Foreword: planning support systems in a connected world

Planning support systems (PSS) were first defined by Britton Harris in 1989 in an article entitled 'Beyond geographic information systems: computers and the planning professional' in the *Journal of the American Planning Association* (vol. 55, pp. 85–92). There he argued that the emergence of geographic information systems (GIS) heralded an era when a wide range of computer-based techniques developed over a long period from the 1950s to aid the process of generating, evaluating and testing plans might be integrated together to provide loosely coupled systems of software that could support, in different ways, the planning process. The various methods and models that he then had in mind were those that originated from regional science and transportation planning, particularly those which are now called land use transportation interaction/integration (LUTI) models. However, right from the word go, PSS implied a wider canvas on which to array a diverse range of techniques that were not solely model-based. The term PSS was also coined in response to the development of such systems in management science, particularly decision support systems (DSS) from which spatial decision support systems (SDSS) were suggested, but Harris argued that although his coining of the term was analogous to DSS and even SDSS, a rather different array of tools and models from those in management science, operations research and locational optimization were necessary.

I talked about these origins in my preface to one of the first books on PSS edited by Stan Geertman and John Stillwell, *Planning Support Systems in Practice* (Springer, 2003), but this was nearly two decades ago. To talk of these origins now is again important because during this time the field has matured. The very existence of this *Handbook* is a sign that the field is now big enough to warrant a new perspective, and as with all perspectives, we need to begin at the beginning. A good indicator of the times back then (which I do not think has ever been formally noted before in discussions of PSS) is that when Harris coined the term, the faculty teaching planning methods and computation in the Department of Urban Studies and Planning (DUSP) at the Massachusetts Institute of Technology (MIT) – namely, Jo Ferreira, Lyna Wiggins, Michael Schiffer and Qing Shen – adopted the term PSS for their teaching and research cluster within the planning programme. This was in the early 1990s, but in the intervening years the basic rationale for building such tools has changed dramatically. By the late 1980s, computers had been scaled to the point where they were personal enough for models and methods in planning to be handled on the desktop, although it was not until 1995 that the world really did see the emergence of graphical desktop computing with the launch of Windows 95. Geographic information systems before that time were more orientated to the mainframe and workstation than the personal computer (PC) and only in 1996 did Esri introduce their desktop software ArcView. Although the Macintosh with its graphical user interface had been introduced a decade earlier, little planning-orientated software had been ported to that platform and this continued to be the case owing to the predominance of the PC architecture. This was when PSS really emerged with a focus not only on qualitative and quantitative methods dressed up as models of various sorts with graphics, that is maps, as inputs and outputs, but on new forms of overlay mapping and evaluation indicators as well as their visualization using a diverse selection of computer tools embedded within GIS.

This history is well known but it is a timely reminder that after 25 years there are many other issues involving computing that are now to the fore in the development of PSS. In the mid-1990s, besides Windows 95 and the introduction of graphics, the Internet became widely available to many users for the first time. Before that, very little software was operated across the net and most tools were developed either on mainframes or standalone PCs. Networking was reserved for printing, rudimentary email, modest information services such as bulletin boards as well as some remote programming but in no way was computing engaged in anything which might have been called online interaction. This was changing fast. Over the next decade until around 2005, new networking tools were added to PSS but the main focus was on visualization. Any communication of ideas was usually done offline, notwithstanding that the computation was almost entirely digital, and that digital participatory environments were being rapidly developed in which GIS and PSS were regarded as the basic infrastructure for different types of planning.

The changes in computing during the past decade, however, have been mind-boggling. Computers have continued to scale down in size and up in speed and storage since miniaturization began in the late 1940s with the invention of the transistor. Just as the PC emerged very quickly in the mid- to late-1970s, the smartphone packed with computation of various kinds, much more powerful than the early PCs, suddenly burst onto the scene around 2007. By this time, the Internet was deeply embedded everywhere in contemporary societies, chip fabrication was about to take another leap in design owing to new materials being introduced, new forms of software linking many computers together such as Hadoop were being developed, and the smartphone quickly became the medium of choice for connecting everyone up to access these new technologies. Scale the smartphone further and we see many new information technologies now being developed which are being embedded not only into these hand-held devices but into our buildings, our natural environments, our pets, our cars and even into ourselves. The implications for how we plan cities in the future can barely be anticipated. This *Handbook* presents us with a state of the art that is undergoing rapid development still, and could well change beyond recognition in the next one or two decades.

All of this is changing our understanding of the city quite dramatically, but before we speculate on how this is changing PSS, which is writ large in the contributions collected here, I need to digress a little. The theories that form the basis of our models, particularly LUTI models, have changed and continue to change in the light of the way our cities, the prime focus of PSS, are also changing. The development of the first tools in PSS more than 60 years ago were based on a theory of cities that alluded to thinking of the city as a system that was well ordered from the top down. We thought then of cities as machines, cast within a long-term equilibrium, composed of a neat hierarchy of subsystems and sufficiently structured to provide a basis for their better planning. Cities were not without their problems, but we felt that these problems were manageable and amenable to a new science involving computer simulations which would yield predictions that we could rely upon and plans that were actionable. In the early days, it was even felt that models could be built to generate optimal plans for cities using quite formal methods.

Since then our image of this neat order has collapsed. We no longer think of cities as being in equilibrium; they manifest as much chaos as order, they grow from the bottom up rather than being planned from the top down. They are more like biological organisms than mechanical artefacts. In short, they are infinitely complex. What has emerged is a new science to deal with these ideas, a science that is built around ideas about emergent order, path dependence, cities in evolution, fractal structures, and so on. This science is fashioned from old and long-standing ideas in social physics and economics involving agglomeration, concentration and diffusion, set within the context of new ideas about networks, hierarchies, size distributions, power laws and scaling. Our models have also responded to this new science, with many more disaggregate structures being developed, models that stress short- and long-term dynamics of change in cities, models that reflect emergence such as those based on cellular automata, and models that focus on micro- and agent-based simulations. The list of new ideas is long and many of these are reflected in the contributions collected together here, but a tension has arisen. Although many of the new models encapsulated in contemporary PSS reflect elements of this new science, the context in which they take place is still very much planning from the top down. Developments in computing are beginning to influence PSS to be much more bottom up but the kinds of software which enable this are in their infancy and it will only be in the next decade that these ideas come of age.

The other major theme, which is energizing this field, involves the refocusing on short-term change in cities, on what we might call the high-frequency city, where the subject matter is what happens over seconds, minutes, hours or days rather than years, decades, centuries or millennia. Much of our urban science and many of our models deal with this latter focus on the low-frequency city where our plans are prepared for the medium- or even long-term future. As computers scale down and become embedded everywhere within the city, and as they spew out ever bigger volumes of data in real time, the focus of our modelling and planning support is beginning to change. Big data are now our concern, which are largely unstructured in that they require some intelligence and technology to discover any patterns that lie within them, while the notion of augmenting our intelligence with the fruits of such big data is leading to a new focus on thinking about how best we might begin to optimize our plans.

From a concern for building formal optimization models of how we might solve urban problems which preoccupied us 50 years ago and which soon dropped off the agenda because of the intractability that such optimization problems encountered, we may well see a return to these ideas, but this time through the lens of big data, machine learning and weak artificial intelligence. Some of these signals are still obscure but we can discern a little of them in several of the contributions that follow. We mentioned previously the marker that Harris threw down in 1989 in the form of PSS that was picked up and institutionalized in the cluster who taught planning methods at MIT. In similar fashion, the same department has just defined a new cluster based on urban and city science, some 25 years later, which they argue is a now a cutting edge for thinking about computation and cities. This will embrace PSS but it shows a definite shift in emphasis and I leave readers to ponder what this will mean not only for PSS but for the future of methods generally in the field of planning.

The contributions here are organized into six parts. These do not deal with my focus on the old or the new science of cities, nor on the differences between high- and low-frequency cities, or on big versus small, or new versus traditional data. Nor have these contributions been ordered so that the raw kernels of the information technologies used in their applications are exposed. So my quest in this foreword is to alert the reader to where I consider these new seams of research and application lie. The editors begin in Part I with contributions that stress data and the way in which data can be linked, often through various kinds of modelling. These are then followed in Part II with chapters where methods are emphasized. This leads to Part III where some of the new ideas about PSS and the smart city are introduced. In Part IV, one of the traditional foci of PSS in participation and engagement is presented and, in Part V, there is a focus on more traditional LUTI models, with many in a new guise. Part VI deals with PSS methods applied to different sectors, such as retailing, housing and education.

I do not describe the various contributions through these parts because in Chapter 1 the editors do a splendid job of introducing the reader to a summary of the various contributions. This helps the reader to navigate what is, at times, difficult terrain that links older to newer ideas but through a focus on applications, which has always been the mission of PSS, to develop ideas that are applicable in practice. There are no purely methods-based contributions here, for all who write about PSS are geared to thinking about applications, albeit from different points of view, some practical, some methods orientated and some reflective introducing elements of planning theory. When we focus on applications, there is immediate feedback on the difficulties and challenges of implementation of such support systems. This is a really valuable feature of the *Handbook*, for the many examples it brings together give a collaborative flavour to the various experiences presented.

There are two key features of the various contributions in this *Handbook* which cut across all the sections. One which we have mentioned already is big data, or data more generally, and this crops up in many chapters. What constitutes big data in PSS is not entirely clear for in the data-science domain, big data are usually associated with petabytes of data which is orders of magnitude, perhaps two orders bigger than any of the data sets handled here. My own personal definition (although the origins of this cliché are obscure) is that big data is anything that does not fit into an Excel spreadsheet, but you know you are dealing with big data when the data in question are streamed in real time. Yet much of the data in PSS is not big in this sense. The data are big because many people use the same data set over and over again, particularly in a participatory context, and this can generate multiple versions of these data. They can be big when small data sets are combined multiplicatively or even when they are added together, coupled in some sense. Although Part I does deal with data as a focus, there are many other chapters in the book where data and big data represent the focus.

The second feature or theme within the *Handbook* is geodesign, a term coined by Carl Steinitz more than a decade ago, to describe the process of using GIS-related software in a design context, traditionally landscape design, from which GIS itself originated many years ago. In one sense, geodesign is a type of PSS but there is a consistent overlay mapping focus to the activity, and it is characterized by a strong participatory environment in which teams of professionals solve or evolve design problems simultaneously, in parallel but with some sense of convergence on one best design. Geodesign is presented in various chapters in Part II on methods and in Part IV on participation, but there is a generic flavour to this type of activity that runs through many of the applications included in this volume.

After the editors introduce the 32 contributions in Chapter 1, three chapters on data are presented in Part I, the first (Chapter 2) dealing with how micro simulation utilizes synthetic data at the micro or individual level, while in the next (Chapter 3), a mixed-methods approach fusing quantitative and qualitative data is introduced. The debate is then elevated to questions of open access, the cloud and open source computational systems introducing AURIN which is an online, cloud-based data portal (Chapter 4). Part II then focuses on methods ranging from chapters on geodesign (Chapter 5), data-augmented design (Chapter 6), geodesign and resilience (Chapter 7), models using sensor data (Chapter 8), LUTI models and new applications (Chapter 9) and, finally, large data systems using GIS in planning policy formulation (Chapter 10). Part III deals with PSS and smart cities, with the first chapter dealing head on with the smart cities and urban analytics focus (Chapter 11). Then follows a much more reflective and critical chapter which gently suggests that we should be cautious about a 1960s-type hyperbole about the smart city (Chapter 12). E-planning in China (Chapter 13), ideas about smart governance as well as the smart city are introduced in Chapters 13, 14 and 15, while a strong focus on mobility and what this implies for data and PSS are presented in Chapter 16.

Part IV, which deals with participation and engagement, is the largest in this *Handbook* with eight contributions emphasizing applications. There is a play on the term PSS as planning support science in Chapter 17, applications in Spain (Chapter 18), energy in the Netherlands (Chapter 19), large-scale participation (Chapter 20), neighbourhood and community design (Chapter 21), PSS workshops (Chapter 22), collaborative planning in the Lower Zambezi Valley (Chapter 23), and extensions and applications in southern Africa (Chapter 24). Part V returns to more traditional large-scale models in PSS, although with the emergence of big data and simulations of the high-frequency city these are no longer as large scale as they were. The Land Use Scanner model developed in the Netherlands is introduced in Chapter 25, cellular automata models in Chapter 26, UrbanSim's UrbanCanvas software in Chapter 27 and accessibility style modelling in Chapter 28. Part VI concludes the book with chapters on PSS in retail planning (Chapter 29), school-place forecasting (Chapter 30), housing development (Chapter 31) housing profitability in South Africa (Chapter 32), and rural planning (Chapter 33).

When you get to the end of this book, you will know as much about PSS as anyone else, for the contributions provide a great array of ideas, all of them focused on planning support. What is very effective is the way the editors have grouped these chapters, implying throughout that there are many cross-currents and themes that permeate the six-part structure of the book. As I have suggested, our notion of urban and regional planning is changing because cities are changing, becoming ever more complex, automated and richer, but also they are subject to many global influences from climate change to ageing, changes in our use and exploitation of energy and the increasing and manifest spatial inequalities everywhere. The contributions in this book, although not dealing directly with these big issues, are all cognizant of the challenges, and the ways in which they might be met are implicit in many of the chapters. It is tempting to speculate on what this all might mean to PSS but the reader has been alerted to the issues and by the end of the book should be in an authoritative position to make these speculations themselves. Read on. Enter a cornucopia of intelligent applications and reflections on PSS. Enjoy.

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March 2019