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Commentaries

Forty years after Lee's Requiem: are we beyond the seven sins?

In his 1973 seminal paper "Requiem for large-scale urban models", Douglass B Lee formulated his main task

> "to evaluate … the fundamental flaws in attempts to construct and use large models and to examine the planning context in which the models, like dinosaurs, collapsed rather than evolved" (Lee 1973, page 163).

This paper ended an initial period of wide enthusiasm in attempting to realise the potential of computer innovations to revolutionise urban planning (Harris, 1960). It was an era when both the planning and the computer domains were strongly influenced by strong positivist ideas about the nature of scientific progress. Planning was mainly a comprehensive–rational, linear but also cyclical process in which experts examined all possible (or politically defined) problems and relevant solutions, which in turn would lead to optimal decisions (Faludi, 1973). Even then this was extensively questioned in academic research that emphasised the limits of human cognitive capacity: that is, information processing (Simon, 1969).

Increased computational possibilities in the 1960s fed the belief that this limitation could be compensated by linking planning practices to improved analytical, quantitative-based computer instruments (supported by funding schemes to develop appropriate solutions). Lee identified two main goals in this development: improving objective ex ante plan evaluation for planning professionals, and learning effects for model experts and decision makers. Lee's (1973, page 163) verdict about these aims was unambiguous:

> "none of the goals … have been achieved [and] for each objective offered as a reason for building a model, there is either a better way of achieving the objective (more information at less cost) or a better objective (a more socially useful question to ask)."

In 1994 the *Journal of the American Planning Association* (JAPA) issued a special edition reflecting on the twenty years of developments in urban modelling and planning practice since Lee's Requiem. As guest editor, Richard Klosterman (1994, page 3) explained that "Given these changes in society, planning, and technology, it seems appropriate to re-examine the use of computer models in planning." In his contribution, Lee (1994) expressed his doubt about the utility of large-scale urban models (LSUMs) in planning practice, asking rhetorically: "That LSUMs are alive and well may be fine for the modellers, but is it of consequence to anyone else?" The late Britton Harris (1994) was explicitly critical of Lee's Requiem in his contribution, stating that Lee conflates an evaluation of large-scale models with an evaluation of comprehensive planning as such: "Lee made use of the apparent connection between planners' dissatisfaction with rigid and excessive comprehensive planning, and with temporarily over-ambitious models, to tar them both with the same brush" (page 33). Put differently, when readdressing Lee's critique, the analysis should not limit itself to the state of the art in modelling (cf Wegener, 1994), but also evaluate how the planning context in which these models operate has changed.

In the twenty years since the JAPA symposium, this topic has gained substantial attention. Two notable contributions by Klosterman (1997) and Geertman (2006) looked at the role of computer support within the changing planning traditions, using the term 'planning support systems' (PSS). They both note that planning has become an increasingly communicative and collaborative endeavour, as highlighted by Klosterman (1997, page 51, emphasis in original): "planning support systems should facilitate *collective design*—social interaction, interpersonal communication and community debate that attempts to achieve collective goals and deals with common concerns." Concomitantly, the field seems to have matured, which is reflected in a range of edited volumes about PSS (Brail, 2008; Brail and Klosterman, 2001; Geertman and Stillwell, 2003; 2009; Geertman et al, 2013). However, despite the increased attention being paid to planners' demands, it still remains debatable whether PSS fulfil a central role in supporting planning tasks (see Vonk, 2006; Vonk et al, 2005). Batty (2014) follows our commentary with his own, describing the new wave of planning support that is being generated from the smart cities movement. He points quite explicitly to the tensions between technologists and policy analysts that is occurring once again as a new unproven science is being driven by the development of large-scale computer systems and sensors to automate the city.

Here we will catalogue whether or not progress in computational capacity has narrowed the gap between these instruments and their intended users, by evaluating to what extent Lee's seven sins still hold true today.

Hypercomprehensiveness

> "(1) the models were designed to replicate too complex a system in a single shot, and (2) they were expected to serve too many purposes at the same time."
>
> Lee (1973, page 164)

The positivist orientation and belief in social science have weakened considerably over the last four decades as the notion of a predictable future has come under increasing scrutiny. It is now widely accepted that "all models are wrong [and we need] humility about the limitations of our knowledge" (Sterman, 2002, page 501). This opens up a way to limit PSS and their models to the boundaries of their specific role within the planning process and avoid hypercomprehensiveness. Most PSS reports start by indicating these boundaries (Geertman et al, 2013), thus helping planners develop a common understanding of how a part of a system (eg, the city) might respond to specific interventions. To accomplish this goal, PSS need to be simple (almost by definition) with the 'what-if' model as a prime example (Klosterman, 1999). One notorious counterexample to this approach is the highly sophisticated four-step transportation model. Developed in the early 1960s, it is still used today (often as a legally binding instrument) to justify large investments in infrastructure, and their microsimulation successors are even more complicated. In response to increasingly holistic planning questions, PSS start to include feedback loops with other land uses and social phenomena, introducing new steps and iterative algorithms, thus further increasing complexity.

Verdict: largely solved. The PSS suite offers much more dedicated models that are aimed at particular planning questions associated with specific planning steps. Still, there remains an ambition towards hypercomprehensive models, especially where they have a strong legal role (eg, transportation planning).

Grossness

> "While the models often sank under the weight of excessive data that were required to provide microscopic detail, the actual level of detail was much too coarse to be of use to most policymakers."
>
> Lee (1973, page 165)

Rasouli and Timmermans (2013) state that the failure of large-scale policies, combined with increasing insights in complexity theory, shifts the attention away from macropolicy questions (eg, how to ensure a free flow of traffic on our network?) towards microscopic individual decisions (eg, how to balance daily activities within a single household). This is met by innovations in microscopic modelling that "capture particular behavioural mechanisms, behavioural heterogeneity and complexity that the [aggregated] models fundamentally ignore" (page 22). Through their higher spatial and temporal resolution, they are more sensitive to heterogeneity in behaviour and to planning interventions on a much lower scale (eg, targeting a specific population group). Agent-based models reproduce complex patterns as emergent behaviour of the interaction of autonomous individuals that follow their own rules. Also, cellular automata (CA) models offer such bottom-up logic.

The above-mentioned advances in computational power, combined with big data as discussed in Batty's (2014) commentary, allow such models to run on PCs. In practice, their use still seems quite limited, though. The increased resolution links better to intuitive understanding, but at the same time poses new fundamental questions about the uncertainty in input data and algorithms.

Verdict: improved, but unsolved. Progress in computational power and availability of more data on higher levels of detail has allowed models to move into a higher level of detail, both in their structure (eg, agent-based, CA) as well as in their geographical scale. Yet these models are much less operational for policy purposes than the previous generation of land-use–transport models, and are largely pedagogic in emphasis and often intent. We now seem to run into fundamental limits of our knowledge about the objects of urban planning: how do cities and their actors function and how do they respond to certain interventions (see Batty, 2014).

Hungriness

> "Data requirements of any model that purports to realistically replicate a specific city are enormous."
>
> Lee (1973, page 165)

There is also a dilemma between the increasingly endless amounts of available data to fill and calibrate the models and the fact that they will still remain a severe simplification of reality. We are still struggling to define the policy-led questions to be examined through big data analysis.

A possible explanation for this shortcoming is the 'latent demand for data': the availability of new data has not satisfied our hunger but increased our appetite instead. Another important reflection is that these increasing amounts of data are highly biased, and often completely unstructured. We have much more geographical information about smart phone users, but not about nonusers per se. We know a lot about the behaviour of car drivers, but remarkably little about cyclists and pedestrians.

Verdict: largely unsolved. Increased data availability opens a dilemma of how to query these data and simultaneously increases our hunger for more data. Moreover, more data at the same time skews our attention towards phenomena that deliver easily accessible data, consequently obscuring other phenomena. Looking at the past forty years, this seems to be a neverending and reinforcing feedback loop.

Wrong-headedness

> "limitations or unintended constraints resulting from the model structure are almost impossible to perceive, and so remain unknown."
>
> Lee (1973, page 166)

The structure of a model, the boundaries and choice of variables, and its internal assumptions about external relations influence the choice of planning interventions where it can be used. Lee (1973) uses the distribution model of the four-step transportation model as an example. Calibrated based on observed traffic flows, by definition it did not (and still does not) offer insights into individual travel choices. A model can, therefore, be used only under the assumption that this underlying behaviour will not change, while we know that it increasingly does.

This sin is strongly linked to the grossness sin. Many models do not include recent insights into individual decision making, but they are nevertheless used to assess plans and policies that are strongly influenced by individual choice. More importantly, since models such as these can be strongly performative (ie, their internal assumptions influence and limit the possible space for reasoning by their users), such wrong-headedness becomes a fundamental sin. This is especially problematic where model outcomes have become legally binding (eg, as in environmental impact assessments or social cost–benefit analyses): for instance, when strategies are judged on travel time savings alone, planners tend to limit their interventions to meet this—strongly contested—criterion (Ferreira et al, 2012).

Verdict: largely unresolved. There are still mismatches between the intrinsic assumptions of the many models and their powerful (often legally binding) repercussions.

Complicatedness

> "As the number of components (eg, variables) increases in a model, the number of potential interactions between them increases as the square of the number of components."
>
> Lee (1973, page 166)

This sin is the pivotal battleground between PSS developers and their potential users. When models are made to improve our fundamental understanding of a certain phenomenon, increasing complicatedness (today sometimes referred to as 'complexity') is often vital. However, there is an optimum level of complicatedness, after which the usability of the PSS drops and the learning is limited to the model itself [see Lee's (1973, page 173) diagram].

Recent studies on PSS in planning practice reveal two main PSS branches: the relatively simple tools that, based on heuristics, provide a quick feeling for urban responses to interventions (eg, scenarios, what-ifs) and the more complicated systems with sophisticated underlying models [eg, land-use–transport interaction (LUTI) models, agent-based, CA]. Especially referring to the last category, a survey among potential users of transport models in the Netherlands showed that low transparency and communicative value are considered as more important bottlenecks to PSS use than comprehensiveness (Te Brömmelstroet, 2010). Especially in the early planning phases (when choices are still largely open), transparency and 'opening up the black box'—not details and precision—were seen as the prime criteria for using PSS in practice.

Verdict: unsolved. Although lip service is paid to it, a real search for a context-dependent usability optimum in terms of complicatedness is still lacking in reality.

Mechanicalness

> "It is all too easy to become immersed in the trivial details of working with a problem on the computer, rather than think it through rationally. The effort of making the computer understand is then mistaken for intellectual activity and creative problem solving."
>
> Lee (1973, page 168)

The current PSS suite has dramatically improved its appeal. Visual gadgetry has brought us maptables, 3D visualisations, fly-through navigation, computer-game-like experiences, and intuitive navigation. This has not replaced our intellectual and creative capacities, but instead helps us to make use of these human capacities to a much fuller extent. Visual animations provide us with a better insight into the expected outcomes of planning interventions and thus help us anticipate potential consequences, also negative ones, and the potential need for anticipatory (corrective) behaviour. Likewise, observations of spatial planning sessions with a touchtable indicate that standing around such a 'big-screen–table-computer' activates participants and keeps them involved for the full session (Pelzer et al, forthcoming).

Verdict: unsolved, but some hopeful developments. The present generation of PSS offers appealing instruments that are seen as supportive in many planning tasks. However, they should not become a goal in themselves but should be used as a means to support creative thinking instead.

Expensiveness

> "While it is difficult to identify the specific costs of any particular model, a rule-of-thumb estimate for a full-scale land-use model is probably at least $500,000."
>
> Lee (1973, page 168)

This seventh sin is clear: developing a model and running it was expensive. For reference, Lee's quoted sum is the equivalent of $5.7 million today. Still, the costs of utilising PSS are relative to how often they are used and the potential benefits they provide. And like all such costs, where one begins and ends the calculation is arguable for models are always built in situ and relate to other infrastructures, agencies, expertise, and data.

The costs of current PSS are quite diverse. Simple PSS can often be acquired for a couple of thousand dollars (or even free and open source), although the development costs can be substantial. More complicated PSS, however, still require substantial public and/or private investments. For example, investments in UrbanSim can exceed $1 million; legally binding transportation models are even more expensive. Developers are increasingly moving towards a business model of providing support in setup and operational management, instead of off-the-shelf sales, and other business models are also being developed (eg, time-leasing or service-packaging).

Verdict: significantly improved but still quite diverse. For some simple PSS, use costs are low, also due to strong competition and the availability of open source alternatives. For more complicated PSS, development costs are substantial and intensive, which makes expensive business arrangements necessary.

From requiem to birthday wishes

It is safe to say that Lee's (1973) prediction that urban models would go extinct has not yet materialised. The same can be said about the rather hopeful notion that if certain requirements are met "advanced information technologies may finally take their place at the centre of professional planning practice, supporting community planning in its fullest and richest forms" (Klosterman, 1997, page 53). Four decades after Lee's paper, PSS are still here and here to stay. The key question is: "In what way and with what magnitude?" Rather than speculating about an answer, we will end with some observations for the decades ahead.

A central point that emerges from the separate sins is that most do not relate only to the models themselves, but also to the way they are perceived and applied. As Batty (2014) recounts below, there is a widespread evaluation still ongoing about what was the essence of the debacle reported by Lee (1973). Many now believe that the inevitable tension between policy analysts, politicians, and model builders played a vital part in the whole experience. Moreover, the PSS family has grown more rapidly in applications that focus much more on supporting shared learning and facilitating social interaction, thus broaching some of these problems. Many sins have disappeared by using advances in these models in a more relaxed environment. They are no longer used to answer a specific question, but rather to expand the planning participants' shared understanding in a collaborative setting. As we argued before, to understand the current role of PSS, one should look not only at the change of the models themselves, but also at the change in the planning context. Based on this argument, we have identified five wishes for further improvement:

- *Embrace ignorance*: Most urban systems are inherently complex and open. At best, PSS can capture but a tiny part of their—often exponential and unexpected—reciprocal relations. We should always leave room to problematise model assumptions and outcomes, and thus also restrict their use as legally binding requirements.

- *Transparency*: As much as possible we need to make assumptions and all relations between input and output of our PSS transparent and understandable (see also Lee, 1994). Only then can a user verify and use the model to learn.
- *Secure soft values*: PSS traditionally work with quantitative information, but in most planning processes key qualitative aspects need to be considered. The performativity of models can be countered by focusing more on these qualitative values.
- *Keep incorporating new technologies*: From the gargantuan mainframe computers of the 1970s to laptops, maptables, and even the hand-held devices of today, the PSS domain has always embraced innovative technologies to improve the interaction between models and users. This open attitude is important to keep up with the ways that planners communicate and to minimise the mechanicalness. Currently, this means trying to include tablets, mobile phone platforms, and the Internet into the PSS suite.
- *A structured dialogue*: A classic mistake in the development of urban models and PSS is to exclude the end user from important choices early in the development process. By improved continuous interaction with the users (see Geertman and Stillwell, 2009), a stronger sense of ownership and a better fit between PSS and users can be achieved. Developing PSS that allow for contextualisation seems an important way forward in combatting the planners' often antagonistic attitude. This confrontation with practical knowledge and the emerging mutual learning process will also improve the models.

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