Australian Urban Robotic Futures: Potentials, Limits and Options,

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Cities across the world are being confronted with a wave of new urban robotic applications that combine artificial intelligence with movement technology in the form of automated vehicles, drones and various types of delivery, maintenance and security robots. Technical and regulatory constraints have previously limited the use of autonomous robots in urban areas but that is changing rapidly as advances in Artificial Intelligence, machine learning and sensors combine with private sector investment and governmental interest in the potential economic, social, infrastructural, environmental and efficiency benefits.

Urban robotics is now being constituted as a major growth sector in national robotics strategies (Australian Centre for Robotic Vision 2018/2022, DTI, 2019) and there is a proliferation of real world projects and urban experiments (Boenig-Liptsin, 2017; Hopkins and Schwanen, 2018; Marvin et al, 2018a; Nagenborg, 2018; Macrorie et al., 2020; Tiddi et al, 2020; While et al, 2020; Woo et al, 2020). Interest in urban robotics has certainly expanded significantly in the COVID-19 pandemic given its potential to minimize and replace human-human contact (Chen et al, 2020; Melanson, 2020).

Urban robotics has significant implications for urban infrastructure and social life. However as yet there is limited understanding of the new functional capacities and strategic urban potential of emerging robotic infrastructures and how they are shaped by experimentation in different places. There are important issues to be addressed in relation to employment, privacy, intensified social control and surveillance, discriminatory profiling, the power of private technology firms and public safety as boundaries between human and machinic management are reworked in different social and spatial contexts (Del Casino et al, 2020; Macrorie at al, 2020). It is profoundly important that these questions are addressed at this early stage of urban robotic development to inform governance, regulation and research in the public interest.

Urban robotics is layered upon, and extends, the digital focus of the 'smart city' in distinctive ways by expanding the physical capacities and capabilities of autonomous machines assembled as proto-infrastructural systems (Elliott, 2019). The emergence of urban robotics reflects advances in service and field robotics that have enabled a diversity of robots to move out of the controlled context of the factory and enclosed testing ground, to interact in the real-world context of the highway system and at a limited scale in the complex environment of the public realm of cities (Royakkers & van Est, 2015; Thorpe & Durrant-Whyte, 2001; While et al, 2020). There is now a significant academic and policy/public literature on the development of commercial autonomous vehicles (AV) and drones (e.g. Lockhart et al, 2021). However, there are three critical gaps in the current literature on 'robotic-city interactions' (Tiddi et al, 2020):

1) Urban technological research has made important theoretical and methodological contributions in the analysis of urban digital applications, networked infrastructures and smart cities, but robotics and autonomous systems are minimally acknowledged in the existing literature.

2) While there is now significant research on autonomous vehicles and drones, there has been limited systemic comparative research on the advent and implications of the application of robotic trials and services in the public and semi-public realm of cities.

3) Whilst social science research indicates that robotic technologies radically shift humans and machines in new configurations relative to one another' the implications for urban governance of this aspect of automation are not yet well understood.

There is a need to address these critical gaps by analysing the existing Australian landscape of robotic capacities and the urban experiments taking place in the public realm, in order to explore
Where and why is urban robotics emerging in particular sectors and what urban challenges does it claim to address? What new connections are being made between humans, robotics and the city? How and where are robots transforming urban space, and to whose benefit and cost? What are the implications for the governance of human-robotic relations and how might robotics systems develop as an urban infrastructure?

BIOGRAPHY
Simon Marvin is Professor of Urbanism at the School of Architecture, Design and Planning at the University of Sydney. He has recently completed, with Andres Luque-Ayala, an international programme of work on the interrelations between digital technologies, operating systems and urban infrastructures. 'Urban Operating Systems' was published by MIT Press in 2020. His current interests focus on the emergence of AI, robotics and autonomous systems and their interweaving with controlled environments and urban contexts. He has published in Urban Geography on the key questions robotics raise for urbanist and in Urban Studies on urban robotic experiments in Dubai, Tokyo and San Francisco. In 2023 he starts a three year ESRC funded programme on Experimenting with robotics as a new urban infrastructure which includes field work in UK, Australia, Japan and the USA.