

A Science of Cities in a Science of Planning

Michael Batty¹

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A Prologue

During my entire academic life, I have been concerned with building symbolic representations of cities in terms of their spatial structure and dynamics while simultaneously researching planning processes conceived of as problem-solving in which such tools might be made applicable. This has meant building ‘models’ of the phenomena and implementing them using digital technologies. In this quest, I have learned that models are abstractions, simplifications; they do not pretend to describe or simulate a world in all the detail we can imagine but they distil the essence of that world, leaving out much that others might consider significant. In this sense, there are many models of any single phenomenon and a good model, to me, is one where there is public agreement about its usefulness to some purpose.

Over many years, I have gradually concluded that *powerful theory* is necessary to any quest for understanding. All the models of cities that I have dealt with have theoretical roots in rather dramatic simplifications of the spatial structure of cities, drawing on urban economics, social physics, transportation behaviour, and geo-demographics. These theories and their models are based on very distinct ways in which to manipulate and explore urban futures, ways which are transparent and have a clear but limited logic. This means that such models can be critiqued rather sharply in contrast to looser more descriptive theory that always admits ambiguity. But at the same time, these theories and models exist in a context of *unpredictability* that has become more obvious – at least to me – during my lifetime when the notion that we can predict the future in any but the most short term and obvious ways has come under continued scrutiny. The assumed logic of model-building is first to predict the present or the past, and if this first test is passed, your model is acceptable in some minimalist sense for future predictions. But as we know the future is unpredictable. This is a dilemma that one learns to live with but it has profound implications for the use of any knowledge in thinking about the future and explaining the past.

As part of my quest to build models that inform planning, I have spent a lot of time attempting to communicate specialist knowledge and powerful theory that is combined in such activities. This has primarily been through *visual media* – opening the ‘black box’ to others who are not privileged in its working as well as rapidly displaying the predictions that such models provide. It is all too easy to generate predictions that are hidden away and obscured by the model but during the last 30 years, our new technologies have become explicitly graphical and this has been of

¹Centre for Advanced Spatial Analysis (CASA), University College London (UCL), 90 Tottenham Court Road, London W1N 6TR m.batty@ucl.ac.uk www.complexity.info & t @jmichaelbatty

enormous importance in enabling one to communicate and critique their essence. My own work however based on developing quantitative models is somewhat different from a good deal of what is talked of in these essays. I tend to see the city system as being somewhat separate from the planning task. Of course they merge into one another, sometimes planning is part of the problem, and there is a great kaleidoscope of possibilities in this array. If I am critical of what has happened with the planning project this last 50 years, it is that many planners and planning theorists have forgotten the city. My view is that they must rediscover the city for at this juncture in time, there are quite remarkable changes taking place due to new technologies and changing values that are destined to change our behaviours in cities in quite fundamental ways. All of this belies the fact that cities are getting more and more complex, at a greater rate than we can keep up. Perhaps it has always been so but the study of this complexity and its implications for the models that I build has been another key theme in my work. From an early life exposed to the systems approach to my recent work where I have been part of what I might call the *complexity project*, this has had an important influence on how we build our models, generate new theory and apply it in planning. It is a task that will never be finished and this essay seeks to convince its readers of its importance.

I have talked so far about models of cities and implied that somehow these fit into models of planning. Most of my work has been on the former and I am well aware that what I call the ‘normal science of urban modelling’ is not something that many reading the chapters in this book will have much experience of. Thus I will first tell you what these models are all about. They are essentially parsimonious statements of how functional relationships between the elements that compose a city – best reflected in its land uses and socio-economic activities – generate the physical structure, the form and function, of what we see around us. These elements are often related using simple functional relations expressed in terms of the way distance and geometry affect the physical disposition of land uses. Models of these processes connecting all parts using flows and networks reflect the markets for land, labour and capital and under the usual regime of competition, an equilibrium pattern that is the morphology of the city emerges. It is this pattern that is usually distorted by planning and the kinds of models that we might build enable us to figure out these distortions in advance. In short our aim is to provide some degree of predictability, or at least some sense of what the future might hold under different planning scenarios which aim to improve different aspects of the human condition. The models that I have worked on tend to reflect economic conditions in polarised markets where much social and economic exchange takes place according to a logic underpinned by urban economics, regional science, transportation modelling, social and demographic structure.

We can also articulate abstractions of the planning process somewhat differently through the way we go about seeking to generate best plans. To an extent I have worked on idealised models of this type, largely fashioned from rather distinct forms of problem-solving and design. I will not deal much with these here for my main thrust has been one of thinking out how models of cities might be used in much less structured processes of planning, not dissimilar to Friedmann’s social learning and Healey’s communicative approaches which they both allude to in their essays herein. In one sense, as you will see in my use of models in planning, communication is of the essence and much of my quest has been to continually think about ways of

improving this. But I am getting ahead of myself already and the best way to explain what I have been doing is to go back to the beginning, starting with my early life.

Early Life, Defining Moments: Liverpool in the 1950s

As in most personal histories, a life is often preordained yet also determined by a succession of historical accidents. Born and brought up in Liverpool in 1945, in the summer of 1959, my parents took me and my brother, on our usual seaside holiday to Grange Over Sands, a ‘posh’ seaside resort north of Blackpool where we stayed for two weeks in a guest house, sampling the delights of a usual English summer. There they struck up a friendship with a couple from Oldham whose daughter, then 17, was in the process of applying to go to University, a pretty rare event amongst my parent’s acquaintances. We visited these friends the following autumn and in the parents’ conversation about what their respective children should do in life, their friends produced a 1959 prospectus from the University of Manchester for an undergraduate course in *Town and Country Planning*. Their daughter had considered this as a possible course – how they came across it I do not know – but in the event, she eventually went to Art School in London, the Slade I think. Town and Country Planning it seemed was not quite Architecture and certainly not Art but nevertheless it was Design tinged with a little social science, and my dad was quite attracted to this. I remember him quite vividly saying to me that if one became a town planner, you would always have a job. In those days, the shadows of a world war still lingered, there were many bomb sites in Liverpool that no one seemed to care about, the mass housing programme to clear the slums of an industrial past was only just gearing up, and memories of the 1930s Great Depression were still deeply entrenched in the British psyche. In 1957, the incoming Prime Minister Harold Macmillan would tell the British people that ‘they had never had it so good’, and Britain was poised to enter a brave new world. Being a town planner did indeed seem like something that would lead to a ‘good job’.

The second accident that determined what I was to do relates to our educational system: back then to 1950, the year when I first went to Primary School. Some two years into the school aged 6-7, we were streamed into classes A, B, C on the basis, I presume, of tests in reading, writing, arithmetic. There I stayed, being ‘tuned up’ to pass exams until the ‘big one’ which in the British education system was the so-called “11+”. This was a national examination taken by all children aged 11+ and on the basis of the results, you were ‘sent’ to either a grammar or technical school, or to a secondary modern school. Some 20% went to grammar schools which were organised around a rich diet of academic subjects, the rest were destined for a world of work where thinking was not a prerogative and where the intention was to fill the gap until age 15 when you could go dig coal, keep the trains running or become a shop assistant, a dreadful way of schooling that indeed was quickly abolished by the incoming socialist Labour government of the 1960s.

So in 1956, I went to a boys-only grammar school, Quarry Bank High, where after the first year we were streamed again by abilities into classes A, B, C, ... At the end of the third year at age 14, the A stream was subdivided yet again into two groups, Arts and Sciences. In the Arts stream you would follow the Classics, Languages, History while in the Science stream Physics, Biology, Chemistry, and so on. Some subjects

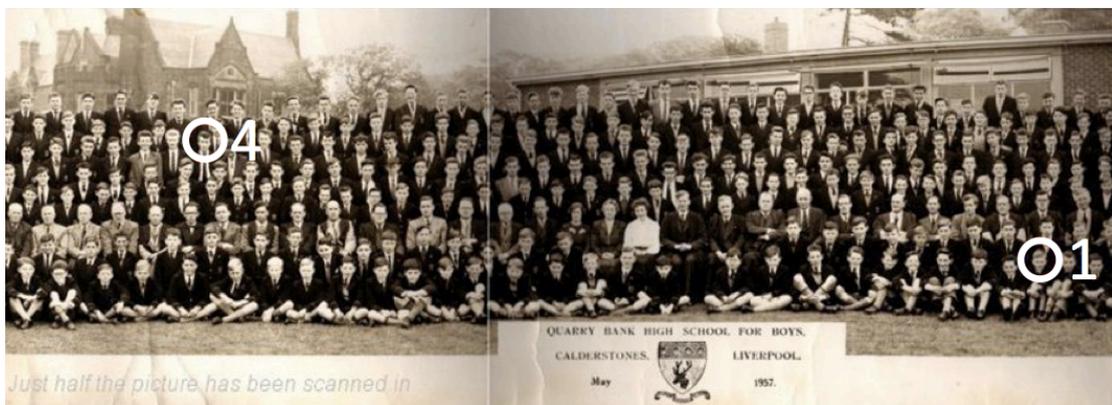
were common like Mathematics but dependent on the stream you were in, this dictated what you could then do after age 15 or 16, always assuming you passed 5 subjects at the national Ordinary Level Examinations stage. At that point you entered the 6th form where you chose 3 subjects that you would study in depth for two years and would dictate entirely what you could do at university. If you had been in the Arts stream all this time, then there was no way you could study science or medicine because you simply had not taken the right examinations. Of course it cut both ways. Someone who had not followed the Arts stream, could not do History or Geography or English or French at university largely because by age 18 you were too far adrift of the syllabuses in any area to start a university course in the same.

This further streaming when you were divided into Arts and Science was particularly pernicious. Surely you may ask, were there not children who were good at Arts and Science? Of course there were but it was the schoolmasters (boys only remember, not one female teacher in the school) who determined what you would do. I found myself in the Arts stream largely because I scored slightly higher marks in subjects like History and Geography than Physics and Biology. I suspect now that there were other constraints on how many boys could actually go into one stream or another and that the mechanism was partly a blunt instrument of organisation. But my going into Arts then dictated what I might do subsequently and of course at age 14, I didn't have a clue. By 16 however, I did have some ideas. I first thought I might like to be a geologist and remember a tearful session with my parents who were told that I needed to pass Physics, Maths and Chemistry at Advanced Level to get into university to read Geology. I then toyed with the idea of Architecture but again I had no Physics or Mathematics and no Art either, and that route was barred. I was however a skilled draughtsman, quite good at Art too and from my 'woodwork' skills, I amongst only one or two boys in the entire school was selected to follow an Ordinary Level course in Geometrical and Engineering Drawing. Not quite Architecture but close, and this did indicate that my school was not entirely top down in its dictation of what its pupils should do.

In 1961 when I entered the second year of the 6th form, the last year before I took the Advanced Level examinations designed for that tiny proportion of the age group that had got far enough to consider university, we were interviewed by the headmaster about where and what we wished to do there. By that time, my dad had planted the seed of Town and Country Planning in my head and I duly told the headmaster that I wanted to be a town planner. He then asked me if I knew anything about town planning and I must confess that I did not except that it was about drawing plans! He berated me and asked me had I not heard of Patrick Abercrombie – clearly he had and his particular expertise was as a teacher of German but Liverpool was a small world and Abercrombie, deceased by then but only recently, had been a Liverpool man. I had not heard of him of course but I remember the headmaster's words to this day ringing in my ears. "Go away, Boy, and read something about town planning and then come back and we will discuss it!". Duly chastened I retreated to the Liverpool Central Reference Library and retrieved Abercrombie's (1935) little book **Town and Country Planning** and devoured it. It did indeed seem to mesh with my interests and as the headmaster subsequently said "Town planning is alright because at least it is sufficiently academic to be worthwhile and it also lets you indulge your drawing skills".

And so that is how I chose to become a town planner, or rather how the world determined that I should become one. In the last year of the 6th form, I flirted, given the fact that I was in yet another stream one year ahead of most boys in the age group, with staying on for a third year in the 6th and trying the Oxbridge examinations, but my parents did not think this was a good idea. No one had ever been to Oxford or Cambridge from my family, no one had ever been to a university, and my dad was keen that I should move on as fast as I could. In fact, I did flirt too with doing economics at the LSE and then land economy which seemed a bit like planning at the College of Estate Management in London University. In the event, I only applied to one university and that was Manchester to do the four year course in Town and Country Planning. And that is about as preordained as one can get, as I will recount in my subsequent portrayal of my years as a student.

To complete the picture of my growing up in Liverpool, I must say something of that marvellous city and the grammar school I went to. You can do no better to get a feel of those times by reading Volume 1 of Mark Lewisohn's (2013) wonderful book **The Beatles – All These Years** where he talks about how the group was formed and what the Liverpool suburbs were like. Lest you do not get the message, one of the group attended my grammar school although 5 years older than myself, and if I might indulge myself a little further, I will show you a picture of what the world looked like in 1957 at that boys' grammar school in England. I will come back to this at the very end of this essay but despite the political incorrectness and strong regimentation of the education it offered, it was a wonderful school and I have much to thank it for. Philip Norman in his 1981 book **Shout!: The Beatles in Their Generation** said that: "In later years, after it had produced two Labour cabinet ministers – William Rodgers and Peter Shore – Quarry Bank came to be nicknamed "The Eton of the Labour Party". In fact many years later, under the Blair government, (Lord) Peter Goldsmith, a boy some 5 years below me at Quarry Bank, became Attorney General, a Labour party appointee. Lest you think that going to the same school as a Beatle is some great thing, John Conway, the Princeton mathematician who invented the cellular automata called the 'Game of Life', was in the same class as Paul McCartney at another Liverpool grammar school, the Liverpool Institute². The 11+ examination that separated and divided did lead to some interesting juxtapositions in British society as any list of the prominent people divided but also accelerated by that system will clearly reveal³



²<http://www.nytimes.com/1993/10/12/science/scientist-at-work-john-h-conway-at-home-in-the-elusive-world-of-mathematics.html>

³http://en.wikipedia.org/wiki/Calderstones_School.

But let me steer back to the main story because in 1962 having taken my Advanced Level subjects in History, Geography and Economics, I ‘went up’ to Manchester so-to-speak where I was to spend 7 happy years, where I met my future wife, and where I cut my teeth and began to reach out for many things that had been not been possible due to the educational obstacle course that dominated my early years.

Machines, Models and Metaphors: Manchester in the 1960s

One of the nice things about writing a personal history if you come from Liverpool is that it is easy to write about your own experiences with the humour of that city in mind: Liverpudlians take everything tongue in cheek. The humour is “... fast, dry and so often containing a black, sad undertone that strikes a chord of understanding, but without arousing pity.”⁴ When I applied to the University of Manchester in 1961, I was called for an interview at the department which with Architecture was located on the first two floors of the old Dental School and was duly interviewed by the professor and the senior lecturer, Roy Kantorowich and George Chadwick (author of **A Systems View of Planning** published 10 years later). It is amazing to think that two of the key people in the department could spend their time interviewing a prospective undergraduate. I shudder to think how little time we spend now in this role but it worked as I was impressed, if not a little intimidated.

In fact, I did not realise that the university system was so small and paternalistic that this sort of interaction was possible. There was no publish or perish culture then, no grant writing and getting, no jet-setting internationalism in crowded airports, no running around telling the world that you were the biggest and the best, it was simply different. My dad who had just learned to drive, actually parked the car outside the department while I went in for my interview. Like the headmaster before, they asked me what I knew about town planning and what I had read and I duly responded – because by then I had learned my lesson and was pretty familiar with the literature (there was not that much) – that I was reading Lewis Keeble’s (1959) book **Town Planning at the Crossroads**. Kantorowich and Chadwick both grinned and I wondered why, little knowing that Keeble, something of a maverick, had been a lecturer at Manchester before moving to University College not long before. When they asked me where I would live – in what hall of residence – I professed profound ignorance and simply said I would have to ask my dad. I volunteered the fact that he was outside – only if you came from Liverpool would you say that – and so they asked him in. I wonder if it is the only interview ever conducted in the Town Planning School at Manchester where father and son were both interviewed by the head of department and his deputy! I like to think so. There was time for this in the old world, and I regret that those times have passed.

So up I went to Manchester in October 1962. In the same class, I met my future wife, and we have both stuck with town planning throughout our lives. At this point, I might stop and say ‘the rest is history’. But it would not be true for this was the beginning. I need to tell you how I have spent the last 50 years working on problems that I firmly believed would turn our knowledge of cities and planning into something that was worthy of sustained intellectual endeavour: problems that I still believe

⁴ **The Hitchhikers Guide to the Galaxy**, http://h2g2.com/edited_entry/A280892.

require all the things that I should have learned at my high school that I was prevented from taking due to the structure of the British educational system. In fact in the long view, I am now not so sure that this has made the difference that I once thought it did for it has not prevented me from following my inclinations and ideologies pertaining to science and art in the design and planning of physical and human systems. Right from the beginning in those early years, I firmly believed that we should be able to make systematic sense of the human condition, the way we built our cities, and perhaps more to the point here, the way we might intervene in their design and planning. In short, I assumed that what I would learn at university would be how one might assemble a science of planning built on the art of design. In a way, this was implicit in what we were taught for planning in 1962 in Britain was in the ascendancy. New towns and green belts, new ideas about traffic and circulation, the beginnings of an optimistic programme for mass public housing, these were all problems and ideas that were predicated on building more efficient aesthetically pleasing cities, more prosperous than anything before and more equitable. The fact that this would be achieved from a top-down technocratic standpoint was barely questioned.

As soon as I got to Manchester, I realised that planning stood astride two very different worlds: the worlds of explanation which were the worlds of social and physical science, and the worlds of design. In fact planning subsumed both and there was an inevitable, indeed essential tension in everything we did: cities versus planning and vice versa. The course was a strange mix of subject areas and ideologies. Heavily dominated by studio work, by learning in an Atelier-style tradition, we were treated to subjects from many different perspectives. We learned statistics and rudimentary location theory, construction and highway engineering, civic (not yet called urban) design, basic economics, property and planning law, a great profusion of areas that we all seemed to take in quite naturally. I believe that we successfully absorbed all this because we were young – we were not trained in anything to speak of as we were undergraduates – not geographers, not architects, not economists, not anything – and also because the studio work that occupied much of our time – probably 80% of it – was so all embracing. In fact the studio started small scale in year 1 at the level of street furniture but veered to large scale by the end of the year and then in subsequent years blended everything from urban design to regional planning across the urban-rural continuum. This was the great strength of our degree. It was truly absorbing and offered an environment for continual debate, discussion and experimentation.

In my first and second years, I began to learn a little about how one might study cities systematically largely through the works of the location theorists, through urban geography and the incipient domain of regional science but it was not until the third year that the excitement began. This was the era in the United States of mathematical models, of computer applications, of transport planning and community renewal. Cities were literally exploding through the decline of their downtowns, through decentralisation, through sprawl and they were pervaded by fiscal crises and racial segregation. We read the writings of Lowdon Wingo Jr., Mel Webber and many others who were writing about cities and their planning in an information age. The idea of systems was coming onto the agenda and Brian McLoughlin and George Chadwick, lecturers in the department along with Lyn Davies and Frank Medhurst, promoted a systematic, almost scientific view of how one might understand cities and

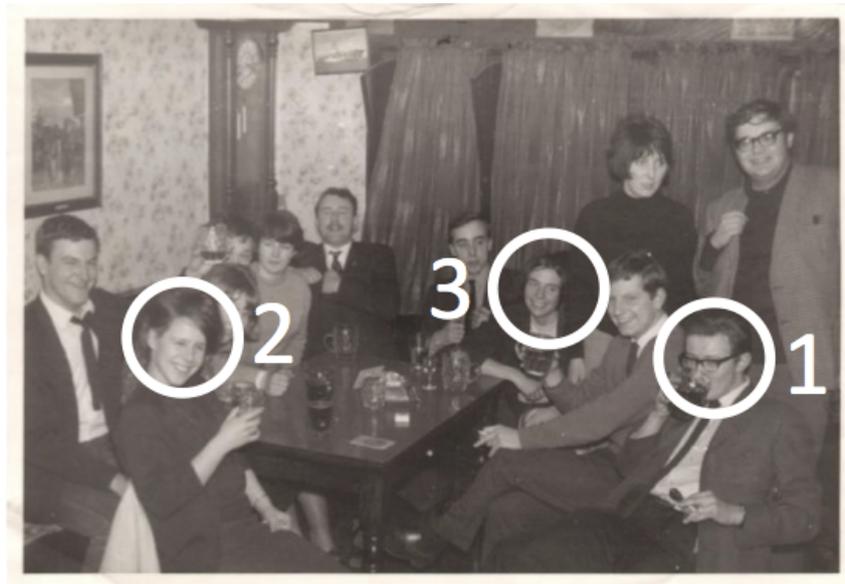
thence plan them. But this was all still very much a world of the top down. The systems model tended to conceive of cities as being in equilibrium and planning as being akin to the controller of a well-defined system of interacting parts that could be steered and managed from the top down. The metaphor was that of the city as a machine, coincident still with the writings of the architectural modernists such as Le Corbusier, and this approach was increasingly writ-large in the wider planning system which by the late 1960s was composed of strategic plans called structure plans and more fine scale zoning which were called local plans.

Our mentor, George Chadwick, ran the final year of the degree. Trained originally as an engineer, then landscape architect, the biographer of Sir Joseph Paxton (Chadwick, 1961), he introduced us all to what some of us have taken to calling over the intervening years ‘the science of cities’ and ‘the science of planning’ (Batty, 2013). Location theory and urban models formed the science of cities and design methods the science of planning. The writings of Britton Harris, Walter Isard, Peter Haggett and many others were infused with design theorists such as Christopher Alexander, all set against a background of cybernetics and general systems theory. John Friedmann too with William Alonso provided an influential source of material and their edited treatise **Regional Development and Planning: A Reader** became mandatory reading, along with the May 1965 special issue of the **Journal of the American Institute of Planners** on Urban Development Models (Harris, 1965).

There was much else happening too in the world of planning. Cities were recognisably more complex than they were hitherto and new metropolitan agencies were being set up in Britain to deal with their longer term planning. The Greater London Council set up in 1964 was the doyen of places for planning and at the end of our course, the majority of the 17 students in my year who graduated set off for London, to seek ‘fame on fortune on streets paved with gold’. The south beckoned as it has done for the last 100 years or longer and by the mid 1960s, London was the place to be. The west coast was also another haven for hippies, flower power, sun, sand and surf but the optimism of those post war years really came to fruition in ‘swinging London’. Below I show a photograph of our final year group taken in a pub in Ashford in 1966 where we were doing our design exam developing a plan for a new town. We were extremely close as a group as spending 80% of one’s time in open plan studio does let you get to know others in considerable depth. I will come back to this but the boy number 1 in this and the previous photo is me and the girl number 2 is my wife. More of this at the very end of this essay where the defining moments of these and later years will become clearer.

I stayed of course in Manchester for the department offered me the chance to do research – I was the only PhD student in the department – one had to start somewhere I guess – and George Chadwick became my advisor. In fact I was paid as a junior faculty member – what was called a Studio Assistant – but in terms of my research programme, I was torn between researching models of cities or models of planning and decided of course to do both. In the course of a PhD this is an overly ambitious task but from 1966 to 1969 were years when I filled in and learned many things that I felt I should have learned earlier – largely mathematics and statistics, some physics but all this was quite hard outside the traditional environment of disciplined learning and scrutiny that one gets in the class room and the laboratory. I also learned to program computers starting with Atlas Autocode where programs were submitted on

paper tape where if you made an error, you had to splice the tape, punch the segment again, and stick it back into the tape. I could tell you a lot about computers in those days but I do not have time. Suffice it to say that it was Brian McLoughlin's group that helped me learn about gravity models and program them and this led to building my first urban models in 1967 that ultimately propelled me on my way out of Manchester and to pastures new. My work on design methods continued but my path had been set in that I would pursue both, with the science of cities eventually taking over in my later years. The science of design, however, did not lay dormant and I worked on both until I became embroiled in the complexity theory that has dominated my work in the last 25 years. More recently with the development of geodesign and our liaison with Carl Steinitz (2012) in CASA these design ideas have come back onto my agenda.



My telling you all this that happened almost half a century ago should give you some sense of why I continue to do what I do. I left Manchester because my job was ending and Professor Kantorowich considered I should move to practice, despite my wanting to stay. I had also married in early 1969 and my wife gave up her job as a planner with the John Madin Design group working on Telford New Town to move back to Manchester, and by that summer neither of us would have jobs. But as my dad so presciently predicted, if you were a town planner there would always be jobs (then, of course, not necessarily now). So despite the call of practice, I took a job as a research assistant in the University of Reading to work on a large grant won by Peter Hall involving the development of urban models where my colleague Dave Foot (who had worked with Brian McLoughlin on shopping models in Manchester and taught me my programming skills) had been appointed a lecturer. My wife also took a job as a lecturer in planning at Oxford College of Technology, soon to be renamed as Oxford Polytechnic, now Oxford Brookes, and that is when we met an entirely new group of young planners from Andreas Faludi through Glen McDougall, Basil Dimitriou and John Glasson to Patsy Healey, two of them also making their appearance here.

Let me dwell a little on the longer perspective of what was happening both to me and planning and our understanding of cities in those years. I have written a short account of this in the book edited by Wood and Jay (2002) **Reflections of 50 Years of the**

Manchester School of Planning and Landscape, 1952-2002 where I talk about the development of the systems approach during the 1960s at Manchester. Somehow what was happening to our approaches to cities and planning during my Manchester years fitted my interests particularly well. The model of cities we adopted was primarily economic, tinged with what was called then and now social physics which saw the city as a system of interacting parts whose mechanisms appeared to function as classical physical systems: potential, gravitation and so on. The model of planning was that of the controller, a function of intervention that was based on the cybernetic metaphor of the steersman, with cities being kept in equilibrium through course correction based on negative feedback. These models were supposed to work in tandem and would reinforce the rights and correct the wrongs that the industrial city had produced during the previous 200 years. Of course it did not take long to figure out the model was deeply flawed. Cities were never in equilibrium, contrary to many appearances. They were continually changing, a kaleidoscope of variety, where the kind of planning that was being introduced was as Jane Jacobs (1961) in her wonderful book **The Death and Life of the Great American City** so presciently argued almost before the systems revolution began, as much part of the problem as part of the solution. The notion that cities were complex systems, built from the bottom up rather than planned from the top down, was many years in the future and by the end of the 1960s when I left for Reading, the dominant model was the one that was articulated in the two books of my Manchester mentors, Brian McLoughlin's (1969) **Urban and Regional Planning: A Systems Approach**, and George Chadwick's (1971) **A Systems View of Planning**. As a student I came in reading Lewis Keeble's (1951) **Principles and Practice of Town and Country Planning** and went out clutching McLoughlin and Chadwick's optimistic statements of where the cutting edge of planning should now be.

There is one last issue from my Manchester years and that relates to the role of an academic. I think I had decided by the time I left Manchester that this is what I wanted to be. To do this, one had to develop ideas that the wider academic constituency would relate to and this meant publication. So before I left I wrote my first paper entitled "The Impact of a New Town: An Application of the Garin-Lowry Model" published in 1969 in the **Journal of the Town Planning Institute**. My belief then was what we were doing should be first and foremost brought to the attention of the planning profession, and that it was our duty as academics to preach the message to practice. My paper was of course written from the perspective of the academic planner and the fact that it was published in the trade journal so to speak marked the direction I thought planning research should go. This was the forum through which I thought we should develop these ideas in practice. In those days, we did not speak of citation indices or impact factors and it is intriguing to me as I write these words to know if my paper on 'impact' has had any impact on the field itself. So quite literally as I penned this paragraph I went to *Google Scholar* to find out: the triumph of connecting to the internet any place, any time. Well it has 34 citations, half my H index, which is quite healthy given that the journal is long gone!

Cutting Academic Teeth: Reading in the 1970s

When I went to Reading University in 1969, Peter Hall, Head of the Department of Geography, was fast becoming a living legend. His books on **World Cities** and

London 2000 were widely acclaimed and he was hard at work on his massive treatise **The Containment of Urban England** which is the most comprehensive treatment of the impact of the post-war British planning system ever to be written. Peter of course has a contribution to this volume but illness prevented his attendance at the Vienna conference where these essays were first presented but he was able to present by Skype. He passed away while we were editing our contributions and to an extent, those writing here are personally if not formally dedicating this volume to him. I have recorded this in a little more detail on my blog but I will simply say his influence on me and my field has been enormous and it will continue to echo down the years⁵.

I became a research assistant on a project that Peter had been successful at winning on modelling and information requirements for urban planning which was to be anchored in applications of the Lowry (1964) model and its descendants to the Reading region. In fact there was very little uncertainty about what we were to do. We were in the business of repeating and extending land use transport models which had been first developed in the US as reported in the May 1965 special issue of the **Journal of the American Institute of Planners** noted above (Harris, 1965), and these models were regarded as crucial to the rational plan-making methods that were widely regarded as being the new foundation for the planning system in Britain.

During those years, models of cities occupied one side of the planning coin and rational processes of design the other side and I largely spent my 10 years at Reading pursuing both in parallel. There was an intellectual tension between the two for urban models were much more structured and technical in focus and required a reasonable amount of mathematical and computational skill to construct while plan-making processes were largely conceptual but I managed to keep both going. It was during those years that I met many people who had founded the field and were still active in it. A wonderful trip to the US in May 1970 starting with Britton Harris at Penn, moving to see John Kain and Jay Forrester at Harvard-MIT, thence to Ira Lowry at RAND in LA, then William Goldner and Paul Wendt in Berkeley and finally Stu Chapin and Shirley Weiss at Chapel Hill in the University of North Carolina, was a superb introduction to the scene. Combined with our close association with Alan Wilson, Doreen Massey and the group at the Centre for Environmental Studies in London, the group at Land Use and Built Form in Cambridge led by Lionel March and Marcial Echenique, and the group at Liverpool around Ian Masser, I acquired a close network of scholars, many who are still active today. The high point of my Reading years were the succession of visitors that Peter managed to bring to the campus to present their work. Because Peter lived in London and Reading was only 40 miles away with the airport in between, we received a succession of international visitors. It was there that I met such hallowed luminaries as Mel Webber, John Friedmann (writing here too), many of those who were central to the development of contemporary planning thought, and quantitative geographers such as Brian Berry, Leslie Curry, Waldo Tobler, Gunnar Olsson, all of whom were deep thinkers in the field. I wrote about these experiences in my article for Peter's 80th Birthday-Festschrift volume (Batty, 2014).

Building an academic career was the real focus of my research and teaching at Reading where I worked on urban models extending them in two directions: first by

⁵ <http://www.spatialcomplexity.info/archives/2163>

exploring how they could be made operational using a variety of quantitative methods and second making them temporally dynamic. The research programme I had joined at Reading provided the momentum and although it ended after three years, my work continued when I was appointed lecturer in 1972 and began a career in teaching. I pulled together the various articles and papers I had written into my first book **Urban Modelling: Algorithms, Calibrations, Predictions** (1976) which I considered to be a very natural step in what I was doing and at the same time I took a year's leave of absence as a Visiting Assistant Professor in Transport Planning at the University of Waterloo where there was a very productive group of engineers building urban models. In the year I spent there, 1974 to 1975, Lionel March who was Director of the Centre for Land Use and Built Form Studies in Cambridge also took a sojourn as Professor of Systems Design and we engaged in many joint projects. This also proved to be my first foray into North America which I was to renew some 15 years later. Living in the relatively harsh winter climate of southern Ontario equipped me and my wife rather well for returning to that part of the world when we moved to Buffalo, New York in 1990.

What was happening to planning thought in those days was in fact a complete re-evaluation of the technocratic model. The notion that rational planning could be implemented organisationally in practice was probably never to be taken literally but managerialism and corporatism combined with continually shifting ideas about what was important in planning also meant that the opportunities to test and extend any well-defined formal framework were inevitably limited. Two other forces emerged that sought to undermine the systems approach. First the experience of actually building urban models particularly in the US was fraught with problems. Douglass B. Lee in his "Requiem for Large Scale Models" published in 1973 in the **Journal of the American Institute of Planners** painted a devastatingly bleak picture of the experience focussing particularly on the fact that besides the inability of the model-builders to second guess the resources needed to build such artefacts, the models themselves and their theoretical bases were highly limited. In short our knowledge of cities and the way their problems were articulated could not easily be embraced by the quantitative models that were eventually built: in short, the models were not very good. The gap between theory and reality was bigger than anyone had ever considered. This was beautifully articulated by Rittel and Webber (1973) in their notion that problems in planning were wicked – if you begin to tackle them they would 'fight back' in Piet Hein's (1969) immortal phrase, and often the solutions designed to alleviate them would actually make these problems worse⁶.

The second perspective that forced planning into a very different mode came from the social sciences. Deep structural forces in society, embedded in the very philosophy of capitalism itself, suggested that the kind of planning that had been developed was merely window dressing, that planning was completely superficial and could do little to alleviate the deep problems of inequality in contemporary societies. This came to dominate discussion. Planning theory which had been articulated best by people like Faludi (1973a, 1973b) (also writing here) appeared superficial in comparison to these more profound differences and the notion that planning was part of the problem gained ground. The flirtation with political economy and structuralism deepened and planning as academia began to veer away from its physical roots in favour of

⁶As Piet Hein (1969) said: "Problems worthy of attack, prove their worth by fighting back."

community action on the one hand, and corporate management on the other. In this process, the focus on urban models lost its appeal and by the end of the 1970s, the movement had virtually gone underground. Beacons still burned in isolated pockets of academia but there was general acknowledgement that the world of cities was considerably more complicated than anyone had ever anticipated and that our theories of how cities actually worked were woefully inadequate. What had seemed like salvation in the early 1960s was regarded as disaster some 20 years later.

Academia of course is a sanctuary for continued thinking about complex matters and these ideas about systems and cities continued. In the 1990s there was a slow revival and this has accelerated as computers have become all pervasive. But at the end of the 1970s, my own academic career was still developing and I decided to apply for a position as a Professor and to return from geography to planning which was my original and continuing focus. In the interim, my Reading years did set me up as a quantitative geographer and many people to this day think of me as this while they think of Peter Hall as a planner although by training, he is a geographer. The labels hardly matter but in 1979 I was successful in gaining a chair of planning in Cardiff at the University of Wales Institute of Science and Technology (UWIST) which had a vibrant planning programme and seemed to me a place very much on the way up.

Running a Department, Keeping Research Alive: Cardiff in the 1980s

I was a Professor in Cardiff from 1979 until 1990, acting as a relatively senior academic, being involved in many roles from head of department to dean. The University of Wales was then composed of semi autonomous colleges like the old University of London and the college in Cardiff I joined was the Institute of Science and Technology (UWIST), a tiny institution with about 1900 students and 16 departments when I went there. There were two professors per department so 32 in all that composed the Senate which ran the place academically. Clearly if you are one of 32 there is a degree of scrutiny that does not exist in larger places. Anyway I tell you this because at Cardiff everyone knew every one else and you could not avoid knowing the Principal (the equivalent of the President or Vice Chancellor). As a professor one tended, in this close environment, to acquire committee jobs especially if you were absent from the Senate meeting for the Principal would always recognise this and when you returned you would have acquired another job. At the time, I found it suffocating; and as I stayed there longer, I acquired more and more jobs and it became harder and harder to keep my research programme on the road.

Anyway I was back in a planning school and what a planning school it was. It was a battlefield from day one. The quality of the faculty was excellent and there is little doubt that in my Cardiff years, I was amongst a group of people who had by the far the most trenchant views about planning and cities as I have ever encountered. By the time I left it was a heavily quantitative planning school but it also had some top class social scientists and planning theorists. In 1979, there were three groups: the arch positivists, the social theorists, and the rest: the planners, the designers, the pragmatists and the practitioners. The positivists were daggers drawn with the social theorists and I found myself in the middle. The crucial issue at Cardiff was the fact that these two warring factions each contained individuals who identified more with Wales than with town planning, were Welsh by birth and language and had come

back to Wales after their education in England. Town planning was a convenient department to belong to; there was no geography, no transport and no political science in the Welsh capital's colleges, and town planning thus became a convenient base. Essentially the positivists were mathematical statisticians while the social theorists were Marxists and the battle ground was the town planning curricula although they made little impact on this because the strictures of the profession exercised through the vestiges of the Royal Town Planning Institute, kept the courses on track.

During the first 5 years I was there, I continued my work on urban models but with a focus more and more on spatial analysis and paralleled this with work on models of the design-decision-making process. I also decided to register for a PhD. You may remember from my Manchester years that I had in fact stayed there after my undergraduate degree to do a PhD but this I had never completed, for there was little incentive to put together the requisite thesis. But by 1980, a PhD was becoming more important and although most of the faculty of the town planning department did not have such a degree, there was strong momentum to complete one. In fact in a British University because there is no course work, it is easy to register for such a degree as all one has to do is write the thesis. But there was no quick route to do this. Registration was for 4 years part-time although I had quite a bit of unpublished material in the area of dynamic urban models and during this period I was able to build on this, completing the PhD in 1984. The thesis like all such theses in those days was then deposited in the University library and the National Library of Wales. There it remained, unread I presume, until some two years ago when I cut up the typescript, scanned it on our new office copier that turned it into a PDF in 15 minutes, and then put on my blog and made it available for all to see!⁷

Another important theme that ran through my early years at Cardiff involved the journal **Environment and Planning B**. For diverse reasons as much to do with broadening the scope of the journal to embrace systematic physical planning, I decided to join the editor Lionel March as co-editor in 1981. In fact, the problem that the journal faced then and for many years after was its niche market which was tiny and growing very little. The broadening to embrace planning methods that I initiated steered clear of urban and regional modelling which was still the prerogative of **A** for Alan Wilson had just relinquished the editorship to Nigel Thrift. Lionel had become Rector of the Royal College of Art and he was particularly preoccupied with affairs of state and so I attempted to put the journal back on the road by broadening the scales that it dealt with but still focussing on methods and models of the design and planning processes rather than of the city system that was more the focus of **A**. It took a long time before the journal attracted enough unsolicited submissions for it to be truly self-sustaining and thus my role in these early years was to run it as a combination of solicited special issues and unsolicited articles. This worked rather well and in 1985 I became editor. I am still the main editor with two others, and the journal now gets a lot of unsolicited articles – too many in fact. It is still quite niche in that we still accept papers on formal architectural design and layout. During my tenure I have written an editorial in most issues and we are now bi-monthly, publishing some 70 articles a year.

⁷ <http://www.spatialcomplexity.info/archives/747>; and Batty (1984)

Back then to what was happening in Cardiff. My research had always been how we might translate systematic approaches to cities and planning into its practice and this is what I began to put my efforts into. To this end, I was convinced that visualisation was the way forward and in the early 1980s with the advent of the micro-computer and accessible computer graphics based on screen memories, I decided to reskill into computer graphics in the belief that if we could add visual interfaces in the form of maps primarily to urban models, we could make these visual interfaces more immediate, more interactive and if we could build user friendly access to such models, then this would be an advance. My focus on graphics developed in two main ways. Learning how to program computers to generate graphics which are produced online rather than offline which was the dominant way before computer memories as displayed on the screen became widespread, led to my writing a more popular book on graphics which was published as **Microcomputer Graphics: Art, Design and Creative Modelling** in 1987. Frankly the book did not do very well as it was badly positioned and ill timed but if you look at it now, you will see the focus on new methods of mathematical rendering, namely the use of fractals which came to dominate my research in the late 1980s. Essentially fractal geometry is based on the notion that a process that can generate routinely and in modular fashion some basic configuration or pattern, can be designed so that as one changes spatial scale from fine to coarse or small scale to large, then the pattern repeats itself. In short you can see the same pattern in the large as you can in the small. This is called self-similarity and many, many processes in society and nature reveal such recursive structures.

Once I had mastered some of this, I was joined in this quest by Paul Longley who was appointed to Cardiff as a lecturer in 1984 to support my research area. Our first paper in **Environment and Planning A** (Batty and Longley, 1986) was all about fractal rendering but we soon switched to city structures themselves exploring their cartography, their hierarchical structure and simple physical models in analogy to diffusion processes that all began to fill in the big picture as to how cities were structured. Temporal dynamics came onto the agenda and we soon became immersed in the wider science of these kinds of system which were built from the bottom up. The idea that cities essentially evolved and grew like biological systems was in direct contrast to the top down approach of the systems approach that conceived of cities more like machines than organisms. So by the late 1980s, some 25 years or more after the systems approach I was immersed in complexity theory which has dominated my research into cities ever since.

This concern for how cities looked and my focus on computer graphics pushed me towards cartography and geographic information systems which were all in the air in the late 1980s. And this of course dominated my next move but before that I should say something about the institutional context in which all this was happening. In 1985 I returned from a 3 week lecture tour in Australia with a very bad dose of influenza to be confronted by the head of the planning school who informed me that he was leaving. I asked who was to be head of department and he told me to look at my contract but I knew deep down, it was to be me. The following day the GP told me that I had viral pneumonia and the great joke from then on was that “when Mike came back from Australia and was told he was to be head, he immediately went down with pneumonia!” I recovered of course but in the next 5 years I had to run the department. I had by now acquired a lot of jobs in the College and I then acquired even more. In fact these were the years when we made some very good appointments in the

quantitative area and the focus changed somewhat to people skilled in transport and GIS joining the department. Neil Wrigley, a geographer from Bristol took the so-called second professorship bringing with him PhD students such as David Martin. Huw Williams joined to lead transport from Leeds, Chris Webster returned as a lecturer to help run our new GIS centre (the ESRC Wales and South West Regional Research Laboratory) while Ian Bracken and Cliff Guy continued to reinforce the methods-based flavour of research in the department. With David Owen, Gary Higgs, and Anne Green as research assistants we had somehow assembled a formidable group. And there some good students too who came through the undergraduate programme such as Mark Tewdwr-Jones and Geoff Vigar.

Despite all this, the place was killing me. Our work on fractals and cities was going very well but I felt I was not suited to running a department that admittedly was a little less fractious than when I first went there and I decided to seek newer pastures. I had been courted many times by US universities and when Stewart Fotheringham, a kindred spirit who had spent the year 1988-1989 in Cardiff as a Leverhulme Research Fellow, joined the NSF (National Science Foundation) National Center for Geographic Information and Analysis (NCGIA) at SUNY-Buffalo, he laid the groundwork for my going there a year or so later as Director. I responded positively to the offer from Buffalo and in late 1990 we made the move. In fact I was to be joining a department and centre which had many key people in geography who had made major contributions to fractal representation – Mike Woldenberg, Athol Abrahams, Babs Battenfield, David Mark and Stewart Fotheringham (who had worked with Paul Longley and myself in Cardiff). So Buffalo was not just about GIS but it did fill in many of the gaps that any self-respecting quantitative geographer should acquire. Last but not least, we knew what living in the Snow Belt was all about from our experiences in Waterloo some 15 years before and we felt we could cope.

Escaping to America, Learning GIS: Buffalo in the Early 1990s

Buffalo was a breath of fresh air – forget all your prejudices about the rust belt, the snow belt, New York, America, the war in Vietnam. We arrived some 6 weeks before the first Iraq war broke out when the US economy was in the deepest recession for many years due to the end of the Cold War. Yet America is still the land of opportunity and the NCGIA at the SUNY-Buffalo site which I was to direct, was as optimistic a setup as one might imagine. It was like a return to the 1960s, reinforced by the fact that the NCGIA was a consortium of three sites in very different parts of America, in California at Santa Barbara, in rural Maine at Orono and in Buffalo, the archetypal rust belt city but a city lying in the shadow of Toronto, the heart of prosperous Anglo-Saxon Canada. I spent a happy five years there returning to Britain frequently for I did not burn my bridges and with Paul Longley our fractals work continued. I cut my teeth on learning about GIS and spatial analysis. As I have implied, this was not rocket science but it cemented together much of my interests in computer graphics with a good deal of the urban and geographical analysis that I had previously developed in relation to urban modelling.

In fact, Buffalo was the place where I learned a bit of UNIX and C, where I began to explore cellular automata, complexity and artificial life, and where with Paul Longley, I put together our book on **Fractal Cities: A Geometry of Form and**

Function which was published in 1994. This was the culmination of 8 years of research and it was my first substantial book on cities since **Urban Modelling** was published in 1976. It is my most highly cited contribution which is somewhat amazing because Academic Press which published it was absorbed in 1996 by Harcourt, its parent company and although the 1500 copies of the printed book sold out quickly, they did not reprint. A consequence of this is that we were given the rights in the late 1990s and we scanned the book and put it up at www.fractalcities.org. At the time of writing (August 6, 2014) there have been 18281 downloads of all or part of the book and our citation count is some 1215. In fact although we did not realise this at the time, what we were doing was establishing quite a strong link between the traditional theories of cities based on urban economics and social physics and the whole issue of what cities physically looked like in terms of the size and shape. We did not develop a detailed theoretical treatment which is still sorely needed and I doubt that myself or my co-author Paul Longley quite have the mathematical skills to really cement urban economic modelling into ideas about fractals, densities, city shape and size and so on. But our book, we think, still points the way for others to elaborate. The fact that this has not been done relates to the difficulties of doing so.

At Buffalo I pushed my research quite heavily towards developing new interfaces to land use models and for this I enlisted the help of my graduate student, Yichun Xie, who embedded simple population density models in a geographic information interface using ArcInfo running on workstations. We also pushed our fractal models further, developing cellular automata as a formal modelling language for translating fractal patterns into operational models of land use and urban development. This would come to dominate the work in my current job at CASA in UCL but again let me stay in Buffalo and fill in the remaining picture.

There is one other feature of my 5 years in Buffalo that I need to relate. My wife who was also trained in town planning as I noted at the onset of this essay, has always understood what I have done and she accepted our sojourns in foreign parts with good grace. In fact at the University of Waterloo from 1974-5, she studied for an MSc in Systems Engineering accomplishing the effort with ease on a sabbatical from Oxford Polytechnic. Her thesis was published as an article in **Environment and Planning B** (Batty, 1977) when Lionel March was editor. In Buffalo, she took a PhD in Political Science and again accomplished it with ease writing an interesting thesis on public policy and Les Halles in Paris, but in the process, working with a colleague on 'Gorbachev's Strategy of Political Centrism' during the 'Glasnost' period prior to the demise of Soviet Union and the transition to the Russian state (Batty and Danilovic, 1997).

Our decision to return to the UK was not prompted largely by domestic concerns. My wife was finishing her PhD. My son was at boarding school in England and destined for university there. The core grant from NSF for the NCGIA was ending. In fact I thought that I might move back into planning and briefly flirted with Berkeley where Peter Hall's job had been repackaged into a form that blended transport with urban planning. In fact at Christmas in 1994, I visited Peter on the way back from Buffalo at his house in west London to discuss Berkeley but it was he who told me that a Centre for GIS was being discussed in UCL. That Christmas I was wheeled in to see the UCL Provost (remember, for Provost read Vice-Chancellor or President) and we discussed

such a Centre. He decided that if the costs looked right he would pursue it and would ask me if I would like to direct it. No promises but some two months later he called me and offered me the job.

Building a Science of Cities: CASA at UCL from 1995 Onwards

At UCL I had a rather different mandate – to build a research centre in spatial analysis and GIS with a strong focus on cities and human settlements. This was always to be a soft money outfit so grant-getting was the order of the day. CASA stands for Centre for Advanced Spatial Analysis, a rather precocious term for what we do, but a great acronym and I can say this with alacrity because I did not invent the term. There was literally nothing there when I arrived in August 1995, and I have told the story many times of how UCL had no record of me on my first day, no office, no nothing but I had a salary: there was more than a little irony in the implication that because you were at UCL what more could you ever want. I had a joint appointment between the Department of Geography and The Bartlett School of Planning but the founder members of CASA also included Photogrammetry and Surveying (now Geomatic Engineering), The Institute of Archaeology, The Centre for Transport Studies, and The Bartlett Graduate School. No one had figured out what happened if CASA actually got a research grant – who would get the overheads, and a management structure had not been sorted by the working group that had convinced the Provost to approve it all. With no proper office for the first 6 months, it was certainly a chastening experience.

Once I got there, I took the job seriously and applied for research grants. I had some experience of such applications from my time as a research assistant at Reading to being a lecturer when I got my first grant, through my years at Cardiff where I was involved in perhaps 3 or 4 proposals, the last quite substantial and then through my Buffalo years where the NSF core grant supported us. In the 1980s, I had also been Chairman of the SSRC (now ESRC) Planning Committee, a member of the SERC (now EPSRC) Transport Committee, a member of the UK Universities Computer Board and so on, so I had quite a lot of experience of the research grants system. Of course in my first year, the unthinkable happened: I applied for three research grants – quite substantial ones and lo and behold I was successful. At the end of my first year in mid-1996, we made our first appointments: some 4 research assistants (postdocs in US parlance) and 2 PhD students, together with our administrator Sarah Sheppard and myself. We were up and running.

I must refrain from telling you the detail of those times for UCL in those years was a roller coaster ride and there are a thousand stories about winning the war and losing the peace. But the research programme that we began is more to the point in this essay. My focus on theories of cities in terms of the models that I had been building was clear enough and a major force in our programme but it is impossible to build a centre around urban modelling *per se*, so really four strands developed in those early years: GIS and spatial analysis with a focus on retailing, geo-demographics, and urban design; visualisation of cityscapes and 3D with multimedia; the emergence of cyberspace and the information or virtual city; and urban simulation using new bottom up type methods such as agent-based and cellular automata modelling which lie at the essence of complexity theory.

In those years, we went hell for leather for new forms of visualisation and new kinds of simulation models, both cellular automata (CA) and agent-based models (ABM). We honed these models around small scale movement systems – pedestrian systems for which our Notting-Hill Carnival model was a great success and some space syntax. David O’Sullivan our first PhD student, now at Berkeley, Paul Torrens, now at Maryland, Naru Shiode, now at Warwick, and Muki Haklay still at UCL are all professors now. Martin Dodge one of our first research assistants is a senior lecturer at Manchester. Andy Hudson-Smith our graphics and visualisation whizz-kid who is a Reader and now Director of CASA (I am Chair) was also part of that group. I am proud to have been associated with this brilliant cohort of graduate students who have gone on to great things in fashioning a science of cities through various kinds of modelling and visualisation. David O’Sullivan’s path-breaking book (with George Perry) on **Spatial Simulation** (2013) and Paul Torrens’ book (with Itzhak Benenson) **GeoSimulation** published just after he left CASA in 2004, all reflect this area. Muki Haklay’s edited collection (2010) **Interacting with Geospatial Technologies** shows another side to our research associated with the delivery of digital services and online public participation in planning. Martin Dodge (who with Rob Kitchin) wrote two major books **Mapping Cyberspace** (2000) and an **Atlas of Cyberspace** (2001) was in the vanguard of all these publications that really put our centre on the map. We have had spin-offs from CASA too. Mark Thurstain-Goodwin who ran our town centres project for several years left in 2002 to found *GeoFutures* (www.geofutures.com). *Intelligent Space* run by Jake Desyllas was another spin-off in pedestrian modelling eventually to be acquired by Atkins, and even *Open Street Map* is a kind of spin-off in that its founder, Steve Coast, was our part time system administrator running our UNIX systems for several years until OSM became big enough for him to be set on the path to riches. Not bad for our first 7 years.

In 2000 I convinced the Provost and the Department of Geography to hire Paul Longley, my erstwhile colleague at Cardiff and then a Professor of Geography at Bristol, to come to UCL where he became Deputy Director of CASA. He built up our PhD programme from its early roots and also put the geo-demographics area on a good footing. In 2003 we published an edited collection of CASA’s work **Advanced Spatial Analysis: The CASA Book of GIS** which paraded our wares in that everyone who wrote in the book was a member or ex-member of CASA, as a post-doc or PhD or faculty. In those years, I personally began to put my thoughts together on complexity, as much from an ESRC fellowship that bought out my teaching from 2001 to 2004, as from the succession of grants that we had to establish CASA. In 2005, I finally published my fourth book **Cities and Complexity: Understanding Cities with Cellular Automata, Agent-Based Models, and Fractals** that drew together many of these thoughts and set the direction for our more recent research.

I must say something about how the fields which I have been involved in have developed, particularly during the years I have been at UCL. In terms of the complexity sciences which we might cast in shorthand as systems theory from the bottom up, cities have become one of the key exemplars. They are the product of millions of decisions which have no coordination other than through the general strictures and regulations placed on society itself by society and thus they are good examples of system where emergent order arises spontaneously – this of course is the

definition of self organisation. Cities have also become a hot topic especially as more than half the world's population now live in some form of city and by the end of this century most will do so. It is therefore not surprising that many working across the sciences, social sciences, humanities and arts are being attracted into this field to think about the future of cities. Cities are no longer the prerogative of planners, nor its profession. Large numbers of people trained in the physical sciences are being attracted to theorise about the city. For me, it is remarkable that towards the end of my career there is this push to make our understanding scientific in the most liberal sense of the word. The point here is that increasingly my own work relates to the researchers of people who are not planners, not geographers or architects but come from diverse backgrounds which are often science-based. This is a strange circularity to a world long gone where I remember that what I wanted from planning was some kind of science. Whether it is this now, I cannot quite decide for it is the nature of cities that there are many sciences.

In parallel to all of this, the diffusion of computation, networks and digital sensors into public spaces – into cities – has generated an equal fascination. The 'smart cities' movement has gathered pace and with it has come the notion of 'big data', unstructured data being streamed in real time, which generates literally billions of observations. Social media has generated new networks and new layers of complexity in cities and the sheer scale of activity in big cities now requires a much more powerful science in its interpretation. In CASA, we have immersed ourselves in this activity and our visualisation work has exploded. Moreover we have always been involved in digital public participation through visualisation which is one of the very obvious ways of communicating ideas about cities to those who do not directly create them but are impacted by them.

The Next 50 Years: When World's Collide

50 years has passed since I first entered the planning school in the University of Manchester and although my first thoughts about town planning were both radically different and remarkably resonant with the ideas I now hold, I think we understand cities a little better than the rudimentary knowledge we had half a century ago. I am encouraged too by the fact that at long last there does seem to be a sustained effort underway to ground our knowledge in more systematic ways of seeking generalisations about cities in terms of their physical form. At the same time, we are recognising that what I and others have called here 'A Science of Cities' is one of many such sciences, many perspectives, many paradigms that both compete and complement one another in providing a more substantial base for thinking about cities than we have ever had before (Batty, 2013). I firmly believe that complexity theory is helping us to think about cities as evolving systems whose future we will never be able to predict but whose form and function can be imagined and designed.

In all of this, I must return to the role of planning thought and theory. Planning has changed in the way it has been articulated as theory and once again complexity theory holds the key to my own interpretation. I see this as a switch from thinking of cities and their planning as a top down to a bottom up, to the switch from rationalism to individual action, and this is quite consistent with the current focus in planning on communicative dialogue which tends to see the planning system as blending with community concerns, as a process of negotiation. On this path, planning has also

indulged itself with notions about how the large scale structural issues that dominate our society determine local action, how the political economy of the city and the state influence what we are able to do, defining the problems that we feel able to tackle and often the way we might tackle them. Complexity theory to me has much to say about these matters and of late, planning theorists too have embraced this perspective in the recent books by Patsy Healey (2006) and Judith Innes (and David Booher, 2010) who are also writing about these ideas in this volume.

My current thoughts about the next 50 years relate to the way information technologies are permeating the city and modern life. Computers will eventually enter every facet of life and whatever can be computable will be. This notion of universality has always seemed far-fetched to me and each additional wave of new IT such as the recent rise of the smart cities movement always takes us by surprise. It was obvious in hindsight that once we had the right kinds of sensors linked to computers that data from every place where sensors could be located would be streamed in real time, generating what is currently called 'big data'. The notion that we can get city data in real time is also shortening our time horizons over which we think about the future in cities. But the biggest change in cities is the emergence of new media, of social media and new kinds of networks which are tracking many of our actions and interactions. The challenge here is to make sense of how information technologies are changing our behaviours from everything to the way housing markets operate to the way we engage with each other socially, with government and with the very acts of thinking about what the future city will be like.

So to finish, some personal recollections. 23 years after I first went to the grammar school shown in the first photograph at the beginning of this essay, the boy identified as number 1 (me) took the girl identified as number 2 (my wife) to visit the girl identified as number 3 (Linda) in the second photograph who was then living in New York City near the Rockefeller Center. Linda had moved to the US in 1968 after meeting an American who carried her case across Piccadilly Circus and who was doing a Masters in International Relations at the LSE. They went to Wharton where I met up with them on my first trip to America in 1970 but they had long ago split up and Linda was by then running a prosperous real estate consulting company in Manhattan. We were on our way to Toronto where I was editing a book **Systems Analysis in Urban Policy-Making and Planning** with Bruce Hutchinson from Waterloo days. In the late evening of the 8 December 1980 about the time we left Linda's apartment, the boy identified as number 4 in the 1957 school photograph was shot dead at point blank range outside the Dakota Building in Central Park West, a mile or so away. For a day or so the world wobbled on its axis and the coincidence of being in Manhattan when this happened and being at school with him has lived with me forever. To conclude I can do no better than quote some lines from his song *Imagine* which became the most popular song of the 20th century. It is full of the hope not only for ourselves but in particular for its messages about how we confront the planning project and a science of cities that I and others have tried to echo through these pages. He, John Lennon, wrote:

*You may say I'm a dreamer
But I'm not the only one
I hope someday you'll join us
And the world will live as one*

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