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Subterranean to Skyline—Street Trees as Boundary Agents in the Composition of the Street Section †

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Abstract: Before we parked cars—we parked trees. These 'parked' verges, supplanted by parking places during the 1900's, now present opportunities in cities such as Oslo, looking to cultivate car free, climate resilient, liveable spaces. The prospect of re-parking street trees has a poetic quality, but is not without its challenges. A key feature of street trees are the way they connect, complement, and conflict with other entities across the full profile of the street section—from subterranean to skyline. It is this attribute, we argue, that makes street trees great infrastructural connectors: boundary agents through which urban space above and below ground can be comprehended, diverse practitioners connected, and the agency of street trees in the repository of the street section, foregrounded in urban development and design.

Keywords: street trees; streetscape; boundary agents; boundary objects; urban ecosystems

1. Introduction

Before we parked cars—we parked trees. *Tree parking*, inspired by the avenues and boulevards of Paris, was first stipulated in the United States Congress law of 1870, setting aside up to half the width of new streets in Washington DC for the creation of "parks for trees and walks": *Parking areas* [1]. The following year, the Washington DC *Parking Commission* was established, and "parking" became part of urban planning vernacular and a regular feature of new built cities. Some 50 years later, as motorised vehicles came to replace horse and carriages, streetscapes were transformed again. City officials felled street trees and widened streets to accommodate increased vehicle traffic, and the original meaning of 'parking' as a place for trees and greenery shifted to parking as a place for cars to stop [1]. It is these former 'parked' verges and the wider street profile, dedicated to car access and parking this past century, that now present opportunities in cities such as Oslo, looking to cultivate car free, climate resilient, liveable spaces.

The prospect of re-parking street trees is made possible by changes in transportation; car-pooling and self-driven cars [2], and changes in urban policies including; increased and improved public transport and restrictions on private cars access in city centres, e.g., Freiburg, Nürnberg and Oslo [3]. Planting more trees is considered, with some foundation, a panacea for tackling and offsetting a range of human driven crises [4] and the role of street trees in planning and policy arenas has transitioned from one focusing on beautification and ornamentation to one inclusive of ecosystem service (ES) provision [5]. Urban trees are now key instruments in the portfolio of nature based solutions (NBS) employed by cities striving for climate resilient, liveable spaces [6,7]. However, space in city centres is valuable and contested [8], and while street trees are often considered emblematic and intrinsic to urban liveability and intergenerational equity, they also connect, complement, and conflict with other entities across the full profile of the street section—from the subterranean to skyline. As such, an appreciation and desire for more trees hasn't stopped cities experiencing net losses of their tree canopy cover or large scale tree failure in new urban planting schemes [9,10].

The failure to arrest the loss of urban trees has been described as a failure to handle the conflicting and contradictory values of urban planners, landscape architects, businesses, municipal authorities and tree managers [8], and also a failure to respond effectively to the ambivalence of urban residents [11]. While the sustainability benefits of trees are widely reported in the literature, from an urban management perspective, tree disservices - functions of ecosystems that are perceived as negative for human well-being [11–13], have not been extensively discussed, and yet it is negative attributes, such as light obstruction, leaf litter, and root uplift, that affect decision-making [8]. The situation has given rise to a reactive, risk averse, complaints-driven approach to urban forestry [8,14,15], resulting in healthy urban trees being prematurely felled [9] smaller canopy trees being planted in their stead, and constraints to innovation and use of urban forestry in green infrastructure [15,16]. In addition, the ongoing melee of conflicting infrastructures under our streets, though ameliorated to some extent by technical solutions [17], still threatens existing street trees, and can result in new tree plantings being omitted from planning proposals [8,17].

The Hug the Streets project, sponsored under the Research Council of Norway's idélab '*Cities that Work*' programme, sets out to capture the complexities of urban infrastructure development; identify opportunities; explore co-creating concepts for infrastructure integration; and prepare the ground for change, through stakeholder engagement in cross-sectoral work. This paper stems in part from the authors's current research on rethinking the need for street trees, how we meet the needs of those street trees, and the way ecosystem services can be integrated into street section design, and also from the authors's ongoing critical development of Star and Griesemer's concept of boundary object and boundary agent [18] as a theoretical lens through which streetscape and street section design and development can be examined. In this short paper, we introduce the idea of the street section as boundary object; a repository of concrete and abstract urban infrastructures, and the street tree as boundary agent; hidden collaborator improving the function of the street section.

2. Boundary Research

The theory of boundary objects was originally introduced by the sociologists Star and Griesemer who, through their study of information practices at the Berkeley Museum of Vertebrate Zoology, identified boundary objects as objects or ideas that emerged through collaboration and dialogue when groups from different worlds work together [18]. Boundary objects are both abstract (e.g., ideas, classification systems, concepts) and concrete (e.g., artefacts, images, maps, tools)—and are part of the collection, management, coordination, and distribution of knowledge. Boundary objects are adaptable to local needs yet "robust enough to maintain a common identity" [18] (p. 393) and through connecting different perspectives from different communities, can facilitate common goals, and also bring the overlooked, obscured, and inaccessible in to view.

Star lists four types of boundary objects [19,20]: Repositories, which are a bundle or assemblage of objects that are indexed in a standardised fashion such as a library or museum. Ideal Type, which are abstract, vague, and adaptable, such as diagrams, maps and concepts. Coincident Boundaries, which are common objects which have the same boundaries but different internal contents, and Standardised Forms, which are standardised indices that serve as methods of common communication.

Whether or not something functions as a boundary object depends on whether it has "interpretive flexibility," meaning it can satisfy the needs of users from different social worlds while also facilitating communication between them [18]. Taken alone, interpretive flexibility could be applied to an array of ideas or objects, therefore, a boundary object also addresses an information need arising from work processes, such as a need to classify or organise and, rather than being static, boundary objects are always in a state of change, of movement from broad ideas to tailored applications [19]. As an analytical tool, the boundary object concept is useful for providing insight into the dynamic process of collaboration, including how boundary objects come about, are produced and maintained, their material effects, and potential transitions into standardised "infrastructure" [20]. Boundary objects, like infrastructure, are both "product and process" [20] (p. 111) engaged in an iterative and relational cycle.

Boundary object and the compliments of boundary organisations, boundary work, boundary crossing, and boundary agents, serve to enhance the linkages between various forms of knowledge (e.g., scientific, indigenous, political) and action (e.g., policies, behavioural changes, decisions), and in doing so facilitate improved information quality and decision outcomes. Studies have shown that different artefacts may function as boundary objects, including documents [21] and geographic information systems (GIS) [22]. Boundary object has been applied in a broad variety of studies in different research communities from information systems [18] to management [23] library and information studies [24] and more recently in the analyses of environmental governance and ecosystem service frameworks [25,26]. It has not, until now, been applied in the case of street trees, the street-section, and those engaged in design, decision making, and management of the above ground and subsurface of the streetscape, and could prove a useful tool in understanding and addressing the challenges of planting more trees in our streets.

Landscape architects are regularly engaged as boundary crossing professionals, who with each new project, enter into new or unfamiliar territory, and set out to negotiate and combine ingredients from different contexts to achieve hybrid situations. In this work they typically take a leading role in engaging with and contributing to a range of boundary objects (maps, visual representations) in the collaborative design and development of the streetscape, and curation of the street-section. Drawing on her own field work and observation of organisational collaboration, Star questioned the consensus models that state in order for cooperation to begin, consensus had to be reached. In fact, she noted that consensus was rare, and when it did exist, was fragile, but cooperation continued regardless [18,19]. In light of this Star went on to posit that boundary objects are a means for interaction and translation, enabling groups to work together when consensus was neither possible nor desired [19]. Landscape architects are a case in point. As boundary crossing professionals, they foster dialogue and synergies across disciplinary boundaries, thought traditions, and urban management remits, frequently collaborating with a range of different actors, from highway engineers to tree officers, without necessarily coming to a consensus: a state of mutualism perhaps, and even resignation to the complexity of the streetscape, but not necessarily a consensus. All the same, the collaboration continues in the design, development, renovation, and reworking of the streetscape and street section.

2.1. Street Section as Boundary Object

The street-section sometimes known as the street-cut, is the cross-profile of the streetscape from the subterranean to skyline. In this paper we specifically focus on the largely hidden space, the subsurface area of the street section, and put forward the idea that, similar to a library and museum, this subsurface space is a boundary object of the repository type. Within the soil, rock, and ecology of the subsurface, are housed a collection of both active and dormant infrastructures, artefacts and material culture that, while heterogeneous in nature, are also organised and standardised, reflecting the materials, design and decision making of those actors engaged in their production and maintenance.

The street-section stems from a need to conceive, generate and assemble the elements of the streetscape, such as utilities, in an iterative fashion, and in this way conforms to the repository type. In common with other repositories—such as a library, the street section also permits that things be individually removed without collapsing or changing the structure of the whole. Thus the addition or removal of a street tree, while reflecting a change in content of the street section, does not change its function: the street section remains.

Another facet of the repository boundary object is its nature as a shared space. In the case of the street section, in its continued creation and management it maintains a coherence across intersecting communities, satisfying the requirements of each of them. A space in which actors from different social worlds manage to cooperate and coordinate with each other regarding new installations, retrofits, upgrades and emergency repairs, in spite of their differing backgrounds and points of view. As a result, the subsurface area contains a comprehensive and extant collection of infrastructures: utility mains, laterals, vaults, valves, sewer, water, gas, telecommunications etc. which may or may not be present, in part or whole, in some or all, of the planning documents, maps and technical designs of a given street section. It is only in opening up that street section, taking a look beneath the

surface, that we see the complete assemblage of elements, including the root systems of trees. It is only in opening up the street section, that the contents can be fully fathomed, and the information stored within, accessed, shared, and utilised.

In considering the street section as a repository, a space curated, we can examine more closely not just the what, but the why, when, and how, agents in the street-section coordinate, cooperate, manage, and even restrict each others actions in space and time.

2.2. Street Tree as Boundary Agent

Since its original formulation, boundary objects have come to been seen in terms of their agency [27], whilst the definition of boundary objects has also broadened to encompass not only technologies and other "objects" but also human and other living entities [28]. Trees, are a fertile territory for the grounding of such conceptualisations. Their activity, agency, and uses are embedded in numerous relationships with humans and other non-humans, and are evidenced in the street section.

Street trees are significant organising elements in the streetscape environment. Increasingly appreciated for their role as living infrastructure [29], trees operate in their own ecological time and have a very different lifecycle to other infrastructure assets: their value increases with time and increases exponentially [17]. Street trees are commonly associated with their rootedness, their fixedness in the streetscape. Highly visible champions of the urban ecosystem, there is much that is also unseen in their agency as autogenic engineers. Street trees have agency in shaping the nature and content of the street-section, and are in a continuous dialogue with the street-section and other agents in this space. In this sense, we can connect street trees with actor network theory (ANT) ideas regarding the agency of non-humans as an essential element in how the natural and the social flow into one another, how the human and the non-human are networked together [30].

Typically street trees are viewed through a dichotomy of services and disservices, greatly reflecting the ambivalence in which they are held but not reflecting their full agency [31]. A street tree's agency can be routine, and familiar, the visible processes of growth, fruiting, colonising. There is also an autonomy in their ability to self seed and spring up in some of the harshest and unlikeliest of places that can surprise, inspire and challenge the fabric of a city [31]. As well as being material actors, street trees are also socially constructed objects. In the abstract representations of the sub-surface street section, namely utility maps and technical drawings, representation of the living elements of the street section are vague and static. The agency of street trees is silenced on paper, but is evident in the street section.

Tree roots are primary contributors to soil formation, soil structure, and soil maintenance. Improved soil structure improves plant growth, and facilitates other subsurface ecosystem services, such as storm water attenuation. However, the full range of a street tree's agency is only just coming into view. A study of street trees from Mitcham, Southern Australia, examining permeable pavement sections and tree planting pits, point to a symbiosis in the subsurface area that could prolong the life and viability of infrastructures [32]. Five years of growth revealed that seasonal desiccation of roots beneath permeable pavements during hot, dry summers, limited shallow root growth, minimising tree root related footpath damage. It also biologically improved the connection of the pavement's stormwater detention capacity to the water storage capacity of the underlying silty clay loam [32]. The ephemeral, seasonal nature of the the root systems with their subsequent decomposition resulted in bio-pores that further supported water infiltration. The same ephemeral roots were not present in the compacted soil beneath conventional, non-permeable paving, observed in the study. Thus the permeable paving, emulating natural conditions, enabled street trees to perform to their full agency, their 'invisible work', in improving the street section's function as a repository for stormwater management infrastructures, that is, improving the soils ability to both detain and direct flood water away from the paved street surface.

The idea of invisible work originally referred to the unpaid housework appraised under feminist activist research [33], and has become an important site of analysis in boundary object research. It has influenced the development of boundary objects in relation to local tailoring as a form of work that, while it may be invisible and vague to the whole group, is at the same time useful and important.

The true extent of the 'invisible work' street trees do for the street section repository is still to be extrapolated. It involves collecting and collating data from numerous sources, but is worthy of further enquiry.

3. Concluding Thoughts

The declining street tree legacy of late 19th to early 20th century planting schemes, and the desire and need to make a similar investments for future urban generations is not easily reconciled with the ever evolving, increasingly complex urban streetscapes. Our urban spaces are situated amongst a heterogeneous group of actors and diverging viewpoints, and rest upon a subsurface of infrastructures and conditions that heavily impact possibilities in streetscape design. What lies beneath the surface can be both an opportunity and a formidable constraint in terms of landscaping, improvements, and living infrastructure development.

As an analytical tool, the boundary object offers a potent lens through which the complexity of the streetscape and the street section can be examined, the agency of actors foregrounded, and an improved understanding of the ground beneath our cities fostered into urban development decision making. To consider the street tree as boundary agent, allows us to explore the full agency of the tree, beyond the dichotomy of services and disservices. Similarly, considering the street section as boundary object: that is as a repository of concrete and abstract urban infrastructures and information, brings the unseen into view, has potential to contribute to the discourse on cultivating climate resilient, liveable spaces, and expands on the premise that rather than nature being hosted in our streets, it is us, and the cities we live in that are hosted in nature.

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