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Loh, Susan, Foth, Marcus, Caldwell, Glenda Amayo, Garcia-Hansen, Veronica, & Thomson, Mark (2020)
A more-than-human perspective on understanding the performance of the built environment.
Architectural Science Review, 63(3-4), pp. 372-383.

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https://doi.org/10.1080/00038628.2019.1708258
A More-than-Human Perspective on Understanding the Performance of the Built Environment

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Word Count: 6442
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The ready availability and widespread deployment of IoT devices and sensors enable a high granularity of quantitative data to be collected to give a real-time appraisal of a building’s environmental performance. Rating and assessment frameworks are increasingly taking advantage of the insights that can be derived from both new building technology and big data analytics. Yet, climate change action requires new perspectives that move towards a post-anthropocentric and more-than-human viewpoint. This paper makes a threefold contribution. In order to highlight a gap, we (1) critique select Green Building Rating Tools and (2) contrast current achievements and targets with what climate change action demands of the built environment’s performance. In response, we introduce to architectural science some of the relevant theories and paradigms from the environmental humanities and design research such as net-positive architecture and more-than-human futures. (3) We discuss several causes for the disconnect between actual and aspirational ends of the performance measurement spectrum and offer some possible responses and actions with a view to stimulate scholarly debate and engagement to leapfrog the performance of the built environment.

Keywords: green building, rating tools, measurement, performance, energy, ecology, more-than-human, digital, net positive architecture, positive development, urban science, urban informatics

1. Introduction

The clear and pressing concern for our planet right now is to avert an anthropogenic “ecocide” (Yigitcanlar, Foth, and Kamruzzaman 2019; Heitlinger et al. 2018) due to a lack of reasonable and impactful action to combat climate change on a global scale (Yigitcanlar, Foth, and Kamruzzaman 2019; Yigitcanlar et al. 2019; Light, Powell, and Shklovski 2017). The urgent need to reduce greenhouse gas emissions has directed government and industry initiatives towards energy efficiency programs (AusGov_DeptEnv&Energy 2015) and funding for technological innovations (CleanEnergyInnovFund). As such, the Australian Government’s climate change plan is
concerned primarily with reducing emissions, securing a national electricity market with some encouragement towards renewable energy sources (AusGov_DeptEnv&Energy 2017). While there is nothing untoward with this direction, it narrows the vision for a better future to CO₂ reduction via energy efficiency alone, without relating it to the bigger picture of connecting energy usage with uncapped human consumption, a neoliberal and unchecked growth paradigm, and other contributing factors such as embodied energy.

Many policy makers and organisations (e.g., 100 Resilient Cities, C40 Cities) believe cities to be the key in addressing the challenge of the climate emergency due to cities being the primary host of economic activity, the centre of population growth and urban sprawl, and the largest consumer of energy and resources. However, the trajectories of cities will not be directed towards a more sustainable urban form that reduces energy, water, and resource consumption if our strategies are limited to efficiency gains only (Zehner 2012). Increased energy efficiency paradoxically tends to lead to increased energy consumption (Herring and Roy 2007). Thus, efficiency gains alone are not sufficient to combat climate change and meet the world’s obligations as part of the Paris Agreement.

Additionally, the recent advent of the Internet of Things (IoT) has made it easier to obtain quantitative data about building performance from various kinds of digital sensors. Yet, the vast quantity of big data may not equate into a high quality of insights. Furthermore, qualitative data from non-machine sources, e.g. human interactions with the building or diverse ecological datasets, appear small and insignificant compared to the prevalence of big data. This risks skewing the focus on actions predicated on quantitative data more easily obtained from heating and cooling machines, temperature and humidity sensors, traffic counts, etc. Additionally, the lack of a holistic and
ecological view that recognises the entanglements of human activity with the natural world may have also contributed to the narrowing of sustainability actions to be primarily concerned with electricity production and consumption.

This paper offers a critique of a selection of current socio-technological approaches to understanding and measuring performance of the built environment. This critique is informed by questioning assumptions around (a) what should be measured rather than what can be measured; (b) what should our aspirations towards innovation in the built environment be rather than what incremental improvements can be made, and; (c) what is not being included or considered rather than what currently is.

The article is structured in three parts (see Figure 1). (1) We discuss and critique several pertinent attributes of current Green Building Rating Tools (GBRT) and summarise constraints and limitations. (2) We highlight what climate change action demands of the performance of the built environment. We introduce the notions of net positive architecture and more-than-human futures, both of which respond to current conditions of climate change, pollution, and loss of biodiversity by flagging the prevalent human-centred design of buildings and cities as increasingly problematic. We examine these concepts and introduce to architectural science some of the relevant theories and paradigms from the environmental humanities and design research. (3) We synthesise the two previous sections by discussing the gap between where performance frameworks of the built environment currently are at and where they ought to be if humanity is to avoid a planetary “ecocide”. We discuss several causes that appear to have led to the disconnect between actual and aspirational ends of the performance measurement spectrum. And finally, we translate the more-than-human perspective on understanding the performance of the built environment into a number of possible
actions and recommendations with a view to stimulate further debate and scholarly engagement that seek to close the performance gap.

[Figure 1 near here].

The goal of this paper is not to provide another assessment tool nor a novel method of evaluating a building. The intention is to highlight the fact that we need to break out of the current paradigm that assessment tools can measure building performance and to use this as an indicator for addressing current environmental issues.

The new knowledge we bring in this paper is to highlight this gap so that we can recognise that a cultural shift is required within the architectural science discipline. The specific focus of scholarly inquiry in this paper is not about incremental improvements to the accuracy of GBRTs but about the broader action plan for the future of the built environment that needs to be recognised when evaluating building performance.

Our hope is that this article may contribute in two ways, (a) to advance our understanding of some of the systemic limitations inherent in the prevalent positivist approaches to measuring performance of the built environment, and (b) to inform and
make way for a new, more-than-human paradigm of understanding the performance of the built environment that could transform the predominant model of ‘less harm’ (i.e., efficiency gains) into a model of ‘more good’ (i.e., net positive contributions) for our ecosystem and planetary health.

2. The Practice and (Unmet) Promise of Green Building Rating Tools
Approaches to understanding and measuring performance of the built environment have evolved since the introduction of assessment schemes. Early building performance frameworks such as Green Building Rating Tools (GBRT) showed a disproportionate emphasis towards addressing energy consumption at the expense of other sustainability aspects such as ecology, and human socio-cultural concerns. Then, within the last ten years, there has been a significant increase in the amount of detailed data and data sources for social and technological performance evaluations made readily available by the advent of ubiquitous computing through IoT data collection which is at the core of smart city technologies and urban informatics (Foth, Choi, and Satchell 2011). With more recent examples such as the Living Building Challenge (LBC), we have seen a shift from a building to a human focus where lived experiences of people in spaces and cities are factored into design and performance criteria. However, the turn to human centredness in some GBRTs fails to address a human exceptionalist notion of the built environment, which considers urban space as designed for, and inhabited by, humans only. Within the age of the Anthropocene – a term used to refer to a new geological era in which human activity is transforming earth systems, accelerating climate change and causing mass extinctions (Houston et al. 2018; Moore 2017) – a human-centred perspective is increasingly untenable. In this paper, we argue for a more-than-human perspective on understanding the performance of the built environment, which de-
centres the human (Forlano 2016) in building performance frameworks and puts people on a par with ecology in the sustainability equation.

This shift from human to ecology focus recognises the complex entanglements between humans, the built environment and the natural ecological environment. It enables a more harmonious co-habitation with the more-than-human ecological environment, which is integral to lifting the performance of the built environment to a level that is compatible with the benchmarks and targets of the Intergovernmental Panel on Climate Change (IPCC)\(^1\) and the United Nations Sustainable Development Goals (SDG)\(^2\). To discuss the above changing foci, the argument we present in this article considers not just energy concerns, but also concerns of ecology and communities. We critically review not just what and how we are measuring but question the positivist paradigm that many GBRTs are embedded within. This will make way for a new perspective on understanding the performance of the built environment we introduce thereafter.

2.1 GBRT Focus and Weighting

The use of GBRTs has been considered a sustainable way to address climate change since ‘the building sector in Australia accounts for approximately 19% of total energy consumption and 24% of overall GHG emissions’ (ASBEC 2010). Since the advent of GBRTs, general expectations have been for an improved built environment with less damage to the surrounding ecological environment. However, this might be difficult to achieve, because the drivers given for adopting GBRTs are more aligned

\(^1\) [www.ipcc.ch/sr15](http://www.ipcc.ch/sr15)

\(^2\) [https://www.un.org/sustainabledevelopment/](https://www.un.org/sustainabledevelopment/)
with financial gains. The motives for adopting GBCA Green Star (as given on the GBCA website prior to April 2019) are the ten benefits of: lower operating costs; higher return investment; attract and retain tenants; enhanced marketability; productivity benefits; reduced liability and risk; healthier places to live and work; demonstration of corporate social responsibility, future-proofed assets; and competitive advantage. Nine of the ten listed reasons above relate directly to economic benefits with only one benefit, ‘healthier places to live and work’ relating to people, but none mention any relationship to ecology on which all life depends. Furthermore, even with the flawed emphasis on energy efficiency alone, Australia is performing poorly. Moore and Holdsworth’s analysis concludes that:

   “Australia currently fails to meet international building performance best practice standards, particularly in the residential sector, and this situation can only be reversed if various levels of government in Australia increase the regulated level of energy performance of buildings coupled with a more holistic and progressive inclusion of all energy consumed and generated within a building. This would be better aligned with improving actual impacts a building has over its lifecycle and on the community at large.”(Moore and Holdsworth 2019)

   With a recent 2019 rebranding of the GBCA focus on ‘carbon, homes, social infrastructure and members’ and a revised vision to ‘create healthy resilient positive places for people,’ (GBCA_Green_Star-Strategy 2018) there appears to be a refocus on people but no mention of ecology. The business case for valuing green certified buildings, however, still retains the motivations of the ten drivers listed above (GBCA_Green_Star-Valuing_Green 2008; GBCA_Green_Star-Business 2013).

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3 Green Building Council of Australia (www.gbca.org.au)
Table 1 shows selected GBRTs to highlight the unequal weighted focus on energy in comparison to ecology or human health or ethical values.

[Table 1 near here].

2.2 GBRT Performance Evaluation

In 2009, the US Green Building Council research suggested that 25% of new buildings with GBRT certification may not save as much energy as originally predicted and many do not track energy consumption in use (Navarro 2009). Additionally, GBRTs have different categories and weightings, therefore, compliance with one rating tool does not mean that it will also achieve another tool’s rating. There are many nuances to be aware of, e.g. a building can fail to achieve LEED rating for minimum energy performance but can still obtain Green Star rating. The disparity in this example is due to the fact that LEED assesses whole building energy performance while Green Star examines base building performance only (Pollard 2011; Roderick et al. 2009). Conversely, a LEED rated building may not perform well with the Living Building Challenge (LBC) framework, because LEED gives points for simulated energy performance while LBC requires data that is metered for one year of operation after the building is occupied – see the Kellogg Building Project for an example (Williams_College 2014).

2.3 Ecology and GBRTs

The concerns for ecology in many GBRTs are often subsumed under other categories with other landscaping concerns, e.g., Sustainable Sites (LEEDS), Land Use and

4 living-future.org/lbc
Ecology (BREEAM and GBCA) or indirectly being affected under *Urban Harmony* in Singapore’s BCA Green Mark. The minimum standards in BREEAM require only 1 credit for LE03: *Mitigating ecological impact* (BREEAM-LE_03). Mitigating impacts with minimum requirements may limit the deterioration caused by the development of a building, but it does not contribute positively to the environment (Birkeland 2008).

Ecology categories are valued about 10% of the tool, but the value is even less upon examining what is actually accounted for in an ecological category. As illustrated in Table 2, the breakdown of the ecology criteria shows a divided attribution of importance to biodiversity with other landscaping concerns, e.g. waste management or hard surface maintenance. The low concern for biodiversity or ecosystems is noted where ecological value is given equal weighting of 3 points as groundskeeping – see Table 2

[Table 2 near here]

The opportunity to offset ecology in some tools is questioned since it may prove difficult to fully transpose habitat and biodiversity elsewhere, or it could be perceived as a form of carbon trading that may or may not yield the same results with the habitat exchange intentions.

A future focus has been initiated in May 2018 where GBCA has put out a discussion paper on prioritising ecology and biodiversity for better buildings and cities. This is a big positive step towards recognising real and negative impacts that buildings have on surrounding habitat and ecological systems. This initiates a promising action of bringing ecological and biodiversity concerns back into the decision-making process of the building industry given the past focus on energy.

As a result of our short critique of GBRTs, we are not proposing a novel method or new assessment tool to measure a building’s performance. We question energy
efficiency as the primary measurement for a green well-performing building. We posit that energy efficient buildings may not decrease net consumption as per the Jevons Paradox (Alcott 2005) where the cost savings in fact, could increase consumption thus contributing more instead of less towards climate change. York and McGee point out that “resource consumption may rise in spite of or coincidently with rising efficiency, rather than because of it” (York and McGee 2016). Similarly, Giampetro believes that “[the] framing of the Jevons Paradox in terms of complex system thinking flags the limited usefulness of the concept of energy as an indicator of sustainability” (Giampietro and Mayumi 2018). Additionally, Giampetro also points out that efficiency assessments function solely as an output/input ratio with a lack of contextualisation of the assessment.

[Figure 2 near here].

Figure 1.3 - Total Energy Consumption: Non-Residential, Non-Industrial Buildings, Australia, 2009 to 2020 (PJ)

Source - pitt&sherry

Figure 2 'A baseline-energy-consumption-part_1-report' published by Department of Climate Change and Energy Efficiency showing an expected rise of total energy consumption of non-residential buildings by 24% between 2009 to 2020.
Thus, we propose to the readers of architectural science and built environment industry, a different perspective, away from current thinking that an energy efficient building is a well-performing sustainable building. We advocate moving towards a more-than-human perspective on understanding the performance of the built environment.

3. Post-Anthropocentric Built Environments and More-than-Human Futures

While the original premise of GBRTs is commendable, our review found that this approach towards understanding and measuring performance of the built environment is ill-fated. It does not provide a framework that guides the built environment industry towards the calibre of action necessary to combat climate change, and it does not sufficiently and adequately focus on addressing the existing building stock either. It appears that these shortcomings do not stem from low quality, data granularity, measurement accuracy, or uptake of any one GBRT, but a systemic problem with this positivist paradigm of framework overall.

While this is disheartening, it does not come as a surprise. The first World Scientists’ Warning to Humanity from 1992 has been largely ignored, and so far, appropriate actions after the second notice in 2017 have been scarce, slow, and inappropriate in comparison to the magnitude and urgency of the existential issues humanity faces in light of the climate emergency (Ripple et al. 2017). Light et al. have issued a strong call to action specifically for architecture and design (Light et al. 2017). Design plays a fundamental role in all human economic and industrial activities, and hence has a similarly fundamental role to play in preventing a planetary “ecocide” (Light et al. 2017; Light, Powell, and Shklovski 2017).

The architecture and design sector must be guided by the imperative to radically transition the built environment to a genuine state of sustainability. This requires more
than mere efficiency gains to be enacted. The guiding principles at the global and planetary level are set by the United Nations through the Sustainable Development Goals (SDG), all of which apply to the design of our built environments and not just Goal 13: *Take urgent action to combat climate change and its impacts.*

Additionally, and following on from the 2016 Paris Agreement, the latest assessment by the Intergovernmental Panel on Climate Change (IPCC) – the United Nations (UN) body for assessing the science related to climate change – was launched on 7 October 2018. It now requires the international community to limit global warming to 1.5ºC, which urgently requires far-reaching and unprecedented changes in all aspects of society with clear benefits to people and natural ecosystems.

In the Australian context, both ASBEC and NCCARF have been playing leadership roles guiding industry and government on a pathway towards a sustainable built environment in Australia. Already at the 2009 NCCARF Symposium, Randolph (2009) argued that the main barriers for the built environment sector to tackle climate change challenges include:

- A lack of focus that the built environment will need to be operating very differently if we are to make it more climate resilient;
- Retrofitting the existing urban areas to move towards more climate resilient outcomes;
- Attitudes and behaviours of households, businesses, public agencies, and recognising the role of pricing, incentives, regulation;

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5 [www.un.org/sustainabledevelopment](http://www.un.org/sustainabledevelopment)

6 [www.ipcc.ch/sr15](http://www.ipcc.ch/sr15)

7 [National Climate Change Adaptation Research Facility (www.nccarf.edu.au)](http://www.nccarf.edu.au)
• Fragmentation of jurisdictions, ownership, interest groups, and decision making.

While the body of work focussing on built environment mitigation and adaptation to climate change is growing, many approaches are largely hampered by trying to loosely fit within existing ‘business as usual’ approaches. In order to inform our discussion in the next section, here we want to introduce two alternative yet interrelated approaches to imagining a sustainable vision and future for the built environment and ways to achieve those: (1) net positive architecture, and; (2) more-than-human design. We have selected these from a range of visions that imagine more desirable futures on the premise of planetary survival, including sustainment (Fry 2003), cosmopolitan localism (Manzini 2009), transition design (Irwin 2015; Irwin, Kossoff, and Tonkinwise 2015), the Chthulucene (Haraway 2016), and prosperous descent (Alexander 2016), to name a few. For reasons of scope and focus, we will only interrogate net positive architecture and more-than-human design to discuss how their resultant ethical, legal, and methodological concerns can shape a new perspective on understanding the performance of the built environment. However, we encourage readers to investigate the aforementioned concepts and theories from studies in the Anthropocene in fields such as environmental humanities, STS, geography, planning and design, with a view to introduce them to architectural science and building performance studies.

3.1 Net Positive Architecture

Net positive (or eco-positive) architecture is being championed by Janis Birkeland (Birkeland 2002, 2007, 2014) and colleagues. Rather than implementing small
incremental improvements that render the impact of the built environment less bad for the planet, Birkeland is one of the foremost thought-leaders to outline what our aspirations for a truly sustainable built environment should be. Her vision recognises both the urgent need for a more radical transitioning of the built environment and the limitations of building codes that set only a minimum standard for compliance. Birkeland challenges the prevalent approach to designing the built environment for optimising GBRT assessment outcomes, which ‘treats nature as a resource rather than a living ecosystem(s), and aims only to minimise the net negative impacts on the environment’ (Birkeland 2007). Her call for ‘positive development’ demands that buildings and cities increase the ecological base as well as improve the economic and social health of surrounding regions in order to provide the infrastructure and space to improve ecosystem health and increase natural capital.

Beyond a net zero energy standard (Alawode and Rajagopalan 2019), Birkeland goes much further and advocates surpassing performance ratings in order ‘to increase the ecological base and improve human and ecosystem health without sacrificing space for human functions, amenity and life quality’ (Birkeland 2007, 2012). Instead of mitigating the bad, Birkeland exhorts us to strengthen and improve our ecologies and life support systems. While this genuine interpretation of sustainability for the performance of the built environment directly corresponds with the action imperatives set by the UN SDGs and the IPCC, it has not been explicitly translated into any of the prevalent GBRT frameworks – and we question whether the positivist paradigm would even allow it. Our review above showed that – at best – design considerations with direct impact on surrounding ecologies are sometimes addressed indirectly in other miscellaneous categories and lumped together with other landscape or site concerns. Ecological and social concerns should be mainstreamed in the core performance
criteria, however our review finds that – if at all – genuine sustainability values and liveable communities are assessed as separate rating tools and not in the main GBRT categories. One notable exception is the Living Building Challenge, which comes closest to responding to the UN SDGs and Birkeland’s call for net positive architecture. Yet, the LBC’s uptake is slow and not at a rate that meets the urgency climate action warrants.

3.2 More-than-human design

The second concept we briefly introduce here that promises to inform a better understanding of the performance of the built environment is the notion of the ‘more-than-human.’ A central notion in design and especially interaction design is the user, or – in the context of the urban – the occupant, resident or citizen. With the scope of interaction design widening in the advent of ubiquitous computing (Foth et al. 2011), urban interaction design emerged as a subfield focussing on cities and associated urban, suburban, peri-urban environments. This situatedness begs the question whether the ‘user’ – and thus ‘usability’ – require different contextualisations beyond the immediate and traditional design concerns of the user, that is, beyond usability (Huh et al. 2007).

While interaction design by now has a long tradition of engaging in questions and issues of environmental sustainability, these are by and large limited by the conventionally accepted usability paradigm, which usually positions responsibility with the user or the consumer (Johnson et al. 2017; Foth et al. 2009; Paulos et al. 2008). Dourish offers a useful critique and offers alternative approaches, such as the aim to design ‘technologies of scale making’ (Dourish 2010). More recently, Foth et al. suggested reframing usability towards citizen-ability in the context of smart urbanism and participatory citymaking (Foth 2018; Foth et al. 2015). Applying these propositions to the context of cities and the built environment, we argue that the lineage development
of the ‘user’ in urban interaction design – from resident, consumer, participant to co-creator – requires a further step and an additional hurdle to take. It requires us to question and reject human exceptionalism and embrace a post-anthropocentric approach to designing the built environment. Forlano describes this process as ‘decentering the human in the design of collaborative cities’ (Forlano 2016). Questioning humans as the exclusive inhabitants of the built environment allows us to consider a more inclusive and encompassing worldview. This post-anthropocentric perspective challenges us to re-think how user-centric design and architectural methods to build buildings can become more-than-human (Abram 1997) and using world-centric design methods (DiSalvo and Lukens 2011; Foth 2017; Giaccardi, Cila, et al. 2016; Giaccardi, Speed, et al. 2016; Luusua, Ylipulli, and Rönkkö 2017).

The more-than-human notion complements perspectives from other fields that consider ecological perspectives, such as the aforementioned concept of net positive architecture (Birkeland 2002), but also sustainable architecture (Vale, Vale, and Doig 1997), and sustainable living (Strengers 2013). These notions borrow from theories in the environmental humanities to investigate circular economy principles as well as the use of sustainable and regenerative materials in building design, and the implementation of sustainable processes such as not just energy conserving strategies but strategies to make net positive contributions with new building developments. As Forlano argues, the potential of post-anthropocentric design goes far beyond sustainable design, which focuses on fulfilling human needs with incrementally more sustainable products and services (Forlano 2016).

Despite this considerable body of work, the gap illustrated in Figure 1 remains in understanding if and how architects and designers can be supported to consider both human and non-human stakeholders such as natural entities and ecosystems as part of
the design process, thereby shifting the focus from creating an outcome that is seen as sustainable to rethinking human habitat as part of a much larger, a more-than-human, and more complex ecosystem of cohabitation (Clarke et al. 2019; Foth and Caldwell 2018; Smith, Bardzell, and Bardzell 2017). We argue that what is urgently needed to break out of the predominant paradigm of traditional, quantitative performance measurement frameworks is a serious consideration of more-than-human perspectives by offering a validated, more accessible urban design methodology. While this is easier said than done, in the next section we contemplate some of the barriers that prevent this goal from being reached, as well as some of the possible enablers we could recruit in a joint attempt to bring about and care for genuinely sustainable built environments.

4. Towards a More-than-Human Perspective

While the previous section introduced two concepts that are much more closely guided by the imperatives of the UN SDGs and the IPCC, we now turn our attention to examining and discussing the disconnect (Figure 1) between the prevalent genre of GBRTs and a new perspective on understanding the performance of the built environment. This different perspective requires us to refocus on what we value and changing how we value our environment and our complex entanglements with the planet’s ecosystems. Firstly, in refocusing on what we value, we want to draw attention to concerns that go beyond (1) technology and (2) big-data. Secondly, the changes in how we value our environment requires current understandings of the built environment’s performance to be re-thought in terms of (3) the law; (4) the design and architecture industry professions, and; (5) architecture curriculum and education institutions.
Digital technologies have precipitated a range of technocentric movements within urban development, manufacturing and construction industries such as smart cities, Industry 4.0, and Internet of Things. Implementation of digital tools such as CAD and Building Information Modelling (BIM) software, 3D scanning, virtual and augmented reality, digital fabrication and robotic manufacturing has improved efficiencies in the architectural process. Such efficiencies are in the documentation of architectural plans, integration of building services and engineering solutions, manufacturing of building components, novel and sustainable material creation (e.g. tall timber buildings) and use in construction.

These are positive outcomes of technology use in the architecture industry, however, there remain several technological affordances which are undervalued within the profession that have potential to create architectural responses that go beyond the use of technology for design and construction purposes. These include the use of digital tools and media to increase community engagement in urban planning and design (Caldwell and Foth 2014), document and understand post-occupancy evaluations across the longevity of a building’s life (Brand 1997), and assessing the impact of a building and its occupants on surrounding natural and built environments through sensors.

Designers must realise that performance standards or indicators are normally obtained through experimental data that allows for the development of equations and models based on assumptions, which are then, used for simulation, and optimisation where the goal of optimum or efficient or desirable levels could be decided by someone with a different set of ecological values. Some of these levels are determined by market forces (Cass and Shove 2018) or go on to determine a set of performance standards which may be achieved through checkbox rating instruments such as GBRTs.
Quantitative digital data cannot capture all aspects of life and the information obtained still requires qualitative user (architectural team) interpretation to address a variety of contexts.

4.2 More-than-Big Data

With the introduction of ubiquitous computing within the last 30 years, technology spread from computational analysis of geographic and spatial data in the 1960s (Foresman 1998) with the advancement of Tomlinson’s Geographic Information System’ (GIS) (Tomlinson 1969). Technology began spreading into all aspects of everyday life, giving us the ability to digitally record data thereof. Coupled with location-based services (GPS) and increasing computing power, internet bandwidth, storage capacity, widespread uptake, and all at decreasing cost, more and more data was available for analysis (Press 2013). Additionally, the types of sources of data – not just of interest to urban studies but also sociology, cultural studies, science – increased as well. Applications running on location-aware smartphones, particularly locative social media apps such as Foursquare and Facebook, produce a wealth of data that can give new insights into the urban condition (Gleeson 2014; Widmer 2015).

Fast forwarding to today, big data analytics is further strengthening the positivist paradigm of current building assessment tools where we can measure just about anything that can be counted, up to the macro scale of cities. The helicopter or bird’s eye view picture of the city rendered by urban big data analytics may be of higher fidelity than what was possible at the time of Robert Moses and Jane Jacobs in the 1960s. Yet, systemic limitations and issues remain, such as the questionable belief that instrumental rationality, quantitative methods, and technological automation will solve all our problems (Kitchin 2016; Foth 2018).
“Urban science has thus far failed to recognize that cities are complex, multifaceted, contingent, relational systems, full of contestation and wicked problems that are not easily captured or steered, and that urban issues are often best solved through political/social solutions, policy interventions, and citizen-centred deliberative democracy rather than technical fixes and technocratic forms of governance.” (Kitchin, Lauriault, and McArdle 2015).

Kitchin’s caution at the city level holds true at the building level as well where any new genre of performance framework for the built environment must go beyond a positivist big data focus and re-embrace the city or building as complex, culturally rich, ambiguous, dynamic, and diverse (Foth, Odendaal, and Hearn 2007).

4.3 Role of the law: Moral rights of nature

The call to shift to a more-than-human perspective to understanding building performance has often been relegated to cries of environmental activists or academics with lofty ideals. This required shift from an anthropocentric towards a more-than-human perspective is not merely moving the goal post but a fundamental repositioning of what we value when we affirm that a building is performing well.

Recent legislative events in Ecuador, NZ and in Australia in the past ten years have actuated a new platform for designers and architects to consider. In 2008 Ecuador’s embedding of the rights of nature into its constitution gives the people of that country the ‘legal authority to enforce these rights on behalf of the ecosystems’ (Global_Alliance_for_the_Rights_of_Nature 2019). In 2012, the Whanganui River in NZ became ‘a legal entity and have a legal voice under a preliminary agreement signed between the Crown and by Brendan Puketapu of the Whanganui River Maori Trust on behalf of the river’ (NZ_Parliament 2017). Similarly, the Ganga and Yamuna Rivers in India have also been given ‘the same legal rights as a person, in response to the urgent need to reduce pollution in two rivers considered sacred in the Hindu religion.’
These three legal cases imply that architects need to concern themselves with the ecological implications of their designs further than just the building site itself. This in turn, not only disputes the limited focus on energy efficiency of current GBRTs, it also earnestly questions the role of regulatory and policy reform in lifting the performance of the built environment.

4.4 Role of design industry leadership

Architecture is an expression of its time, and what we value as noteworthy today is revealed through the performance indicators we value in current design competitions. Competitions are usually seen as a stimulus for ‘the production of innovative proposals for technical and aesthetic solutions to design problems,’ but they also play a critical role in defining social values and opening up discussion on political and economic agendas, which directly impact on the built environment (Adamczyk et al. 2004).

In tandem with the traditional architectural prizes of Pritzker Prize and Architecture Gold Medals of several countries, some national architectural awards now include a category for sustainable architecture such as the Australian AIA Award (Aus_AIA_Award). The American AIA Committee on the Environment (COTE) Top Ten green awards celebrate projects ‘with exemplary performance data and post-occupancy lessons’ that demonstrate meeting its criteria for ‘social, economic, and ecological value’ (American_AIA_COTE). The Banksia Foundation Sustainability Awards (Banksia_Foundation_Awards) recognise an Australian individual or organisation’s efforts to meet the United Nation’s 17 Sustainable Development Goals.

International events can be significant catalysts for global awareness such as the World Expo created in 1851 in the Crystal Palace in London. After 150 years, ecological issues were brought to the forefront by the World Expo 2000 theme of Man,
Nature and Technology. The resulting manifesto – the *Hannover Principles: Design for Sustainability* drafted by architect William McDonough – comprised ten principles, the first of which was to ‘insist on the right of humanity and nature to co-exist in a healthy, supportive, diverse and sustainable condition.’ Unusually pertinent for its time, it further supported the more-than-human approach to design in Principle 5 where we were to ‘accept responsibility for the consequences of design decisions upon human well-being, the viability of natural systems and their right to co-exist’ (Hanover_Principles 2000).

Together with awards recognition and global event participation, leaders in national design institutes and global design communities need to articulate and enact guidelines, policies and prize expectations to direct architects and designers to aim higher in prioritising nature. There is currently no urgency to address diminishing biodiversity or overt reference to considering ecology in design or planning solutions. The AIA’s Sustainability Policy (Aus_AIA) urges action for climate change primarily through ‘reducing energy demand and increasing the energy efficiency of buildings’ with some reference to innovating practices and procedures that ‘move progressively toward a built environment that positively contributes to natural systems.’ However, it is hopeful that the architectural community will heed the AIA Environment Policy, adopted from the 1993 International Union of Architects ‘Declaration of Interdependence for a Sustainable Future,’ which recognises that ‘we are ecologically interdependent with the whole natural environment (…) [this] requires partnership, equity, and balance among all parties.’ (Aus_AIA-Edg).

4.5 Role of education

In the last decade there has been a growing understating of the role of higher education in developing a sustainability agenda for the built environment professions (Altomonte,
Rutherford, and Wilson 2014; Domenica Iulo et al. 2013), and most schools of architecture include sustainability principles in their curricula. According to Domenica Iulo, the approaches to sustainable education considers sustainability as: core value; technology domain (main focus on technology); choice, and; specialist knowledge. All approaches have benefits and limitations, and they are not mutually exclusive (Domenica Iulo et al. 2013).

In the USA the National Architectural Accreditation Board (NAAB, 2004), recommended that all architectural programs address ‘sustainable design’ as a student performance criterion. In Europe, the program EDUCATE (Environmental Design in University Curricula and Architectural Training in Europe) investigated the barriers and opportunities of implementing sustainability in pre and post profession education in architecture (Altomonte, Rutherford, and Wilson 2014). The project’s main findings are that education for sustainability should break away from traditional disciplinary compartments, especially the dichotomy between technical rigour and creative explorations. It also suggests there should be a better link between the education sector and the professional domain.

Finally, in Australia, the national standard of competency for architects, which underpins the accreditation of architecture education, provides a roadmap for the development of these competencies. Five knowledge domains including sustainable environment and social and ethical domains support the development of the competencies. The sustainable environment domain describes the role of the architect merely as ‘minimising’ the impact on natural resources (AACA 2019).

Sustainability education follows a technical, course-based approach from the specialist perspective, which still dominates most architecture programs (AACA 2019; Domenica Iulo et al. 2013). However, if we are going to move towards a more-than-
human perspective, education should move away from a reductionist thinking (Hes and Plessis 2014) towards a ‘culturally based approach from a generalist perspective which encompasses systems knowledge and interactions among many disciplines’ (Domenica Iulo et al. 2013). It is clear that the complexity of the problems we are facing in practice and education are beyond the capacity of any one individual, and as suggested by Buchanan (Buchanan 2012), education needs to move away from producing the solitary star architect and towards collaborators able to work together with specialists in the areas of design, psychology, engineering, health, biology, and ecology.

5. Conclusions

The more-than-human perspective on understanding the performance of the built environment advocates moving urgently beyond the focus on technology, human centredness, positivist quantitative analysis, and the singular entity of the building. The interconnectedness of building systems with human and ecological life systems is no longer a novel idea, so, the upholding of ethical values and positive and urgent actions to combat the climate emergency, protect biodiversity, and lead habitat stewardship should permeate all architectural design considerations.

The critical reflections this paper makes, hope to stir further debate and engagement by practitioners and scholars in the field. We critiqued building measurement tools such as GBRT and the use of big data for such measurements to contrast with the architectural aspirations of net positive and more-than-human design. With these insights, a new direction is advocated by considering the roles of the law, design industry leadership and architectural education. Grounded in a critical analysis and reflection, we highlight the shortcomings of the current GBRT genre to contrast with the bigger picture of protecting and sustaining planetary health.
For building performance evaluations to be tenable, sustainable design actions should include the production of regenerative materials and their embodied energies prior to use on building sites, in concert with post-occupancy evaluations of the building in operation for at least one year after completion. Current building performance assessments carry a predominance of energy efficiency over other concerns of human health or thriving biodiversity. To date, many certifications are for design predictions only and not for the actual performance of the building as per green design intentions. It is understandable that green building certifications originated with this intention to stimulate participation in this new concept in the 1990’s (LEED and BREEAM) and early 2000’s (AUS Green Star). After nearly 25 years of increased engineering expertise and building knowledge, it is timely to re-think the original premises in order to address exigent demands of climate change, diminishing biodiversity, and a planetary “ecocide”.

The call is not merely to shift the GBRT category weightings around to include ecology or liveable community design but to shift the very foundations from which we base our assessment. The aim of this article is not to provide another new evaluation tool but to provoke more reflective discussion within architectural and building science to generate stimulus in rethinking the current frameworks that we use to set our environmental targets. Shifting the basis for making design or business decisions from technocratic solutions to those based on more-than-human ecological values will yield a different kind of built environment – the kind that supports peace, prosperity, care, stewardship, equality, good human and ecological health, clean energy and water, and the other sustainable goals of the UN SDGs. A new understanding of building performance with this new perspective enables us to place people and ecology on a par in the sustainability equation.
Table 1: Weightings for four categories in select GBRTs

| Green Building Rating Tool       | ENERGY        | Human Health & Wellbeing | Human Values & Communities | ECOLOGY          |
|----------------------------------|---------------|--------------------------|----------------------------|------------------|
| LEED\(^9\) - US                 | min. 25%      | indirectly with IEQ      | N                          | Indirectly <10%  |
| BREEAM\(^10\) - UK              | min. 25%      | IEQ qualities             | N                          | Indirectly <10%  |
| Green Star\(^11\) - AUS         | min. 25%      | indirectly with IEQ      | Other Communities tool     | Indirectly <10%  |
| NABERS\(^12\) - AUS (is energy rating only) | 100%          | N                        | N                          | N                |
| PassiveHaus - Germany           | 100%          | N                        | N                          | N                |
| NetZero - US                    | 100%          | N                        | N                          | N                |
| CASBEE\(^13\) - Japan           | min. 25%      | N                        | Other Community Health tool | N                |
| BCA\(^14\) GreenMark - Singapore | min. 25%      | indirectly with Smart Healthy Buildings | 2 pts for Social Benefits | Indirectly <10%  |
| WELL\(^15\) - US                | N             | 100%                     | N                          | N                |
| Living Building Challenge\(^16\) | high          | high                     | high                       | Assessed under Place |
| *UN 17 Sustainable Development Goals\(^17\) | high          | high                     | high                       | high             |

* Although the SDGs are not a rating tool, they are a benchmark used here for comparison.

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\(^9\) Leadership in Energy and Environmental Design – USGBC (www.new.usgbc.org/leed)
\(^10\) Building Research Establishment Environmental Assessment Method (www.breeam.com)
\(^11\) Green Star rating - Green Building Council of Australia (www.new.gbca.org.au/green-star/)
\(^12\) National Australian Built Environment Rating System (www.nabers.gov.au/)
\(^13\) Comprehensive Assessment System for Built Environment Efficiency (www.ibec.or.jp/CASBEE/english/)
\(^14\) Building and Construction Authority (www.bca.gov.sg/greenmark/green_mark_buildings.html)
\(^15\) International WELL Building Institute (www.wellcertified.com/)
\(^16\) LBC-International Living Future Institute (www.living-future.org/lbc/)
\(^17\) United Nations 17 SDG (www.un.org/sustainabledevelopment/sustainable-development-goals/)
Table 2: Ecology concerns embedded within other criteria in select GBRTs

| GBRT                     | Energy | Ecology listed in other category | Other credit criteria listed together with Ecology                                                                 | Breakdown of Ecology criteria                                                                 |
|--------------------------|--------|----------------------------------|--------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| LEED                     | Y      | Sustainable Sites                | 1. Construction Activity Pollution Prevention  
2. Site Assessment  
3. **Protect or Restore Habitat**  
4. Open Space  
5. Rainwater Management  
6. Heat Island Reduction  
7. Light Pollution Reduction | **Protect, Enhance, and Restore Biodiversity and Ecosystem Services:**  
1. Local Biodiversity, Habitat Protection and Open Spaces  
2. Global Biodiversity, Habitat Protection and Land Preservation  
3. Sustainable Use and Management of Ecosystem Services |
| BREEAM                   | Y      | Land Use and Ecology             | Detailed check list for:  
1. Site Selection  
2. Ecological value of site and protection of ecological features  
3. Minimizing impact on existing site ecology  
4. Enhancing Site Ecology  
5. Long term impact on Biodiversity |                                                                                                                                               |
| Green Star Design and As-built | Y      | Land Use and Ecology 22pts       | **Ecological Value 3pts**  
To reward projects that improve the ecological value of their site  

**Sustainable Sites 3pts**  
To reward projects that choose to develop sites that have limited ecological value, reuse previously developed land and remediate contaminated land | 1. Endangered, Threatened or Vulnerable Species  
2. Ecological Value  
3. Reuse of land  
4. Contamination and Hazardous Materials  
5. Heat Island Effect Reduction |
| Green Star Performance 2018 | Land Use and Ecology 6pts | Ecological Value 3pts | Groundskeeping 3pts |
|--------------------------|--------------------------|----------------------|---------------------|
|                          |                          | To recognise practices that preserve the ecological value of an occupied site and enhance its natural diversity |
|                          |                          |                      | To encourage environmentally sensitive landscape, hard surface and building exterior maintenance practices that reduce environmental impacts and improve ecological value |

| Green Star Communities | Environment 29pts | Integrated Water Cycle 7pts | Greenhouse Gas Strategy 6pts | Materials 5pts | Sustainable Transport and Movement 3pts | Sustainable Sites 2pts | Ecological Value 2pts |
|------------------------|-------------------|-----------------------------|-----------------------------|----------------|----------------------------------------|------------------------|----------------------|
|                        |                    | 1.                          | 2.                          | 3.             | 4.                                     | 5.                     | 6.                   |
|                        |                    | 7.                          | 8.                          | 9.             |                                        |                        |                      |
|                        |                    | 1.                          | 2.                          | 3.             | 4.                                     |                        |                      |
|                        |                    | 5.                          | 6.                          | 7.             |                                        |                        |                      |
|                        |                    | 8.                          | 9.                          | 10.            |                                        |                        |                      |

| BCA GreenMark - Singapore | Indirectly affected through Urban Harmony (10pts) | Sustainable Urbanism 5pts | Integrated Landscape and Waterscape 5pts |
|---------------------------|---------------------------------------------------|--------------------------|------------------------------------------|
|                           |                                                    | 1.                        | 2.                                       |
|                           |                                                    | 3.                        | 4.                                       |
|                           |                                                    | 5.                        | 6.                                       |
|                           |                                                    | 7.                        | 8.                                       |
|                           |                                                    | 9.                        | 10.                                      |

| Living Building Challenge | Place   | Limits to Growth | Urban Agriculture | Habitat Exchange | Car-Free Living |
|---------------------------|--------|------------------|-------------------|------------------|-----------------|
|                           |        | 1.               | 2.                | 3.               | 4.              |

1. Operational requirements for Biodiversity  
2. Natural Biodiversity  
3. Site Maintenance Procedures  
4. Landscape  
5. Hard Surfaces and Building Exterior  
6. To encourage and recognise projects that enhance the ecological value of the project site  
Designing for a building’s humancentricity looks at how its presence can coexist in harmony with its surrounding context and positively impact the movement and comfort of the people in its neighbourhood.
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