very largely be generated using various rules that encoded information that the designer or builder wished to include as a key influence in their design. George Stiny and Bill Mitchell in the first article provide an excellent summary of one style of morphology which has been widely published in this journal. It is based on the notion that there is a grammar to architecture and that good design exploits this grammar. They articulate this in much the same way that linguistics can be constructed in terms of formal rules of grammar but they apply this to shapes. They illustrate such a grammar in the construction of Palladian villas, particularly developing this for the example of the Villa Malcontenta, a classic example of this style of building.

In essence, shape grammars are based on how shapes are combined from elemental objects according to a series of rules that define the principles of good design. In this sense, good design reflects how architects construe the construction of quality space that meets certain needs or how more unself-conscious building generates such space. Thus, rules that would assume organic growth might be quite different from those that assume planned growth. The great tension in architecture and to some extent in planning, is in terms of who makes the best rules: architects and planners trained professionally to examine problem contexts, or less expert but equally if not more knowledgeable users of the environment. In the case of Palladian villas, the rules are quite easy to define as these were prescribed by Palladio relating to features such as symmetry, distribution size, aspect ratios of rooms and so on which are then applied in sequence to the stages of building the plan – grid definition, exterior-wall definition, room layout, interior-wall realignment, principal entrances, exterior ornamentation, windows and doors, and thence termination.

Although shape grammars do appear to generate quite accurate designs with respect to well-known sets of formalized rules, there is always the issue of intuition both in applying these rules and in extracting and defining them. Downing and Flemming take seven bungalows designed and built between 1914 and 1926 in Buffalo, New York and show how various rules used to generate their shapes can be linked to various conventions and practice. These bungalows represent a certain style of building popular at the time and the

authors succeed in defining a series of rules that when operated in sequence produce the ground plans and elevations of the houses concerned. To an extent, shape grammars represent a kind of pattern book approach to architecture, not so dissimilar from the creation of planned towns whose rules might be specified using methods of cellular automata that we will describe a little later when we review the articles relating to urban simulation.

These articles established a tradition in the journal associated with the first editor Lionel March and only represent a sample of the work on shape grammars reported during these years. Fast forward to 2007 to our third article on morphology by Larry Sass that uses shape grammars of the Palladian villa to actually reason about the design while also constructing a rapid prototype. In some respects, this is the logical outcome of all this work, a model which actually generates a physical output built on the rules that are used to define the way shapes are combined and morphed together. The production system that physically manufactures the model (using a 3D-printing device) is defined as a grammar based on 16th Century masonry construction rule sets. Sass argues that these construction rules can be used to build Palladian villas simply starting with floor plans and hardly dealing with elevations at all. The Palladian villa based on the Villa Cornaro is fabricated in this way and presents a very impressive outcome of a model that is rule-based with enough formality and non-specificity to generate clear examples of buildings that were put together in the past largely using intuition but based on pattern book logics.

Lionel March, George Stiny, Ulrich Flemming, Bill Mitchell and Phil Steadman between them laid the foundations for a theory of building that is still quite rudimentary but is beginning slowly to pay real dividends with respect to our understanding of what is possible and what is practical in architecture. Moreover, they developed much of their work in this journal and it is fitting that one of the latest contributions in this area is from Phil Steadman and Linda Mitchell who develop what they call 'architectural morphospace', a space of all possible forms which they catalogue and explore with respect to key variants and classes of building that either do or do not or possibly cannot exist. They propose a method for dissecting a building into simple blocks that can then be combined or rather filled to represent a very large variety of shapes. Some of these are physically impossible, in fact most may be, but this space can be used to classify different building types. More importantly, it can be used to show how building types have evolved and might evolve in the future, plotting morphological trajectories through the space of forms. As they argue, this is not a method of or for design, although there are implications for how good designs might be generated in this space of possibilities using genetic algorithms and evolutionary optimisation. Their work not only takes forward shape grammars without actually building directly on their base but also takes forward the kinds of thinking that March and Steadman (1971) laid out in their book, *The Geometry of Environment* forty years ago, which set the world alight with respect to the founding of this journal.

Urban Flows, Forms and Fields

The notion of a building, a building complex or a city being represented by a set of flows is germane to the application of social physics to spatial systems at many scales. Regional science which was one of the drivers of research in the early days of both *Environment and Planning A* and *B* adopted the classical gravitational model as a basis for defining how flows of traffic, materials, trade, migration and related demo-economic activities could be represented and simulated; and this led to many efforts at generating models that articulate location as a consequence of flow. Indeed, the spatial interaction paradigm is predicated on this basis. From this came many ideas about accessibilities and connectivities which have gradually found their way down to finer scales of activity, yet still retaining the idea that form is a function of a set of flows that all together define fields of like activity and influence in cities and their buildings.

In fact, at the finer spatial granularities which this journal has tended to focus upon, economic flows and fields merge into ones that relate to perceptions, to visual fields. Early in this journal, a distinct tradition based on examining buildings and parts of cities at the level of building complexes in terms of their visual integrity became well established. A particular focus was the urban viewshed that defines how far one is able to see from any vantage point in the city or within a building. This may not seem overly significant in terms of bigger questions relating the economic rationale of cities and their development. But in terms of the use of space and buildings, how far one can see and what one can see is central to the way we actually use (and sometime abuse) buildings and their space. The idea of a visual field of course comes from landscape. There have been a fair smattering of articles dealing with visual landscapes in the journal but by far the dominant focus has been on visual fields at the urban level. The field *per se* is not the issue but it is the way an observer experiences how the field changes, as an observer moves through the field. This provides a sense of flow and flux and several articles over the last 30 years have dealt with these issues and the development of tools that have enabled analysts to get to grips with their representation in terms of form and function.

Michael Benedikt in a path breaking article in the early years defines the idea of a visual field around an observer, and which after Clifford Tandy, a landscape designer working in practice in the UK in the 1960s, he calls as isovist. This is the viewshed around a single individual which of course changes as the individual moves from place to place. If we define isovists for every point in space, then we define an isovist field, which portrays the sense of continuity or otherwise from any point in the field itself. Trajectories across the field then define particular types of experience in moving through complexes of buildings or streets in the city. Benedikt's article defines many of the basic elements used to define such fields. The visual field may in fact be attributed in

various ways – in terms of how far one can see, what elements or activities in the environment are accessible from different points in the field, how much time it takes to move in the field, how fast one can move and so on. Fields in this sense relate to open space but they can equally well define the inside as well as the outside of buildings.

It took a long time for Benedikt's ideas to be picked up but in the development of a method of morphological analysis called space syntax, the visual field has become central. Space syntax measures the relative accessibility or connectivity of different places to one another; in fact, these places are not usually locations but street lines – which are essentially lines of sight or uninterrupted movement. We will have more to say how such lines are defined below but in essence, how far one can see or move is captured by the idea of the isovist. More than 20 years after Benedikt published his article, Alasdair Turner, Maria Doxa, David O'Sullivan and Alan Penn fashioned the methods of space syntax into notions about visual fields. Their particular methodological advance is to show how a set of isovists can be used to generate a graph of mutual visibility between locations which is called a visibility graph, whose local and global characteristics provide methods for making comparisons between locations. A variety of graph theoretic methods can be explored using such graphs, and the authors show that visibility graph properties are closely related to spatial perception, such as way-finding, movement, and space use.

Urban morphology has also been massively informed by approaches other than space syntax and shape grammars. Fractal geometry has emerged during the lifetime of this journal and ideas about how building forms scale as they repeat themselves in self-similar fashion at different spatial scales have become important. In fact, in the next section, we will point to articles in this volume that define models that build on fractals, automata, and scaling but here in the spirit of examining visual depth, we include an article by Andrew Crompton and Frank Brown in which they explore depth in building elevations. They make a point that resonates with the work of Christopher Alexander, referred to earlier; old buildings generate depth which is captured by $1/f$ scaling, thus resembling the fractal geometry of nature, but they discover that this is not the case for modern buildings. They find similar scaling distributions in newspapers and conclude that it is this kind of scaling – the repetition of motifs at ever larger scales, that provides real interest in both nature and in man-made artefacts. In many respects, this is the notion that for buildings and space to be intelligible, they must contain the sort of interest in form that is represented by distributions of objects or components that scale.

Our fourth article in this section takes this further, not in terms of buildings but in terms of lines of movement which are best illustrated by streets. Bill Hillier, Alan Penn, Julienne Hanson, Tadeusz Grajewski, and Jiangmi Xu argue that the pattern of streets with respect to their configuration correlates strongly with their use. In short, streets that are more accessible within the city tend to have higher traffic volumes, an observation that is widely borne out

in many urban land use transportation modeling efforts and in widespread empirical analysis of traffic patterns. The authors argue that most cities are based on a deformed grid, whose regular equivalent does not privilege any one street over any other. It is this deformation that produces structure and variety in cities and they go on to show how their own measures of space syntax – particularly measures of depth from one street to another and their overall accessibility measure which they call integration, enables patterns of streets to be determined whose measures correlate strongly with the traffic that uses these streets. Their conclusion that it is not the local properties of a space that are important but it is how such local spaces relate to the larger urban system in terms of configuration that determine traffic and land use patterns. This has always been controversial – which came first? the street or its land uses? – and it has generated a healthy debate in the pages of this journal in the last decade.

The configuration of streets and the size of spaces that they enclose determine not only the pattern of vehicular pattern, but the movement of pedestrians. Dirk Helbing, Péter Molnár, Illés Farkas, and Kai Bolay, in their article on self-organizing pedestrian movement illustrate quite clearly how individual pedestrians behave collectively in enclosed spaces, thus generating rather different kinds of configurations and patterns at an even finer scale. They build models of social forces that determine how pedestrians move relative to one another and how they avoid obstacles in the physical environment, be they buildings or other pedestrians. In particular, they introduce learning into their model through the simple expedient that the more people walk in a certain area, the more that area becomes walked and even walkable. In short, as patterns come to be impressed in the landscape, this generates even greater activity, through positive feedback. The authors show how pedestrians organize themselves into feasible patterns at high densities, how log jams can form, and how obstacles are tackled. There are important implications here for the design of pedestrian spaces to avoid congestion and to provide more walkable environments, and these have important implications for urban design.

The last article in this section generalizes much of this work. Sergio Porta, Paolo Crucitti, and Vito Latora review the network metaphor in spatial analysis and design, pointing to the obvious lack of development of network science for planar networks in comparison to topological. In one sense, space syntax sidesteps this by moving from planar to topological in switching from what Porta and his colleagues call the primal problem – the street network as a graph where nodes are intersections of streets – to the dual problem – where each street is a node. Notwithstanding this, they suggest that we should draw on the rich heritage of network science which has seen enormous development during the last decade, to develop much more considered measures of accessibility than those used before. They demonstrate what they call multiple centrality assessment (MCA), a methodology for geographic network analysis, based on primal rather than dual street graphs, working in a metric, rather than

topological, framework, and generating a plurality of centrality indices rather than a single index.

Urban Simulation

The first issues of *Environment and Planning A* were dominated by urban and regional models which Alan Wilson, the first editor, was centrally involved in. These models were aggregate, cross-sectional, comparative static with little appeal to dynamics, articulating the city as though it were fixed in time, but parsimonious, testable, and operational. As we have explained, *Environment and Planning B* tended to steer clear of taking articles in this tradition until the family of journals had established itself by the early 1990s. But by then, the field of urban and regional modeling was very different. Dynamics had come dramatically onto the agenda. Notions that models should be richer and more detailed – more disaggregate – as well as dealing with behavioral processes explicitly was widely accepted, and thus the repertoires of possible urban model types have expanded. In particular, these new styles of model build on individuals or agents. This has led to agent-based models (ABM), their spatial equivalents being sometimes simpler and referred to as cellular automata (CA), and various other styles such as micro-simulation.

This section contains articles that are strongly in the CA tradition with some appeal to ABM. First, David O'Sullivan develops a graph-based CA, built along lines where graphs in the sense of networks are used to portray how adjacent cells influence one another. Usually in CA, variations in the size of neighborhoods are not allowed but he argues that reality is such that irregular cell-based neighborhoods are required. He grounds his ideas in terms of the proximal model of space and introduces geo-algebra as a method for representing and processing what he calls graph-CA. This provides a powerful framework for examining different classes of CA and enables the formalism of CA to embrace relational logics that provide interesting ways of relating structure to process. The framework that he introduces enables CA to be generalized to deal with hierarchical structures as well as multi-graphs of relations, and this leads on to measures of structure and variety that relate to spatial evenness, clustering, and segregation.

A major application of CA modeling has been developed as part of a project financed by the US Geological Survey called Megalopolis. This has led to the SLEUTH (Slope, Land cover, Exclusion, Urbanization, Transportation, and Hillshade) model which was originally developed for the San Francisco Bay Area. In the next article, Keith Clarke, Stacey Hoppen, and Len Gaydos provide an initial specification for the model which essentially divides a spatial system into small cells – such as those associated with land parcels or pixels in a remotely sensed image (from whence much inspiration for these styles of model has come), and then defines plausible rules of transition between the cells with

respect to urban development. They base these rules on data associated with topography, road networks, and existing settlement distributions. As the model generates a temporal dynamics, the CA adapts itself to the outcomes that are simulated. In this example, the simulation runs to the present day from 1900 with data compiled initially from old maps but from many other anecdotal historical sources. The simulation is probabilistic as are many such models in that there is uncertainty about transition and thus the probabilities structure a random process of allocation, quite usual where there are so many cells and so many different possible configurations. Strictly there is always a deterministic version of such a model outcome although the compounding of possibilities makes such a determination difficult to generate.

In contrast, Lena Sanders, Denise Pumain, Hélené Mathian, Francois Guérin-Pace, and Stephanie Bura develop an agent-based model system (SIMPOP – population simulation model) for simulating the evolution of settlement patterns over long time periods. Their multi-agent systems formalism defines each settlement as a separate entity interacting with the others and transforming itself. The rules allow for the simulation of an urban transition from a relatively uniform and rather homogenous agricultural landscape to a highly differentiated contemporary urban settlement pattern, thus showing how various modifications of the rules can generate different varieties of urban system. One impressive feature of their model is the ability to generate hierarchical structure which is a classic form of system differentiation as a system becomes more complex through time. Moreover, they test the impact of initial conditions in as systematic a way as is possible in this style of model, showing quite clearly how different parameterizations of the model structure affect various outcomes. Although not emphasized much in this article, SIMPOP is based on a detailed and effective purpose built software system that relates back to ideas in systems dynamics.

The ideas in SIMPOP are picked up at least implicitly in the article on urban settlement transitions by Claes Andersson, Steen Rasmussen, and Roger White. They formulate a mathematically well-defined urban model based on modified Markov random fields. It is constructed on a lattice where lattice-wide interactions are possible, and from this it is possible to generate a series of emergent structures such as those similar to diffusion-limited aggregation. They build their model around the idea of births and deaths of urban activity and this is diffused through the Markov fields which link different types of urban activity together. They also show how phase transitions can be a consequence of the simulations with respect to clusters of growth, and they dimension the model to various physical parameters which give some sense in which the model is able to generate structures that are city-like.

Our last article in this section exploits the notion of simulation in a game-based context in much greater detail than any other examples. SIMPOP was also constructed to provide a game-based environment but the model developed by Erez Hatna and Itzhak Benenson essentially defines a game so

that the rules of urban development can be studied – extracted from the game and then used to fix the rules in the simulation model. They argue that urban development is usually conceived of in models as 'first-order recursion' where the state at a previous time instant, influences that at the next time instant. They test this by constructing a mock-up city which gamers (students) are asked to develop through the sorts of bidding process that take place in reality between developers and users of (housing) development. From this, the rules are extracted and built into the simulation, thus enabling the simulation outcomes to be compared to the game. In fact, these experiments are rather successful, showing that for the most part first-order recursion in cities is the name of the game. Yet, there is sufficient uncertainty in these outcomes for the authors to caution against assuming that all development is like this: development which is routine may be but there are clearly longer term issues in urban development that come fighting back many years later to change the world. This is an increasingly important theme in the journal.

Planning and Design Processes

Planning is a very broad church. In one sense, it is impossible to define for it relates to a style of human behavior which is predicated on rational action in the interests of a collectivity wider than the individual. Planning as it is assumed in the context of these journals, involves methods, processes, ideologies and dialogues that pertain to the betterment of the human condition, although at one extreme, it might pertain to any form of considered (planned) action at whatever scale and on behalf of any group. As we noted at the start of this introduction to the work of *Environment and Planning B*, the focus in our domain is largely on the planning and design of physical artefacts, set of course in a social context and in no way independent of this. To this end, we have encouraged articles in positive planning theory and in the methods of planning and design. In particular, we have focused on the interface between planning, design and the tools that are used to generate and evaluate such design, to embed these in the wider context of stakeholder participation. Here we have selected articles that link the philosophy of design to human action in terms of evolutionary models; we explore the limits to rationality and the key dilemma over whether to plan or not; we introduce the important idea of planning as a dialog, in terms of argumentation which lies at the root of contemporary approaches to planning as cooperation; and we show how the models and tools introduced by other authors in other sections of this volume can be used to construct planning support systems.

In the first article in this section, Peter Allen draws on the paradigm of evolution to demonstrate that innovations often occur in human systems through what are called bifurcations in the general secular trend. These discontinuities

are like phase transitions and they can be set off when enough people come together to produce a culture of invention, with enough positive feedbacks between them to spark off new ideas and establish new trends. This, he argues, is the way the world works, in fits and starts through bifurcations and punctuated equilibria. He shows the famous example of the Belousov-Zhabotinskii reaction in which spiral chemical waves develop when the reactants cause waves that can appear spontaneously or be initiated by touching the surface with a hot filament. This is self-organization in action but a more graphic portrayal is given in terms of form using origami where one geometry suddenly and unexpectedly turns into another. Behind these ideas is the notion that rational behavior is never what it seems, that design is often inspiration, apparently coming out-of-the-blue so-to-speak. His message is that we need to build planning and design into our models and that it is not enough to consider them separately only to be brought together when we consciously attempt such planning and design.

The myth of rationality that Allen implicitly alludes to is taken up directly in the next article by Mel Webber. He argues that rational planning as it emerged from the scientization of society in the post war years is 'fundamentally flawed'. In short, he says there is little or no consensus about what the most important issues are. The kinds of causal theory presumed in areas where there are more definite predictions to be made, simply do not pertain in planning human systems. Although writing over 25 years ago, he calls for more decentralized, participatory planning which meets the needs of a 'plural public'. He echoes much of what has dominated planning as an activity in the pages of this journal over its history, and he explicitly raises the issue of dialog, quite consistently with all the other authors writing in this section. In fact, his argument that rationality is not possible, is bolstered by the fact that uncertainty is endemic in planning for the future and these two trends converge to suggest that much more decentralized bottom up approach to planning must be the order of the day. To an extent, much of this has come to pass since these writings were first published, and they are echoed in both Ernest Alexander's and Harvey Goldstein's articles that follow.

In his article with the controversial title, "To plan or not to plan, that is the question: Transaction cost theory and its implications for planning", Ernest Alexander makes the case for developing planning in association with the institutions that enable it to function, rather than the narrower technical problem-solving model based on rationality. In fact, this might now seem to be quite obvious for much of planning is now regarded as the design of effective institutions for enabling change and brokering consensus. His approach explicitly sees planning as depending on more hierarchical and more market-like forms of organization, stressing cooperation that culminates in institutional design. To this end, it is important to see planning as associated with different types and sizes of organization, and his conclusion is that its practice

must reflect this. Like Webber before and Goldstein after, this implies transparency and dialog. Harvey Goldstein, again in an article more than 25 years ago, puts the seal on this argument by invoking the notion that planning must be based on argumentation through a shared discourse. He defines at least three types of reasoning—utilitarian, systems, and procedural, which he goes on to argue must form a basis for public discourse on what constitutes a 'good society'. His arguments are both infectious and convincing. At least in a modest way, there has been progress, as the last two articles in this volume and section imply.

Planning support systems (PSS) were first defined by Britton Harris (1989) in a path-breaking article in the *Journal of the American Planning Association*, where he argued that we needed to gather together the wide variety of methods and techniques that currently constitute the planner's toolbox and fashion these into a more integrated environment that he called PSS. PSS were implicitly assumed to be broader and deeper than DSS – decision support systems – but their feature was integration, somehow removing the duplications and inconsistencies that always creep in when one uses several different tools initially developed for different purposes, together. Lewis Hopkins, Harris's student, in a far reaching article defining the structure of a planning support system for urban development, provides an example of this environment in which various tools are mapped into each other through the notion of "actors, flows, investments, facilities, regulations, and rights, as well as elements familiar in GIS". His system includes "sketch planning, model building, scenario building, evaluation, lineage tracking, and plan-based action" and the conceptual apparatus he provides stands above the application of mere routine tools in simple sequences that do not relate to the wider structure and intellectual coherence of the planning task.

Our last article is one that continues to be far reaching for it heralded the development of new interfaces between various skilled professionals and the public in terms of new media to support planning. In 1995, when it was first published, the World Wide Web was in its infancy. Tim Berners-Lee had only invented it in the early 1990s and the notion that planning support would be drawn to the web, seemed fanciful. But Michael Shiffer saw otherwise. His development of multimedia systems in planning on the desktop was then central to the sort of PSS that Harris had in mind but the notion of opening this to the wider public – to use the web to engage debate and dialog, to use the web to facilitate argumentation and collaboration – had barely been thought through. Shiffer provides a veritable treasure trove of ideas in his article and demonstrates what he calls multimedia-based collaborative planning systems (CPS), drawing on examples from the National Capital Planning Commission in Washington, DC. This style of distributed computing is still advancing by leaps and bounds and the notion of dialog between professionals and their publics is likely to see dramatic changes in terms of the use of these technologies in the decade to come: p(P)lanning and d(D)esign will be at the forefront of these advances.

Where Will the Journal Go Next?

We exhort readers of this volume to go in search of the journal that you can retrieve at www.envplan.com/B.html. We have included a mere sample of the articles that we have published over the last 37 years, and although we consider these are amongst the best, there are many of equal quality which for various reasons have not taken pride of place in this volume. Moreover, if you scan the contents of the journal you will see how things have changed and what has driven the field at different points in time. Today, we see a dramatic revival of interest in cities as systems, in developing a science of cities, and in using this science to help us create better designs. But at the same time, institutional planning which came out of the reaction to the poor quality of life in nineteenth century industrial cities and was so strongly associated with the central state, has dramatically declined. Institutional structures have become ever more complex, new forms of data relate to developing digital worlds, and new ways of communicating ideas in terms of policies and plans through the Internet all promise to keep the rate of change in this field substantial.

The future is likely to hold a little more of the same but we think there will be a strengthening of scientific approaches. We think that more and more data and models will come to rely on online data sources, many of them dealing with finer scales than anything we have had access to hitherto in urban design informed by these new technologies. At the global scale, we also see more focus where the grand challenges of climate change, aging, migration, energy depletion, security and so on will continue to be explored. Integrated models will become more significant while models that cross scales are likely to appear. All of this, we believe will be reflected in our journal. It will be interesting to see where the journal is in another 37 years, but it is unlikely that we will be its editors. It would be interesting, too, to see if we or our generation can understand any of it such is the rate of change in intellectual and day to day life.

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