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Future Cities—City Futures
Emerging Urban Perspectives

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EMERGING URBAN PERSPECTIVES

FUTURE CITIES—CITY FUTURES

Christian Veddeler
Joran Kuijper
Michal Gath-Morad
Iris van der Wal
(Eds.)

TU Delft OPEN

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Emerging Urban Perspectives

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TU Delft OPEN Publishing, Delft University of Technology, The Netherlands

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Future Cities—City Futures
Emerging Urban Perspectives

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FUTURE CITIES—CITY

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Preface—by the Research Sponsor

Helmut Hentrich Foundation

Werner Sübai

What will our cities look like in the future? This question has occupied the minds of architects and urban planners since the beginning of dwelling. In 1950, only 30 per cent of the world's population lived in cities; by 2050, the equivalent figure is expected to be approximately 68 per cent. For cities in developing countries, the forecasted number even reaches 85 per cent.

'The architect must permanently broaden his or her horizons'; this quote by Helmut Hentrich, the founder of HPP Architects, forms the basis of the Helmut Hentrich Foundation's founding purpose. Starting from this understanding, the reason for the Foundation to support Future Cities and City Futures is to further a research project that engages in the discourse of designing and developing future cities and to document and make accessible the findings in a comprehensive book publication.

It is important for the Helmut Hentrich Foundation to help meet the prevailing challenges of future cities in an interdisciplinary discourse and gain valuable insights into what trajectories of future changes for the city, urban space, and architecture are possible, and how such scenarios could translate into planning and implementation practice. For this

← Cycleslangen, Copenhagen (photograph by Rasmus Hjortshøj).

purpose, a research brief was developed at the Architecture Faculty of Delft University of Technology that addresses complex questions of continuously progressing urbanization and its associated challenges. The various contributions to the book address topics including demographic developments, global climatic change, and steadily progressing digitalization in the context of sustainability goals, CO_2 neutrality, ESG compliance, and the forthcoming European taxonomy. Academics, practitioners, planners, architects, researchers, and scientists face major challenges in this discourse. The room for maneuvre and the timeframe for transformation and implementation need to be defined. The more that efficient opportunities for solutions can be identified, demonstrated, and implemented, the more effectively can noticeable and positive impacts on the future of cities and on urban life in balance with the environment be achieved. In line with the Helmut Hentrich Foundation's focus on fostering discourse, this publication presents various contributions that have emerged from a transdisciplinary exchange that address the complex challenges that future cities are facing. It provides ideas, observations, and considerations for urban life and the built environment of past, present, and future, including urban design and the positioning of architecture within knowledge- and experience-based discourse, and it juxtaposes perspectives from academia and practice. It addresses change, development, and innovation, and it bridges from ideas to the articulation of solutions, both analogue and digital, for inclusive, sufficient, sustainable, and desirable urban futures. Since the early 1970s, we have known from the Rolling Stones that time waits for no one. So, in the spirit of Bob Dylan, it is time to actively listen and to catch some answers blown by the wind.

Werner Sübai is member of the Board of Trustees of the Helmut Hentrich Foundation, Architect, and Senior Partner of HPP Architects GmbH

Preface—Glancing into Future Cities—City Futures

Roberto Cavallo

← Stad van de Toekomst/ City of the Future Biennale Session on September 21st, 2018, Architecture Biennale Venice (photograph by Jutta Hinterleitner).

A few weeks ago, during an information meeting at the Faculty of Architecture, Delft University of Technology, a group of master students asked me what we mean by City of the Future, which is also the name of a multidisciplinary graduation laboratory we offer to students of various master tracks. My response to them was that from my point of view, City of the Future can't be simply a byword for futuristic depictions of the city. This isn't to say that portraying the future is not an interesting matter, but to me the main concern is, above all, transitioning the city of today and its inhabitants toward the future. I'm talking about cities in which development and transformation must be intertwined with equable and simultaneous consideration for economic, ecological, and social aspects. To achieve this, the ambitions of the city and strategic approaches are required to include people's prospects. Next, and especially because our society is confronted with ever-increasing complexity, to tackle the challenges of today and the future, we are expected to bring together professionals and academics of different disciplines and engage with various institutions and citizens (Cavallo & Lucente, 2019).

Bearing in mind these issues, we embarked on the Stad van de Toekomst/City of the Future design research project. Initiated by the Royal Institute of Dutch Architects and the Delft Deltas, Infrastructures & Mobility Initiatives, the project foresaw the collaboration with the Dutch Ministries of Infrastructure and Water Management and Internal Affairs, the Delta Metropolis Association, and the five largest cities in the country: Amsterdam, Rotterdam, The Hague, Utrecht, and Eindhoven. Each city designated a 1 × 1 km transformation area to be analyzed, researched, and designed by two interdisciplinary teams of architects, city planners, urbanists, engineers, sociologists, geographers, and visionaries: in total ten teams of professionals (Berkers et al., 2019). Besides participating as researchers, we immediately decided to join the initiative with educational activities allowing students of various master tracks to team up and work jointly on the same locations, establishing an interplay with the professionals. This has been a very fruitful experience for the students and for us too: a remarkable way of interplaying research and design (Harteveld & Cavallo, 2019). In the meantime, the book Stad van de Toekomst/City of the Future has been published, and the project has become a prime example to follow and has attracted attention and praise throughout academic, professional, and institutional networks.

I was therefore delighted when the Helmut Hentrich Foundation approached me expressing interest in this topic. In fact, the main purposes of the Helmut Hentrich Foundation, such as supporting talent, broadening architects' horizons, linking research and practice, and boosting interdisciplinary approaches, are very much in line with the key subjects addressed by Stad van de Toekomst/City of the Future. And it is by following this common thread that the research collaboration under the name of Future Cities—City Futures has started. Looking at the results accomplished by the Future Cities—City Futures research and brought about in this volume, I'm thrilled to see that the messages

enclosed in our contribution to Stad van de Toekomst/City of the Future have spread fruitfully at the international level and been embraced by several scholars and colleagues. Without any doubt, many aspects addressed by the Dutch experience are further developed and elaborated in this book in extremely interesting dimensions, in turn creating new opportunities to reflect on urban environments' futures.

Roberto Cavallo is Associate Professor, Chair of the group of Architectural Design Crossovers, Head of Section Theory & Territories, Department of Architecture, Faculty of Architecture and the Built Environment, Delft University of Technology

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Acknowledgements— City Futures—Future Cities

This book is the result of research on future cities that started in 2019 at the group of Architectural Design Crossovers, Department of Architecture, Faculty of Architecture and the Built Environment, Delft University of Technology. A research brief on future cities was given in a Master Elective Design Studio in Architecture & Urban Design titled 'Future Cities—City Futures' in early 2020. This brief then provided a foundation for a series of research and design exercises held as part of a multidisciplinary studio that linked research and design themes from the group of Architectural Design Crossovers with the collaboration of the Chair of Urban Design at the Faculty's Department of Urbanism.

Initially, we sought to investigate the evolution of future cities and the consequences of various future scenarios on urban and building morphologies. Unexpectedly, the emerging COVID-19 pandemic boosted our research and education in this area to key relevance. In response to these canonical events, we have expanded our original research agenda to include cross-disciplinary emerging urban perspectives from researchers reflecting on the urgent and overarching challenges and opportunities that cities were, are, and will be facing. *Future Cities—City Futures: Emerging Urban Perspectives* is the outcome of this transdisciplinary discussion. The book begins from foregoing research conducted at

← Sandkaj, Copenhagen (photograph by Rasmus Hjortshøj).

Architectural Design Crossovers group, including the publication *De stad van de toekomst* (Berkers et al., 2019). Five main research trajectories were distilled from its chapter *The City is Never Finished!* (Harteveld & Cavallo, 2019) as inspiration for the five sections of this book.

We would like to thank the design studio coordinators Roberto Cavallo from the group of Architectural Design Crossovers and Maurice Harteveld from the Chair of Urban Design, and the studio tutors Boudewijn Almekinders, Johan van Lierop, and Steven Steenbruggen. The environment for research and discussion that you provided has made an invaluable contribution to this book. We also thank all the participating students for their contribution to the associated design studio: Anne Leltz, Anne van den Berg, Bethany Kiss, Chaewon Yoo, Floor van Dedem. Gabriele Caradonna, Gerjan Agterhuis, Ilse van den Brink, Isabel van Ommen, Izk K Chan, Jamie Taal, Jan Houweling, Jasmijn Ponssen, Kevin Hollander, Lukas Kulikauskas, Maciej Górz, Maciej Król, Mihaela Tomova, Monique Monique Vashti, Peishan Zhang, Phoebe McGuire, Roos Jeronimus, Sabine de Groot, Sawa Wadi, Sorawit Pattarasumunt, Te Zang, and Wenda Andryani.

The research trajectory at Delft University of Technology's group of Architectural Design Crossovers and the editorial of this book have been generously supported by the Helmut Hentrich Foundation. We wish to express our deep gratitude to its members, including Werner Sübai, Gerhard Feldmeyer, and Joachim Faust, for their encouragement.

We are also thankful for the fruitful collaboration with the publishing team, Frédérique Belliard and Just de Leeuwe of TU Delft OPEN Publishing, the university publisher of Delft University of Technology. Their beneficial input, ideas, and suggestions have greatly improved the quality of this volume. And we owe our special thanks to Simon Milligan, who took on the strenuous task of style and language editing. His valuable editorial suggestions have improved the consistency, language, and readability of each chapter. Simon has helped to unite a diverse collection of contributions into a coherent book without sacrificing the characteristics of individual inputs. We extend our sincere gratitude to Lola Ben-Alon of Columbia University, Graduate School of Architecture, Planning and Preservation (GSAPP) in New York City, for providing a peer-review. We would also like to thank Christoph Hölscher and the Chair of Cognitive Science at ETH Zürich for enabling two members of our editorial team, Christian and Michal, to meet, collaborate, and discuss ideas for this book.

Finally, we thank our esteemed authors, and our photographer, Rasmus Hjortshøj, for contributing so diligently to this book. Thank you for your commitment, effort, and expertise, as well as your patience during the editing phase, which took longer than expected. Without your dedication, this book would not have been possible.

Christian Veddeler
Joran Kuijper
Michal Gath-Morad
Iris van der Wal

Amsterdam and Cambridge, April 2023

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INTRODUCTION
[OVERVIEW AND PROLOGUE]

INTRODUCTION [OVERVIEW AND PROLOGUE]
INTRODUCTION [OVERVIEW AND PROLOGUE]
INTRODUCTION [OVERVIEW AND PROLOGUE]

Words by the editors

Overview—Emerging Urban Perspectives

Christian Veddeler
Joran Kuijper
Michal Gath-Morad
Iris van der Wal

← Park Play, Copenhagen (photograph by Rasmus Hjortshøj).

The global COVID-19 pandemic that started in late 2019 has affected the ways in which cities are perceived. The sudden standstill of urban life raised the question what the pandemic's impact will be and how it affects the way cities are used, designed, and built. Inspired by recent events, this book provides a platform for critical discussion on alternative visions of urban futures.

In the recent crisis, cities all over the world experienced numerous lockdowns, travel bans, and some of them curfews aimed at flattening the epidemic curve. These mitigation measures resulted in various side- and after-effects, including restrictions in the use of the city, its public spaces, and infrastructure, with exceptional social and economic implications. The crisis has changed personal lives, living environments, and the urban realm as such: social distancing and remote work have fundamentally affected the way cities function and where and how people work, play, learn, and live. Fundamental characteristics of city life, such as proximity, density, and accessibility suddenly became its Achilles' heel: cities turned into infection hotspots where the virus was most transmissible and thus threatened the health of citizens, societies, and humanity.

‘A city is a pattern in time. No single constituent remains in place, but the city persists.’

John Holland. Hidden order: How adaptation builds complexity (1995, pp. 1–2)

The pandemic crisis uncovered the vulnerability of today’s cities to disease and at least momentarily raised serious doubts regarding their resilience, as entire neighbourhoods, in particular business districts, were abandoned overnight. Offices, shops, restaurants, schools, libraries, theatres, and museums were closed. Photographs of cities such as the ‘The Great Empty’ series by The New York Times in spring 2020 (Kimmelman, 2020, March 23) showed empty streets, abandoned city squares, and dwindling public transport. This created a sudden awareness and lasting impression of how the perception of cities was transformed radically and how rigorously everyday urban life was impacted.

Undeniably, the urban crisis brought about by the recent pandemic has revealed and exaggerated many urban challenges that predated it and were apparent beforehand. Beyond its immediate urgencies, the crisis offers both opportunity and impetus for engaging again in fundamental discussion about future cities and city futures.

This book provides a platform for transdisciplinary discourse between urban designers, architects, and researchers to re-envision the future of cities in light of the challenges and opportunities presented by the recent pandemic.

So, what does the future hold for cities worldwide?

A return to a pre-pandemic status quo (Alraouf, 2021) seems illusory and even naive. The question what is a new normal, a now normal, or a next normal, even if overused as expressions, remains highly relevant, as it fuels the prevailing debate on urgent challenges that cities are facing, whether instant or fundamental, temporary, or long-lasting, imposed, amplified by the virus or pre-existing.

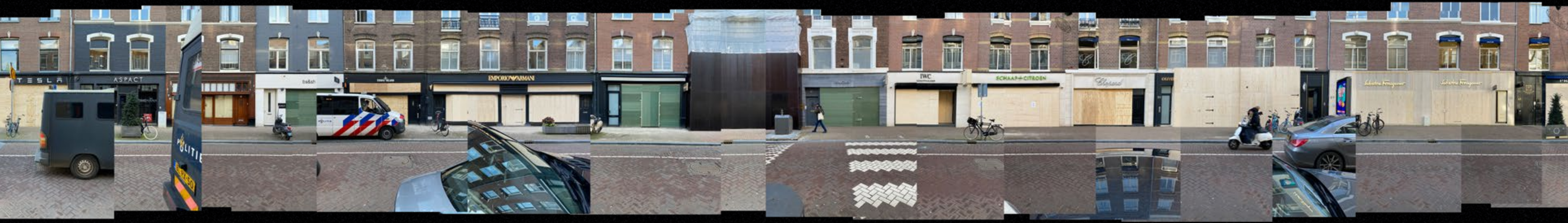
Aside from the challenges presented by the recent pandemic, cities increasingly face unprecedented pressures of globalization, expanding urbanization, demographic shifts, and environmental concern as identified, for instance, in the United Nations report (UN, 2018). Cities must accommodate

[West]

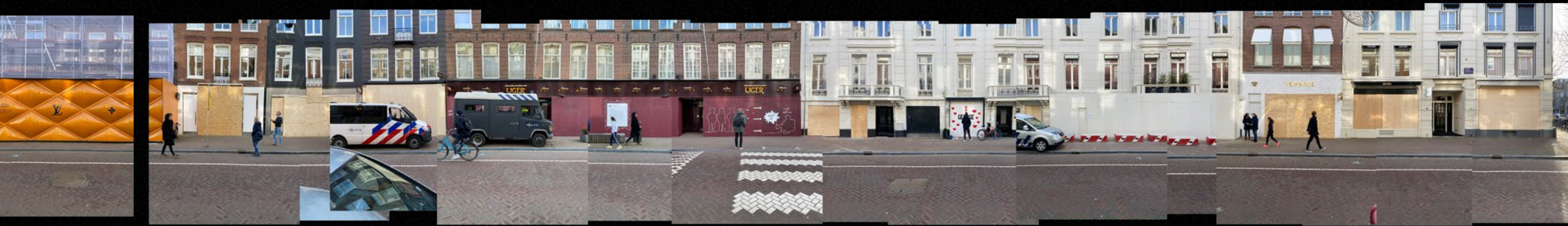
P.C. HOOFTSTRAAT (NORTH SIDE) AMSTERDAM, THE NETHERLANDS
P.C. Hooftstraat, Amsterdam, in lock-down on January 31st 2021. To prevent vandalism and destruction by riots that took place in that neighbourhood at that time, the closed luxury stores transformed into temporary fortresses.

[East]

Photographs by Christian Veddeler, edited by Joran Kuijper



[East]



P.C. HOOFTSTRAAT (SOUTH SIDE) AMSTERDAM, THE NETHERLANDS

[West]

Photographs by Christian Veddeler,
edited by Joran Kuijper

a growing population and at the same time reduce pollution, waste, and the depletion of scarce resources and energy. Cities must position themselves in a competitive global market (e.g., Florida 2008; Glaeser 2011) and reflect the possibly conflicting agendas of the many stakeholders and interests involved (Batty, 2018).

Given the many challenges that cities are confronted with, the prediction of what urban futures will be like seems tempting, yet remains largely erratic. Instead of future prediction, attempts to identify and understand fundamental urban problems as factors driving urban change deserve full attention. The evaluation of scenarios of possibility, plausibility, and probability allows the exploration of a range of urban conditions and opportunities that enable the invention of alternative and desirable city futures.

A question central to this book is how to face these challenges while providing and safe-guarding positive outcomes, concerned with the improvement of the quality of urban life: How can future cities be made more liveable, sustainable, and resilient? How can cities continue to provide a wide range of opportunities for all necessities of life?

To tackle these complex questions, the book includes a collection of 25 chapters written by 37 emerging voices in urban design and research. Together, they contribute from a diverse spectrum of interest, expertise, academic disciplines, and practice. They approach the built environment from a sociocultural, respectively socioeconomic perspective, from the viewpoint of urban policy and public health, with environmental concerns for urban sustainability and circularity in mind, and through the lens of urban computer and data science, providing a take on urban digitalization and transformation of cities into 'smart' cities. Together, their contributions reflect the complexity and diversity of challenges and opportunities underpinning future cities.

Future Cities—City Futures intends to be a platform for transdisciplinary urban discourse. The book chapters are grouped around five overarching themes, introduced in an overarching prologue. Each theme has a separate section →

PART 1 ***THE KIND OF PROBLEM A CITY STILL IS***
[COMPLEXITY]
addresses the phenomenon of complexity in cities, urban success throughout human history, qualities, strengths, advantages, and the pressures, challenges and threats cities are facing.

PART 2 ***LOCATION, LOCATION, LOCATION***
[PROXIMITY]
identifies the importance of proximity of place and people. It discusses both urban and social constituents such as proximity, density, and accessibility as main drivers of urban life.

PART 3 ***CONTRADICTION AND COEXISTENCE***
[DIVERSITY]
looks at the make-up of diversity in cities and addresses equity and inclusion, inequalities, affordability, and tendencies to segregation and gentrification.

PART 4 ***GROWTH AND CHANGE***
[DENSITY]
emphasizes how density forces development and shapes cities.

PART 5 ***FORM AND PERFORMANCE***
[INGENUITY]
questions urban ingenuity and addresses the technological urban shift from a linear to a circular economy and a predominantly material to a digital world.

The introductory prologue below firstly provides the overarching context of the five parts of the book. It connects the individual book chapters to past and present discourse on seminal urban research and practice. The prologue does not aim to provide a systematic literature review. Instead, it introduces a short overview of selected urban positions to provide a context and introduction to the book's transdisciplinary discussion on cities:

Secondly, the prologue briefly introduces the individual research trajectories provided in the book's chapters in sidenotes. We hope that the juxtaposition of established urban theories and research with the emerging perspectives in the individual authors' chapters establishes a foundation from which to discuss fundamental urban questions:

How can the city's resilience be improved in current and future crises?

How can the city be made future-proof?

How can future cities become more healthy, sustainable, prosperous, enjoyable, safe, and just?

How can the quality of future urban life be improved?

What kind of cities do we want to live in?

Notwithstanding the high degree of complexity and uncertainty inherent in attempting to answer such questions, this book is not about the prediction of the future. Instead, it aims to define the conditions that future cities would need to meet and to envisage a range of scenarios for possible, and possibly desirable, city futures.

To gain a better understanding of the challenges and opportunities of future cities, the book presents a multiplicity of research trajectories that go far beyond the core concerns of urbanism. The transitional conditions between

and interdependencies of inhabitant and habitat, society and environment, and physical and virtual domain allow speculation about inclusion, diversity, initiative, participation, and quality of life.

The aim of this book is to collect and contrast a unique and open-ended array of individual perspectives, insights, observations, ideas, research, strategies, inventions, and solutions that are all critically engaged with several dimensions of future cities and city futures.

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Prologue—Future Cities—City Futures

Christian Veddeler
Joran Kuijper
Michal Gath-Morad
Iris van der Wal

> 'Cities, like dreams, are made of desires and fears, even if the thread of their discourse is secret, their rules are absurd, their perspectives deceitful, and everything conceals something else.'
>
> *Italo Calvino. Invisible Cities (1978, p. 44)*

PART 1 THE KIND OF PROBLEM A CITY *STILL* IS *[COMPLEXITY]*

The title of this section is taken almost verbatim from the last chapter's title of Jane Jacobs's *The Death and Life of Great American Cities* (1961, pp. 428–448). Our addition of the word 'still' emphasizes the relevance of revisiting Jacobs's arguments in today's context. In her critique of the functionalist city, she argues for the recognition of complexity in urban planning instead of providing generalized and oversimplistic solutions. Jacobs states that urban planners misunderstand a city when they tend to deal with problems of simplicity, jumping to easy conclusions

← Asakusa, Tokyo (photograph by Rasmus Hjortshøj).

and only paying attention to reducing the number of variables while disregarding many others. In her words, 'cities happen to be problems in complexity' (Jacobs, 1961, p. 433); she proposes understanding the city as an intricate process rather than a physical object. Thus, city planning must deal with such systems in which the collective behaviour of its parts entails the emergence of characteristics that can hardly, if at all, be inferred from the properties of the parts (CSS, 2022). In the words of Rittel and Webber (1973, p. 160), this complexity is characterized by its 'wicked problems'. They are 'ill-defined', contain confusing or contradictory information, complex interdependencies, and the conflicting values and interests of diverse actors, stakeholders, and decision-makers. Rittel and Webber (1973, ibid.) emphasize that such 'wicked problems' are difficult to solve, as there is no single solution. Outcomes are not about right or wrong but rather about better and worse.

The design of future cities should take account of complexity as it continues to be central to the problems of cities accelerated by various drivers, such as globalization, demographic development, and environmental and health concerns.

Tamara Streefland in Chapter 1 reflects on complexity by imagining our urban lives in 2050.

In Chapter 2, Jolijn Valk presents a broad vision of the city as a growing field for biodiversity and cultural diversity.

Recent figures for demographic development indicate massive global urbanization that continues to go hand in hand with sizable demographic growth. UN Habitat (2020) expects that the world population of currently 8 billion people (UN Habitat, 2022, November 15) will increase to 9.5 billion by 2050 and will peak at almost 11 billion in 2100. From 1900 until today, the global population has risen fivefold, not least because the average lifespan has also doubled (Zakaria, 2020). Currently, 55 per cent of the world's population lives in cities. With urbanization expanding at its current rate, this proportion is expected to increase to approximately 68 per cent by 2050 (UN Habitat, 2020). In other words, by 2050 no less than 6.3 billion people will live in urban areas, in comparison to merely 2.3 billion in 1990 (UN, 2018). Not only the scale but also the pace of the development is unprecedented and best illustrated by comparing the current figures to historic ones: In 1800 only 3 per cent of the significantly smaller world population lived in urban areas, but this number increased to 14 per cent in a century and to 30 per cent by 1950. Extrapolating the present growth rate, at least theoretically, full urbanization would be reached by 2100 (Florida, 2008).

Urbanization is not only characterized by demographic growth but also by migration between continents, countries, regions, and cities: Batty (2018, p. 19) denotes the historic change of the last two centuries as a transition from a 'non-urban to an urban world': This, in his words, is a complete transformation of human habitat from 'rural to urban' and from 'local to global'. Different parts of the planet certainly are confronted with different intensities of urbanization. In the Western world, in Europe and North America in particular, urbanization is saturating. While still moderately rising, it will peak within the next 30 years alongside the demographic decline of ageing societies (Zakaria, 2020). Developing countries are and will be the main contributor to the rapid increase of population, associated urban growth, and the continued rise of megacities with populations larger than 10 million (Baklanov et al., 2016).

As of today, cities provide 80 per cent of the world's GDP (UN Habitat, 2020). Cities also contribute significantly to ecological damage, as the process of urbanization continues to have significant adverse effects on the environment globally with air and water pollution, biodiversity loss, soil degradation, deforestation, global greenhouse gas emissions, and climate change as consequences. Even though urbanized areas account for less than 2 per cent of the planet's surface, cities consume 78 per cent of the world's energy (UN, 2022b) and are largely reliant on fossil fuels. They produce more than 60 per cent of global greenhouse gas emissions (ibid.). Cities also account for an estimated 50 per cent of global waste (OECD, 2022).

The rapidly increasing rate of urbanization and population growth will intensify this tendency. The physical expansion of cities not only requires exceptional efforts but will create enormous pressures on scarce resources, such as land, raw materials, and energy, which might reach beyond the planet's environmental capacity (Raworth, 2017).

Consequently, questions of both urban sustainability and resilience play a fundamental role in the design of future cities. The Brundtland report (1987, n.p.) provides a compelling definition of sustainability as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. Due to the vast and enduring impact of urbanization, the challenge of enabling sustainable urban life is essential. Goal 11 of the United Nations' Sustainable Development Goals (UN, 2022a) consequently addresses sustainable cities and communities. Central socioeconomic targets are inclusion, safety, and diversity. Positive environmental impact aims at resource efficiency, mitigation, and adaptation to climate change. The UNEP (2022) addresses the strong link between the quality of urban life and natural resource management, as higher resource efficiency correlates with greater productivity and innovation.

Another focal point of attention is urban resilience to unforeseen calamity. The United Nations Office for Disaster Risk Reduction (UNDRR, 2022, n.p.) defines resilience as 'the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management'.

Due to the high concentration of people, cities are particularly vulnerable to the consequences of climate change, natural disasters, and the spread of disease (UNEP, 2022).

As witnessed during the recent COVID-19 crisis, cities are affected by the spread of contagious disease. Epidemics and pandemics are not part of cities' history but today's

In Chapter 3, Cresci, Galeazzi, and Von Richthofen discuss the challenges of urban decarbonization.

urban reality. The recent events have exemplified the ostensible symbiosis of urban concentration and infection spread (Salama, 2020). Martínez and Short (2021) use the COVID-19 pandemic to describe urbanization as an accelerant of infection and cities as target-rich environments for virus transmission. The cities considered most efficacious in combining both dense concentrations of people and global connectivity have proven to be especially vulnerable to disease transmission. Their main competitive advantage of local and global proximity also bears at least one major disadvantage (Rode, 2020).

Bola Grace addresses the relationship between population health and the built environment in Chapter 4, titled 'Heart, Health, Habitat', discussing societal and built-environmental factors of health, equity, and inclusion.

Pilosof, Oborn, and Barrett in Chapter 5 discuss the impact of future cities' hybrid healthcare systems across physical and virtual environments.

So far, pandemics have not eradicated the city from existence. Instead, the most recent has become a catalyst for urban change (Mir, 2020). Past responses to pandemics have significantly influenced both the conception and shape of cities.

For the last two centuries, urban development was driven by engineering efforts to make cities healthier and to improve the quality of urban life (Sennett, 2018). Next to the establishment of medical institutions such as hospitals, the introduction of underground sanitary infrastructure and water treatment facilities provided the foundation for better hygiene.

The establishment of zoning codes and building regulations above ground were established to safeguard the reduction of overcrowding and pollution and the improvement of air circulation and daylight access (Bereitschaft & Scheller, 2020). Such initiatives improved public health and reduced the risk of contagious disease significantly. Until recently, the Spanish Flu of 1918–1920 was the last global pandemic.

The question is whether to expect longer lasting effects on the city induced by COVID-19. The sudden awareness of vulnerability to airborne disease has resulted in a considerable change in people's behaviour. Salama (2020) describes the socio-spatial implications of such impact: driven by the immediate threat of the disease, measures for social distancing and the widespread introduction of remote working have led to the general avoidance of face-to-face contact and proximity, formerly perceived as essential prerequisites of urban life.

Working from home caused dispersion, disaggregation, and both physical and social fragmentation (Harris et al., 2016). Consequently, it has led to abandoned offices, entire business districts closing, deserted streets and public spaces, and a decline in the use of public transport. Concerns for public health, expressed through social distancing measures, lockdowns, curfews, and travel bans, have outweighed the former pull of cities and have diminished their associated benefits. Simultaneously, nonurban lifestyles in geographically dispersed locations outside of dense cities have suddenly gained attractiveness (Lennon, 2021).

In Chapter 6, Els Verbakel uses the work of her students to illustrate 'cities of the new real' and discusses the relationships between physical space, synchronous time, virtual space, and asynchronous time.

As a matter of course, such change not only reflects issues of changing urban morphology but also raises environmental concerns; city densification is recognized as an environmental strategy consistent with reducing the ecological footprint of cities in contrast to low-density urban sprawl (UN, 2015). At least temporarily, COVID-19 caused a conflict of city densification and measures for mitigating the pandemic. Environmental protection and public health valued opposite ends of the spectrum of concentration of people in cities.

It is unlikely that this dilemma will last, given the less severe impact of the latest COVID-19 variants. Also, there is evidence that connectivity and living conditions, rather than urban density, are related to the COVID-19 infection rate over time (Hamidi et al., 2020). The argument that COVID-19 is a driver of 'dis-urbanism' (Aidarova & Aidar, 2021), the exodus of population from cities to dispersed areas, with the knowledge of today, seems to have been no more than a short-lived phenomenon.

In contrast, the accelerated adoption of digital tools during the pandemic and the lasting hybridization of knowledge work might persist and affect both the city and citizen behaviour profoundly. Remote working, telecommuting, video conferencing, cloud-based collaboration, online learning, shopping, and social media entertainment are unlikely to disappear with a fading pandemic. Until recently, the benefits of urban living in human proximity outnumbered its disadvantages of high prices for buying and renting property (Beddoes, 2020, June 11). The change that remote work introduces is significant, as living close to a place of work appears less relevant and no longer seems to be decisive in determining where to live (Shenker, 2021, March 26). Will the fundamental change of commuting patterns between work and home have a lasting impact on the city's form and function, as Batty (2021a) suspects? Will this new 'geography of work' (Florida, 2021) change the value of urban locations profoundly in favour of remote working and living in cheaper suburbs—or even outside of cities (Bereitschaft & Scheller, 2020)?

Will this lead to a permanent decline in office demand and drag down urban life alongside retail amenities, cultural institutions, and public transport? Or is the city resilient enough that, despite the disruption that COVID-19 caused, the appreciation of the complexity of urban life and its associated benefits are here to stay?

‘If the environment is visibly organized and sharply identified,

then the citizen can inform it with his own meanings and connections.

Then it will become a true place, remarkable and unmistakable.’

Kevin Lynch. The Image of the City (1960, p. 92)

PART 2 LOCATION, LOCATION, LOCATION] *[PROXIMITY]*

Harold Samuel, the founder of Land Securities, the largest commercial property development company in the UK (Frangoul, 2017, March 2), is deemed responsible for having coined the expression ‘location, location, location’ (Safire, 2009, June 26), which emphasizes the role of location in determining the value of a building: This prevalent catchphrase highlights the value of proximity in urban real estate.

To explicate, urban economics identifies the importance of proximity to production and consumption and its association with spatial concentration and density. Quigley (2006) describes the mechanism of agglomeration effects and states that spatially concentrated economic activity is the key force that brought cities into existence.

← Sendai (photograph by Rasmus Hjortshøj).

In his book *Inventing Future Cities*, Michael Batty (2018) describes cities as progressions of such aggregation, with urban form and organizing structure resulting from intricate negotiation and decision-making of many stakeholders over time: therefore, cities have evolved constantly. Urban agglomeration enabled the specialization of labour, the surplus production of food, goods, and materials, trade and markets, and the acceleration of technology and science (Lynch, 1954).

The economic power of proximity, according to Jacobs (1969) is based on grouping, pooling, and division of labour. Density, accordingly, becomes both a prerequisite and advantage of cities and a stimulus for economic activity (Sennett, 2020). Growing density reflects the evolutionary progress of cities, with the number of possible human connections and opportunities growing in parallel to the size of cities (Batty, 2018). The trade-off between the benefits and costs of density is best explained with population concentration increasing due to the attractiveness of a city, and rising pressure on higher housing and land prices (Duranton & Puga, 2020). Marshall (1920) rationalized the advantages of economic agglomerations for the development of cities originating from access to goods and services, pooling of skilled labour, and the exchange of information, knowledge, and skill: Face-to-face contact enables social interaction, local cohesion, and trust building in geographic proximity. Even 'weak ties' in large-scale and informal but localized urban networks have proven to be strong, because the manifold connection to relative strangers in cities provides wider access to opportunities and ideas (Granovetter, 1973).

Spatial competition for location, in relation to transportation costs, is no less than the trade-off of proximity and distance, utility gains, and cost savings of transportation and production. The German agriculturalist von Thünen (1826), first identified the economic rationale of the benefits and costs of proximity by considering land use and densities around the central market of an agrarian town. High transport costs for

In Chapter 7, Filipa Pajević investigates the impact of pandemic-driven changes in the function and valuation of physical workspaces in real-estate markets.

both goods and people forced production to take place near that market and the residences of workers. Consequently, cities traditionally have grown around spatially centralized economic activity: Land and real estate property closer to the centre is more valuable and produces higher land and house prices, rents, intensity of land use, and densities (Batty, 2018). From centre to periphery, the spatial distribution of household income typically decreases (Quigley, 2006).

To explain the continuous and accelerated evolvement of cities as preferred human habitats, Edward Glaeser in *Triumph of the City* (2011) and its sequel *Survival of the City* (Glaeser & Cutler, 2021) emphasizes the phenomenon of proximity as the main driver of urban agglomeration and its main function: To connect people. Urban density enables face-to-face interaction and social and economic exchange. Being more than spatial systems of location and geometry, cities enable community, dynamic collaboration, creativity, commerce, and entrepreneurship. Despite the pervasive availability of long-distance travel and telecommunication, physical proximity among people spurs the creation of ideas, ingenuity, innovation, and progress, because 'cities magnify humanity's strengths' (Glaeser & Cutler, 2021, p. 249). Therefore, cities have become the most attractive environments for the growing majority of people to live in. Driven by proximity and density, cities provide opportunities for interaction, exchange, and development. Moreover, they offer access to the necessities of life, including housing, employment, markets, health care, services, technological advances, information, knowledge, education, social, cultural, or religious life, communities, rights, security, stability, and predictability (Etezadzadeh, 2015).

From a neuropsychological perspective, Mavros, Olszewska-Guizzo, and Makowski in Chapter 8 discuss social density, crowdedness, perceptions, people's responses to their built environment, and the relevance of their findings for urban design.

Nevertheless, cities are confronted with significant challenges caused by this much-acclaimed proximity. Glaeser and Cutler label such downsides the 'demons of density' (2021, p. 5): These include shocks, stresses, pressures, and the threats that face cities. The inventory of ills includes crime, congestion, pollution, and obviously disease. Furthermore, fierce competition in a dense and expensive housing market leads to gentrification and segregation. Urban inequality consequently drives social tensions and possibly conflicts.

In Chapter 9, Achilleas Psyllidis discusses design strategies for urban health and well-being by revisiting proximity, walkability, and accessibility.

In line with von Thünen (1826), Harris et al. (2016) suggest that the cost of distance has historically determined the location of production, consumption, work, and life: the avoidance of cost related to transportation led to the local concentration of workforces, facilities for mass production, employment options, goods, and services, in the logic of economies of scale. However, technological progress in transportation and communication led to a significant reduction in shipping and travel costs for materials, goods, people, and information while increasing the speed to bridge ever-increasing distances. The nineteenth- and twentieth-century inventions of electrified transport and commuting with buses, trams, trains, and later the private motor car, increased travel radii and resolved the problem of productivity at a distance. Subsequently, the value of proximity was reduced (Batty, 2018): 'Distance got replaced by travel time, telecommunication eliminated both' (p. 123).

Technological advances in transport and communication technology allowed people and goods to be moved over space and time. This had a significant impact on the demand for physical proximity in cities and urban structure (Krugman, 2011). Shipping and commuting led to the dispersion of the population out of city centres (Batty, 2018). Decentralization, had a radical effect on urban structure and produced car-dependent suburbanization and urban sprawl. Deindustrialization shifted production to the service sector. It reduced dependency on specific sites and the city centre, which was no longer the sole midpoint of economic and cultural activity (Hernández-Morales et al., 2020).

The arrival of digitally-based services seems to make the site redundant more generally. Moving information has become more important than transporting people and goods (Harris et al., 2016). While in the nineteenth century the cost of transport collapsed, in the twentieth century this was the case for communication. Today, with widespread availability of communication technology, we witness near zero cost for digital transport of goods and services (Zakaria, 2020) and 'near zero marginal cost for digital production' (Raworth, 2017, p. 191).

Considering the impact of economic globalization on marginalized shipping costs and offshoring production, Saskia Sassen in 'Locating Cities on Global Circuits' (2005) challenges the historic relevance of location from a global perspective. As cities are parts of nonlocal interaction, the categories of physical proximity, built density, and the locality of urban space, she argues, appear negligible. Cities are rather embedded in large, complex, and globally distributed networks that are characterized by 'deterritorialisation', 'dematerialisation', and 'digitisation' (Sassen, 2005, p. 145). Translocal 'tunnel effects' (Ascher, 1995) describe how geographically distant but technologically interconnected global metropolises prefer highly developed communication networks over the immediate proximity, scale, and form that local binding would offer. Marshall McLuhan's notion of the 'global village' (1962) anticipated communication technology that allowed a globally universally connected humanity. Building on that idea, futurist Alvin Toffler (1970; 1980) foresaw the facility of 'electronic cottages' as dispersed future workplaces of telecommuting, with the home, and not the city, as the centre of society. The parallel of recent COVID-19-induced experiences of remote working at global scale seems to confirm Toffler's forecast.

Not only since the recent pandemic, a central question for the development of future cities is whether technological progress is the driver of the devaluation of physical proximity. With the internet and information technology emerging, The Economist in 1995 proclaimed the 'Death of Distance' (Cairncross, 1995, Sept 30). Due to the insignificant costs of participation within both universally accessible and global networks of information and communication, trade, and transport, in Cairncross's argument, distance becomes practically irrelevant.

Leamer and Storper (2001) object to that perspective. Despite the dispersion of transportation and communication with the low costs of commuting, shipping, and digitally transmitting information, they claim that physical proximity is becoming more relevant rather than less: The ever more specialized division of labour, in their argument, requires both face-to-face interaction for meaningful and long-term relationships and the spatial concentration of economic activity enabling purposive coordination and collaboration.

Glaeser (2011, p. 61) coins this ostensive contradiction 'the paradox of the modern metropolis': even with significant reductions in cost, time, and effort for connecting across distances, urban location remains critically important. Glaeser and Cuttler (2021, p. 196) insist on the 'sticking power of cities': In their argument, the benefits of physical adjacency and face-to-face contact as main advantages for socialization and collaboration in the long term outperform any advance in technological communication. Similarly, Florida in *The Rise of the Creative Class* (2002) and *Who is your City?* (2008) emphasizes the importance of both physical location and proximity as a consistent driver of innovation and economic growth. He outlines the phenomenon of a 'spiky world' (Florida, 2008, p. 15) in a pictorial illustration of local peaks of economic resources, activity, ingenuity, and concentrations of creative talent. He states that the aggregation of high-level economic activities takes place only in a select number of global metropolitan areas. This view contrasts with the image of a globalized and equal opportunity 'flat world', which is free from specific geography, as coined by Friedman (2005). Local 'clustering', according to Florida (2008, p. 19), is a key driver of economic activity: It results in

local concentration, and connection of people, productivity, creativity, and talent. As such talent is mobile and privileged in choosing where to live, cities that are attractive, competitive, and offer opportunities peak, while cities without these characteristics do not.

Gia Jung in Chapter 10, titled 'Cities and love', presents an original perspective on generative design as mapping of human values in cities.

The value of location therefore is characterized by its relation to space but also to time: It is both the properties of physical place that matter and the intensities and qualities of dynamic interaction among its inhabitants (Batty, 2018).

‘But the city is not, cannot and must not be a tree.’

Christopher Alexander. A City is not a Tree (1988, p. 84)

PART 3 CONTRADICTION AND COEXISTENCE

[DIVERSITY]

In *The Death and Life of Great American Cities*, Jane Jacobs (1961) vigorously articulates her critique of modernist city planning and urban renewal as a severe oversimplification of the city as a seemingly functional system doing no justice to the complexity and diversity of human life. Her critique addresses the ‘functional city’, as initially proclaimed by the ‘Charter of Athens’ (CIAM, 1933), that dogmatically coupled decentralization, reduced density, and separation of activities through designated urban zoning. The division of areas of living and working improved access to space, light, and air but created low-density, monofunctional urban sprawl outside of the traditional city.

Dalia Munenzon in Chapter 11 highlights the relevance of urban commons as a remedy to urban, social, and environmental vulnerabilities.

Instead of universally planned, mono-functionally zoned cities, standardization, repetition, and monotony, Jacobs (1961) advocates urban planning in open-ended processes that are gradual and small-scale. She argues for dense and diverse neighbourhoods and for preservation: The integration of a variety of uses and users appropriately reflects human behaviour and the social composition of communities that, in her words, are fine-grained, mixed, and connected. Lively public spaces and walkable streets, squares, and parks nourish the participation and engagement of citizens

← Nørreport, Copenhagen (photograpgh by Rasmus Hjortshøj).

in their communities. Jacobs maintains that in well-functioning cities, enrooted residents as a matter of course exercise social control with their 'eyes on the street' (ibid., p. 35). This implies not only crime prevention but identification, care, and trust.

Jacobs (ibid.) critizises the codified functionalist plan, that according to her argument, only appears to be rational but in fact is deterministic in nature, and engages in formalistic simplicity. Built on the logic of division of labour, functionalism favours simplicity over diversity and combines top-down control, economies of scale, standardization, and mass production. It applies Taylor's 'principles of scientific management' of 1911 (Taylor, 2004), which rationalize the division of elements of work, and of work and responsibility. The division of labour processes into standardized tasks that are separated from management supervision became the basis for control, increased productivity, and efficiency. The rise of the factory and the office alongside their geographical separation from residential areas for workers drove urban segregation into zones for production and habitation. In alignment with Taylor's management logic, the spatial separation and specialization of home life from work life became industrial urban reality (Zakaria, 2020): Synchronized life would alternate between two geographical poles in the rhythm of the assembly line. Physical separation of material and intellectual work, labour, and capital (Lefebvre et al., 1996), and of different social classes (Sennett, 2018) was reinforced. Not only did the division of labour enable the introduction of a functionalist structure of cities; it also established social divide (Harvey, 1989).

Read (2005) exposes the orthodox agenda of functionalist planning as ideologically, spatially, and socially normative and exclusive because it treats the city as an 'instrument of social betterment, efficiency and hygiene' (p. 12). Functionalist cities therefore fail to allow for diversity: for inclusion, heterogeneity, and the intricacy and thus complexity and contradictions of urban experience (Venturi, 1966).

In Chapter 12, Brendon Carlin presents an original attempt to describe architecture's capacities to empower inhabitants, within specific forms of order, social relationships, and forms of life that are produced through the design, construction, use, and maintenance of architecture, technology, and infrastructure.

As of today, many cities are still overzoned, monofunctional, and therefore inflexible. Urban buildings mirror the city's spatial and temporal separation of uses and users: of life, work, production, and consumption (Ratti & Claudel, 2016). Marc Augé (1995) explains this phenomenon in his reflection on 'non-places', where the homogeneous and anonymous functionality of commerce, transit, or leisure entails compliance of their users imposed by formalized rules. Limited operation hours exemplify the production of temporarily used buildings that follow the logic of modern labour (Sennett, 2005). Planning for standards and mono-functionality restricts adaptability for alternative uses. It produces overdimensioned, unsustainable, and for most of the time largely vacant urban buildings, infrastructures, and districts. The result is severe underutilization of such resources as land, energy, material, and capital.

This effect became clearly visible during the unexpected COVID-19 crisis, with entire central business districts abandoned in lockdown, becoming practically useless overnight. The obvious shortcomings of the functionalist city are substantiated by the fact that it could not adapt to the complex problems that confronted it. This seems to confirm Harvey's (1989) statement that when a city does not allow contrast, fragmentation, discontinuity, heterogeneity, and difference, it becomes vulnerable to the reality of diversity, and both persistent and abrupt change.

Referring to Hilberseimer's paradigmatic Hochhausstadt project of 1924, Christopher Alexander in *A City is not a Tree* (1988) identifies the shortcomings of the functionalistic urban plan in relation to the complexity of human life. He criticizes the simplicity of the 'artificial city', which is deliberately structured as a closed and static system. Its 'nested hierarchy', which is defined as a 'tree structure', separates the city into zones, functions, and units. This, in his argument, is in sharp contrast to the reality of overlapping hierarchies in social networks, better defined as a 'semi-lattice' structure. Planning the city according to the rigid logic of a hierarchical tree structure forbids any diversity, ambiguity, or multiplicity: The richness of urban life.

Colin Rowe and Fred Koetter in *Collage City* (1978) address modernist urbanism's socio-spatial dilemma. In their book's chapter the 'crisis of the object' (pp. 50–85), they formulate the problem of little variation and differentiation achieved by the porous structure of the modernist city plan and the mechanical array of similar architectural objects: The ambiguous relationship of these objects and the open space that surrounds them results in largely undefined public space. The lack of scaling boundaries and spatial contrast impedes peoples' orientation and the notion of belonging. The hierarchical order of buildings and infrastructure, instead of spatial and social cohesion, segregates unrelated environments. Excessively available but underutilized and therefore anonymous open areas do not function as public urban spaces but as separators of territory (Rowe & Koetter, 1978). Abandoned green areas between buildings, typically uninviting for public use, discourage spontaneous and informal interaction and lack a sense of ownership. The identification of city users with such space remains fragile.

Wolf Mangelsdorf emphasizes the importance of quality of urban life instead of merely urban form in Chapter 13 titled 'Wechselwirkungen: Rethinking urban planning and densification'.

As the space between is neither public nor an attractive destination for residents, it becomes a distance to bridge between city functions, described by Sennett (1977, p. 14) as 'vector space'. The open space misses the fine grain that Jacobs (1961) considered essential for public space to function. Accordingly, it is weak, unattractive, hostile, and therefore largely neglected. The private domain of housing units cannot compensate for the fundamental lack of urban life. Spatial zoning consolidates both the spatial and social segregation of home and work and the disintegration of urban life (Sennett, 2018).

By contrast, Sennett (ibid., p. 241) emphasizes the importance of the 'experience of a collective life' in creating community. He argues that cities must accommodate the complexity of human life, which is full of contradictions and ambiguities. Public space here is essential to enabling diverse and meaningful social encounters. It must be as useful for the individual, the local, and the stranger, as it is for communities, all engaged in different ways of living that coexist in the city (Lefebvre et al., 1996). The public space of the city must therefore provide a variety of form and flexibility of functions that allow contrasting social and cultural identities to meet and engage.

Pietrostefani, Dabaj, and Boano in Chapter 14 elaborate on rethinking spaces of exchange for future cities. Using the example of Beirut, they illustrate the relevance of urban thresholds that enable social activities and self-supporting local neighbourhoods.

Schreiber and Carius (2016) identify such interaction as a precondition of urban sociability to prevent socioeconomic polarization and spatial segregation. For Sennett (2018), the experience of complexity and diversity substantiates urban virtues of learning to live with strangers of different lifestyles and ethnic and class backgrounds.

Social distancing, remote work, and unparalleled restrictions in the use of public space during the COVID-19 pandemic abruptly demonstrated how vulnerable urban life is in the public domain. The restriction of access to public space has limited direct face-to-face contact between strangers (Sennett, 2020). Martínez and Short (2021) suggest that the inaccessibility of public space particularly for lower income groups was detrimental, due to lack of alternatives: Having limited private space at their disposal for collective interactions, inaccessible public space led to loss of social intimacy.

With a focus on cognition, Michal Gath-Morad, highlights the importance of choice for architectural and urban design of active and healthy built environments in Chapter 15.

Sharon Yavo-Ayalon reflects on New York's sidewalks as a lively public space in Chapter 16 and the impact of COVID-19 on public space and urban life.

The increasing privatization of outdoor and green spaces (Scott, 2020), and conditions of work reinforced social inequalities, as spatial and social polarization do interrelate (Honey-Rosés et al., 2020). The fact that social distancing and remote work, was not feasible for essential workers, and the 'face-to-face economy' (Glaeser & Cutler, 2021) additionally not only made evident the imbalance in the exposure to disease infection of manual and mental labour (Sennett, 2020); it also exaggerated social divides (Harvey, 2020).

The COVID-19 pandemic thus unveiled the exclusive nature of remote work, the importance of public space for urban society in general, and the vulnerability of deprived parts of urban society to exclusion from these. It amplified existing conditions of growing inequality, social exclusion, and spatial segregation (Glaeser & Cutler, 2021).

‘What is real is the continual change of form: form is only a snapshot view of a transition.’

Henri Bergson. Creative Evolution (1911, p. 301)

PART 4 GROWTH AND CHANGE

[DENSITY]

Cities are confronted with constraints related to globalization, demographic development, environmental concerns, and technological advance that require strategies to steer, facilitate, and shape transformation. Expanding urbanization at unprecedented scale increases pressures on cities to cope with constant adaptation and change. Regarding cities not as static objects but as dynamic processes (Jacobs, 1961), as described above, provides both opportunities for urban evolution and threats of urban stagnation and decline.

With a focus on urban morphology, Batty (2018) describes how the growth of cities is characterized by two opposing directions of progression: Outward expansion and inward densification. While expansion identifies growth in size outside of the existing city, densification means development of vacant areas and existing structures from within. The forces that drive urban growth into densifying city centres, sprawling suburbs, or polycentric clusters (Batty, 2021b) vary.

As described above, urban proximity and agglomeration effects have traditionally attracted development towards city centres. Pulled by a market, ‘centripetal forces’ (Glaeser, 2011) concentrate economic activity. This causes densification and concentric growth around the heart of cities. In the

← Addis Abeba (photograph by Rasmus Hjortshøj).

logic of such urbanizing forces, the closer a location is to the centre, the more valuable it is. Push forces in the opposite direction drive expansion of cities into the surrounding land. At the periphery of cities, they cause dilution of urban activity and have a significant impact on the morphology of the traditional city. Batty denotes such a development outward growth (2018, pp. 136–143), where 'centrifugal forces' (Glaeser, 2011) unevenly diffuse spatial distributions of economic activity and population. The push of dispersed natural resources, in particular cheap and available land, attracts building development away from the inner city. The trade-off for lower land prices is the greater distance of sprawling 'edge cities' (Harvey, 2000, p. 8) from the city centre, resulting in de-agglomeration and fragmentation of the city. Outward urban growth is often characterized by urban sprawl, low-density building, monofunctionality, homogenous form, and dependence on commuting by private car to connect the urban fringe with the city centre.

Enabled by ever-increasing transportation facilities and dominated by the private motor car since the twentieth century, peripheral city expansion equals suburbanization. Both urban sprawl and its attendant dependence on infrastructure are resource intensive and consume vast amounts of land, raw material, energy, and capital. As infrastructure is often dimensioned for peak hours, it provides overcapacity most of the time. It is financed by taxpayers' money but only used selectively, which consequently entails that development of cheap suburban land is subsidized by public funds (Downs, 1999). Hardin (1968) defines such a phenomenon as a 'tragedy of the commons', where public goods and resources are overexploited by individuals to satisfy self-interest but are depleted for all. Furthermore, the environmental costs of suburbanization are significant: Sprawl and its associated infrastructure and commuting cause unsustainable levels of congestion, emissions, and pollution. Originally seen as an opportunity of liberation from overcrowded and high-priced city centres, suburbanization has often caused urban decline (Batty, 2018). Concurrently with the prevalence of the private motor car and building of transport infrastructure, in the twentieth century a massive urban exodus took place from the city's traditional centre to its outskirts (Glaeser & Cutler, 2021). In parallel, urban de-industrialization led to factory jobs vanishing. Glaeser (2011) summarizes accordingly the two indications of 'bad cities': urban sprawl from an environmental perspective and urban exodus from an economic one. Despite its negative impact on city centres, for a long time, urban sprawl became the unchallenged blueprint for modernist urban planning. In most global cities, it remains the dominant model of growth (Batty, 2018).

Since the last quarter of the twentieth century, instead of propagating only outward growth, some planning initiatives have shifted towards models compacting existing cities. To revitalize neglected city centres, the development of brownfield sites is preferred over greenfield expansion. The promotion of urban public transport and restrictions on private car use aim to reduce congestion and make redundant traffic infrastructure available for repurposing (Moreno et al., 2021). Inward growth (Batty, 2018, pp. 144–151) not only aims to restructure city centres but also implies reconcentration and the reintroduction of urban activities, proximity, and density.

Upward growth (Batty, 2018, pp. 151–161) implies vertical densification of urban space: the introduction of inner-city high-rise buildings significantly intensifies the use of land while exploiting the value of its central location. Whereas this building typology was previously reserved for commercial uses, urban business districts, and satellite cities of mass-housing projects, nowadays mixed-use and residential functions have become a vital driver of high-rise development in central urban areas.

Next to its positive social and economic impact, densification is instrumental in minimizing the urban ecological footprint, to support the achievement of climate goals and to enhance urban resilience (UN, 2015). Compacting cities helps reduce the energy and resource consumption for buildings, infrastructure, utilities, and transport: The use of shared amenities is intensified, and travel distances in compact cities are shorter and may be walkable or bikeable. Commuting time and congestion is significantly reduced. The decline of carbon emissions and pollution is beneficial for the quality of sustainable urban life. Following these arguments, upgrading existing urban areas through re-urbanization and increased densification is preferable over the creation of entirely new cities. Resource-intensive urban sprawl can be limited, and for this reason, massive infrastructure can be reduced.

However, the downsides of the density described above exacerbate a problem many cities have: The excessive costs of inner-city housing make urban life unaffordable for large parts of a city's population. Even if the recent COVID-19 pandemic temporarily diminished the attractiveness of dense city centres, the more affluent population continues to prefer city centres over suburbs. Consequently, popular urban areas face segregation and gentrification while the city periphery experiences disaffection and social decay (Harvey, 2000). The report 'Cities of Tomorrow' (EU, 2011) identified how safeguarding the quality of urban life through provision of and access to education, work, and affordable housing is essential to avoid social seclusion.

In Chapter 17, Sabine Georgi and Tobias Just reflect on urban growth and transformation from a real-estate perspective, identifying challenges for cities, existing properties, public spaces, and transport infrastructure.

Glaeser (2011) explains that the excessive costs of inner-city property and rent are caused by a market mismatch of high demand and low supply: Wherever restrictive zoning limits the usability of land, increased building density and height, and mixed-use functions, project development is constrained. He argues that rigid rules for monument protection, even if comprehensible from a preservation perspective, maintain the status quo: Both restrictive zoning and preservation cause stagnation of new building, increased scarcity, housing market competition, excessive housing costs, and thus segregation of those who cannot afford to live in the city. He summarizes this dilemma: 'If cities can't build up then they will build out. If building in a city is frozen, then growth will happen somewhere else' (ibid., p. 163).

Marvin Bratke provides a response to development pressures from an on-demand society. His case studies in Chapter 18 illustrate solutions for more resilient and adaptable urban environments, co-creation, co-ownership models, and platforms for circular planning.

In addition to the three growth models described above, the idea of polycentric cities has recently gained momentum with the notion of self-sufficient and compact urban neighbourhoods within metropolitan areas. The most prominent example, the 15-Minute City by Carlos Moreno (Moreno et al., 2021), propagated a shift from the monocentric city to a city of 'urban villages'. As part of Paris's urban renewal programme, Paris en Commun, the 15-Minute City, or in French la ville du quart d'heure, provides proximity, density, diversity, and accessibility: Mixed-use zoning allows diverse urban functions to be juxtaposed. Short travel distances, preferably by foot or bike, enable convenient access to all essential urban functions, including living, working, commerce, healthcare, education, and entertainment.

The model's emphasis on proximity offers both higher quality of urban life and ecological sustainability. It both promotes social interactions and citizen's participation and it aims to break car dependence, traffic congestion, and pollution and reduce areas for parking in favour of pedestrian-friendly streets.

In Chapter 19, Hannah-Polly Williams develops a three-pillar framework for characterizing a sustainable city driven by low emissions, purposeful urban planning, and equitable distribution.

The 15-Minute City obviously revisits concepts presented by Jane Jacobs (1961) of urban life in New York's Greenwich Village in the 1960s as an example of a vital urban community. However, to avoid becoming a victim of its alleged success, the 15-Minute City model must cope with the risk of segregation and gentrification (Florida, 2021): A critical question is therefore how to ensure even distribution and fair accessibility of attractive urban functions over various 15-minute neighbourhoods and how to guarantee free access and exchange across diverse neighbourhoods. Glaeser (2021) warns that the dictates of market prices will drive the concentration of appealing functions towards privileged enclaves that will remain unaffordable and therefore inaccessible for lower-income groups, thus fuelling inequality and social, economic, and geographical divides.

‘The chief function of the city is to convert power into form,

energy into culture, dead matter into the living symbols of art,

biological reproduction into social creativity.’

Lewis Mumford. The City in History (1961, p. 571)

PART 5 FORM AND PERFORMANCE

[INGENUITY]

The increasing demand for larger, denser, more inclusive, fairer, more sustainable, resilient, healthier, smarter, and more meaningful urban environments fundamentally challenges the existing conception of the city and its utilities, infrastructure, transport, and buildings. The key issue for the high-performance cities postulated is their function in a continuously changing environment: Moraci et al. (2020) address the central question of how to ensure the future city's positive environmental, economic, and social impact.

A claim frequently heard is that urban development needs to become ‘smart’. This often implies a shift in perspective from material to digital city networks and from material to virtual city space. Digital tools and the integration of both physical and digital infrastructure have made valuable types of information available for the first time in the history of the city. This information allows new insights into patterns of

← Yokohama (photograpgh by Rasmus Hjortshøj).

urban behaviour and performance. The interrelationship of function and use and the real-time alignment of demand and supply couples citizen and city, inhabitant and habitat (Harrison & Donnelly, 2011). The smart city becomes a 'complex eco-system' (Picon, 2015, p. 81) in which digital and physical worlds meet and life-cycles of growth and change develop.

As often stated, the smart city aims for the provision of urban solutions to advance synchronization, efficiency, predictability, safety, and security. Thus, it addresses environmental and social sustainability to improve urban resilience, comfort, and the quality of life (Gassmann et al., 2019; Gath-Morad et al., 2017): The application of smart technology allows control of city performance in stages of planning and in use. This provides a largely untapped source of information to improve decision-making in design, planning, building, and city operation. Data and technology are leveraged for better use of resources, assets, and services, and to empower the participation of citizens, providing for current and future needs of the city population.

In Chapter 20, Samsurin Welch discusses digital disruption and the future city and looks at building resilient cities to adapt to the combined threats of COVID-19 and climate change.

However, such bold promise can be both vague and audacious, because speculation about hybrid forms of analogue and virtual cities is challenging. The shift in attention from the built environment's form to its performance (Batty, 2018), alongside 'the change from atoms to bits' (Negroponte, 1995, p. 4), emphasizes once more understanding the city as a dynamic and interactive process rather than a static built object, this time stressing information as its driving force.

The tension between virtual and physical domains has the potential to drastically change cities' functions and eventually their form, appearance, and the behaviour of their inhabitants. 'Ubiquitous computing' (Weiser, 1994) makes available technologies, such as the internet of things (IoT), cloud computing, artificial intelligence (AI), big data, blockchain, and a digital twin, a dynamic virtual model of the city (Harrison & Donnelly, 2011).

In Chapter 21, titled 'Urbanizing smart cities', Laura Narvaez Zertuche develops a concept of urban artificial intelligence that highlights the relevance of active citizen participation and social and spatial intelligence instead of a primary focus on technology alone.

In Chapter 22, Argota Sánchez-Vaquerizo and Zurera Gómez discuss the complexity of smart cities' sociotechnical systems with a focus on design and use of space with urban digital twins.

The smart city therefore consists of both the physical city and its digital twin. Sensors integrated into buildings, utilities, vehicles, and devices, allow ubiquitous detection and measurement of both conditions and performance of any smart object in its vicinity (Alfa et al., 2018). A strong network with fast transmission capabilities, large bandwidth, and high data capacities interconnects these sensing objects and enables 'machine-to-machine communication across physical space' (Ratti & Claudel, 2016, p. 30) within IoT infrastructure and a unifying cloud computing platform. Urban data is collected and processed in real time. AI performs algorithmic big data analysis (Majumdar, 2018): Data patterns are detected and prediction models provided and simulated for performance assessment. The digital twin allows evaluation and automatic execution or, alternatively, provision of information for human decision-making (Ratti & Claudel, 2016). Self-learning and evolving systems facilitate feedback loops and iterative improvements. Superimposed onto the built environment, such a setup allows perpetual detection of patterns of user behaviour and measurement of urban conditions and performance. With 'atoms and bits joining forces' (Picon, 2015, p. 58), city life-cycles of production and consumption can be synchronized to match real-time supply and demand of critical necessities and services for urban life.

Accordingly, access to and utilization of assets, resources, materials, and energy supplies can be improved and environmental impact reduced by avoidance of emissions, pollution, and waste. Real-time alignment of supply and demand has the potential to improve urban efficiency throughout. Efficient building activity, use, maintenance, and recycling of physical assets can be enhanced.

The integration of life and work in place, and in time can diminish the vulnerability of monofunctional and underutilized districts and building types (Harrison & Donnelly, 2011). Instead of segregation, the integration of users and uses facilitates the provision of multifunctional facilities that are flexible, adaptable, and shared. This includes complementary urban functions, such as decentralized production of food and fabrication of goods. Smart buildings and smart homes are enabled to reflect the needs of their users and accommodate diverse lifestyles.

Buildings, infrastructure, utilities, and vehicles can also be equipped with technology that enables their operation as 'prosumers' (Gassmann et al., 2019, p. 16) within a power network, not only consuming but also providing local renewable energy production and storage. Autonomous and electrified mobility can be shared and made available on demand. There is the potential to replace the traditional car and to return valuable space to the public that currently is dominated by individual traffic.

The life-cycle stages of buildings of design, construction, operation, maintenance, repair, rebuilding, and recycling are anticipated, and can be monitored and improved. As part of the circular economy, buildings will serve as material storage for future construction. Valuable resources tagged with material passports will be digitally traced throughout their life-cycles enabling their specific reuse and recycling.

The inclusion of city stakeholders in the smart city enables citizen access and participation, engagement, influence, and empowerment (Ratti & Claudel 2016). The use of smartphones provides individual access to the city: augmented reality merges personalized digital content and physical space through displays and allows the simulation of a multiplicity of real and virtual information (Picon, 2015). In Batty's (2018, p. 17) words: 'Physical bonds loosen … the ethereal ones tighten, form no longer will follow function.'

The application of smart technology is often claimed to have the potential to increase the quality of urban life in the face of the many critical challenges to cities and the aspiration to create positive social, economic, and environmental impacts. However, it is worth critically evaluating its potential.

Stokholm Poulsgaard, Vejlgaard, and Lind provide a circular-building perspective on carbon budgeting for architectural design in Chapter 23.

In Chapter 24, Pablo van der Lugt highlights the potential of mass timber building for future-proof cities.

In Chapter 25, Christian Veddeler presents a case of business model innovation for architecture and urban design practices, addressing circular design and the question how to decouple urban growth from finite resource depletion.

In *Smart Cities. A Spatialised Intelligence* Picon (2015) anticipates two main directions of digital urban development: top-down protocols and bottom-up initiatives.

1 Picon (ibid.) identifies a strong tendency of smart city initiatives to increase efficiency, profitability, and control. Top-down protocols determine flows of people, goods, and information within city networks. Smart city data is employed to measure, assess, compare, forecast, adjust, and optimize quantifiable performance parameters. Expert command and control of complex and dynamic processes here becomes the central driver of the smart city. However, the limitations of such hierarchical directives and the exclusive use of information is obvious. It bears the risks of reapplying the functionalist, technocratic, and omniscient attitude towards city planning that Jacobs (1961) criticized so strongly. Any attempt to solve qualitative urban challenges solely with a quantitative optimization of flows would once again misunderstand the complexity of urban life and repeat the provision of simplistic answers for complex challenges that have proven to be inadequate already.
2 The second tendency predicted by Picon (2015) has a qualitative focus and provides the opportunity for bottom-up initiatives and direct interaction of the cities' inhabitants, supported by smart technology. Picon highlights the potential of inclusive empowerment of individuals as key stakeholders of the city. The widespread availability of mobile and smart devices such as smartphones allows a growing number of individuals to access and process information and to engage within digital city networks for direct interaction, participation, and decision-making.

Sennett (2018) rationalizes the contrasting characteristics of both paths the smart city might take by the difference between open and closed systems: Whereas the former enables top-down control through predetermined rules and hidden complexity from the user, the latter allows interactive coordination in a bottom-up logic.

The implementation of smart cities, due to its sizable scope and expenditures, requires long-term planning and the commitment of diverse stakeholders' interests. Forecasting its success is difficult. Next to technological challenges, the success of the integration of digital and physical systems is hard to predict as both have divers life-cycles, require diverse expertise of planning and operations, and entail diverse funding, business models, incentives, and citizen stakeholder interests (Gath-Morad et al., 2017). Smart cities cause disruption and often evoke public resistance. On the one hand, this is because smart initiatives are often commercially driven (Koolhaas, 2014). On the other, concerns are growing about data privacy, ownership, and accessibility. Both the application of intrusive surveillance technology and the practice of commercial data mining have the potential to violate existing privacy laws. Despite the advantages smart cities promise to provide, downsides, like the fear of a 'digital big brother' (Picon, 2015, p. 82), cannot be denied. Authoritarian, exclusive, and specialist directives and technocratic and restrictive command and control are serious threats undermining the very idea of urban life. Cybersecurity is an equally relevant issue, as the failure or manipulation of smart systems, intentionally or accidentally, can have devastating consequences (Gassmann et al., 2019).

Even if the physical form of the city is not yet substantially affected by the digital turn, smart maps seem to anticipate spatial transformation by digital impact (Picon, 2015). Their capacity is to integrate large amounts of quantitative and qualitative information. Such maps reach a high degree of complexity in both space and time. As GPS-driven wayfinding and orientation in an urban environment no longer require the simplicity, regularity, and clarity of the traditional city plan, such maps indicate points of origin for an evolution of smart urban form. Picon's (ibid.) central questions in this context are whether the application of augmented reality allows a new understanding of urban complexity both in physical and digital terms and whether the liberation of the city from the form of its two-dimensional plan will generate a 'truly three-dimensional type of urbanism' (Picon, ibid., pp. 115–116).

Smart cities provide a chance to innovate the city's form, function, and performance (Batty, 2018). Once-established paradigms of city planning are challenged, as habitually employed routines, models, and types that originate from a twentieth-century functionalist agenda have failed to adequately address issues of urban complexity. With the introduction of an additional digital layer, intricacy will only accumulate.

Two criteria for evaluating the smart city paradigm, should therefore be its ability to tackle urban challenges while promoting human-centred urban design to ensure thriving city life.

OUTLOOK

A large proportion of our future human existence, the way we live, work, learn, play, and communicate, will take place in–and therefore depend on–future cities. But cities face the disruptive pressures of globalization, urbanization, demographic development, environmental issues, and digital transformation. Although the routines of urban planning have remained mostly unchanged for decades, the demand for future cities inevitably requires appropriate strategies to adapt, with consequences for urban complexity, proximity diversity, density, and ingenuity required. The critical elaboration of current urban discourse in this editorial, alongside the formulation of individual perspectives in the forthcoming book chapters, enable this book to become a transdisciplinary foundation to discuss future cities and city futures.

The goal of this multifaceted discussion is to increase the repertoire of urban design strategies and to envision meaningful environments that are attuned to diverse conditions of life needs, life-styles, and life-cycles. The shift in attention from seemingly omniscient master-planning to human-centred urban intervention indicates a transition from generic models to the factors of specific context and complexity. The aim of improving the quality of urban life requires under-

← Miami Beach (photograph by Rasmus Hjortshøj).

standing and consideration of manifold interests, agendas, and actors. In the following chapters cities are not regarded as static objects but as dynamic processes that are a complex urban ecosystem of habitat and inhabitant and consist of both physical and to an increasing degree virtual domains.

The following chapters challenge existing notions of urbanization, urban programmes, urban morphology, life-cycles of urban growth and change, and a city's form and performance. Particular attention is given to the ability of future cities to provide meaningful and healthy quality of urban life and a high degree of sustainability and resilience, not necessarily for bare survival but for an evolutionary progression of positive social, economic, and environmental impacts. As a whole, the emerging perspectives presented in this book call for the invention of future cities and speculation about city futures while resisting the temptation of predicting either of them. Instead, the objective is to formulate a transdisciplinary research agenda that contributes to the broad discourse on future cities and city futures.

The prologue section 'Form and Performance' in part is based on research of on one of the authors (Christian Veddeler) unpublished essay 'Smart City: Elements of an ecosystem of supply and demand' (Veddeler, 2020), developed as part of the Operations Management seminar at Judge Business School, University of Cambridge.

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Cityringen Metro, Copenhagen (photograph by Rasmus Hjortshøj).

ABSTRACT

It is time for a new urban future, one in which we are interconnected with our planet, our communities, and our resources. From where we stand in 2022, it feels like an ambitious goal to change how we live and how we design our urban environments. But shaping these new cities is possible. This article sketches a rough depiction of this future, reimagining not only what urban regions look like but also how we relate to them, through three sections: (1) Connected to our planet and all species, (2) Shaping interconnected communities, and (3) Reconnecting to resources.

KEYWORDS
interconnectedness; urban; future; nature; resources.

Chapter 1— The Interconnected City: Imagining Our Urban Lives in 2050

Tamara Streefland

During the global pandemic, we have felt more than ever the consequences of a flawed global economy characterized by the destruction and exploitation of nature, overuse of our global commons, wealth and income inequality, fragile supply chains, and governance failures (Gladek & Black, 2020).

IMAGINING A NEW URBAN FUTURE

This has contributed to a fundamental breakdown in how we connect to each other, and how we connect to the natural ecosystems on which we depend. Global urbanization trends show that cities will not only house more humans but will also require more land, resources, and energy. Cities are powerfully positioned to break the pattern of uncoordinated, unregulated, and extractive linear economies that put us in this mess. They are high-impact 'leverage points' (Meadows, 2012): collectively, cities around the world are responsible for 75 per cent of all resource consumption and 60–80 per cent of CO_2 emissions (UNDP, 2015).

Transforming how we live in cities has the potential not only to improve the quality of life of the majority of the planet's future urban population but also to help bring our global economy within planetary boundaries. Unlocking this potential means we embrace a new urban vision in which cities are additive, integrated pieces of a connected global ecosystem.

A VISION FOR 2050

Transforming towards a sustainable urban future will require broad buy-in across society. Building a positive vision can help sketch a desirable future and encourage widespread participation (Folke et al., 2019). We believe that providing a tangible and positive image of what a city could look like in the future can bring different groups together to form the conditions and drive the actions to achieve it. The vision presented here showcases a direction and a possible future in which every resident can have agency in building their community without causing a negative impact elsewhere. Think of it as a compass, not a map. We are not starting from scratch. Instead, we leverage efforts that are underway and are inspired by research and thinkers and build on existing vision and theories.

This vision also builds on our work at Metabolic, in which we have reimagined futures with sustainability leaders, governments, urban designers, titans in the construction sector, community members rooted in their neighbourhoods, and experts on critical urban systems, including food, energy, and water.

Now, let us explore our own interconnected urban future.

CONNECTED TO OUR PLANET AND ALL SPECIES

Looking back from the year 2050, it is surprising that so many humans once thought that nature and the Earth were things to be controlled, dominated, and exploited. In the Western world, such ideas might be traced all the way back to Aristotle's hierarchy of beings (Schouten, 2017). With the colonial expansion of European powers and the rise of capitalism, nature was treated as a commodity, and resources were extracted for private consumption on a new, planetary scale.

The results were disastrous. Global climate change reached a crisis point in the 2020s, sooner than many people had anticipated (Rockström, 2020). Ecosystems were collapsing. We saw animal populations decline 68 per cent between 1970 and 2016 (Almond et al., 2020), and forests covered just 31 per cent of global land area in 2020 (FAO & UNEP, 2020). Decades of destroying habitats to cultivate oil palms, plant soy for meat production, and build cities ultimately created unlivable conditions through climate change, pollution, and overexploitation. Inequalities were exacerbated as marginalized populations inside and outside our cities were hit hardest.

Today, in 2050, our relationship with nature has changed drastically. We see the health of other species and ecosystems as equally important to our own. Instead of putting humans on a pedestal as masters of the universe, we recognize how interconnected we are. We deeply consider nonhuman perspectives when building our urban habitats (Forlano, 2016), including what other species need to thrive. After all, we understand that the health of the ecosystem underpins all human well-being. This is not new, as we have always lived in symbioses. Microorganisms in our gut keep us healthy, fungi decompose organic materials to create healthy fertile soils, and insects pollinate our plants and protect crops from pests. Today, we appreciate and facilitate these relationships rather than ignore, destroy, or commodify them.

What shifted our understanding of how to live together with other species and the planet? Our world woke up to the fact that nature and cities have never been, and could no longer be thought of as, separate systems. As Timothy Morton (2007) argues in Ecology without Nature, we have collectively scrapped the concept of 'nature', finally realizing that we are in a co-dependent relationship with the rest of the planet and that our very well-being relies on it (Schouten, 2017).

PRACTICING SYMBIOTIC STEWARDSHIP

Today, in 2050, local and regional governments act as active stewards of the natural ecosystem. They constrain urban sprawl, leaving space for local ecosystems to thrive undisturbed. They have enabled our neighbourhoods to become constellations of habitats for multiple diverse species, with butterfly gardens, beehives, food forests, and wildflowers . Rows of identical ornamental trees no longer line our city

streets. Now, a beautiful mix of native plants and trees fills our neighbourhoods. We removed manicured grasslands or 'grasphalts', which were often taken over by invasive populations of ducks, rats, pigeons, and free-roaming domestic cats at the cost of other species (Loss et al., 2013).

RESTORING SPACE AND EQUILIBRIUM

We live in dense, compact cities that are planned with the intrinsic understanding that we as humans need a habitat just as much as other species do. The local footprint of cities has increased to 5 per cent, including some of the local ecoregions, but the reliance on land beyond the city limits has declined drastically. When people travel on the light rail out of the city, it is hard to pin down where exactly along the route the city ends and where nature begins.

Many efforts have been taken to mitigate the effects of climate change, but the majority of our largest cities are still located in deltas, subject to extreme weather events and floods (Edmonds, 2020). We had to adapt to changing local climate conditions and take them into account when developing our neighbourhoods. When inner-city rivers flood during extreme weather events, natural drainage channels guide the water out of the city. We are armed with smart planning and monitoring tools, but we are mindful of limitations in our ability to predict the future. Measures such as living breakwaters (Moosavi, 2017), sand motors (Luijendijk & Van Oudenhoven, 2019), and monitoring systems ensure resilience across scale, from individual houses up to entire regions.

Our municipalities rely on and work with natural ecosystem interactions to create well-being across cities. The tree canopy draws carbon from the air, storing it in roots and providing shade for the entire city (Lafortezza et al., 2018); quality urban soils hold water and provide fertile ground for plant growth in neighbourhoods (Solomon & Nevejan, 2018). The integrated green spaces we live in promote social cohesion for local communities.

Today, we truly enjoy our shared landscapes. Being closer to nature has improved happiness and general public health, resulting in a massive decline in health care costs across the globe. It is easy to visit our mountains, shrublands, and forests, whether to hike, to swim, or simply to be there. Living with other species interconnectedly and allowing space for heterogeneity of populations has created the resilience we needed.

SHAPING INTERCONNECTED COMMUNITIES

Looking back from the year 2050, it seems strange that cities were once designed and governed for profits instead of the people and communities that lived, worked, and played in them. In the 20th and early 21st centuries, thanks to increasingly top-down urban planning driven by private interests, it was almost impossible to operate a city without the investment of corporations through financial models related to the value of land and large operating contracts.

As a result, everyday urban life suffered from overlapping systemic issues. Cities increasingly struggled under the pressures of real estate speculation, mass tourism, urban migration, and the battle for space. The financialization of large cities, driven by large-scale foreign investments and developments, pushed out traditional communities and left impersonal spaces (Sassen, 2009). Furthermore, we experienced the damaging effects of an affordability crisis, an explosion of homelessness, and racialized environmental injustice (Plumer et al., 2020). Mass tourism, fuelled by Airbnb and ridiculously cheap airfares (Christiano & Gonella, 2020), turned many historic city centres into drinking holes. Some cities felt more like theme parks than places where people lived. Healthy urban life had become accessible only to the lucky few, leaving monotonous spatial patterns for a homogenous population and many empty houses. Cities could not continue to operate this way.

Today, our relationships with each other and our ways of living together have been transformed. Cities are filled with diverse, healthy, and interconnected communities. Habitats spark creativity, resilience, and interaction. Every person can now afford to live happily in a city no matter their age and demographic and socioeconomic status, so our streets are home to vibrant communities. This vibrancy is fostered by factors including accessible resources and health care, a strong relation between residents and their surroundings, and the collective shaping of communities (Montgomery, 2013). We began to seriously ask ourselves: Who is the city for? Who should be able to live in the city? Who has a voice in how the city is built and maintained? Although individualism used to be the norm, we now go about our everyday lives more collectively. Working together to provide for our core needs, care for local resources, and cultivate indoor and outdoor communal spaces gives us a sense of place and a safe living environment. Unexpected encounters and communal stewardship lead to new friendships across generations.

NEW APPROACH TO URBAN DESIGN

Thanks to innovative governance and ownership structures, communities shape their local environments to reflect their unique stories and specific needs, as suggested by Richard Sennet (2017) in *Building and dwelling: Ethics for the city*. They are continuously evolving; removing rigid planning rules led to an explosion of diversity in cities. Where there were once uniform central business districts that hid the Earth beneath asphalt, we have now cultivated living, thriving environments. Bedrock, cacti, moss, and various types of mushroom provide evidence of the local habitat, reminding humans of the city's place in the world.

Each neighbourhood has a lively, unique centre of its own, as proposed in the 15-minute city (C40, 2022). New landmarks combine traditional building practices with experimental technologies and materials such as timber. To celebrate heritage, we also reuse recognizable elements of demolished older buildings.

We also no longer individually own wifi routers, laundry machines, or cars, and instead we share these utilities and services, and other necessary stuff. Our new tight-knit communities can organize and collaboratively build the social structures that are at the basis of equitable distribution of resources. Social relations are important to building thriving communities, as Mark Granovetter (1973) argued in *The Strength of Weak Ties*. Our social cohesion enhances resilience to crises, prevents gentrification, and has proven to be the best remedy for loneliness and its adverse health effects (Mineo, 2017).

The city government's role is now to stimulate, enable, advise, and facilitate communities in creating thriving environments. We make most of our decisions at community level, for example, through the kinds of participatory budgeting programs that over 40 countries experimented with in the early 21st century (Cabannes & Lipietz, 2018). Ultimately, we have given the right to the city back to its residents. Our communities sit in the driver's seat, with support from developers, architects, the municipality, and natural environment experts. Experimentation with urban living labs and community projects has taught us new modes of governance and subsistence (Weber, 2019).

This transition to polycentric urban development and planning has drastically changed where people need to go and how they get there. Most cities banned all cars from their inner boundaries as early as 2025 (Araya, 2020). Roads were transformed into forested corridors connecting neighbourhoods, with space for zero-emission transportation.

This overhaul of the mobility system to provide better public transport and designated cycling and walking paths

Figure 1 →
2021, Fall in Amsterdam. 'Walking through the city I already see the vision of the future manifest' (photograph by Tamara Streefland).

has improved both air quality and water retention, along with the quality and accessibility of public spaces. Dense, walkable neighbourhoods promote an active lifestyle and ensure access to services (Nieuwenhuijsen, 2020) while compounding the environmental benefits of the compact city. Parks, elevated promenades, and layered marketplaces connect areas that used to be separated by train tracks and highways. The city has become more equitable by removing these invisible borders between wealthy and marginalized areas.

This variation in our city's texture lets people change pace as they walk from neighbourhood to neighbourhood, increasing awareness of their immediate environment (Simone, 2008). No longer living in the fast lane and hurrying from A to B, people now pause, notice where they are, and engage with fellow pedestrians.

NEW BALANCE OF HOW WE SPEND OUR TIME

Today, we have a healthy and dynamic balance between work and play. We find connections and opportunities everywhere, starting with the community centre, the beating heart of each neighbourhood. This is where we gain skills, repair our belongings, and sign up to become stewards of the local vegetable garden. Increased efficiency driven by automation has created more time for people to participate in these activities at the community centre and for leisure and personal connection to nature. It is easy to lose track of time while we are checking out a program at a neighbourhood hub or weeding a pocket garden.

A nine-to-five job is a thing of the past. We shortened the typical five-day workweek, which freed up our time and space, including unused offices that have been retrofitted into affordable housing. We think economic activities should be designed for personal development and be inclusive, and so should the benefits.

Changing how we spend our time working and living together in our cities had to begin with how we educate and care for our children. Today, schools are exciting and engaging places that emphasize skills for a resilient future, encouraging children to cultivate strong relationships with their surroundings and care for it through place-based education programs (Zsóka et al., 2013). Children form close connections to their food at schools and community gardens, and they grow up knowing apples come from trees, not plastic boxes. We value and stimulate curiosity and creativity through classes in subjects such as bioart and through apprenticeships with local businesses, such as plumbers and bakeries. In our cities, young people are flourishing. They have access to various fulfilling life pathways supported by collaborative programs between entrepreneurs, community organizations, municipalities, and universities. Learning about the intricacies of natural ecosystems by spending time with them, combined and repairing skills, builds the competent and empathetic rebels we need in this world: a new generation of global citizens fit for a resilient future in the Anthropocene.

NEW FORMS OF OWNERSHIP

Today, the models for ownership and capitalization of resources have changed. Municipal governments actively redistributed the existing housing stock, and they now act as the gatekeepers of affordability, creating the conditions necessary for people to stay in their communities. In addition, they now support alternative models of ownership and user rights, such as cooperative models and community land trusts (Co-operate, 2021). Municipal governments aim to keep value and jobs tied to their local and regional commons. Water, energy sources, and even waste streams are retained within urban regions and communities through high-value circular business models. This reduces environmental impacts and generates local jobs while preventing the privatization of these resources and leakage of value to global multinationals.

Ownership and agency over urban spaces and the process of creating them proved crucial to creating such successful, resilient, tight-knit communities. Today, everyone is empowered to shape their own urban environments and their own lives according to their means, resources, cognitive and physical abilities, and of course, their desire. As a result, the city's social fabric has been reshuffled, creating a lively city centre. We have let loose and brought back serendipity in doing so.

RECONNECTING TO RESOURCES: INTO SIGHT, INTO MIND

It is hard to believe that just three decades ago, cities were massive resource drains, fuelled by extensive supply chains and virgin resources. Massive infrastructure made the footprints of cities extend far beyond their physical presence, with pipes, wires, and roads winding through the land to bring resources in and take waste out (Brenner & Katsikis, 2014). Perhaps most shocking to us now in 2050 is that cities once produced vast amounts of waste and greenhouse gas emissions.

Today, our ways of connecting with our resources and supply chains have changed dramatically. The majority of the world's largest cities won the race to zero, launched in 2019 at the UNSG climate summit, and reduced their footprint massively by adopting transparency as a core value in urban governance.

Globally, we have seen a massive shift in diet thanks to the accessibility of more diverse crops, the wide availability of meat replacements (Godfray, 2019), and our ability to live closer to nature. The inner city has a lush foodscape made of local food gardens, rooftops, alternative spaces for food production, and neighbourhood aquaponic greenhouses. Crucial nutrients such as phosphorus and nitrogen cycle endlessly. Automation, such as smart sensors to optimize watering, maximizes the efficiency of our resource use. We stopped using ancient water sources from deep-lying aquifers that would take centuries to restore, recognizing that not all water is a renewable resource. We capture rainwater on roofs, squares, and every other suitable place. Did we really use drinking water to flush our toilets? It seems unthinkable today.

CIRCULAR ECONOMY IN THE BUILT ENVIRONMENT

The built environment used to be the largest source of waste globally (Zhang et al., 2022). But we have moved away from the traditional linear process of development: initiate, design, build, use, and demolish. In the race to zero, existing buildings were all retrofitted using the principles of the circular economy to become more energy efficient, which dramatically cut the energy demand of our built environment (Pomponi & Moncaster, 2017).

Today, circular economy principles and design for carbon neutrality are incorporated in all new buildings and neighbourhoods. Construction materials are reclaimed through urban mining, and digital twin models predict and optimize resource use (Blok, 2017). Every building produces renewable energy whatever its function. Local smart grids and batteries allow electricity to flow where it is needed. We now obtain our heating from multiple sources depending on the location, including residual heat from data centers, surface water, and geothermal heat.

Our buildings are now designed to exist for centuries instead of decades, with a human focus and built of sustainable, biobased materials. These buildings also help maintain a healthy climate and urban environment: They rarely exceed eight stories, and appearances vary in size and colour (Kyttä et al., 2016). Wastewater treatment plants and other infrastructure that used to be tucked away are now visible, and visitable, as parks or makerspaces.

COLLABORATION IN GOVERNANCE

To sustain our thriving economies, our innovation landscape is fuelled by cross-sectoral collaboration in which universities, local governments, civic organizations, and entrepreneurs create and implement innovative technologies. Governments and municipalities take an entrepreneurial stand to provide the conditions enabling innovation to thrive, and they play an active role in convening the right parties (Mazzucato, 2014). The return of high-risk investment made by governments benefits the public infrastructure such as schools and public utilities at the foundation of our cities as suggested by Mariana Mazzucato (2018) in *The Entrepreneurial State*.

Value today is found in more than just material and financial models. We still measure our performance to inform our decision-making by setting science-based targets, but we use widely different indicators from GDP, which used to be the only metric that seemed to matter. We find value in many more things: our immediate surroundings, having ownership and agency over our resources, the number of disease-free days, our family health and well-being, access to diverse communities, learning and what we can learn from each other, and having the time available to enjoy these things.

From Global to Local Economies

The neighbourhood plays a central role, with each one having a different function because of its unique characteristics. Some neighbourhoods produce more resources due to their post-industrial nature, design, accessibility, or proximity to natural resources. Others, such as the centre of Amsterdam, use more due to their higher densities and older building stock. Residents have options for resource and ownership models, so everyone can contribute to closing resource loops. Community infrastructures, such as libraries, community centres, and community farms, form a network of resource centres throughout the city, which are then linked to the larger facilities. This network plays a crucial role in transporting resources from peri-urban areas into communities.

Our long, intransparent, wasteful supply chains are no more. We now build and maintain our cities with the resources available to us, and we value the ecosystems that provide them. Our cities are regenerative by design. Overall, we have eliminated the very concept of waste, and our circular economy cycles materials continuously at their highest value (Velenturf et al., 2019).

Our relationship with materials has also changed. Of course, we still have stuff in our lives; we have just changed the definition of what is new. Products and consumer goods are now considered mere reconfigurations of materials that can be used almost endlessly, if we take good care of them.

The driving force behind these changes is access to information. Our cities are no longer black boxes; we have clear insights into how resources flow through the city, the urban metabolism of the city (Athanassiadis, 2015). Via a dashboard, each household accesses information to better connect with available resources and their impacts. Whether we are city officials, entrepreneurs, or family members, we know what is available for today's dinner, how much water we used last week, and the impacts of our consumption, including emissions and land use.

MOVING FORWARD

We have imagined a new urban future: A future that connects the city to its surroundings and its resources, humans to wilderness and other species, and people to other people within their communities: a future in which we are interconnected.

But today, as 2022 draws to a close, it is critical that we move faster. Given

> "Agreeing on a single universal vision for cities is impossible; every city's context is different, as are the needs of its people and other species."

their massive ecological footprint and impact on human well-being, cities must operate within planetary boundaries. German geographer and naturalist Alexander von Humboldt realized this in the 1800s when he wrote about the long-term effects of humankind's activities on the environment. He criticized deforestation, wasteful irrigation, and perhaps most prophetically the 'great masses of steam and gas' produced in industrial centres.

With the disappointing commitments from COP26 still fresh in our minds, it becomes even more urgent that we do whatever it takes to transition our global economy to a fundamentally sustainable state. However, aligning on this 'what' is the next crucial step. The knowledge that the current urban model benefits few and contributes to widespread harm, and that cities will continue to grow renders systemic change vital and imperative.

Finally, reading this vision, you might also wonder how it fits your city. Perhaps it does not. Agreeing on a single universal vision for cities is impossible; every city's context is different, as are the needs of its people and other species. We know that, and we encourage urban residents around the world to think about what will work for them. That is exactly what we hope to do with this vision. We invite you to build on this vision, take elements from it, and propose new visions. We hope our ideas ignite conversations and most importantly, action.

Note
This chapter presents an adaptation of Streefland (2021, December 8a,b).

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ABSTRACT

My vision for future cities is that the cityscape of the mid-twenty-first century is drawn beyond divisions of culture, nature, and species. As the prevailing agenda of homo economicus is scrutinized and the concept of property challenged, the relevance of universal rights and agreements for all living things come to the fore. Superhospitality, the symbiotic cohabitation of both humans and nature, is facilitated by future cities that welcome all living beings. Variety becomes the key element of a new unity that includes both nature and culture, and the former is no longer a resource for appropriation by the latter. Cities, and with them urban society, progress to a model in which biodiversity and cultural diversity gravitate towards one another. The urban environment will be conceived as a growing field: as an ancient garden, not a modern machine, and as a shared task more than a given.

Tomorrow's city celebrates individuality by offering a choice in where and how to live. It enables the formation of an ecosystem of diverse communities and life-styles. The welcoming character of shared and adaptive buildings and spaces is made possible through the use of circular, biobased, and even living, building materials, which allow the city to self-regulate, to regenerate, and to respond to environmental conditions. Such a city requires nurturing, maintenance, and care as it grows and develops just like plants in a garden.

KEYWORDS
variety; living architecture; city future; biodiversity; diversity; culture–nature; lichen.

Chapter 2—Gardening the City: Superhospitality—Envisioning a Symbiotic Urban Future

Jolijn Valk

According to German philosopher and historian Philipp Blom (2020), humankind has arrived at a tipping point in history. We are in the midst of a social transition, realizing that we no longer are willing to believe in the narrative of the earth as an inexhaustible resource that is 'given' to us, not only to inhabit but to rule.

CULTURE–NATURE

The associated assumption that humans stand above nature and other species no longer remains credible. We continue to realize the negative impact of modern life on nature and witness its multiple adverse effects. In a new urban era, instead of imposing our will on nature, we will aim to cohabitate in harmony.

The city was historically a human settlement that contrasted with yet depended on a symbiotic relationship with nature. The modern machine-like city has not only separated itself from its former companion but engages in exploitation of its resources while increasing the human ecological footprint. Consequently, the current models of urban growth are devastating to planet earth.

Are we aware of the cost at which urban life is made possible? Today, Bruno Latour's (1991) argument that we should align with nature and live within the capacity of the planet is becoming prevalent. Both human and nonhuman interests, he argues, need consideration. Latour emphasizes the importance of balanced relationships of all living beings, not only human interests. In We *Have Never Been Modern* (1991), Latour addresses why the simplistic separation of nature and culture is problematic: 'Here lies the entire modern paradox. If we consider hybrids, we are dealing only with mixtures of nature and culture; if we consider the work of purification, we confront a total separation between nature and culture. It is the relation between these two tasks that I am seeking to understand.' (ibid., p. 30). To provide an example, it is evident that highly urbanized environments can negatively affect people's health, both physically through poor air quality and noise pollution, for example, and psychologically by causing stress. Conversely, the benefits of contact with nature, which has positive effects on health and reduces stress, are evident (Sternberg, 2010). The recent COVID-19 crisis has explicitly proven the positive effects of access to green spaces, resulting in the improved well-being of urban dwellers (De Vries, 2021, October 4).

In the history of urban planning, health has repeatedly been a key design driver. Urban space, form, programme, and infrastructure were employed to reduce or prevent outbreaks of contagious diseases. The aim of eliminating the pollution of urban rivers, canals, and waterways, which acted as open sewers, slums of cramped alleys, courtyards with no daylight access, and poor unventilated housing led to new urban planning initiatives and codes in many cities worldwide. In postwar European urbanism, the modern and healthy city was designed around the principles of light, air, and space. The separation of urban activities and functions became the blueprint for city planning. Organized as a machine, the modern city separated its functions strictly and hygienically. Living, working, recreation, and traffic did not infect each other with the virus of inefficiency but often lacked the fundamental capacity to meet the desire of human life for identification, well-being, and physical, emotional, and spiritual needs.

CITY AS ORGANISM

By comparing the city to the human body, the Greek architect Konstantinos Doxiadis (1968a) identified the true nature of cities as an organism. Just like the human being, the city contains vital organs, such as a heart at its centre. Similar to the human body, to stay healthy, organs can only sustain natural and limited pressures to grow (ibid.).

In his text Ekistics: An Introduction to the *Science of Human Settlements* (1968b), Doxiadis observed that modern human settlements do not satisfy the needs of their inhabitants. The root problem, he concluded, was that the living conditions in modern cities were not in balance with human life needs, as cities were growing too large, too crowded, too noisy, and too damaging to their natural environment: Historic cities were simply not prepared for the industrial growth of the nineteenth and twentieth centuries. The old heart of the city was not made for the huge increase in inhabitants and buildings; the roads, as the city's arteries, were too narrow for modern transport and therefore clogged and caused a state of urban cardiac arrest. Doxiadis (ibid.) criticizes how modernist city planners neglected adequate provision for natural urban growth and change, which has had adverse effects on the health of the city and its vital functions. In contrast to the analogy of the single human body, Doxiadis (ibid.) adds to the equation a city with multiple hearts that does not rely on one but many centres and is thus able to resiliently adapt to dynamic shifts. The failure of one of the individual centres would not affect the survival of the entire population.

The recent COVID-19 pandemic raised the obvious question what its lasting impact would be on the city, and what we can anticipate for possible urban futures. Is COVID-19 here to stay, and will it shape our future cities? Two phenomena are relevant:

First, during the recent pandemic, the quality and importance of the natural environment and the outdoors became

"The integration of nature would enhance the attractiveness that cities have as a preferred habitat for humans and other living beings to endure and evolve."

evident, especially for city dwellers, for health, well-being, and happiness. Second, several unexpected effects caused by lockdowns, travel bans, and remote work also became evident: Air pollution and noise emission abruptly declined, with mobility coming to a momentary standstill. Nature, which had previously been pushed out of cities, used the opportunity to re-occupy niches of abandoned buildings, infrastructure, and public spaces in manifold forms. Flowers and plants bloomed from the cracks between the paving slabs, and wild animals started to search for food in abandoned streets. Caused by the absence of humans, for a short period, nature found its way into human territory uninterrupted. We can only imagine what effects a prolongation of this return would have meant: beautiful indeed, but also estranging human inhabitants from their inherent habitat.

With lockdowns hopefully a thing of the past and human domination of cities having returned, it is a good time to reflect on whether and how urban cohabitation of humans and nature could be beneficial for future life in cities. Can cities have a positive impact on the environment instead of exploiting it? Is nature's resilience a reason for hope (Goodall, 2022) that damage formerly caused by civilization can be undone? Can city dwellers benefit from nature-induced higher levels of well-being, and is it safe to say that therefore urban societies need to include nature?

CITY OF HEALTH

Walking through empty streets in Amsterdam during the lockdown triggered my imagination of novel built environments contributing to human health and how these could be realized: Can the urban environment be as conducive to health as wholesome nutrition, activity, in case of illness as medicine, or in prevention of disease as vaccines (Van Acker, 2020, April 15)? Today, the design of cities merely reflects certain aspects of our environmental context and conditions, such as culture, socioeconomic structures, and technology. Health and well-being are often neglected. Faced with the staggering fragility of our ecosystem and potential threats to our own survival, it is time to embrace superhospitality, which can contribute to both urban health and sustainability: To exchange human domination, exploitation, and hostility for symbiosis, care, and unity. The symbiotic integration of nature into cities offers great opportunities to contribute positively to environmental impact. Due to the concentration of city areas, nature can be preserved outside of dense cities, avoiding periphery sprawl, but nature can also be preserved within: in compact cities, walkability and bikeability enable outdoor activity. At the same time, the allocation of space for urban nature to flourish allows carbon capture and reduces the risks of extreme heat, flooding, and other climate impacts (IPCC, 2021). It positively contributes to diverse living conditions, welcoming all the city's living inhabitants (WEF, 2021, September 2). Furthermore, the use of biobased building materials allows the built environment to become regenerative: Sprawl and congestion is reduced alongside waste, pollution, and emissions. This is beneficial for urban well-being, sustainability, and resilience. As of today, urban trees store about 7.4 billion tonnes of carbon and sequester about 270 million tonnes of carbon every year (IPCC, 2021). What if this amount could be substantially increased or supported with the additional inclusion of diverse species of urban living beings?

LICHEN

Looking at the building level, the materiality of the facade plays a crucial role in the integration of nature into the built environment. When building began with humanity seeking shelter, protection, and warmth, cladding became its primary component. Accordingly, covering is the antecedent of building structure and the oldest architectural detail. Originally it was made of animal skins or textile products. 'Man is clad in skin, the tree in bark' (Loos, 1897, p. 62). What the facade is to a building is what the skin is to a human and the bark is to a tree.

Whereas nature has the capacity to respond and adapt to a changing context of environmental conditions and phenomena over time, the built environment is rather static. Building materials rarely have the ability for significant adaptation. What if we could create buildings that would return to nature in the same way as Loos's skin cladding (1897)? What if buildings could adapt to environmental conditions just as living organisms do? What if building components could be made of living materials, actively contributing to the metabolism of urban ecosystems, of symbiotic city life, or even living architecture?

In an ongoing research project of Urban Echoes, which investigates the potential of living architecture and materials, lichen was recognized as a component to bring together building and nature: 'A lichen is not a single organism. Rather, it is a symbiosis between different organisms—a fungus and an alga or cyanobacterium' (Anbg, 2022). Lichen is neither plant nor animal. Widely spread over the planet, it lives among fungi species in a mutualistic relationship: Living, breathing, growing, and reproducing in complex but mutually beneficial relationships of organisms. Algae and bacteria produce nutrition through photosynthesis. In return, the fungus provides protection and structure and collects moisture and nutrients. In a symbiotic relation, the alga and the fungus enable both their individual and collective growth, which each organism alone would not be able to provide. A lichen constantly releases oxygen. That makes it a welcome cohabitant in cities. Allowing it to cover large surfaces of facades and other building surfaces would enable large amounts of oxygen

Figure 1 ▸ p. 80

Figure 2 → *Lichen (photograph by Urban Echoes).*

to be produced, which could have a positive impact on environmental quality in cities. It is the quality of this lichen that inspires. It not only addresses symbiotic cohabitation but provides a capacity to be regenerative and resilient to environmental change.

What if a living building skin supports the natural evolution of cities? What if one of the oldest living organisms could become a new building material for the creation of truly biophilic future cities?

SYMBIOSIS NOT OPPOSITION

Symbiotic natural growth would become a vital source of heightened urban resilience. The integration of nature would enhance the attractiveness that cities have as a preferred habitat for humans and other living beings to endure and evolve.

To reverse the loss of biodiversity caused by increasing urbanization, cities must allow the integration of nature and the dedicated space it needs. The return of nature to abandoned city centres during the COVID-19 lockdowns, as described above, has illustrated that even short-term changes in human behaviour have remarkable effects on our highly urbanized planet. We have witnessed that little is needed to allow cities to become greener and nature to flourish: Anecdotal evidence of a reindeer walking the streets of Tokyo (Singh, 2020, March 22) and the canals of Venice becoming so clean that one could see fish swimming (Jacobo, 2020, March 18) reminds us how resilient nature is to overcoming temporary human confinement, suppression, and exploitation. The opportunity emerges for diverse life in cities not only to coexist but to symbiotically cohabitate. Urban nature provides superhospitality as inclusive ecosystems for humans and diverse animal and plant species. Not only will this introduce a mutually beneficial interaction between humans and the built and natural environment; it will also help restore the balance between nature and culture. It will have a positive impact on the planet and create mesmerizing beauty. Environmental design will become both a discipline and paradigm for the creation of novel and inclusive cities.

At a time when cities are densifying and the pressure on public space is increasing, claiming more space for nature in the city seems a challenging idea. However, the recent pandemic has shown how creating space that integrates nature into the city and introducing safe habitats for both humans and other species helps structure the reconception of our built environment, architecture, and cities. Our built environment must be reshaped to enable the symbiosis of culture and nature. Cities must become a living garden to be nurtured rather than planned, reconnecting biodiversity and cultural diversity for human and natural habitation. The city is structured by life-cycles and not by the array of built objects. Cities that flourish like gardens in many dimensions enable environmental restoration while giving humans a sense of care and belonging instead of material ownership and dominance.

The future of the city is in symbiosis, not in opposition. Superhospitality, the symbiotic cohabitation of both humans and nature, is the blueprint of future cities that welcome all living beings.

Figure 3 ▸ p. 81

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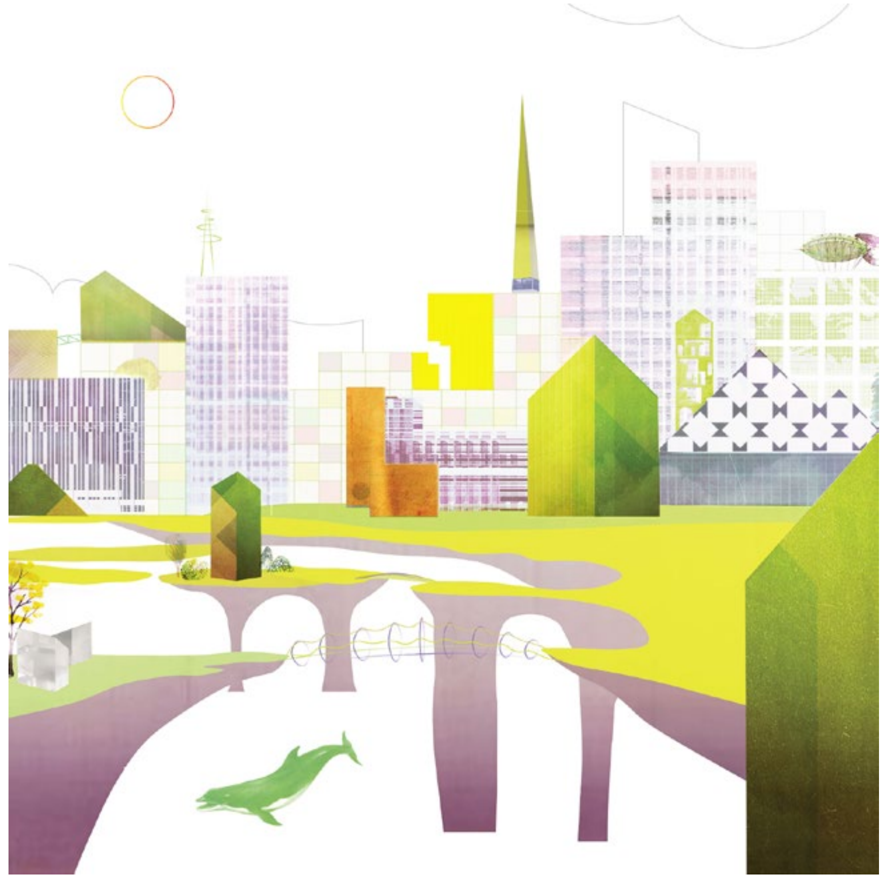
Figure 1
Daily acts of care (graphics by Urban Echoes).

Figure 3
'SuperHospitality' (graphics by Urban Echoes).



ABSTRACT

This chapter addresses the challenges that cities face from the transition to a zero-carbon economy. To provide transparency and information to investors and the public, we present a tool that monitors the decarbonization performance of real estate assets, neighbourhoods, and cities. Working from Arup's total value approach, we aim to quantify the financial, economic, social, and natural value of building projects. We further introduce the Circular Buildings Toolkit, developed together with the Ellen MacArthur Foundation, to chart circularity pathways for the built environment. This leads to the Carbon Risk Impact Screening of Portfolios (CRISP) tool developed by Arup. This tool monitors real estate assets and tracks their path towards net-zero carbon emissions. The EU and national legislations mandate the implementation of carbon reduction measures in each sector, such as the architecture, engineering, and construction industries. The CRISP tool allows its user to calculate whether these goals are met on time or pinpoint the 'stranding' of real estate assets in the future: the moment at which the asset will no longer satisfy carbon requirements. We explore how the tool can be expanded to neighbourhood and city scales.

KEYWORDS
decarbonization; carbon risk; stranding; postfossil futures; cities.

Chapter 3—Urban Decarbonization: Destranding Cities for a Postfossil Future

Paolo Cresci, Francesca Galeazzi, and Aurel von Richthofen

The Intergovernmental Panel on Climate Change's report for 2022 highlights the urgency to drastically reduce carbon emissions to avoid immanent and irreversible damage (IPCC, 2022). This requires us to rethink the way we plan, manage, and live in cities (C40 et al., 2019).

Figure 1 ▸ p. 87

At the same time, the economic aftermath of the pandemic has triggered the largest global recovery project. The European Green Deal and the post-Covid recovery and resilience funds have mobilized significant sums of money for the sustainable recovery path of the EU member states, often directly related to the decarbonization of the economy, the decoupling of carbon from the economic activities and the development of a circular post fossil economy (European Commission 2019; 2020a). The policies introduced in 2018 by the EU Action Plan for Financing Sustainable Growth, including the Sustainable Finance Disclosure Regulation and the EU Taxonomy, have created an important shift across all sectors towards providing more transparency on the sustainability performance of investments and considering sustainability as a risk factor in investment decisions (European Commission, 2020b). Additionally, the framework of the Taskforce for Climate Related Disclosures (TCFD) is becoming mandatory in more countries such as the UK and Canada and is likely to be adopted in the EU in the near future (TCFD, 2021). All these policies point at the need to address and quantify the risks related to the transition to a zero-carbon economy and provide transparency and information to investors and the public. In the real estate sector, transactions and investments are increasingly being linked to the decarbonization performance of the assets, which need to demonstrate how they are aligned with the national targets (CRREM, 2022). The current energy crisis related to oil and gas embargoes triggered by the Russian invasion of Ukraine offers the opportunity to accelerate a transition into a postfossil future even further.

A TOTAL VALUE APPROACH

Current architecture, engineering, and construction practice is producing a value gap in which the investments that are being made do not represent best total value in a holistic valuation of assets. We need to make this wider value visible, include it across public and private sector decision-making criteria, and de-risk investments. Looking at projects that adhere to the pre-Covid, fossil status quo neglects an opportunity for value creation and fails to address global problems adequately. We have an opportunity to close the value gap and drive real change at scale. The solution lies in using 'total value' approaches to enable the capture of wider value in all our investments in both public and private sectors (Arup, 2020). Total value considers the combination of financial, economic, social, and natural value:

- Financial value is the value to investors: profit, essentially the net present value of future cash flows arising.
- Economic value is the value to the public purse: value for money, essentially the benefit–cost ratio.
- Social value is the value to society: the benefits accruing to stakeholders, local communities, and end users.
- Natural value is the value to the environment: the benefits accruing to environmental assets and their stocks and flows.

THE NECESSITY OF CIRCULAR ECONOMIES

One answer to the decarbonization challenge is to move from the current unsustainable linear economy and the damage it creates to our ecosystems towards a more restorative, circular economy. A circular economy follows a new model of production and consumption and is guided by three principles, driven by design:

- Eliminate waste and pollution.
- Circulate products and materials at their highest value.
- Regenerate nature.

This needs to be underpinned by a transition to renewable energy and materials. A circular economy decouples economic activity from the consumption of finite resources. We have developed a Circular Buildings Toolkit with the Ellen MacArthur Foundation (Ellen MacArthur Foundation & Arup, 2022). It is a resilient system that is good for business, people, and the environment.

THE CONCEPT OF DECARBONIZATION OF THE REAL ESTATE SECTOR AND CITIES

The limited possibilities to offset carbon emissions and the rising commitments and therefore demand for carbon credits have caused a rapid rise in carbon prices. Any asset with fossil footprint, including practically all the built stock, therefore has a growing carbon and financial liability. The moment that these liabilities outweigh the income they generate is called 'stranding'.

The concept of stranding is borrowed from banking and finance. It refers to investments that cannot be recovered after a specific moment in time. If a company cannot change its economic revenue model but factors such as costs, taxes, and changes in customer behaviour increase, it will not be able to generate profit from it at a certain time in the future. The company performance and the adjustment to the stranding risk can be modelled. It is therefore possible to predict the time and the rising costs of stranding.

Figure 2 ▸ p. 88

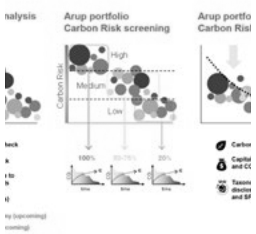


Figure 3 ▸ p. 88

Figure 4 ▸ p. 89

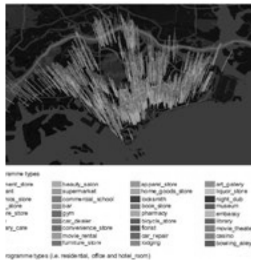


Figure 5 ▸ p. 89

By applying this concept to assets such as buildings and infrastructure, and by extension to cities, we can predict the stranding moment and advise clients and cities on how to act now.

CARBON RISK IMPACT SCREENING OF PORTFOLIOS

To do so, we developed the Carbon Risk Impact Screening of Portfolios (CRISP) tool (Arup 2022). It allows us to screen and visualize the stranding risk for real estate assets of emitting more carbon than allowed by the national climate neutrality commitments. With this information, we can advise how to counter the stranding risk strategically, for instance by retrofitting assets with non-fossil energy systems, upgrading the thermal envelope, and adopting sustainable management strategies. These assets then become future-proofed because their performance can be tracked against the sectoral and national targets for decarbonization, an obligation written into EU climate law in 2021 (European Commission, 2021). CRISP can be applied to private and public assets. While using CRISP with clients across Europe, we see a growing demand to assess the impact of buildings on topics such as climate resilience, health and well-being, financial value, decarbonization of mobility systems, infrastructural assets from direct heating and direct cooling to water and drainage, nature-based solutions, and so-called 'scope 3' resources stemming from third parties operating on the assets.

DECARBONIZATION OF CITIES

Our aim is to extend the CRISP tool to the city scale in the near future. European cities are mostly built and have strong potential to improve their carbon emission contribution. Currently, the material usage, energy, and emissions of cities are assessed from average figures for large administrative boundaries (Von Richthofen et al., 2017; Aydt et. al., 2022). This hinders targeted interventions and the strategic implementation of proven remedies. For this end, we will use Artificial Intelligence systems to automatically formulate programme and usage profiles mapped across large building datasets at the urban scale. Such an approach has been explored by Shi et al. for the domain of urban building energy modelling, which requires similar input data (Shi et al., 2021). Data and digital twin technologies are being explored to assist urban policy formulation (Quek et al., 2021). The ability to assess the decarbonization potential of urban assets would allow city makers to see precisely where buildings are at risk of stranding, what level of investment is needed to decarbonize them, what policy measures are effective, and why.

We described the paradigm shift in EU legislation to link economic recovery to decarbonization. European cities hold a large potential for retrofitting in a transition towards net-zero emissions. Embracing sustainability means fully engaging with circular economy opportunities and monitoring the decarbonization process. For this end, Arup and the Ellen MacArthur Foundation, C40 cities, a number of academic partners, and clients have developed the total value approach, the Circular Buildings Toolkit and the CRISP tools. We have sketched how to scale these approaches from buildings and portfolios to cities and communities.

Our vision for the 'next normal' is a future in which carbon is a currency, net-zero emissions a goal, and data insights help us distribute recovery funds fairly and efficiently. We can see a circular economy emerging from the pandemic crisis. This has wide-ranging implications for the built environment, the economy, and our society at large. We see three major geopolitical shifts emerging from the current crises: The climate crisis is gradually turning into climate action, post-Covid recovery funding is linked to sustainable solutions, and the energy crisis triggered by the Russian invasion of Ukraine and subsequent embargo on fossil fuels all foster circularity and sustainability across all sectors. All these crises accelerate the transitions to a postfossil future that holds many opportunities, despite the immediate challenges: We will see the rise of zero-carbon integrated urban solutions and circular economies in cities and urban ecosystems, such as lower capital expenditure for investors and developers, lower operational expenditure for users, higher value to society, higher value to the natural environment, healthier cities, higher climate and financial resilience, and healthcare systems. If carbon is becoming the next currency, then a fair carbon taxation system needs to be established. Here again the local, urban scale seems to best represent local activities and encourage healthy regional competition for sustainable solutions. We hope to contribute to this transition with Arup's aim of shaping a better world.

Note
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“We will see the rise of zero-carbon integrated urban solutions and circular economies in cities and urban ecosystems.”

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Figure 1
The Arup total value (diagram by Arup, 2022).

Figure 2
The Circular Buildings Toolkit is a framework that presents strategies and case studies, offers tools and workshops, and allows these to be combined for specific projects that can be shared again (diagram by Arup, 2022).

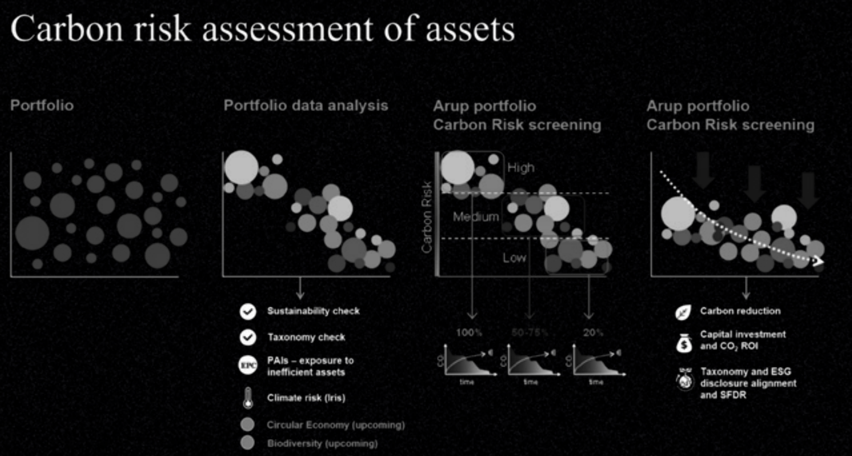

Figure 3
Principles of the Carbon Risk Impact Screening of Portfolios (CRISP) tool for identifying assets at risk of stranding and for monitoring the progress of lowering their carbon emissions (diagram by Arup, 2022).

Figure 4
Carbon Risk Impact Screening of Portfolios (CRISP) tool dashboard interface (diagram by Arup, 2022).

Figure 5
Automatically formulated programme profiles mapped across Singapore as data input for detailed urban building energy modelling (diagram by Shi et al., 2021).

ABSTRACT

Research into healthcare has traditionally focused on individual characteristics such as genetics, age, genes, and lifestyle. However, wider determinants such as societal and environmental factors impact how and where we live. Therefore, the inextricable relationship between our health and the health of our planet is continuously being demonstrated.

Currently, global challenges such as the COVID-19 pandemic, the climate change crisis, and increasing inequalities require a paradigm shift in our approach to the built environment. Climate change, pollution, and extreme weather events can reduce health and well-being, increase illness, and even increase mortality. Our attention to the relationship between the built environment and its impact on our physical and mental well-being increased significantly during the pandemic as we spent more time at home during global lockdowns and movement restrictions.

These crises have also put a spotlight on health, equity, and inclusion, with evidence showing that the lack of inclusive design and innovation can result in environments that exclude children, women, and the elderly. The built environment offers several opportunities for improvement from a health perspective and thus remains an extremely powerful tool for tackling health inequalities and supporting population health and well-being.

This chapter therefore explores the complex interplay of factors between population health and the built environment. It provides a brief historical perspective, then highlights some of the challenges we face, from managing complexity and embracing inclusive innovation practices to internal and external factors influencing health in the built environment and takes a closer look at the consequences of the COVID-19 pandemic. It concludes with some opportunities for incorporating population health considerations into our approach to future cities.

KEYWORDS

population health; built environment; well-being; health equity; inclusive innovation.

Chapter 4—Heart, Health, Habitat: An Inextricable Relationship between Population Health and the Built Environment

Bola Grace

Our health is shaped by the environment we live in, both natural and built. Our built environment covers all of the physical structures engineered and designed by people: the places in which people live, work and socialize and routes of transportation.

THE IMPORTANCE OF THE BUILT ENVIRONMENT TO HEALTH AND WELL-BEING

These interconnected factors impact many determinants of health. According to the World Health Organisation, 'Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity' (World Health Organization, 2021a). Factors such as population density, access to water, and recreational facilities are critical in minimizing the transmission of disease and encouraging healthy behaviour. These shape the social, economic, and environmental conditions that are critical for health and well-being (Glasgow Centre for Population Health, 2013).

A BRIEF HISTORICAL PERSPECTIVE

Throughout recorded history, whenever people have lived in close proximity, they have encountered outbreaks of communicable diseases. From smallpox and typhoid in Roman times to bubonic plague in mediaeval Europe, to cholera in 19th-century Europe, wherever large groups of people live, infectious diseases have found a home. Roman sewage and aqueduct systems were thus required by law to improve sanitation and minimize the spread of diseases, with

Roman baths symbolizing the 'great hygiene of Rome' (Karabatos et al., 2021).

During the industrial revolution, diseases such as cholera and frequent outbreaks of diarrheal diseases and tuberculosis were the key public health threats, with unsanitary environments and overcrowding being key contributors to the spread of diseases and epidemics, resulting in significantly lower life expectancy (Frumkin, 2021).

The early 20th century saw housing reforms with improvements through better sewage systems, and minimum distances between toxin-producing factories and residential areas. By the mid-20th century, there was more focus on individual behaviours, such as smoking cessation, and industrial reform, such as the removal of lead from paint, than on larger planning issues. Key health concerns focussed on chronic diseases, rather than infectious diseases, and the built environment was implicated in the exposure of people to pollution and toxins that impact cardiovascular and respiratory diseases (Pinter-Wollman et al., 2018).

In recent times, most aspects of the built environment have been positively impacted by regulation and legislative decisions, with evidence showing that access to parks and green areas can encourage an increase in physical activities, resulting in a positive impact on diseases such as depression, mental health, and obesity. More recently, the COVID-19 pandemic, associated lockdowns, and public health strategies across the world have reemphasized the important link between population health and the built environment.

CHALLENGES ASSOCIATED WITH THE BUILT ENVIRONMENT AND OUR HEALTH

MANAGING COMPLEXITY

The subjectivity associated with the built environment can sometimes present challenges to selecting the best strategies in planning design. Furthermore, strategies that work well in one setting do not necessarily transfer well to other settings. However, there is increasing evidence that health-related policy changes to the built environment can have significant effects across the population. Those responsible for design and planning the built environment continue to play important roles in shaping population health. Public health specialists can also help with inclusive innovation and design approaches to ensure that we have environments that consider the diverse population needs.

EXTERNAL FACTORS: CLIMATE, AIR QUALITY, NOISE

With more people now living in cities and towns than ever before, urban populations are particularly exposed, and negative health impacts are likely to increase due to climate change, with many implications for health outcomes. A recent review (Ebi et al., 2021) showed that extreme weather and climate events, such as heat waves, cyclones, wildfires, and floods, continue to cause significant human morbidity and mortality, and adversely affect mental health and well-being. The US National Center for Environmental Health also highlighted several ways in which climate change impacts human health; examples include changes in vector ecology causing diseases such as malaria, dengue fever, and Lyme disease. The impact of low-quality water and food can include cholera and malnutrition. Environmental degradation can cause undesired migration, civil conflict, and other mental health impacts (Centers for Disease Control and Prevention, 2022). Extreme heat is implicated in cardiovascular diseases and death, and severe weather injuries have been shown to deteriorate mental health and cause fatalities.

Epidemiological studies have shown numerous adverse health consequences associated with both short- and long-term exposure to air pollutants (Chen & Kan, 2008). Air pollutants can be released from both the built environment and natural resources, and transportation, industrial processes, farming, and energy generation can negatively impact

air quality; sympathetic planning of the built environment can help to minimize the impact of such activities.

Noise from road traffic, aircraft, and railways has been demonstrated to represent a cardiovascular risk factor. Excessive noise causes sleep deprivation and high stress and negatively impacts mental health, especially for parents of young children and ageing residents, and has become a considerable health risk in highly populated areas. Road traffic noise exposure has been connected with cardiovascular diseases such as arterial hypertension, myocardial infarction, and stroke (Münzel et al., 2018), and aircraft noise exposure at night can induce coronary artery disease.

INTERNAL FACTORS: HOUSING, BUILDING, NEIGHBOURHOOD, GREEN SPACE

Most people spend around 90% of time indoors, with a high proportion of time spent within the home environment (Klepeis et al., 2001). Many factors within the home environment can affect mental and physical health: damp, infestation, noise, lighting, housing tenure, and design.

Indoor air quality 'refers to the quality of the air in a home, school, office, or other building environment' (United States Environmental Protection Agency, 2021)The pollutants within these environments include smoke, combustion, mould, pesticides, and volatile organic compounds from products and materials. Damp and poor air quality are linked to increased symptoms of asthma in children. Accidents remain a major cause of death in poorly designed buildings, especially among children, and overcrowding can exacerbate the occurrence of accidents. Indoor heating, tobacco smoking, asbestos, and organic compound cooking pollutants have been implicated in respiratory diseases with harmful effects on lung function, increased asthma, increased respiratory and cardiovascular hospital admissions, and mortality. There is also increasing evidence of reduced fecundability, lung cancer, and stroke. Fertility researchers examining factors associated with the built environment have found that people who live in socioeconomically deprived neighbourhoods, are less likely to conceive, than those living in neighbourhoods with more resources (Willis et al., 2022; Grace et al., 2022) with residence negatively impacting reproductive intentions (Grace et al., 2022).

Inclusive design of neighbourhoods and urban green spaces, including parks, playgrounds, and residential greenery, can encourage healthy active lifestyles, improve well-being, and reduce morbidity and mortality through relaxation, stress reduction, and social cohesion (Hunter et al., 2019). Careful design of green spaces in urban settings can also help address population health issues related to obesity, respiratory and cardiometabolic diseases, and mental health and well-being.

THE IMPACT OF COVID-19 ON THE BUILT ENVIRONMENT

As the COVID-19 pandemic caused widespread panic during the first half of 2020, the demand for all forms of travel plunged, and the traffic on our urban streets was drastically reduced. COVID-19 pandemic recommendations from WHO included maintaining physical distance, avoiding crowded areas, ventilating indoor locations, and encouraging citizens to spend more time outdoors. Ventilation was reported as crucial, and people were encouraged to open windows when indoors to increase the proportion of outdoor air (World Health Organization, 2021b).

COVID-19 also drove a substantial shift to working from home, bringing more focus to health and safety within the home working environment. Most populations, when confined to their homes under lockdown restrictions, longed for fresh air and exercise, but standard pavements were either too crowded or too narrow to permit pedestrians to maintain the recommended government social distancing requirements. In response, many cities blocked off roads to traffic and dedicated these to pedestrians and cyclists. During this period of lockdowns and restrictions, our understanding of the importance of our environment to our physical health and mental well-being increased significantly.. This has resulted in people wanting to make informed decisions about where to live and work, with an increased desire to live in healthier environments (Frumkin, 2021).

According to the European Environment Agency (The European Environment Agency, 2022) the COVID-19 lockdowns may have some direct, short-term, positive impacts on our environment. Examples include improvements to greenhouse gas emissions and air quality, especially in highly polluted cities, as well as lower levels of noise and traffic pollution. However, some of the negative consequences on the environment include more plastics and waste due to global demand for personal protective equipment. The impact of social inequalities was also more evident, as poorer people are more likely to live in poor-quality, overcrowded spaces, reducing their ability to comply with social distance recommendations and increasing the risk of disease transmission. Potential long-term implications include increased working from home, reconfigured streets, changes to how we travel, increased demand for parks and green areas, and a marked exodus from urban areas (Mahima et al., 2022) all these require corresponding changes to the way we have approached the built environment from a health perspective.

OPPORTUNITIES FOR IMPROVEMENT FROM A POPULATION HEALTH PERSPECTIVE

According to the WHO (2017), the most promising intervention approaches include park-based interventions combined with social promotion activities and greening interventions such as street trees, greening vacant lots, and green infrastructure for water management. Some indoor pollutants can be controlled at the source or reduced by filtration and ventilation.

Healthy Streets (Healthy Streets, 2022), 'a set of ten evidence-based aspects of the human experience of being on streets' was developed through research into the ways that cities, towns, and street environments impact on our health and well-being. The Healthy Streets Indicators describe the important factors for ensuring streets are healthy, welcoming, and accessible for all people. Evidence (Pineo, 2020) suggests that overheating can be reduced through green infrastructure such as parks, green roofs, walls, and more green spaces in cities. Early engagement of the local community can help assess needs and requirements. Inclusive innovation approaches can provide positive outcomes through the involvement of multidisciplinary teams for design, planning, and management and targeted intervention to specific underrepresented groups such as children, the elderly, and diverse cultural backgrounds.

Many health risks arising from climate, air quality, noise, and traffic can be mitigated through building climate-resilient health systems with improved risk reduction, preparation, response, and recovery. Vulnerability and adaptation assessments should be conducted, and health system adaptation plans should be developed to help identify priority actions to effectively limit risks. The US Environmental Protection Agency (2022) provides five strategies for combating climate change impact on the health of the population, summarized as follows: 'a) Anticipate Climate Impacts and Assessing Vulnerabilities; b) Project the Disease Burden; c) Assess Public Health Interventions; d) Develop and Implement a Climate and Health Adaptation Plan and e) Evaluate Impact and Improve Quality of Activities.'

The law remains a crucial tool in creating a built environment that puts the health of the population at its core through regulations designed and en-

"The built environment remains an extremely powerful tool for tackling health inequalities and for improving population health and well-being."

forced by planning boards and government administrative departments. (Perdue et al., 2003) highlight five main legal avenues for affecting the built environment: 'i) environmental regulation to reduce toxic emissions; ii) zoning ordinances that designate an area for a specific use and related developmental requirements; iii) building and housing codes that set standards for structures; iv) taxing to encourage or discourage activities or behaviours; v) and spending to provide resources for projects that enhance the built environment.'

Finally, although the COVID-19 pandemic caused significant destruction globally, it resulted in significant changes to our approach to the built environment, from the scale of buildings to the entire cities (Frumkin, 2021). It provided an unprecedented opportunity to review the way we approach the built environment and its impact on our health, ultimately highlighting ways to implement disease prevention strategies through urban planning and building design. Some of these proved popular with the general public, highlighting promising approaches for long-term utility such as repurposing streets for pedestrians and cyclists, reemphasizing the importance of parks and green spaces, improving air quality in cities, and reducing noise and traffic pollution (Mouratidis & Yiannakou, 2022).

To conclude, the built environment remains an extremely powerful tool for tackling health inequalities and for improving population health and well-being. It is not enough to simply inform people about healthy living; our built environment must never present a barrier to healthy behaviour and has the opportunity to promote and encourage it. Intervention in city planning, neighbourhood design, and building projects using inclusive innovation approaches that put population health at their heart must be adopted for all our sakes.

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ABSTRACT

Hospitals are being transformed into healthcare ecosystems. The notion of housing the sick in isolated facilities is being replaced by the concept of a 'City of Health', an environment that promotes health and provides care at the place of living within the local community. This transformation was catalyzed by the COVID-19 pandemic, which highlighted the shortcomings of existing hospital facilities and accelerated the development of digital health and remote care to connect across diverse built environments. When healthcare systems were challenged to prevent contamination and control hospitals' occupancy, innovations in telemedicine technologies, robotics, and AI systems provided an alternative to remote care and home hospitalization. New hybrid models have evolved to integrate care pathways multiplied by the mode of delivery—physical or virtual—and the location of care—at the hospital, the community, or the patient home. Though hybrid models accelerate the flexibility of the healthcare system and provide personalized service through multiple options, the growing complexity challenges both the patient and the healthcare provider to control the operations and choose the best care pathway. We investigate the development of healthcare ecosystems in the use of telemedicine technologies for service innovation and integration of care between hospital and home, drawing on the case study of Sheba Medical Center and Sheba BEYOND, the first virtual hospital in Israel. We conclude by highlighting the potential for the development and use of Digital Twins in integrating the data of users, services, and environments to improve efficiency through real-time analytics and prediction models to support the design of the evolving healthcare ecosystem.

KEYWORDS
healthcare ecosystem; digital health; hybrid care model; virtual environment; telemedicine.

Chapter 5—Future Cities Healthcare Ecosystems: Digitally Enabling Hybrid Care Models across Physical and Virtual Environments

Nirit Putievsky Pilosof, Eivor Oborn, and Michael Barrett

The dramatic growth of digital health during COVID has accelerated opportunities to transform how healthcare is provided and where it is delivered. Emerging digital technologies, including remote patient monitoring, telehealth, and AI-based predictive diagnostics, have boosted the shift towards hospital-at-home services that can be scaled for improved service provisioning (Oborn et al., 2020).

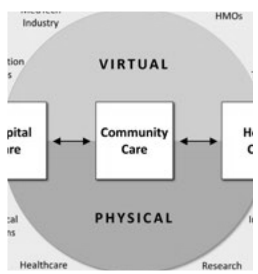

Figure 1 ▸ p. 105

INTRODUCTION: TOWARDS DIGITALLY ENABLED HEALTHCARE ECOSYSTEMS

Recent estimates are that, by 2025, up to $265 billion worth of care services, representing up to 25 per cent of the total cost of care, for Medicare fee-for-service (FFS) and Medicare Advantage (MA) beneficiaries in the US could shift from traditional facilities to the home (Bestsennyy et al., 2022). The shift of healthcare services from the hospital to the home and the community, enhanced by remote care integrating physical and virtual spaces, is transforming the concept of a hospital into a digitally enabled healthcare ecosystem (Figure 1).

The hospital, envisioned as a 'House for the Sick', is gradually developing into a 'City of Health' incorporating health promotion, continuity of care, and medical treatment. Hippocrates' vision that 'The function of protecting and developing health must rank even above that of restoring it when it is impaired' (Adams, 1981) is revisited by the development of digital technologies supporting health and care across the built environment.

The new model of the healthcare ecosystem is shifting the paradigm away from providing care in a medical facility, a building with a physical location, dominated by an in-person meeting at a specific time. The healthcare ecosystem promotes health and care in diverse locations, both physical and virtual, in synchronous or asynchronous meetings, moving beyond the limitations of place and time. This paradigm shift requires adjustments in processes, regulations, reimbursements, business models, and collaboration initiatives from all the stakeholders involved in the healthcare ecosystem (Li et al., 2021; Oborn et al., 2021; Pilosof et al., 2021b; Wiedner et al., 2017).

Studies show the potential for new models of care across the healthcare ecosystem. Home hospitalization, for example, can reduce costs, health care use, and readmissions, while increasing physical activity compared with conventional hospital care (Levine et al., 2020). Beneficial mechanisms include continuity of care, the power and familiarity of the home, and streamlined logistics. Patients who decline home hospital care most often lack social support at home and cite safety and the ease of remaining in the hospital as the main reasons for their decision (Levine, et al., 2021). Optimizing home hospital for diverse patients and their clinicians needs to facilitate better informed discussions of the risks, benefits, and alternative service pathways from the traditional hospital (Levine, Paz, et al., 2021). The challenge is to compare and contrast different situations of care and to allow increased flexibility in selecting across various models of care. For this purpose, the system should strive to provide the right balance between hospital, community, and home care and between in-person and remote care, as complementary hybrid models and not a replacement of one service by the other.

HYPOTHESIS: NEW HYBRID MODELS OF CARE

The transformation of hospitals towards a healthcare ecosystem accelerated through increased adoption of digital technologies during the COVID-19 pandemic. The pandemic highlighted the shortcomings of existing hospital facilities and enhanced the growth of digital health and remote care. The shift of healthcare services from the hospital to the home and the community, supported by remote care technologies and community-based services, led to new hybrid models of care integrating physical and virtual environments. Reinforced by the diverse stakeholders of the healthcare ecosystem, hybrid models of physical and virtual care hold the potential to enhance the flexibility of healthcare systems and provide personalized services for patients, families, and caregivers.

CASE STUDY: SHEBA BEYOND VIRTUAL MEDICAL CENTRE

Sheba Medical Center (MC) in Israel, with its ARC Innovation Centre, accelerated the use of telemedicine technologies for remote care for inpatient and outpatient care during the COVID-19 crisis. The hospital developed new models of care, including inpatient telemedicine to treat COVID-19 patients remotely within the hospital intensive care unit, internal medicine unit, and acute psychiatric unit to prevent contamination and reserve protective equipment (Oborn et al., 2021; Pilosof et al., 2021a, 2021b). The first virtual hospital in Israel, Sheba BEYOND, launched in 2021, extended this model, and developed hybrid programs for home hospitalization. The programs led to the design of medical units with physical and virtual beds, which allowed for inpatient hospital-care with remote home-care based on patients' medical conditions and personal preferences. We see these developments as a bold move towards leveraging a digitally enabled ecosystem strategy approach involving new hybrid models of care.

Our research, ongoing from June 2020, is based on qualitative semi-structured interviews across the Israeli healthcare ecosystem. The interviews include the management of Sheba MC and Sheba BEYOND, medical staff from the hospital and the Health Maintenance Organizations (HMO), IT directors, Telemedicine and Medtech organizations, architects, and policymakers at the Israeli Ministry of Health. The thematic qualitative data analysis, based on principles of naturalistic inquiry (Lincoln & Guba, 1985) and a grounded approach to conceptual development (Golden-Biddle & Locke, 2007), was adopted to identify emerging themes from the interviews and observations.

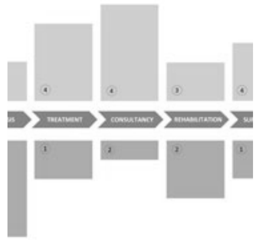

Figure 2 ▸ p. 105

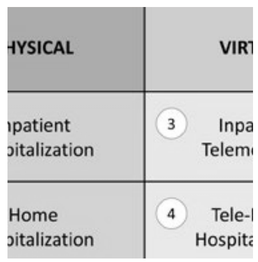

Figure 3 ▸ p. 105

RESULTS: HYBRID CARE MODELS ACROSS PHYSICAL AND VIRTUAL ENVIRONMENTS

Sheba MC and Sheba BEYOND, its virtual arm for remote care, developed new hybrid models of care based on a collaboration between the hospital, the HMOs' community-based care services, and the support of the Israeli Ministry of Health. The partnership between the hospital and the community services was possible only after changing regulations and reimbursement models by the Ministry of Health to promote telemedicine adoption. The dramatic increase in digital health fuelled the development and implementation of medical devices and remote technologies and allowed ongoing experimentation and testing of novel business models. The service of home hospitalization, for example, is provided by expert doctors at the hospital with nurses from the community-based HMOs using telemedicine technologies for remote monitoring, diagnostics, and communication.

The hybrid models of care are defined by the mode of delivery, either physical or virtual, and by the location of care, either at the hospital or at the patient's home. This results in four main care pathways: (1) inpatient hospitalization, (2) home hospitalization, (3) inpatient telemedicine, and (4) tele-home hospitalization (Figure 2).

1 *Inpatient hospitalization—physical care at the hospital*
Traditional inpatient hospitalization, involving bedside care by a professional medical and nursing team with medical equipment and expert support, is commonly considered the best option for critical acute patients. Although many procedures can only be performed at the hospital, inpatient care holds risks of secondary infections, delirium, falling, and physical and mental deterioration.

2 *Home hospitalization—physical care at the patient's home*
Home hospitalization, the relocation of care from the hospital to the patient's home, changes many aspects of care, including the patient–caregiver relationship and the family's role and involvement. The HMOs' community-based services become more central in facilitating maintenance and enhancing personal relations, mostly by nurses and local doctors. The patient's home environment often also contributes to caring by promoting comfort and minimizing stress. However, this pathway is best suited for medically simpler issues that do not require advanced technologies for diagnostic purposes or direct observation by specialists.

3 *Inpatient telemedicine—virtual care at the hospital*
Inpatient telemedicine was developed during the COVID-19 crisis to provide a solution that avoids physical contact with infected patients, which significantly increases the risk of transmission and the need to quarantine exposed healthcare workers. The new model evolved from the electronic intensive care unit and showed potential beyond COVID to augment safety, particularly for patients who are more distant from care staff and control rooms and in circumstances of staff shortage and high occupancy rates. Although virtual care can enhance care, it also can compromise the patient's privacy and sense of control.

4 *Tele-home hospitalization—virtual care at the patient home*
Tele-home hospitalization was developed to maintain care during the COVID-19 crisis. Telemedicine technologies allow the medical team to care remotely for patients hospitalized at

"Changing the paradigm of hospitals from providing medical treatment in designated buildings to 'Cities of Health' promoting health and care in physical and virtual environments call for new approaches in architecture and healthcare design."

home when they are unable to accept or prefer to avoid hospital or home visits due to the risk of infections. Monitoring and supervision of patients by virtual technologies allow specialist supervision of ongoing treatment and enhance continuity of care with objective data about the patient's condition during and between encounters rather than relying on patient self-report. If the patients' condition deteriorates, they have direct access back to the hospital ward without going through the Emergency Department. However, virtual care requires the users to have technological abilities and the system to provide ongoing support.

DISCUSSION: FLEXIBILITY ACROSS THE HEALTHCARE ECOSYSTEM

The Sheba MC study revealed the transformation process of the hospital within the evolving healthcare ecosystem in Israel. Although the transformation is at a preliminary stage of development, including pilots and reconfiguration of programs, it indicates a shift toward a new era of hybrid models of care. The study indicates the dependencies between the various stakeholders in the healthcare ecosystem and the need to collaborate, develop innovation processes, and facilitate new strategies for engagement. Understanding the stakeholders' perspectives, the needs of patients and caregivers, and the culture and roles of organizations, including competition and trust issues, is essential for advancing and scaling the new models of care.

The study demonstrates how hybrid models integrating physical and virtual environments, enabled by telemedicine technologies, foster flexibility in providing care services. Planning for change and flexibility has always been a major challenge in healthcare design (Pilosof, 2005, 2020). Yet, in most cases, the requirement was conceived as being only for the architecture of the building. For this reason, hospitals are often described as functionally complex and subject to frequent change over time, posing the most difficult design challenges in contemporary architecture (Hamilton, 2021; Kendall, 2018). COVID tested the flexibility of organizations to adapt and innovate, resulting in increased flexibility beyond the hospital to the wider ecosystem, allowing digital resilience in times of crisis.

This flexibility supports personalized patient care throughout the various phases of the patient journey, including diagnosis, treatment, and rehabilitation. Figure 3 shows the choice of care pathway available at each phase of the journey - physical care or virtual care and the location of care at the hospital or home. This choice of care provision, whether determined by the medical staff or the patients and their families, can enhance the quality of care, healing processes, human experience, and the efficiency of organizations. However, these emergent and multiplicative sets of options add to the complexity of the healthcare system, leaving the caregivers, the patients, and their families with a constant need to choose the best care pathway (Figure 3).

CONCLUSION: THE FUTURE HEALTHCARE ECOSYSTEM

The future healthcare ecosystem holThe future healthcare ecosystem holds the potential to accelerate flexibility and provide personalized service with multiple options of care. Yet, the growing complexity will challenge both patients and healthcare providers to control operations and choose the optimal care pathway in each case. Changing the paradigm of hospitals from providing medical treatment in designated buildings to 'Cities of Health' promoting health and care in diverse physical and virtual environments call for new approaches in architecture and healthcare design that will support this challenge. How can architectural design go beyond focusing on designated buildings to include the inter-relationship of diverse spaces and enable the transition to the new era of digital health?

Taking inspiration from medicine, which has made significant advances moving from Evidence-based Medicine (EBM) to predictive, preventive, and personalized medicine, architecture needs to move from Evidence-based Design (EBD) to an architecture that enables predictive, responsive, and personalized places for health and care. Yet, developing an architectural design of digitally enabled health ecosystems requires the integration of digital innovation with place-making of physical and virtual environments. This development can benefit from using Digital Twins to improve operational control and patient experience (Croatti et al., 2020). Integrating the data of users, services, and environments—physical and virtual—can improve efficiency through real-time analytics and prediction models and support the design of evolving future cities' healthcare ecosystems.

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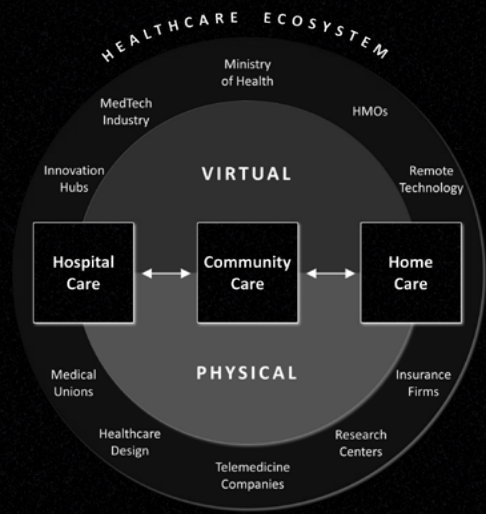

Figure 1
The digitally enabled healthcare ecosystem facilitates the integration of physical and virtual care across hospitals, community-based services, and home care (graphics by the authors).

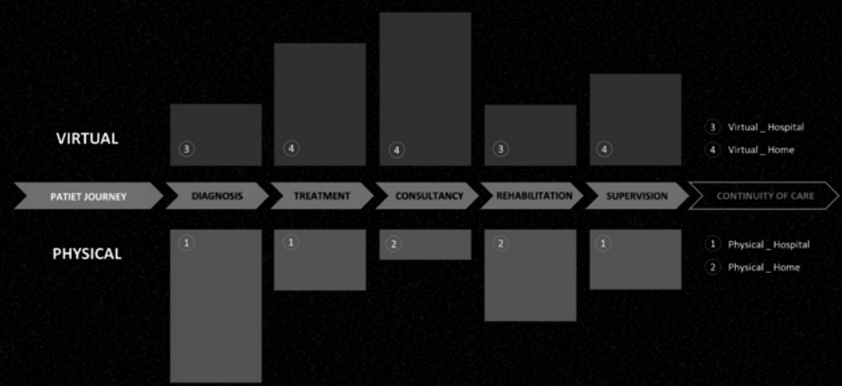

Figure 2
Example of combinations of service modes across a patient journey (graphics by the authors, adapted from CADRE HKS, 2018).

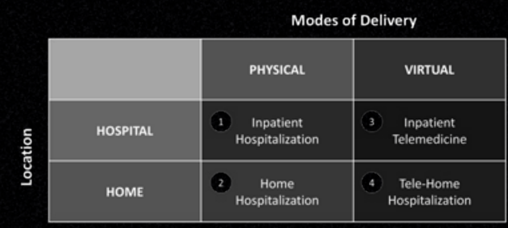

Figure 3
Matrix of care pathways multiplied by the mode of delivery—physical or virtual, and the location of care—at the hospital or the patient home supported by community care (graphics by the authors).

ABSTRACT

This chapter will address the possibility of cities in 'the new real', a condition which is evolving as we speak, redefining the relationship between what we call real physical space and real synchronous time versus virtual space and asynchronous time. As with diseases and pandemics in the past, the very idea of the city is once again challenged. Over a century ago, the fear of overcrowding led to the ideas of the functionalist city, demanding distance, air, sunlight, and green space as basic ingredients of a healthy, controllable city. Today the drive for decongestion is empowered by a virtual substitute that allows alternative digital forms of togetherness, flows of information, and commodities.

However, this 'digital twin' lacks basic ingredients of the city as we know it. Conversely, the new urban real has evoked new behaviours and has demonstrated the social resilience of physical urban environments. In a context such as Israel, characterized by a culture of tactics more than strategies, we have seen an immediate reaction to these fluctuations produce new realities. This chapter presents possible design approaches addressing these shifting realities by showcasing work of groups of students and teachers at Bezalel studying the Israeli City as a laboratory for cities of the new real.

KEYWORDS

urban design; resilience; tactical urbanism; virtual space; density.

Chapter 6—Cities of the New Real

Els Verbakel

This new tension field of redefining the relationship between, what we call, real physical space and real synchronous time versus virtual space and asynchronous time, has become our default modus operandi. It causes our daily life to continuously shift between real and virtual, between synchronous and asynchronous, led by capricious graphs of infection rates and unpredictable, government-imposed codes of conduct.

THE POSSIBILITY OF CITIES AND URBANITIES IN THE NEW REAL

As with diseases and pandemics throughout history, a new challenge has arisen to the very idea of the city, the culmination of density, congestion and togetherness, and the inverse of social distancing. Over a century ago, the fear of overcrowding and its social, political, and economic implications paved the way for the functionalist city, promoting distance, air, sunlight, and green space as basic ingredients of a healthy, efficient, and controllable city. Today the drive for distancing, isolation, and decongestion is empowered by advanced network technologies that allow new, virtual forms of togetherness and flows of information, production, and consumption. However, this digital substitute lacks basic ingredients of the city as we know it, such as density, informality, and chance encounters.

On the other hand, the new real has produced behavioural patterns and has demonstrated the social resilience of our physical, real-time, and real-space urban environments. When lockdowns limited our movement to supermarkets and pharmacies, dating and socializing moved into the cereal aisle. When restaurants and cafes were forced to keep customers out and move to deliveries, people brought crates and blankets and improvised the twin of an outdoor restaurant.

In a context such as Israel, characterized by a culture of tactics more than strategies, we have seen an immediate reaction to these fluctuations produce new realities. This chapter explores possible design approaches addressing the new urban real through work by groups of students and teachers at the Department of Architecture at Bezalel, Jerusalem, who use the Israeli city as a laboratory for cities of the new real.

TOWARD A NEW SITUATIONISM

The new real has generated a fluctuation between functional and dysfunctional thinking, between transferring functional and efficient space into the virtual world, while strengthening the dysfunctional, informal, 'messy' space in physical, real-space and real-time environments. In contexts such as Israel, a region that finds itself in a constant state of instability and uncertainty, urban space is characterized by a culture of tactics much more than strategies, which has led to a series of immediate reactions to these fluctuations. These in turn have produced new realities and opportunities for alternative forms of urban life. One could argue that these fluctuations produce a new form of situationism. As in the earlier version of the situationist movement, cities of the new real now provide a platform for a polarizing effect by which functionalist organizational models are organized in virtual space. In contrast, the dysfunctional, the dynamic labyrinth, drift, congestion, complication, and friction are deliberately enhanced in physical space.

In what follows, we move through the work of students and lecturers addressing these themes in the Israeli urban field at Bezalel's Department of Architecture in Jerusalem. Their architectural design explorations and journeys have created a body of work that critically but also productively addresses the possibility of giving urban form to fluctuations in the new real. The materials produced by groups of students and teachers use the Israeli city as a laboratory for cities of the new real. The following text should be read as a collaborative project of studio teachers, students, and the author and represents a broader attempt at the department to produce critical thinking through educational practices.

STUDIO RAMLA
(Sagit Yakutiel & Lealla Solomon)

The Ramla group focused on the Klausner neighbourhood in the city centre of Ramla. As at an earthquake's epicentre, the heart of the neighbourhood is lifeless, a large vacuum surrounded by bustling urban life. The neighbourhood lies between the decaying leftovers of Ramla's glorious Palestinian history as a central administrative crossroads on the route from Jaffa to Jerusalem, and the dominant civil public buildings constructed with the establishment of the state of Israel. Throughout the centuries, the city faced several invasions first by Crusaders, Ottomans, and the British, and ending with the Israeli war of independence, which led to the expulsion of many of its Arab citizens. This spurred a centripetal development of the city, towards its periphery, leaving the old historic centre neglected and underused.[1]

THE RETAIL APOCALYPSE
(Leora Berry, Omri Levy, Rachel Gottesman, Roee Dowek)

The recent pandemic has not necessarily changed existing trends in commercial spaces and retail areas but has accelerated them. Shopping centres around the world, not long ago offering the promise of economic prosperity, have since the 2008 financial crisis, experienced a gradual decline in what has been defined as the 'retail apocalypse' (Fischli et al., p. 16). This radical change to their typically large scale, dependencies on private transport, and promotion of consumption cultures in a relatively short period of time (Poynor, 2000) is a dramatic one, significantly affecting human behaviour and the environment. The lockdowns, restrictions, and health regulations not only limited access to these areas, but also contributed to the growth of e-commerce and other alternatives. In many cases, shopping areas were partially or completely abandoned, leaving large-scale, robust, vacant voids, ready for intervention.

Early 21st century retail spaces are generally widespread, low-rise, large-spanned buildings, planned to accommodate visitors in large numbers that cultural institutions can only dream of. Inside, they bring together a diversity of commercial activities: small shops,


Figure 1a ► p. 115

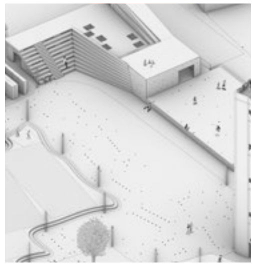
Figure 1b ► p. 115


Figure 1c ► p. 115

1
Text based on the studio description by Sagit Yakutiel, and Lealla Solomon.

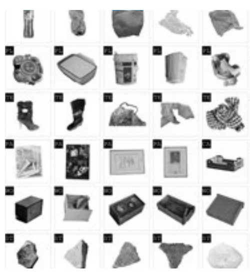
Figure 2 ► p. 116

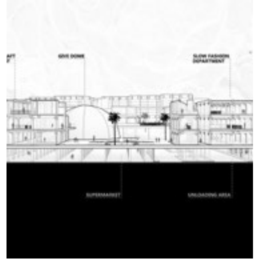
Figure 3a ► p. 118

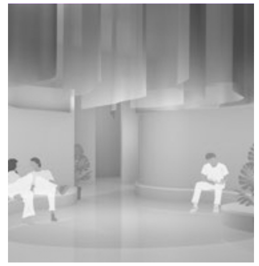
Figure 4a ► p. 119


Figure 5a ► p. 120


Figure 3b ► p. 118

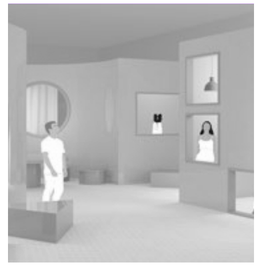
Figure 4b ► p. 119


Figure 5b ► p. 120

Figure 3c ► p. 118

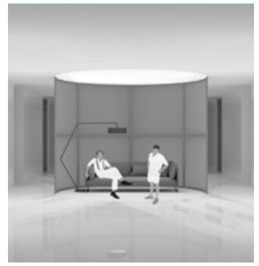
Figure 4c ► p. 119


Figure 5c ► p. 120


Figure 3d ► p. 118

2
Text edited by author, based on the studio description by Leora Berry, Omri Levy, Rachel Gottesman, and Roee Dowek.

large supermarkets, health facilities, food facilities, logistic and management areas, storage spaces, and quite often large areas allocated for private vehicles. Although these retail spaces are usually planned as a flexible space, they are carefully orchestrated to provide a seamless consumer experience. Any proposal for change must primarily understand this logic to offer legitimate substitute programs and scenarios. The approaches below introducing new forms of exchange, social interaction, and redistribution question current strategies of dealing with social, political, and environmental crises. Through unconventional hybrids and juxtaposition of intentions, they encourage continuous change, presuming that the new real might well be a gradual shift rather than a fixed state of reality.[2]

SYNTHETIC LANDSCAPES
(Dan Hasson, Rachel Gottesman, Dor Schindler, Noa Guy, Tamar Ofer)

The recent global pandemic is just one factor in an ongoing transformation of cities worldwide, a process led by powerful natural forces which are radically changing the future of cities and the way we live our lives. The COVID-19 pandemic, global warming, extreme weather events, loss of open spaces, pollution, extreme damage to natural habitats, and biodiversity loss are creating a multifaceted crisis, forcing us to rethink our relationship with the environment and question the fundamental anthropocentric notion that humans can treat nature as a resource and a playground for our needs and fantasies.

Urbanization and industrialization began in Mandatory Palestine in the

"As with diseases and pandemics throughout history, a new challenge has arisen to the very idea of the city, the culmination of density, congestion and togetherness, and the inverse of social distancing."

Figure 6a ▸ p. 120

Figure 6b ▸ p. 120

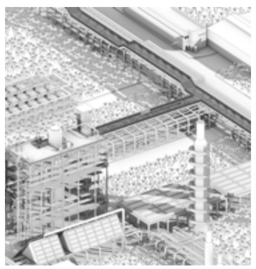

Figure 7a ▸ p. 123

Figure 7b ▸ p. 123

1920s and accelerated after 1948, with the foundation of the Israeli state. Within a few decades, the local landscape experienced radical transformations, which resulted in numerous environmental, spatial, and social challenges. Our studio studied these historic developments of cities in relation to their natural environment and focused on understanding these underlying natural structures, lost landscapes including river beds, sand dunes, marshlands, forests and chalk ridges. These had seemingly vanished but reappeared in the urban fabric as destructive forces, floods, wildfires, and pollution, thus transforming cities into constant friction zones.

One such site is the refinery industry in Haifa, constructed in the 1930s by the British colonial government at the bank of the Kishon River on sand dunes below Mt. Carmel. The development of the refineries resulted in complete destruction of the natural environment: seasonal wetlands were drained, sand dunes were flattened and paved, the course of the Kishon River was diverted, and its water heavily polluted. The whole of Haifa Bay now suffers from massive air pollution with severe impacts on public health. Soil, water, and air pollution spreads far beyond the limits of the industrial zone, with grave effects on both the population and the now gone natural environment.

The aim of the eco-historical site analysis and design strategy is to rethink these friction zones as a middle ground, mediating between environmental and urban systems, reframing the hierarchies of human and non-human, and offering opportunities to decolonize natural elements within the urban field.

LIFE ITSELF
(Alon Sarig, Georgia Hablutzel, Daniel Finkelstein)

Following *D:ream* 1990's (D:ream, 1994) distinctive call for celebration,[3] our studios decisively oppose the all too frequent usage of trendy terms such as crisis, catastrophe, emergency, and other current psychoses and apocalyptic anxieties. This unpopular but fun resistance has fortunately left us enough architectural and academic space to deal with 'life itself' (AdomediaTV, 2015).[4]

By accepting this methodology, one that deals mainly with the banality of good rather than the banality of evil, our studios aim to joyfully explore the current architectural affair between the contemporary home and the building. They look closely at alternative modes of dwelling impacted by our current domestic realities such as non familiar shared homes, self-sustaining and off-grid housing, new work-home relations, and more, and propose alternative, correlative spaces and structures.[5]

HAIFA BAY
(Zvi Efrat, Lior Ramon, Ido Levi, Elvira Turek)

'To understand the kind of damage that climate change will inflict, look at COVID-19 and spread the pain out over a much longer period' (Gates, 2020).

Gates's prognosis stresses the fact that the global pandemic, as well as presenting a great deal of challenges with current struggles, gives us a glimpse into the potential challenges of the coming decades. COVID-19 is not merely a health catastrophe, just as climate change is not only an environmental predicament. They are both socio-political crises that illuminate the ills, conundrums, and prospects of our society and our cities. Hence, architects must realize that current circumstances require re-examination and challenge of existing conceptions of the discipline.

The Haifa Bay Studio focused on the industrial area of Haifa Port. Haifa's modern port has been intertwined with local history for decades, from the British Mandate, through the establishment of the state of Israel, and up to the present day. Its industrial area comprises industrial and commercial complexes that serve a comprehensive range of national operations as well as several medium-sized private companies. In accordance with the modernist planning of its time, the port was designed within a segregated designated zone. As a result, the port of Haifa has become an inacces-

3
'So teach me now that things can only get better / Only get, they only get, take it on from here / You know, I know that things can only get better' (D:ream, 1994). D:ream were a one-hit wonder duo. Their song Things Can Only Get Better, The UK Labour party used the song as a theme during the party's successful campaign in the general election of 1997.

4
Benjamin Netanayhu used this term at a conference in February 2015 in front of supporters and Likud party members. The conference took place in the Israeli Ma'ale Adumim settlement. 'The biggest challenge we face, in our lives as citizens of Israel and as a country, is the threat of Iran arming itself with nuclear weapons. People talk about housing prices and the cost of living, but I do not forget the matter of life itself' B. Netanayhu. Perhaps in a provocative way, the student work reclaims life itself as belonging to the everyday home rather than geopolitics.

5
Text edited by author based on studio description by Alon Sarig.


Figure 8a ► p. 125


Figure 9 ► p. 123

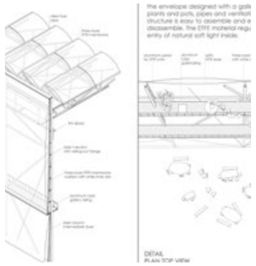
Figure 10a ► p. 125


Figure 8b ► p. 123

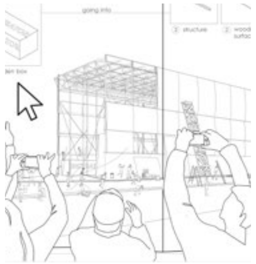
Figure 10b ► p. 125

sible, hostile, and polluted space, a buffer between the city and the sea.

Industrial areas in city centres, and that of Haifa in particular, exemplify the great difficulty of an architectural operation in the pandemic and the climate crisis. They reflect the economic, ecological, and social forces that shape our city. We at Haifa Bay Studio invited students to take a stand and to mediate those forces to ensure a positive future for this area and the city.[6]

FIVE PRINCIPLES OF THE NEW REAL

'The space of flows ... links up distant locales around shared functions and meanings on the basis of electronic circuits and fast transportation corridors, while isolating and subduing the logic of experience embodied in the space of places' (Castells, 2001, p. 155). Throughout these studio works, the common quest for a new form of situationism clearly emerges, dismissing modernist principles of functionalism and efficiency, searching for new icons of a postcapitalist society, arguing for slowing down, recycling spaces of capitalism and blurring programmatic distinctions. At the same time, these approaches accept our new state of being through utopian, dystopian, and sometimes cynical stances. The space of flows (Castells, 1989) allows for real-time synchronous interaction over great distances and reframes the need for physical space to be an overarching, all-encompassing organizational system. But in contrast to Castells, these projects do not accept the idea that the new space of flows will dominate the 'space of places.' Instead, these new spaces, facing contemporary environmental, social, economic, and political challenges, will adopt alternative tactics and strategies of survival that can be characterized by an evolving list of principles::

1 *Scales of Duration*
Architectural design approaches in cities of the new real, such as those presented above, will be developed at different scales of duration, addressing temporary scenarios, expiration dates, circular processes of recycling waste, buildings, and urban fragments, oscillating between night and day, and navigating peaks and valleys in waves of external threats to urban life.

2 *From Void to Vacuum*
Interventions in built and open spaces will search for the voids that have been created by evolution, revolution, and trauma. Design strategies will avoid filling these voids but rather redefine their edges and their roles within the surrounding context as a vacuum that has the ability to remain open and at the same time provide a platform for temporal togetherness.

3 *Elements of Slowness*
The architectural project relies more than ever on understanding its own timeline and the way in which it participates in processes of change. As opposed to Aldo Rossi's primary elements in The Architecture of the City, which had the capacity of accelerating urban transformations, these new primary elements promote processes of slowing change.

4 *The Programmatic Blur*
The recalibration of the relationships between time, space, distance, and simultaneity and the understanding that we have the ability to withdraw into cocoons at any time when triggered by outside threats has led to the understanding that any space will have to be able to adapt in real time to multiple programmes. Architecture thereby becomes the act of recalibrating usage of spaces, providing opportunities for programmatic blur, and creating an opportunity for typological hybrids yet to be explored.

5 *Polarized Environments*
As a broader sociological phenomenon of the inverted Gaussian curve, where extremes become more common than the average middle ground, spaces will accommodate the possibility of polarization without judging the pernicious effects of segregation. Polarized environments can become strategies for separating human presence from sensitive ecosystems, private from public, and global from local, delineating their boundaries without regretting the distinction and accepting the impossibility of harmonious coexistence.

This growing and evolving list of principles reflects a new form of realism, moving between utopia and dystopia but rejecting the idea of a functionalist, engineered environment. They present a new situationism that searches to re-establish the significance of a messy, incomplete, and inefficient architecture of built and unbuilt environments, coordinated with spaces of flows but establishing its own rules of engagement.

6 Text edited by Author, based on studio description by Zvi Efrat.


Figure 11 ► p. 125


Figure 12 ► p. 125


Figure 13a ► p. 127


Figure 13b ► p. 127

AFTERWORD
(Ifat Finkelman, Head of Foundation Studies, Department of Architecture, Bezalel)

We design buildings that will stand 'forever', or at least for generations after they have been designed and built, assuming we have the power to predetermine the purpose of each space in the building for many years, perhaps forever. The environment that was perceived by modernists about a century ago as tabula rasa is no longer empty. We build in a built space that changes rapidly and in an open space inhabited not only by humans.

In an age of constant change, is there more room for architecture that will last forever? What will a building look like if it is to retain its relevance for many years to come? The action in urban environments provokes a lively debate on the question of the need for new construction and encourages a re-examination of the existing and an exploration of its financial, technological, political, environmental, and social contexts.

Within these contexts, the notion of 'users' is replaced by 'stakeholders' that expand beyond the anthropocentric worldview to a more-than-human one, whereas processes and changes that occur over time lead to scenario planning that takes over the 'programme' and recognizes that time and temporality are necessary variables for practicing, teaching, and discussing architecture.

When it comes to the education of architects, this 'reverse play between architecture and its context ... in which for a particular duration studying the context of architecture takes priority over studying architecture itself' as proposed by Reinier de Graaf (2015, p. 85), is inevitable in our efforts to provoke and encourage meaningful critique while conveying the knowledge of architecture.

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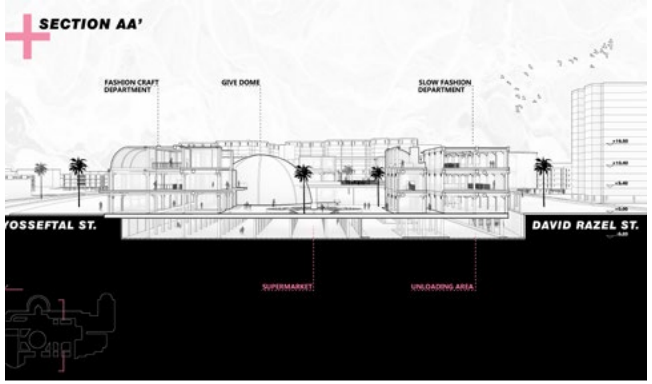
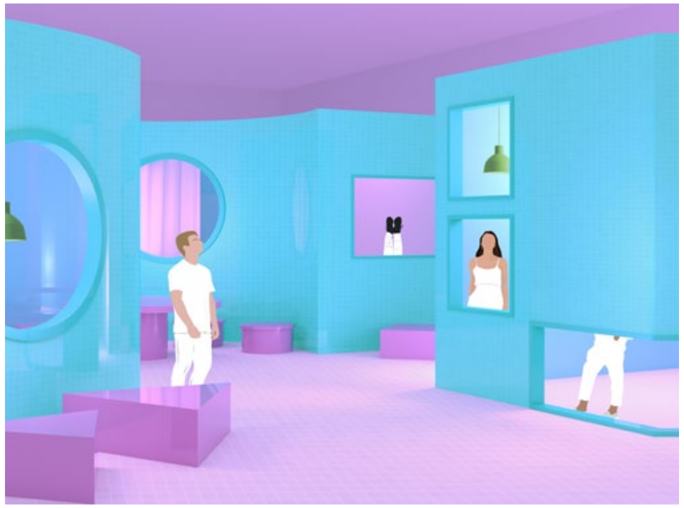
Figures 1a b c
The Urban Vacuum redesigned the vacuum as a space that is continually changing without hierarchy or regular form, funnelling the particulars of city life yet always remaining unspecified. The design intervention re-signifies the void without overfilling or erasing the wounds it represents. To allow informal uses to take place, the project retains one constant, the location of the Wednesday market stalls, which have not changed for decades as they are passed on from father to son. The project focuses on defining edges such as buildings, tiered seating, and storage and strengthening urban connectivity, internal courtyards, community facilities, and programmatic flexibility and versatility (graphics by students: Yael Benayoun and Oneg Yehuda Altshuler, 3rd year; teachers: Sagit Yakutiel and Lealla Solomon, Bezalel Academy of Arts and Design, Jerusalem).

Figure 2
NOT / In my Back Yard revisits the opportunities of illegal waste collected from unused sites and proposes an architectural solution to reuse and recycle locally in an urban event. The project surveyed and catalogued the variety of waste found on sites and the possibilities of reuse and recycling to create a toolbox of usable materials based on lifespan and availability of raw materials and their usage in construction. The proposed urban conversion site included three urban scales: the fair, a vertical iconic recycling landmark; the plot, an empty parcel used for the conversion process while waiting for future development; and the truck, an educational recycling vehicle that wanders about the city (graphics by students: Kfir Maccabee and Tomer Malka, 3rd year; teachers: Sagit Yakutiel and Lealla Solomon, Bezalel Academy of Arts and Design, Jerusalem).



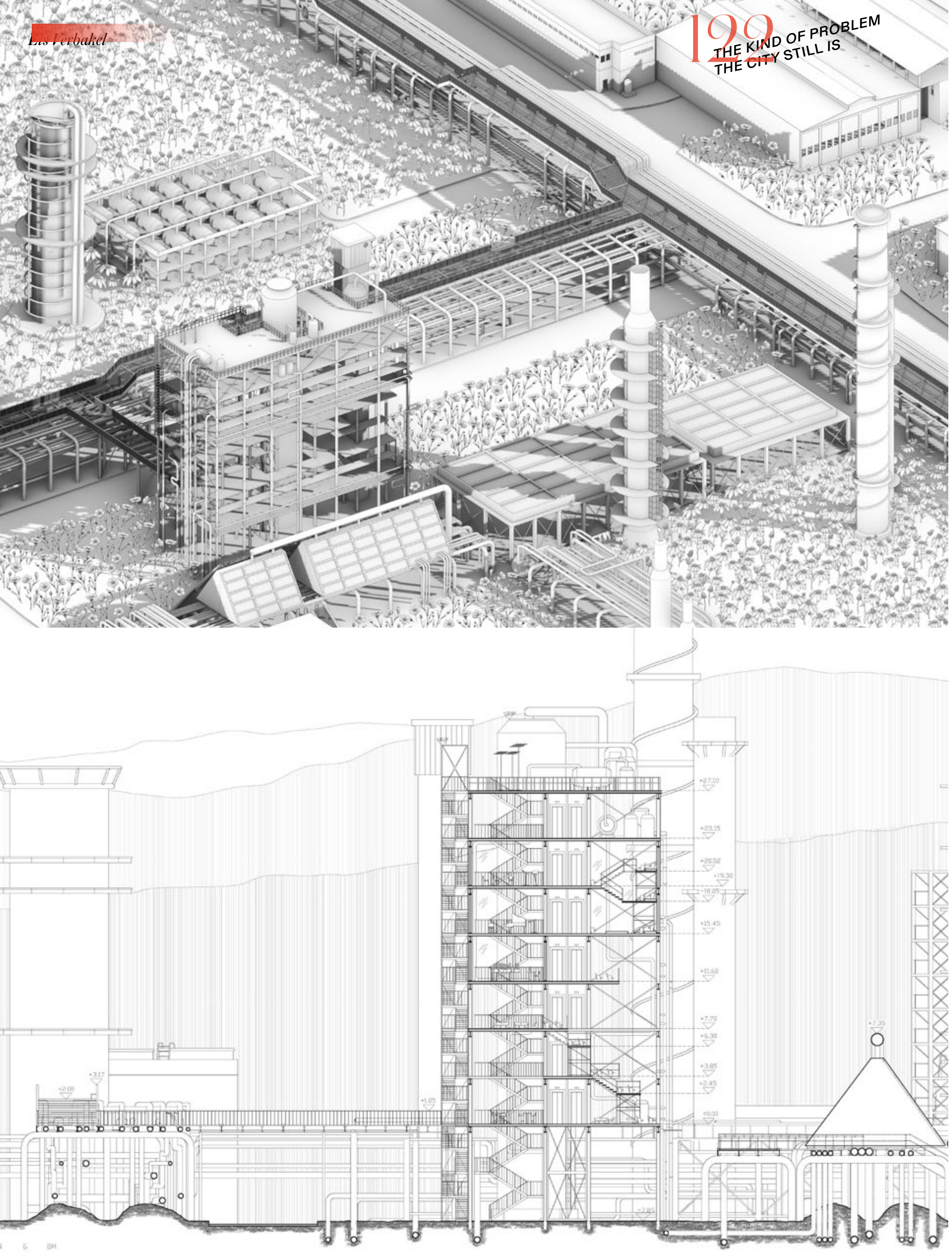
Figures 3a b c d
The New Mall proposes to re-form the way society addresses commerce by slowing its pace and adopting practices of reuse, repair, and recycling for used commercial goods. The central atrium was turned into an open public area that seamlessly connects the pedestrian paths originally proposed in the historical masterplan. The New Mall becomes a place of ex-change, adjustment, and trade in clothes, furniture, electrical appliances, games, and any other product or goods that someone might find valuable (graphics by students: Yoav Shayovitz and Iris Ben-Ichu, 3rd year; teachers: Leora Berry, Omri Levy, Rachel Gottesman, Roee Dowek, Bezalel Academy of Arts and Design, Jerusalem).

Figures 4a b c
After the decline of commercial traffic in the Ness-Ziona mall, its current attractions are its health facilities. The proposed Ness-Ziona Matchmaking Terminal divides the mall into a synchronic system, completely separating the existing urban health facilities placed on the outer shell from a new central destination in its core. The interior space functions as a matchmaking terminal where single women and men enter via a future metro station and spend time in search of a romantic match. The NZMT polarizes the connection between public health and human interactions and encourages rethinking of the physical spaces needed in our future environments, adding new opportunities to today's virtual dating apps (graphics by students: Naomi Van-Essen and Meidan Loya, 3rd year; teachers: Leora Berry, Omri Levy, Rachel Gottesman, Roee Dowek, Bezalel Academy of Arts and Design, Jerusalem).



Figures 5a b c
The Kiryat Malachi Social Mobility Centre introduces an innovative educational approach into an existing commercial power centre, transforming what was once an inequality generator. The project suggests a possibility for change, integrating the educational hubs within the commercial ones and creating a direct pedestrian connection between the city and the site. By doing so, the project reimagines the commercial centre as a place for education, civic exchange, and redistribution, giving the citizens new tools and resources for social mobility (graphics by students: Talia Raviv & Mohar Cohen, 3rd year; teachers: Leora Berry, Omri Levy, Rachel Gottesman, Roee Dowek, Bezalel Academy of Arts and Design, Jerusalem).

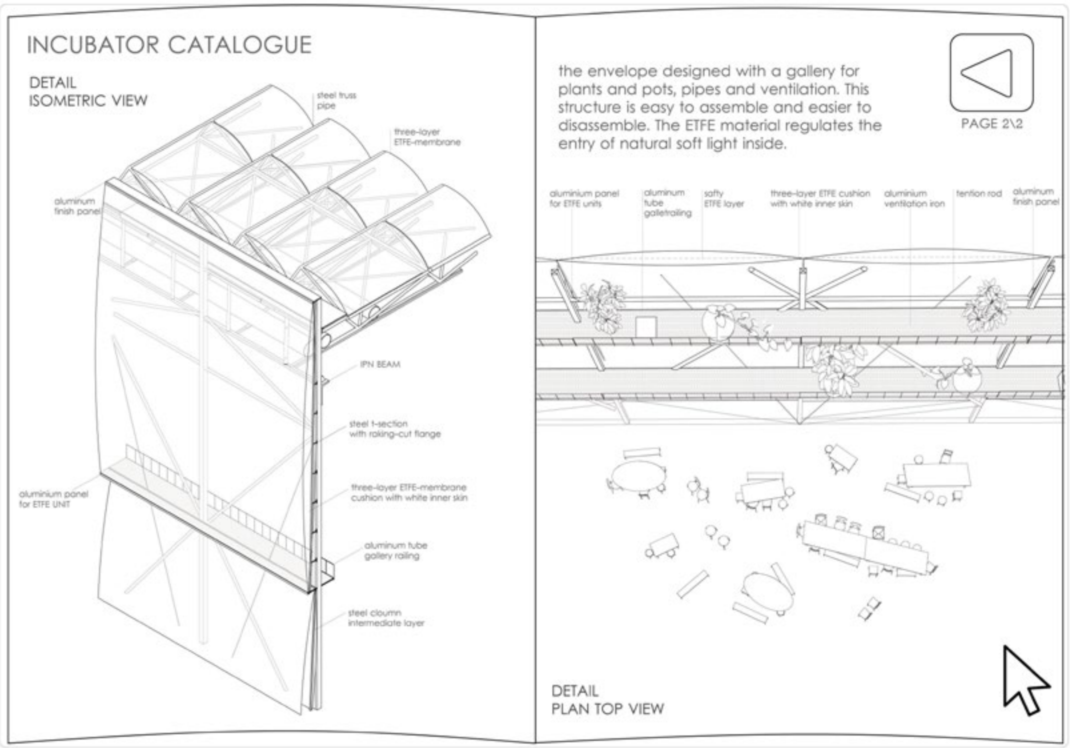
Figures 6a b →
The Black Gold' project (2021) offers an in-depth ecological and historical site analysis of the refinery area based on elaborate mapping and historical aerial photos. The students reconstructed the bay area at the end of the 19th century, when the place was an open natural landscape with a small fishing village, and then traced 100 years of development, civic engineering, infrastructure construction, urbanization, and pollution. The project calls for a stop to the refinery's activity and offers a slow-paced strategy of soil biopurification that uses plants and fungi. This strategy allows the ground to slowly recover while nursing a botanic ecosystem that reintroduces nature to the city (graphics by students: Shira Drach and Hadar Aspir, 3rd year; teachers: Dan Hasson, Rachel Gottesman, Dor Schindler, Noa Guy, Tamar Ofer, Bezalel Academy of Arts and Design, Jerusalem).



Figures 8a b
The BOIDEM by Yuval Maya Cohen is a critical response to one of the greatest contributions of Yiddish culture to the current Israeli homescape: the Boidem, a home for old (Alte Sachen) or unused domestic objects, furniture, and other daily items trapped between the floor and the ceiling. In her project, Cohen explores fundamental issues of space and storage, obsessive consumption, and accumulation, while offering a new architectural relationship between everyday objects, space, and human beings (graphics by student: Yuval Maya Cohen, 2nd year; teachers: Alon Sarig, Georgia Hablutzel, Bezalel Academy of Arts and Design, Jerusalem).

← Figures 7a b
The Wadi (stream) project analyses the main highway and train system of Tel Aviv metropolis, which was constructed in the river bed of Ayalon River, which flows only in the rainy season. The historic river was a fundamental landscape feature and part of an agricultural ecosystem that supported countryside settlements for hundreds of years. Despite repeated attempts to control the water flow, the highway and railroad suffer from seasonal floods that interrupt the city's traffic and cause great economic damage. Forecasts indicate that the road and railroad infrastructure would need to continue to expand to respond to increasing traffic needs, which will result in further damage to the river. The students propose a new, vertical relationship between the city's infrastructure and the river, thus reconstructing the historic ecosystem of the river and its agricultural surroundings while implementing an efficient traffic system (graphics by students: Yssaf Ohana and Ofri Halevi, 3rd year; teachers: Dan Hasson, Rachel Gottesman, Dor Schindler, Noa Guy, Tamar Ofer, Bezalel Academy of Arts and Design, Jerusalem).

Figure 9
Alma Rotkopf-Kishon's project, Get-A-Room, aims to create a social network in the body of a building. It is a semi-private, sem-icommunal co-living complex divided into rooms rather than apartments. The project questions how contemporary habitats can adapt themselves to various settings ranging between the individual and the commons (graphics by student: Alma Rotkopf-Kishon, 2nd year; teachers: Alon Sarig, Daniel Finkelstein, Bezalel Academy of Arts and Design, Jerusalem).



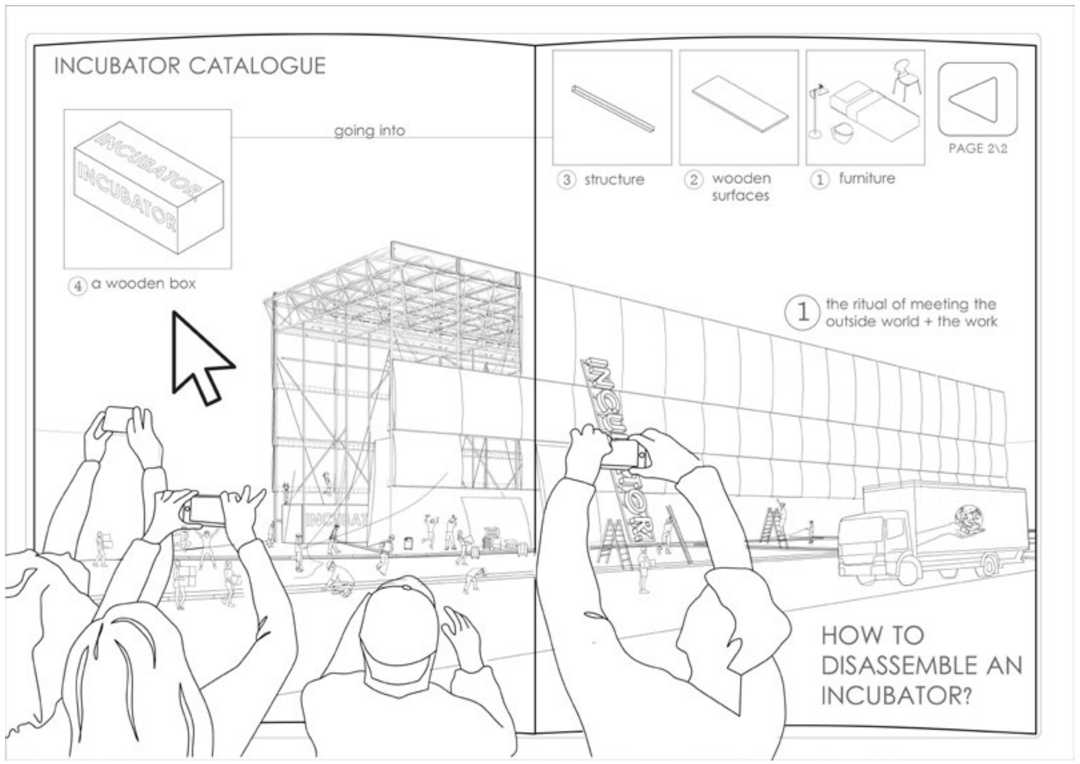


Figure 11
In the Resurrection project, Gilad and Omer propose a roadmap for the regeneration of the industrial area of Haifa Port as a productive urban centre which fits the values of the 21st century. Through a series of interventions on existing infrastructure and on-site industrial architectural typologies that complement a gradual environmental rehabilitation of damaged land, the proposal aims to bridge between the history and legacy of industry to its future (graphics by students: Gilad Zimnavoda and Omer Graf, 3rd year; teachers: Zvi Efrat, Lior Ramon, Ido Levi, Elvira Turek, Bezalel Academy of Arts and Design, Jerusalem).

← Figures 10a b
In the The World Wide Incubator, Yssaf Ohana re-examines one of today's most unique architectural work-home examples to vernaculars of capitalism: the Incubator. Ohana proposes to critically analyse the wisdom of these traditional self-sustaining, suburban 'McMansion' incubators and transform them into an urban mechanism that operates at three scales: the globe, the building, and the home. Ohana's World Wide Incubator suggests a self-sustaining off-grid platform that provides for all the needs of its inhabitants: food, work, leisure, and maybe even the possibility of falling in love. While blurring the traditional boundaries between the home and the globe, Yssaf's project creates a time-based, architectural instrument for every possible sort of work (graphics by student: Yssaf Ohana, 2nd year, teachers: Alon Sarig, Daniel Finkelstein, Bezalel Academy of Arts and Design, Jerusalem).

Figure 12
The In Situ project by Liron and Eden aims to challenge the architectural and planning conceptions of industrial zones by recycling waste and building materials on site. At the urban scale, a series of axes and parks that rely on artificial waste-based topography are proposed to link the industrial area to the city. At a building level, a vocational school is to be built that will replace the old, introverted, generic, and disposable industrial typology with accessible, ecological, and humane architecture (graphics by students: Liron Braier and Eden Hen, 3rd year; teachers: Zvi Efrat, Lior Ramon, Ido Levi, Elvira Turek, Bezalel Academy of Arts and Design, Jerusalem).

← *Figures 13a b*
In their Post Industrial Beach project, Shai and Alma reimagined Haifa port as a natural space in its pre-industrial state of a large-scale sandy beach. The new pseudonatural beach, reappropriated by and for the city, establishes three interconnected areas consisting of modular units of light architecture, which will facilitate a range of public uses (graphics by students: Alma Kishon and Shai Keselbrener, 3rd year; Teachers: Zvi Efrat, Lior Ramon, Ido Levi, Elvira Turek, Bezalel Academy of Arts and Design, Jerusalem).

“This new tension field of redefining the relationship between real physical space and real synchronous time versus virtual space and asynchronous time, has become our default modus operandi.”

LOCATION, LOCATION, LOCATION [PROXIMITY]

LOCATION, LOCATION, LOCATION [PROXIMITY]

LOCATION, LOCATION, LOCATION [PROXIMITY]

LOCATION, LOCATION, LOCATION [PROXIMITY]

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Krøyers Plads, Copenhagen (photograph by Rasmus Hjortshøj).

ABSTRACT

Although some definitive transformations have been brought on by the COVID-19 pandemic, not least the spread and adoption of remote working practices across diverse sectors of the economy, the ones commonly discussed are not entirely novel but an intensification of pre-existing trends. In this chapter, I argue that although the ongoing pandemic undoubtedly presents challenges to the management, organization, and implementation of workplace cultures, greater problems are posed by changes. Given the ongoing sprawl of work across multiple spaces, including offices and homes, it is realistic to assume that changes in the spatiality of work will affect property costs, taxes, and the structure of municipal—and private—budgets, as well as investments. Drawing on discourses in real-estate markets in Toronto, Canada, I conclude that as researchers and practitioners we need to concern ourselves more seriously with the long-term implications of changing real-estate markets and costs; more specifically, the latter are likely to exacerbate existing, pre-pandemic challenges that we did not manage to resolve even at a time of relative calm.

KEYWORDS
COVID-19; corporate office; real estate; remote work; urban planning.

Chapter 7—The Importance of Being Earnest: About Pandemic-Driven Changes in the Function and Valuation of Workspaces, and the Financial Interests Underlying Real Estate Markets

Filipa Pajević

The COVID-19 pandemic has accelerated trends and challenges in office-based work and workplaces already underway. The increasing mobility, flexibility, and digitization of work, the worker, and the workplace were affecting the spatial organization of work long before the pandemic had struck, by extending the spatial boundaries of the office and dissolving the barriers between corporate and private domains.

The novelties of office-based work brought on by the COVID-19 pandemic have less to do with organizational and spatial fluidity of work and the worker, and more with the absorption of digital and remote working practices across economic sectors that previously lacked the capacity. Although the ongoing pandemic undoubtedly presents challenges to the management, organization, and implementation of workplace cultures, greater problems are posed by the valuation of physical workspaces, whether offices or homes, and the impact of these changing values on property costs, taxes, and the structure of budgets and spending. Drawing on discourses in real-estate markets in Toronto, Canada, I argue that as researchers and practitioners we need to concern ourselves more seriously with the long-term implications of changing real-estate markets and cost structures, as the latter are likely to exacerbate existing, pre pandemic challenges that we did not manage to resolve even at a time of relative calm.

Structured in three parts, this chapter first presents a brief overview of the more recent literature on pandemic-driven changes in office-based work, drawing from a recent issue on COVID-19 by the Journal of Corporate Real Estate. This is followed by a presentation of key themes and challenges as identified by the real estate and planning community in Toronto during the ULI/PwC Annual Trends in Real Estate 2021, and the 15th annual Post City/Streets of Toronto Real Estate Roundtable, hosted by the Rotman School of Management, University of Toronto, in 2022. The rest of the chapter reflects on implications for the future of work, real estate, and cities more broadly as we continue to grapple with an increasingly digital, flexible, mobile, and remote workforce. The main purpose of this chapter, and its key contribution to the broader discourse on post-pandemic futures, is to highlight the need to better understand the conversations in real estate as well as key trends, because the former contain essential clues about investor interests that often dictate the extensiveness and impact of the latter. I argue that the impact of COVID-19 on places and spaces used for work is a function of changing organizational and individual needs as well as changing investor and developer interests.

COVID-19 AND THE PHYSICAL WORKPLACE: AN OVERVIEW OF RECENT LITERATURE

When the first wave of COVID-19 deprived downtowns and inner-city neighbourhoods of office workers and supporting economic activity, legitimate concerns surfaced about the health and welfare of workers as well as the future of the corporate office, the most valued segment of commercial real estate (Hernandez-Morales et al., 2020; Thompson, 2020). This in turn prompted questions and discussions about the future of downtowns and buzzing neighbourhoods as well as the continued functioning of services such as public transport in the face of changing commuter needs. Moreover, as urban planning scholars and practitioners, we felt compelled to revisit, and possibly rethink, some of our long-standing assumptions about how and where we work in cities. Although some definitive transformations have been brought on by the COVID-19 pandemic, not least the spread and adoption of remote working practices across diverse sectors of the economy, the ones commonly discussed are not entirely novel but an intensification of pre-existing trends.

For example, a recent study of 'COVID-working' in Italy shows that office-based work is performed from multiple locations, with the office becoming an option rather than the definitive, established place of work (Tagliaro & Migliore, 2021). Locations other than the home and the office include coworking spaces, neighbourhood cafés, and any space that can serve as a temporary workplace. The authors conclude that these changing workplace locations and patterns of working demand a rethinking of organizational values and cultures and of management practices in virtual work environments. They also suggest that remote working, or working from home (WFH), may improve gender inequality despite posing challenges to maintaining productivity in a largely familial and therefore often distracting and disruptive setting. However, none of these observations point to a new or profoundly revolutionary way of working. Indeed, the office is but a node in a network of workplaces, and this may not be a direct result of the pandemic, but merely an acceleration of changes in ways of working that were already afoot before the pandemic struck. Sociology, management, and urban studies scholars have been discussing the 'extendedness' and the increasingly 'fuzzy' boundaries of the traditional office for some years (Halford, 2005; Kingma, 2016; Martins, 2015; Richardson, 2020; Shearmur, 2020). These earlier studies show how workers in predominantly knowledge-intensive occupations balance the need for mobility and 'digital multipresence' by frequently changing work locations or adapting spaces to the needs of the task at hand (Brown & O'Hara, 2003; Hislop & Axtell, 2007; Koroma & Vartiainen,

2018). This means that the real novelty of COVID-working is the pervasiveness of remote working and the swift adoption of digital workplace technologies across multiple economic sectors that are not limited to knowledge-intensive sectors and occupations. Essentially, COVID-19 is accelerating existing trends rather than radically transforming the corporate office (Pajević, 2021; Shearmur et al., 2021). Consequently, it is too soon to determine the extent to which WFH has improved or exacerbated gender imbalances at work and at home; more research is needed to assess if and how gender relations have been restructured by COVID-19.

Other reflections on pandemic-driven changes in work and workplaces discuss the ubiquity of virtual work environments and the ever-increasing reliance on digital tech, applications, and mediation devices to survive the workday (Horváth et al., 2021). Indeed, Horváth et al. explore the limitations of digital and remote working in higher education institutions. The authors argue that the two-dimensionality of the digital workplace cannot yet replace the benefits of a physical workplace; they conclude that until the technology evolves to rival the benefits of a physical space, digital workplaces should only serve to complement an existing physical work environment and to support workers' needs. Again, although these are useful and valuable observations of work during COVID-19, they do not signal a profound change in attitudes towards remote working and digital workplaces. Earlier studies of teleworking, homeworking, and the digitization of work tasks and processes concluded that the needs for face-to-face interaction, chance 'watercooler' encounters, and office gossip continue to require a shared, communal workspace (Axtell et al., 2008; Graham, 1998; Hislop & Axtell, 2009; Kingma, 2018; Messenger & Gschwind, 2016; Pajević & Shearmur, 2017; Vilhelmson & Thulin, 2008). This suggests that, irrespective of how advanced and immersive virtual realities become, they cannot eliminate the need for and benefits of in-person interaction, which will remain fundamentally an activity rooted in physical places. In other words, places will continue to matter, albeit less frequently and more fleetingly.

Thus, the acceleration of the rate at which different spaces are used for work at different times during the day, week, month, and year, is not a pandemic-induced change in the world of work (see for example Brennan-Horley, 2010; Elliott & Urry, 2010; Urry, 2007). That said, what will be a direct outcome of adjusting to the COVID-19 pandemic will concern speculation in and development of office spaces when building investment portfolios and securing long-term returns. Exploring 'disrupted' real-estate markets in the UK, which suffered extra disruption due to Brexit, Seger et al. (2021) show falling rates of property ownership primarily because of financial anxieties. A reduction in office footprint and ownership are seen as a risk-averse, cost-saving strategy with immediate benefits in that corporate spending can be directed to other endeavours. Similar changes in real-estate markets were also observed in Canada, with companies opting to rent rather than own their official workplaces. Moreover, there has been a premium on flexible leases to better cater to any economic or other fluctuations, whether external, such as the pandemic, or internal, such as organizational restructuring. However, such premiums on flexibility have exacerbated real estate costs and, in turn, put greater pressure on companies to pursue and support remote working options (Pajević, 2021). This suggests that pre-pandemic corporate real-estate markets in Canada, and possibly elsewhere, had already witnessed a change in property valuation and ownership, but for reasons likely arising from the lack of proper mechanisms to counter and regulate markets. Indeed, recent pre-pandemic research on the impact of mobile workers, including remote ones, on urban planning in Europe show a difficulty in establishing the administrative boundaries that have previously defined land-use and function, thereby creating something of a conundrum for planners and policymakers, not least in zoning and development (Di Marino & Lapintie, 2018; Marino et al., 2021). In the next part of this chapter, I focus on the more pressing effects of COVID-19 identified by the real estate and planning community in Toronto, Canada.

REMOTE FRIENDLY? REMOTE FIRST? REMOTE ONLY? THE OUTLOOK IS MURKY

The following insights were collected from two virtual real estate events, one organized by the Urban Land Institute in 2021 and the other hosted by the Rotman School of Management, University of Toronto, in 2022. Both are round-table panel discussions on the current state of real estate in the Greater Toronto Area (GTA) and examine the latest trends and projections for the future. It is important to mention that for the purposes of this chapter, I will only be focusing on office and housing real estate. Moreover, with WFH and the blurring of corporate and private domains, it is impossible to examine office real estate without looking into how COVID-19 and remote working has affected the other workplace: the home.

Overall, the discussants and panellists agreed that the outlook is murky. It is simply too soon to tell what businesses are going to do and what will affect future investment in office real estate. However, concerns have arisen that both office real estate and housing have become a financial mechanism for generating wealth, and so there are vested interests in maintaining high values. At the close of 2021, warehouses and medium-income homes were at the top of the list for investors. The office sector was, and continues to be, under substantial pressure, but not for lack of demand; in fact, investors are continuing 'to bet on the office', but there are concerns about the future of older, less conveniently located office buildings. Regarding a permanent or a temporary shift to remote work, most discussants agreed that 'office uncertainty' will remain for a while. This is not because of COVID-19 per se, but rather due to uncertainties regarding how, when, and who will return to and use the office now that flexible and hybrid working arrangements are in high demand. The consensus is that the office is going to remain important but will 'look different' because the emphasis will be on 'programming an office experience'. Office design will be essential because the amount of time spent at the office, however brief, will be vital for building and maintaining a corporate culture and building trust among employees. In sum, changing patterns of working are a factor in how office real estate will evolve, but equally important are investor interests and speculation about the value of top-tier office space, especially once it has been redesigned to prioritize work culture over the work itself.

Concerning the housing market, the shift to remote work created the possibility to move to more affordable and more spacious locations outside of the city core. This fuelled the growth of suburban markets, exacerbating rents and values of properties outside of the city centre. However, though it had been anticipated that costs of properties in inner-city neighbourhoods would plummet due to low demand, the dip was small and temporary, and housing in these areas remained out of reach for a growing majority. As a result, finding affordable housing both in and out of the city centre became quite the quest. The suburban markets were inflated by demand, and high values in inner-city neighbourhoods were maintained by investors and buyer (and borrower) incentives. Indeed, low interest rates kept housing markets resilient throughout the pandemic, with borrowers and mortgage-holders scrambling to secure ownership before interest rates returned to pre-pandemic levels. In the absence of specific programs and policies to decouple affordable housing from market-based valuation practices, Toronto's

"Remote friendly?
Remote first?
Remote only?
The outlook is murky."

housing situation will continue to be a challenge for low to middle-income residents.

The discussants cautioned against raising interest rates in response to the ongoing high demand for housing in suburban markets, expressing concern over misinterpreting high demand for capacity to afford (especially considering that prematurely raised interest rates contributed to past crises). Inflation, a changing and increasingly insecure labour market, in tandem with ongoing speculation over property values will undoubtedly restrict access to housing even more, and yet there is little consensus over how to prevent or even just stall these unwanted effects. Some discussants were in favour of more housing supply and density, others pushed for development in the suburbs (i.e. sprawl), and the remaining few saw no path forward without the combined effort of public and private institutions in the form of regulation. There are too many opposing views and far too few viable proposals to prevent Toronto's housing markets from becoming impossible to navigate in the near future.

MUCH TO DO ABOUT EVERYTHING

As a result of the COVID-19 crisis, more sectors and occupations have become 'remote friendly', and those with existing remote-working capabilities are exploring 'remote first' and 'remote only' options as they look to a post-pandemic future. However, each of these options bears implications for office space users, holders, and investors. For companies, this poses new challenges for attracting and retaining talent; for investors, changes could signal a shift in property demand and values, especially in areas with a heavy concentration of office buildings and office-based workers, such as the downtown. And for workers, this could either improve or worsen access to employment and appropriate and affordable housing.

Although the real estate and planning community is cognizant of these changing market dynamics, I was surprised to hear hardly any mention of how COVID-19 affects the way we think about corporate real estate. There was no mention of it being seen as a long-term investment strategy for pension funds, or as an important source of municipal revenue (property taxes fund public services, including public transit). I consider this to be a substantial gap in the current state of knowledge on COVID-19 and its effects on real estate and cities more broadly. COVID-19 has accelerated pre-existing trends and highlighted points of tension, but the financial interests and mechanisms that underpin real estate market dynamics in cities remain enclosed in a blackbox with a tightly fitting lid. We will need to know more about these mechanisms to create better responses to the changing function and value of workspaces, not the least of which are corporate offices and our very homes.

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ABSTRACT

Although it may seem intuitive that people prefer spaces that are occupied to some extent and at other times are concerned by overcrowding, the tipping points at which a space becomes too empty or too crowded are difficult to define. In architecture and planning, new computational approaches such as space syntax and spatial network analysis allow designers to forecast aggregate levels of pedestrian flow and occupancy with remarkable accuracy. But is there really a single optimum occupancy? How does the design and aesthetic of spaces change our perceptions? These are some of the underlying questions motivating our research project, a Neuroscientific investigation of the Interaction between Crowdedness and Environment typology. Neuroscientific methods such as mobile electroencephalography have in recent years begun to change how we study the spontaneous and unconscious responses of people to their environment. In this chapter, we weave together a conceptual overview of how people perceive the environment, classic and contemporary approaches to crowding, and how neuroscience aspires to change urban planning.

KEYWORDS

urban design; social density; aesthetics; environmental neuroscience.

Chapter 8—Disentangling the Social from the Aesthetic: Neuropsychology for Urban Design

Panagiotis Mavros, Agnieszka Olszewska-Guizzo, and Dominique Makowski

Cities changed during the pandemic. Because of movement restrictions and lockdowns, downtown streets that used to bustle with crowds stood empty. Even today, business districts feel different because people have switched to working from home.

Figure 1 ▸ p. 151

INTRODUCTION

In some cities, the street space was reclaimed from cars and given to cafés and restaurants to set up outdoor tables at which their patrons could congregate more safely. These streets have changed too; now they are occupied by furniture instead of parking spaces, and most importantly, people can be seen at various times of day.

It is said that the sloped public square in front of the Centre Pompidou in Paris resembles a beach; it looks as welcoming when it is empty of people as when it is full. Indeed, no matter what time of the day one walks by, the space can be appreciated whether or not people are sitting, playing music, or watching impromptu performances. However, other places lose their appeal when they are too empty or too full of people; some streets feel overwhelming and exhausting, while others feel dull or unsafe. Can design features and aesthetics moderate the effect of occupancy, or of crowding, on how spaces are perceived?

Although it may seem intuitive that people prefer spaces that are occupied to some extent and at other times are concerned by overcrowding, the tipping points at which a space becomes too empty or too crowded are difficult to define. In architecture and planning, new computational approaches such as space syntax and spatial network analysis allow designers to forecast aggregate levels of pedestrian flow and occupancy with remarkable accuracy. But is there really a single optimum occupancy? How do the design and aesthetic of spaces change our perceptions?

These are some of the questions motivating our new joint research project, a Neuroscientific investigation of the Interaction between Crowdedness and Environment typology (NICE). Neuropsychology, the science of the relationship between mental activity and its brain substrates, is a relevant and promising approach to investigating the role of architecture and urban design in people's lives. The application of neuroscientific methods such as mobile electroencephalography has recently begun to change how we study the spontaneous and unconscious responses of people to their environments. In this chapter, we weave together a conceptual overview of how people perceive the environment, classic and contemporary approaches to crowding, and how neuroscience aspires to change urban planning.

REDEFINING URBAN VIBRANCY

From Jane Jacobs to William H. Whyte, Jan Gehl, and others, theorists and practitioners of urban design have also realized the multiplier effect of social presence for feelings of safety as well as for urban vibrancy and enjoyment. Interestingly, this social turn can be observed in recent trends in architectural visualization. However, we often use the term 'crowding', which carries negative connotations, across various domains of life from the depletion of attentional and cognitive resources to feelings of discomfort and stress, from housing (Evans et al., 2007) to public transport (Haywood et al., 2015), and even in retail and tourism (Yin et al., 2020). As a result, interest in the psychological effects of crowding on people is longstanding and often driven by residential and urban crowding. Early studies showed that higher social density reduces cognitive performance and elevates psychological and physiological stress (Saegert, 1973; Evans, 1979); more recent studies have shown that crowding can even skew perceptions of social class and product valuation (Baker & Wakefield, 2012). In such approaches, crowding is intrinsically viewed as something negative that has to be avoided through scheduling or design and planning. This is analogous to traffic in transport studies, which find that increasing the throughput of highways leads to increased driver satisfaction. But people walking in urban space are not the same as car drivers idling at a traffic junction.

The pandemic perhaps attuned us to the fact that social presence is also necessary for urban vibrancy. Indeed, in line with Hebb's (1955) theory of optimal arousal, there seems to be an inverse 'U' relationship between levels of crowding and willingness to visit urban public spaces (Nouri, 2011). Indeed, both our intuition and empirical studies suggest that a degree of social density is desirable and indeed even beneficial. This is the case for several social animals too: studies have shown that too little and too much social interaction are both detrimental for health (Love & Zelikowsky, 2020). In other words, moderate levels of social density are preferable, and spaces that are too empty or too full become less attractive.

There might be a difference between objective and subjective experiences of crowding. In the 1970s, researchers began distinguishing between the spatial condition of density and the psychological experience of perceived crowding (Stokols, 1972). Indeed, crowding can be measured objectively as people per unit of space, termed social density, or as people per metre per minute, termed pedestrian flow. In parallel, subjective assessments such as surveys can help gauge how people perceive and experience various levels of social density. Furthermore, perceptions of density and crowding appear malleable to a certain extent. The psychological perception of when a space feels crowded is not a stable construct based on the number of other people but is influenced by other personal, spatial, and behavioural parameters, from noise to room height. For instance, does a given number of

people per space feel the same in the double-height space of a library reading room or on the platform of a busy train station? Perceptions of crowding can be moderated by internal factors such as personality traits (Wiesenfeld, 1987), demographics (Yin et al., 2020), and social culture (e.g., contact vs noncontact cultures; Kaya & Weber, 2003). Environmental factors can also influence how social density is perceived, from neighbourhood density (Bonnes et al., 1991) to design (Evans et al., 1996). Indeed, our recent findings suggest that similar numbers in pedestrian crowds lead to different evaluations depending on whether these are experienced indoors or outdoors (Mavros et al., in review). Perhaps acknowledging the importance of social presence for urban affect, even architectural visualization is moving away from older paradigms of showcasing architecture without people; new rendering software includes increasingly realistic and often animated humans engaging in various activities from walking to jogging and street-dancing as a means to help stakeholders better imagine the experience of spaces as they would be built.

THE NEUROSCIENCE OF PEOPLE-ENVIRONMENT INTERACTIONS

Following the age of sanitary reform, post-industrial cities underwent a huge transformation towards provision of healthier living spaces. The focus was then placed on physical health and decreasing the spread of communicable diseases. Better ventilation in buildings and improvements in sewer drainage, water supply, and garbage removal led to major changes in the planning of urban neighbourhoods (Peterson, 1979). Another challenge to well-being resulting from city life recognized back then was cognitive overstimulation. As Frederick Law Olmsted, the 19th-century designer of New York's Central Park, wrote: 'A man's eyes cannot be as much occupied as they are in large cities by artificial things [...] without harmful effect, first on his mental and nervous system and ultimately on his entire constitutional organisation' (quoted in Beveridge, 1995, p. 36). Planners in this era sought to alleviate the overwhelming crowdedness by introducing nature into cities through 'breathing spaces': parks and outdoor recreation areas adjacent to working-class neighbourhoods (Corburn, 2007). The large open areas there promoted ventilation, and vegetation captured dust and toxins that would otherwise be inhaled by residents. In spite of clear improvements in living standards and lowering the burden of many dangerous infectious diseases through improved sanitation, the efforts of 19th century urban planners to alleviate the negative impact of post-industrial cities on mental health were unsuccessful.

Indeed, despite the clear improvement in living standards in cities across the world since the 19th century, although this admittedly varies across neighbourhoods and cities, the quality of our urban living environment is still, in many ways, innately defective. Studies consistently show that mental disorders such as depression, anxiety, and substance dependence are as much as 38 per cent more prevalent in urban populations than rural ones (for example see a meta-analysis of 20 studies by Peen et al., (2010)). The COVID-19 pandemic spurred increasing discussion on mental health in cities and how contact with urban nature helped keep people sane through all the associated hardships. Widely introduced lockdowns led to sensory deprivation from a limited diversity of environmental exposures, including exposure to nature; this drew attention by analogy to prison research. These studies have documented that living in confinement deprived of diverse stimuli for prolonged periods of time can lead to psychological distress (Hocking, 1970; Leiderman, 1962; Haney, 2003). As a potential alleviating factor, green space accessibility has been shown to be very important for city residents as a way to alleviate the stress and uncertainty arising during the pandemic (Da

"Aesthetic and other elements of the architectural environment interact with levels of social density to influence the subjective experience of urban spaces."

Schio et al., 2021; Vos et al., 2022). Such findings are a call for architects and urban planners to enquire how the planning and design of our cities and buildings contribute to social and psychological issues and what can be done to heal contemporary cities.

Thanks to years of research in environmental psychology, today, a consensus has emerged among scientists that urban green spaces are media of sanative and restorative values; the consensus is corroborated by a growing body of empirical and observational knowledge (van den Berg et al., 2007; Berman et al., 2008; Hartig et al., 2003; Olszewska-Guizzo et al., 2022). Several theories have been proposed to describe the mechanisms by which green spaces in cities can benefit people's well-being; such theories are typically centred around visual properties. The biophilia hypothesis postulates that all humans are innately affiliated with any natural elements due to natural asymmetry (fractal patterns) in nature (Kellert & Wilson 1993). The attention restoration theory (ART) argues that urban space provides sensory overstimulation and constant 'goal-oriented' patterns of attention, which cause mental fatigue, whereas natural environments recruit the opposite pattern of 'stimuli-driven' attention, which allows restoration of our depleted capacity for attention (Kaplan, 2001). According to ART, contact with nature induces 'soft fascination', which is key to the restorative experience (Kaplan & Berman, 2010). Restorative experience is the state in which the environment gently engages the individual's attention, diffusing and relaxing strenuous cognitive processing and focus on detail. However, it is still not well understood which are the specific components of the environment that can foster positive health outcomes, either from passive or through active interaction with them.

Here, environmental neuroscience with portable, wireless, yet reliable brain imaging tools can help unveil some of the unconscious mechanisms by which the human brain operates in various spaces. During the last decade, research in environmental neuroscience outside the laboratory has been spurred by new mobile electroencephalography (EEG) technologies such as wireless and ambulatory signal acquisition devices. New developments in signal processing techniques have allowed the effects of walking and other muscle artifacts to be minimized and removed from the EEG signal, which has enabled the study of 'cognition in action' (Gramann et al., 2014, p. 22), in many fields from sports science to pedestrian navigation, environmental effect, and psychological restoration, recordings have been validated outside the laboratory for studying both cognitive tasks and person–environment interactions (Aspinall et al., 2015; Mavros, 2019). It is possible to compare urban with rural and to investigate responses to specific features within built-up and green spaces. We can learn how certain design strategies can impact the emotions, cognitive and attention processes, and even social interactions, including navigating through crowds: which spaces make us more nervous and which calm us, and finally, how this all applies to the specific groups in the society, for example the elderly, youth, and others.

THE NEUROSCIENCE OF AESTHETIC EXPERIENCE

The aesthetic experience of art or space engages our cognitive and emotional processes. This is the focus of neuroaesthetics, a young and fast-growing field concerned with the biological and neural basis of aesthetic experience and judgement. For instance, behavioural data show that artworks that are perceived as being more ugly or more beautiful at either extreme of an aesthetic judgement scale are remembered better. Similarly, the aesthetic quality of urban spaces can influence route choice (Johansson et al., 2016). However, Bourdieu's (1977) idea that the perception of art is socially constructed is still debated: whether beauty is inherent to the object of appreciation or to the person contemplating it. Several studies suggest that certain physical features of an artwork, such as symmetry and contrast, influence aesthetic rating. Other arguments propose that aesthetic preferences are related to the visual complexity of objects and to scenes that progressively reveal visual variations at multiple scales, which has been called the fractal dimension (Taylor, 2021). Here, an interesting parallel can be observed. Loss of complexity in the fractal dimension of physiological signals is associated with a wide range of physical and psychological disorders. Similarly, people are more attracted to space and objects with higher complexity. Other recent studies have also demonstrated a connection between one's sense of self and past experience and aesthetic judgement (Lee et al., 2020).

The links between neuroscience and architecture are also strengthening, as in the emerging fields of neuroarchitecture and neurourbanism, as part of renewed interest in the links between environment and mental health. This is partly due to our scientific curiosity to understand how our brains perceive and react to different environments, but equally to advancing evidence-based urban policy, planning, and design. Psychophysiological measurement methods such as eye-tracking, EEG, and fMRI have been used to study the affective and attentional processes of looking at urban or natural environments. Eye-tracking metrics such as dwell time can highlight, for instance, how the facades of buildings attract visual attention (Hollander et al., 2020), and EEG measures can reveal people's emotional reactions, such as approach/positive emotion (e.g., frontal-alpha asymmetry), cognitive load (e.g., theta/beta ratio), and more.

The framework of neuroaesthetics has been applied to architecture and urban and landscape design. Researchers have started to systematically examine people's responses to architectural spaces, both conscious responses through self-reports and unconscious ones through such psychophysiological measures as skin conductance and brain activity. These studies can provide insights into the influence of factors such as form, proportions, height, materiality, and other factors on experience, attention, and emotion (Vartanian et al., 2015).

Coburn et al. (2020) identified three components driving our perception and appreciation of interior scenes: coherence, fascination, and hominess (see Chatterjee et al., 2021). This last is a dimension specific to architectural interiors that represents the extent to which a space feels comfortable and personal. The first two dimensions have also been found to be critical axes in our perception of natural scenes. Coherence captures the degree to which a space feels organized to the viewer, and fascination encapsulates the visual richness and complexity of a space. Interestingly, the research found that fascination was associated with a viewer's sense of excitement and desire to explore the space. At the urban scale, fascination might be related with the notion of urban vibrancy (Montgomery, 1998).

Within the fields of restorative theory and landscape architecture, the contemplative landscape model (CLM; Olszewska-Guizzo, 2018) is a similar attempt to establish a universal framework for design and assessment of urban green spaces. It consists of capturing seven key-characteristics of a landscape scene: layers, landform, biodiversity, colour and light, compatibility, archetypal elements and character of peace, and silence. From a phenomenological standpoint, landscape views are just images, perceived by senses and processed by the brain. Recent studies on highly contemplative spaces in Singapore have shown that spaces ranked highly using the CLM framework can elicit changes in patterns of brain activity associated with relaxation and mindfulness (Olszewska-Guizzo et al., 2020) and induce the brain activity desirable in clinical depression treatment (Olszewska-Guizzo et al., 2022).

Urban design and architecture have a long tradition of systematically measuring objective factors relating to form and

Figure 2 →
Example of neuropsychological measurement in a field experiment: a participant wearing a portable multimodal fNIRS/EEG headset while exposed to a dense urban environment (photograph by Agnieszka Olszewska-Guizzo).

function. Capturing subjective factors such as aesthetic and design qualities present various challenges, and for some they are indeed 'unmeasurable' (Ewing & Clemente, 2013), but they are nonetheless important to understanding how people experience and engage with the urban and architectural space. Factors such as enclosure, imageability, and legibility cannot be as readily assessed building or room height but are linked with human behaviour such as walkability and urban vitality.

In most of the studies mentioned above, the presence of others is considered a confound, something to be experimentally controlled for: stimuli are created carefully to not include people because these could bias the results. While the research on how these parameters influence spatial experiences is ongoing, it is equally important to understand how it is also modulated by human presence; whether scenic or dull, streets do not feel the same when they are empty as when bustling with activity.

THE NICE PROJECT

We recently began research on the NICE project to investigate these questions. What is the joint influence of environmental qualities and social copresence? Are the levels when a space starts to feel crowded stable, or do they depend on aesthetic and other spatial qualities?

Our approach is to combine the methodologies discussed above into environmental neuroaesthetics. In our studies, we show participants urban environments that vary in design, aesthetics, and spatial properties as well as levels of human occupancy. During these experiments, we record their physiological arousal, brain activity, and conscious preferences. Over the next year, we will employ this method to conduct a series of online, laboratory, and field studies to understand the joint influence of social density and environmental aesthetics on perceptions of crowding, sense of presence, and willingness to visit.

Our research also raises new questions. How will environmental neuroscience relate to our notions of designers' agency, intuition, and preference? The psychological effects of space on well-being are increasingly recognized. This approach will allow us to better understand design paradigms. Arguably, our methodology can only capture instantaneous responses to the environment, but this can complement other longitudinal research on the effects of prolonged exposure to various environmental factors.

Our efforts aim to redefine our perception of human presence in spaces. Rather than simply considering what is the maximum capacity when designing spaces, perhaps it is time to consider optimal capacity too – the minimum presence to make a space feel vibrant and attractive. Furthermore, if there is a link between the aesthetics of the environments and the acceptance or even attraction of higher number of people (i.e. tolerance for higher crowding), this can also have implications for design approaches of spaces, who due to their function or location in the city, are expected to be bustling with crowds.

CONCLUSION

Inspired by the experience of emptying cities during the pandemic, we argue that it is important to re-examine notions of social density and crowding with novel methods from neuroscience and environmental psychology. Aesthetic and other elements of the architectural environment interact with levels of social density to influence the subjective experience of urban spaces. Establishing an empirical understanding of the importance of both well-designed and socially vibrant environments will not only increase our knowledge of how people engage with their existing environments, but help drive better policy, planning, and design decisions.

Figure 3 ▸ p. 151

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Figure 1
Image of Orchard Road, Singapore's prime retail and pedestrian avenue, during pre-pandemic pedestrian rush-hour. How does the number of people walking influence our subjective experience of the environment? (photograph by Panagiotis Mavros.)

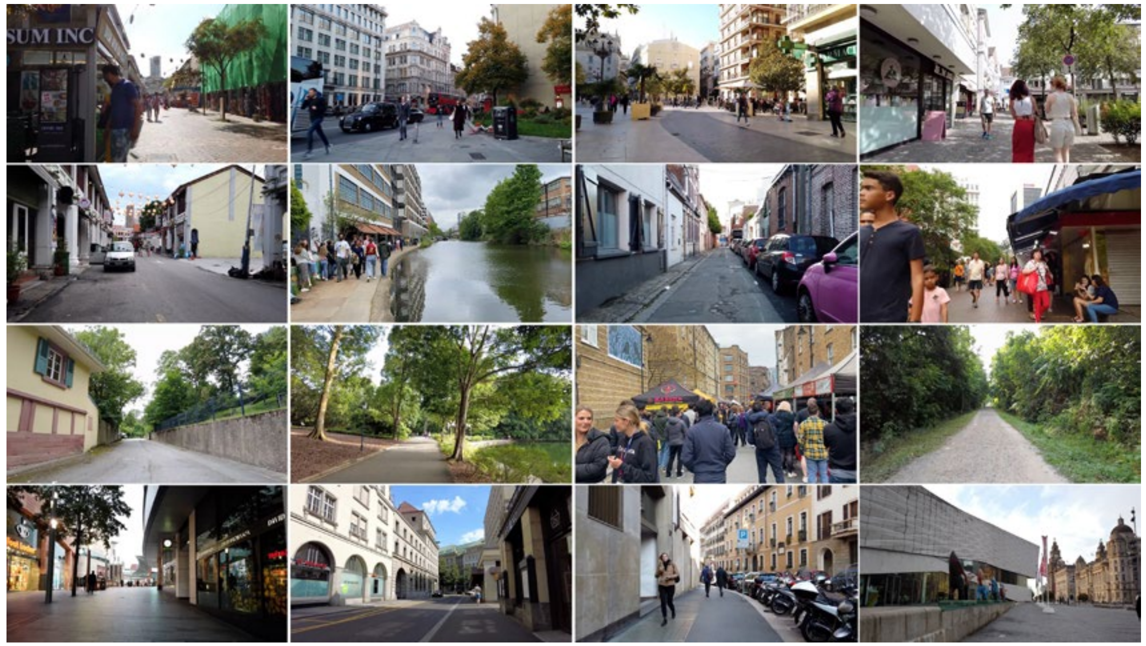

Figure 3
Frame samples from video walkthroughs that were collected from different cities and countries. These videos will serve as a large database of environmental stimuli, varying in environmental typology, aesthetic qualities and social pedestrian density. They will be used to assess subjective experience and environmental preferences (photographs by the authors, adapted from original video sources by Daniel Sczepansky (POP Travel) CC BY SA and Thomas Lim).

ABSTRACT

Can planning and design influence health and well-being in urban settings? Even though it was the public health issues faced by industrial cities that originally gave rise to the field of city planning, their paths have diverged over the years. However, how human settlements are planned, designed, and built can drastically improve or harm human health and well-being through factors that either promote or obstruct healthier lifestyles. Global organizations currently advocate city designs that enhance access to a wide range of resources and experiences for all. But how do we evaluate the successful translation of these goals into healthy, resilient, and socially cohesive human settlements and communities? This chapter revisits fundamental concepts of proximity, walkability, and accessibility that are omnipresent in planning and design directives for healthier communities. It critically examines prevailing conceptualizations and measures and offers alternative directions for operationalizations that accommodate the variety of human behaviours and the complex linkages between factors in the urban environment.

KEYWORDS

urban health; well-being; proximity; walkability; accessibility.

Chapter 9—Designing for Urban Health and Well-being by Revisiting Proximity, Walkability, and Accessibility

Achilleas Psyllidis

Since the rise of the industrial city in the nineteenth century, it has become increasingly evident that health and well-being are strongly determined by environmental and socioeconomic factors. Overcrowding prompted by urban population growth, poor sanitation, insufficient infrastructure, air pollution, and unequal access to resources such as clean water compromised health and accounted for the rapid transmission of communicable diseases (Hall, 2014; Freestone & Wheeler, 2015).

ENVIRONMENTAL DETERMINANTS OF URBAN HEALTH AND WELL-BEING

In recent years, it has also become clear that numerous elements of the built, natural, and social environments are partly responsible for various chronic physical and mental illnesses, including obesity, cardiovascular and respiratory diseases, stress, and sleep disorders (Giles-Corti et al., 2016). Infectious diseases cannot be excluded from consideration either. The COVID-19 pandemic has underscored the critical links between the way cities are designed and used and potential transmission risks (Psyllidis et al., 2021). To contain the spread of the virus, people around the world were mandated to stay at home and limit their mobility to locations in their immediate vicinity. This emphasized that where we live and the quality of our surroundings matter. It further accentuated existing inequities in access to opportunities such as proximal outdoor public and green spaces for physical activity and recreation, often leading to distress and, thus, to reduced levels of physical and mental well-being.

Remarkably, the challenges that modern cities face and can impact health and well-being have much in common with the issues encountered in nineteenth-century human settlements. Noise and air pollution are associated with negative physical and mental health effects in cities worldwide. Increasing levels of urbanization and built-up space compromise the size and quality of green spaces. Population sprawl and land-use diffusion create large dependencies on car and motorized vehicles, limiting pedestrian and cycling infrastructure and discouraging active travel, which in turn leads to increased levels of obesity. Socioeconomic and sociodemographic disparities in access to education, job opportunities, affordable housing, and ethnic and age segregation jeopardize well-being and social cohesion and are further accentuated by spatial inequities. Limited access to clean water, quality food supplies, and sanitation facilities are still preponderant issues for cities in developing countries, especially in informal settlements of the global South.

Planning and design directives for urban health primarily emphasize the regulatory role of the physical and natural environments. Originally, the focus was on tackling direct physical effects such as overcrowding and the deleterious impact of contaminated water and air by increasing available greenery (Ebenezer Howard's 1898 garden-city movement is a prime example), reconfiguring the street layout, and zoning land uses such as separating polluting industry from residences (Barton, 2015; Freestone & Wheeler, 2015). More recently, the World Health Organization (WHO) introduced the 'Healthy Cities' programme to promote health development and well-being in urban settings, additionally highlighting the role of social determinants of health (Tsouros, 1995; Barton & Tsourou, 2013; WHO & UN Habitat, 2016). The core values and principles of this initiative are further reinforced by the recent Sustainable Development Goals (SDGs), developed by the United Nations (UN) (United Nations General Assembly, 2015). A common denominator across these approaches and strategies is the plea for improved and equitable access to a wide range of resources, opportunities, and experiences.

It is abundantly clear that achieving healthier lifestyles and well-being in urban settings depends on accessibility. Therefore, to design health-promoting urban environments that cultivate interactions and social cohesion, we in fact need to design for accessibility. But how do we evaluate the successful realization of SDGs and Healthy Cities' goals? How do we operationalize the achievement of improved and equitable access to resources, opportunities, and experiences? Which indicators are currently used? And is the current arsenal of planning, design, and policy-making tools appropriate? What do they capture and what do they leave out? Common indicators that are broadly used in urban health planning and design revolve around generic metrics such as the number and mixture of facilities within fixed radii, maximum walkable distances to the nearest resources, and proportions of public and green spaces within a buffer or neighbourhood unit. Although relatively easy to operationalize, these metrics generally lack specificity. How can we improve on one-size-fits-all indicators and metrics? The following sections revisit fundamental and interrelated concepts of proximity, walkability, and accessibility, to account for different age groups, population demographics, needs, and preferences.

PROXIMITY IS IMPORTANT, BUT IS IT ALWAYS ENOUGH?

Proximity is at the heart of urban planning, design, and public health approaches and strategies. It is a prerequisite for easy access to resources and facilities, a key indicator of potential exposure to environmental factors such as noise, air pollutants, and vegetation, a catalyst for walking and cycling, and a principal component of human-scale urban form. Most importantly, it is the baseline ingredient of essentially all walkability and accessibility measures. Therefore, designing for accessibility


Figure 1a ► p. 160


Figure 1b ► p. 160


Figure 1c ► p. 160


Figure 1d ► p. 160

implies that we need to begin with proximity. But how do we conceptualize and operationalize proximity? What makes something proximal? And proximal to what?

Proximity is commonly understood in spatial terms and is predominantly captured by Euclidean or travel-time measures of distance or in relation to a spatial unit such as a neighbourhood unit or catchment area (Clifton et al., 2008; Kimpton, 2017; Xu, 2019). We usually choose to live close to a school or a park, have dinner at a nearby restaurant, and prefer to shop within walking distance from a metro station. All these examples have the concept of proximity at their core. But there is always the need for a reference point. Home location is by far the most common reference when operationalizing proximity. The reach of resources and facilities is almost exclusively assessed relative to where we live, often by drawing circles around the residential space, the 'first place' in Oldenburg's (1999) famous taxonomy of places, or by calculating the number and per centage of facilities within a neighbourhood defined by a census tract or postcode area. But it might sometimes be at least as important to also consider what is proximal to our workplace, the 'second place', or the places where we spend our free time, the 'third places'. Even though this might sound trivial, it is quite striking that spaces outside of the home are barely considered when operationalizing proximity.

A widespread proximity-based assumption is that people use locations near their homes. Although this assumption holds some truth on some occasions, proximity does not imply actual use. Assuming use because of proximity can have substantial implications for how we assess exposure to environmental factors. For instance, if people live close to a park but never really use it, are they exposed to the health benefits of greenspace? This assumption can be primarily attributed to the scarce availability of actual human activity data. During the COVID-19 lockdowns, proximity played an important role because people were often allowed to perform outdoor activities only within a limited distance from their homes. This, in turn, could have affected the spread of the disease as several aspects of urban form and human activity on nearby streets might have influenced the transmission risk, as shown in Figure 1 (Psyllidis et al., 2021). Besides the obvious spatial aspects of proximity, social space may have other 'hidden' influences, such as on interpersonal relationships and ties (Chande et al., 2020). Adding this dimension to the conceptualization and subsequent operationalization of proximity could be essential, especially in the context of communicable diseases, and could open new avenues for approaches that are not constrained by typical geographical boundaries.

TOWARDS A WALKABILITY INDEX FOR ALL

Healthy community design is inextricably linked to walkable community design. WHO, the Centres for Disease Control and Prevention (CDC), and the Active Living by Design programme, among others, endorse daily walking and cycling as important forms of physical activity for healthier lifestyles (Healthy Places by Design, 2008; CDC, 2017). Proximity to a variety of facilities and activities is considered the cornerstone of any walkable environment. In spatial terms, short distances encourage walking and cycling, whereas long distances often result in car dependency, which is considered an important determinant of obesity. Therefore, several city planning, design, and policy directives have long promoted a mixture of land uses and activities within walking distance of people's residences to achieve walkable communities. The '15-minute city' model is one of the most recent hypes of this type (Song et al., 2013; Carpio-Pinedo et al., 2021). But how are short and long distances defined? Do they mean the same thing to everyone? Are the density and mixture of destinations the sole factors that influence the walking behaviour of various population groups? And what about the quality and experience of the walks to these destinations?

The widely used shortest paths, though easy to measure, can barely capture actual walking behaviours, let alone elicit what encourages people to walk or not. Subtler qualities that relate to how people perceive the street environment, including the size, texture, and configuration of such physical elements as street furniture and paving materials, the feeling of safety, and the time of the day or night, may strongly influence walking choices and behaviour (Ewing & Handy, 2009; Ewing et al., 2013). With a few notable exceptions, these qualities and perceptions have barely been considered in urban design literature and practice, owing primarily to difficulties in objectively measuring them, especially at scale. Other socioeconomic and sociodemographic factors such as age, gender, income, and ethnic background may also influence choices about active travel (Ma & Banister, 2006). Do children and the elderly make similar walking choices or have comparable activity spaces? Do people from different income groups and ethnic backgrounds engage equally often in active travel? An inclusive walkability measure should consider these aspects in combination, ideally with varying weights depending on context. Similar considerations apply to an inclusive cyclability measure. However, limited data availability on the actual travel behaviour of specific population groups often results in them being underrepresented or entirely neglected in related indices, designs, and policies. Moreover, to achieve successful operationalization at scale, planners and designers need to draw on reliable and appropriate methods from geographic information science and urban analytics.

DESIGN FOR EQUITABLE ACCESSIBILITY SHOULD ALSO BE DESIGN FOR CO-ACCESSIBILITY

Goals 3 and 11 of the SDGs set specific targets for 2030: adequate and equitable access to resources, services (targets 3.7 and 11.1), and facilities such as transport systems (target 11.2) and green and public spaces (target 11.7) must be ensured universally (United Nations General Assembly, 2015). According to recent UN statistics, only half of the world's urban population have convenient access to public transport, and the average global share of urban areas allocated to streets and open public spaces is 16 per cent—far from the 30 per cent target (UN, 2021). Such generic metrics give some insight, but more specificity is required when assessing the achievement of the defined targets.

The concept of spatial accessibility draws heavily on those of proximity and walkability described above, and its objective measurement is conditional to the factors discussed in the previous sections. The way we measure spatial accessibility matters and can strongly influence how we evaluate the success of access-promoting designs and policies. Figure 2 illustrates this with an example around access to greenspaces.

An aspect which is consistently neglected when designing for equitable accessibility is the likelihood that individuals from different population groups use similar services and facilities concurrently. This aspect corresponds to co-accessibility to opportunities, resources, and destinations (Milias & Psyllidis, 2022). Widely used accessibility indicators and metrics often do not distinguish between facilities that are accessed by large yet homogeneous, population groups and those that are frequented by more diverse populations. This calls for new approaches that extend the conventional conceptualization and operationalization of accessibility. Recent evidence on this subject suggests that the chance of encounters between population groups is influenced by the location and spatial distribution of services and facilities and the time required to reach them, as shown in Figure 3. Designing communities that facilitate interactions between population groups can have several societal and mental


Figure 2a ▸ p. 161


Figure 2b ▸ p. 161

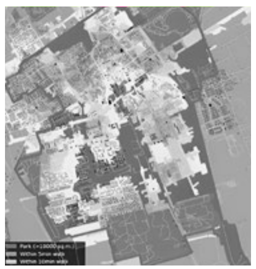
Figure 2c ▸ p. 161

> "What is needed is an enhanced understanding of the linkages between the various environmental determinants of urban health and well-being."

health benefits, and new operationalizations of co-accessibility can open new avenues for how we understand and evaluate spatial segregation.

PROSPECTS FOR HEALTHY CITY FUTURES

What makes a city healthy and sustainable? Emerging voices from the planning, design, and public health domains and related global organizations increasingly acknowledge the vital role of environmental determinants in people's health and well-being. Healthy and sustainable neighbourhoods, cities, and human settlements provide equitable access to a wide range of resources, opportunities, and experiences through walkable street environments that host a variety of amenities and accommodate quality green and public spaces within short distances. However, successful delivery of the potential health and well-being benefits to all citizens in urban areas across the world requires new approaches to conceptualizing, measuring, and designing the core attributes of urban environments. This chapter contested widely used indicators and metrics of proximity, walkability, and accessibility and provided recommendations on how to make them more inclusive by accommodating the needs and behaviours of diverse population groups. We should also bear in mind that cities are complex interlinked systems, and as such they demand place-based systemic approaches to design and planning. What is needed is an enhanced understanding of the linkages between the various environmental determinants of urban health and well-being. To achieve this, universal access to high-quality and reliable data is key. New methods, especially from the fields of geographic information science and urban analytics should also be employed to allow operationalization and analysis at scale. Putting people, health, and well-being at the heart of design and planning and acknowledging their complex interlinkages can help shape healthier, liveable, and more resilient human settlements and communities.

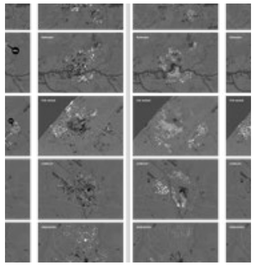

Figure 3 ▸ p. 162

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a
Inverse sidewalk width

b
Street integration

c
Activity exposure

d
Pedestrian flows for weekdays

Figures 1a b c d
Factors pertaining to urban form and human activity along streets in Amsterdam, the Netherlands that have a variable impact on potential transmission of the novel coronavirus (graphics by Psyllidis et al., 2021).

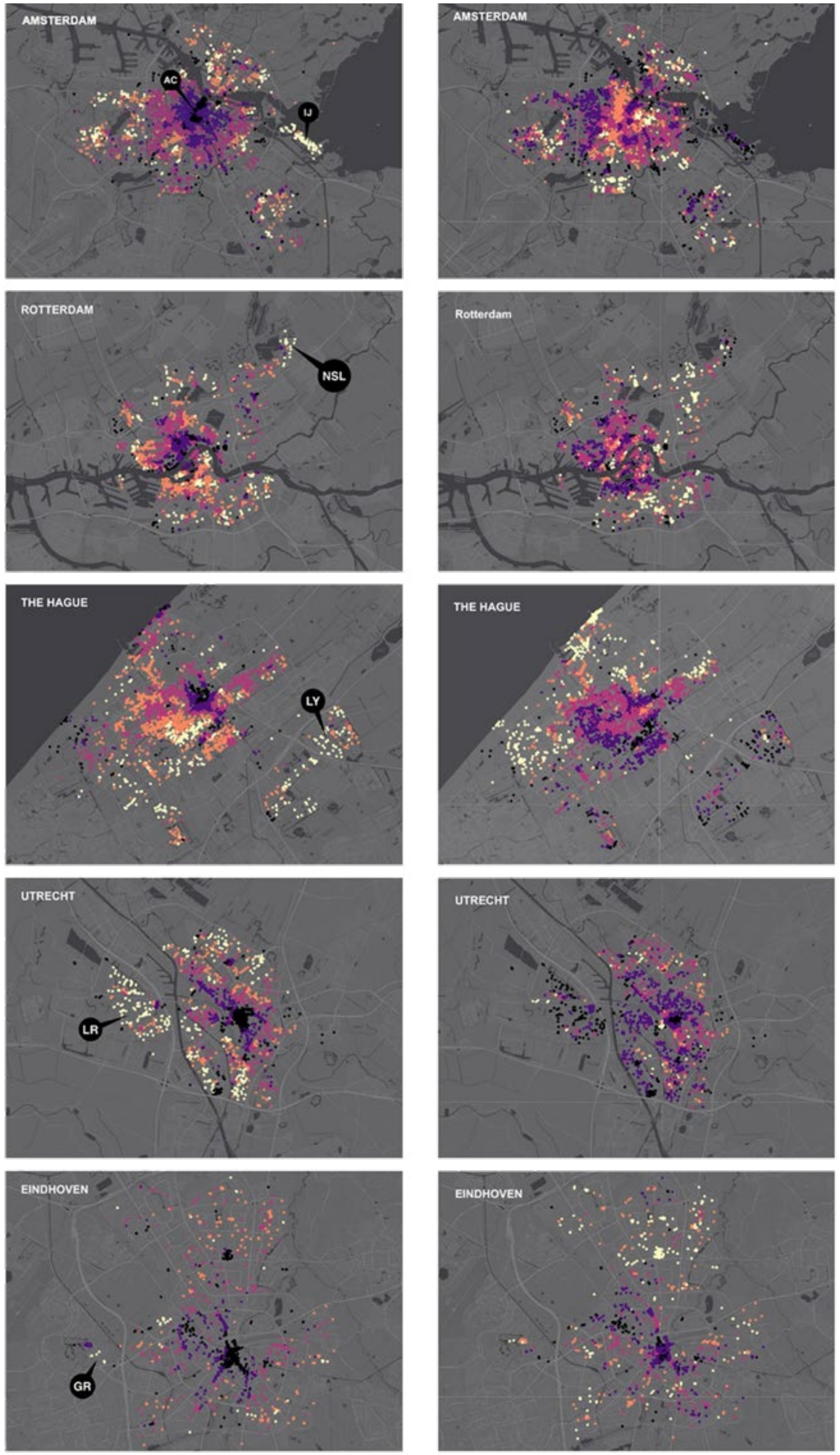
a

b

c

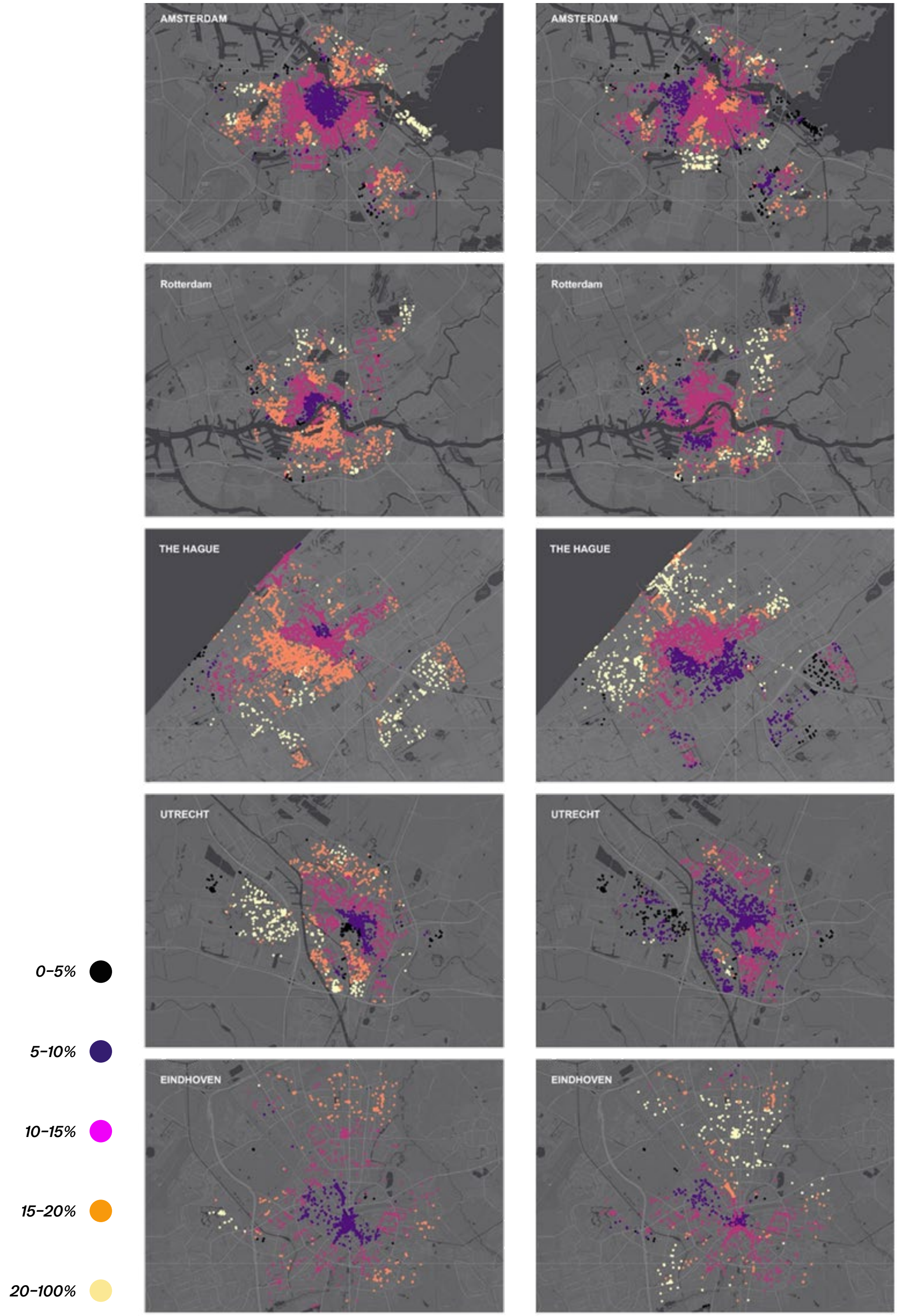
Figures 2a b c
Evaluating access to urban parks in Delft, the Netherlands, using different measurement approaches. (A) distribution of parks, (B) measuring access using Euclidean buffers, and (C) measuring access using network buffers. With Euclidean buffers (middle), only 0.1 per cent of inhabitants are estimated to lack access to a park within a 15-minute walk. In contrast, network buffers (right) estimate that 14.3 per cent of inhabitants lack access to a park (graphics by the author, visualization by Roos Teeuwen).

5 minute walk
Children (0–15 y.o.) Elderly (65+)



← Figure 3 →
Variations in the percentages of children and elderly populations relative to all other groups who have access to a facility with a 5 or 15-minute walk in the five largest Dutch cities (graphics by Milias & Psyllidis, 2022).

15 minute walk
Children (0–15 y.o.) Elderly (65+)



ABSTRACT

Generative design is both heralded as the new frontier of human creativity and criticized as a technocratic imposition on the design process. This essay demystifies the popular misconception of generative design as a race towards hard optimization and instead presents a human-centric practice of the discipline in three parts. This essay first compares generative design as the contemporary sociotechnical practice of design with the romantic partner search problem. Design and planning future cities is not a problem of finding the global optimum but a social project of mapping collective human values onto the built environment. Next, generative design aspires to provide a sociotechnical platform that brings together shared intelligences across design, social data sciences, and computational methods. Beyond the current segmentation among disciplines and professions, the new framework of generative design fosters collaboration among designers, engineers, stakeholders, and end-users. Lastly, to evolve our technological mediums as architects and planners, we must equip ourselves with computational frameworks and creatively overcome the division of intelligence between machines and humans, engineering and design, arts and sciences, and top-down vision and bottom-up ideation. The design of future built environments is a wicked problem in which parameters and objectives are undefined throughout the process of searching for solutions. To project human vision and values, and not parameters and objectives, generative design establishes a framework that codifies social and design processes into the computational geometric and geographical design space.

KEYWORDS

generative design; wicked problem; computational design; sociotechnical system.

Chapter 10—Cities and Love: Generative Design as Mapping of Human Values

Gia Jung

What are we looking for in modern love? Romance, partnership, growth, inspiration, or something else? To the readers seeking to converse on generative design for future cities, the question may seem irrelevant. However, I have found romantic search to be the most useful analogy for conceptualizing generative design as research and practice. On the most superficial level, we observe a similar trend in the expansion of objectives. Historically, marriage has served as a social means to an economic end.

In contemporary culture, we seek many qualities in our partner that would enrich our life. This is not unlike our cities: beyond the primitive hut, we yearn for inclusive communities, sustainable ecosystems, and equitable homes. We desire our cities to inspire us and set the stage for life—and for us to love them.

The problems of romantic matching and place-finding are similar. The objective of each search, whether person or home, is idiosyncratic, with its own set of characteristics. Often, we do not even know the criteria of our objectives, whose bounds and metrics often shift as interim results appear. The sequence of search is nondeterministic in that we cannot replicate every run of a search whose result reconstructs the overall ranking. These particularities make cardinal ranking unfeasible before the search or even at all. Christian and Griffiths (2016) detailed the Optimal Stopping Problem in searches for both partners and apartments as an example of how we can apply algorithmic solutions to our daily lives. Their recommendation? Noncommittally look at up to 37 per cent of the total search space, and then commit when you meet a candidate that beats all the prior candidates (Christian & Griffiths, 2016).

Although urban planning can be simplistically conceived as a sheer problem of search, optimization, and perhaps prediction, this reductive approach fails to capture the holistic picture: how do we imagine and realize our longing for home? According to Picon (2017), at the core of city-making lies the groundlessly optimistic, hopelessly ideal, even utopian vision for the future. In this sense, collectively planning and designing our future cities differs fundamentally from our individual search for love because we can come together to build as we imagine.[1] Here, the problem of place-finding becomes a more complex project of place-making. Our collective ability to design, develop and build our vision in cities is at the heart of what inspires contemporary practice of computational design.

The centuries-old quest of making a collective home, the ideal city, and the eternal return, now compels both urbanists and technologists. We are building generative design models and planning platforms together.[2] Today's generative designers insist that computation can create a collective intelligence beyond individual human intelligence and eventually form a collaborative platform. Architects, planners, developers, social scientists, and even data and computer scientists will design and plan together for future cities on this computationally intelligent blueprint built upon design intuition, computational efficiency, and social awareness. Popular misbelief pictures generative design as either an iron-fast optimization of rational objectives or the conspicuous expression of parametric forms. This chapter aims to tell the lesser-told story. Generative design is a social practice of computational design, one that is built on human values. It maps the space of wicked problems in design by marrying human intuition and machine intelligence, bridging vernacular and canonical systems, and codifying social aesthetic values.

WICKED PROBLEM OF DESIGN: HEROES AND ANTIHEROES

'Home is where the heart is', they say, and this alludes to the wicked nature of architectural design problems. This heart's design vision is not static: its constraint range moves, and its outputs are interdependent. Defining the problem space of a new city project is less straightforward than, say, calculating the shortest path from point A to point B. Cities pose a set of challenges that often collide, contradict, and compromise each other across domains of politics, economics, technology, and design as Rittel and Webber (1972) first conceptualized as 'Dilemmas in a General Theory of Planning'. Every urban development is another attempt to answer the centuries-old question: How do we realize a social vision in a built form? Urban planning, design, and development require us, ever-more-dynamic metropolitan citizens, to reach a consensus on inspiration for the future. And the problem is as old as humanity: we do not know what we want.

Hence, design and politics are critical to architects and planners' toolkits: designers provide a singular vision of the built environment, and planners negotiate divergent interests. In this sense, generative design is not novel at all, but only now has it become socio-technically feasible to bridge top-down imagination and bottom-up ideations. The former relies on a singular drive, the visionary architect, while the latter depends on collaborative intelligence, anonymous hands. Heroes have embedded their names in the authored canvas while antiheroes have paved the everyday vernacular that enabled life to unfold on civic ground. Ratti and Claudel (2015) finds the juxtaposed modes of design in etymologies of the latin words, Artifex and Civitus: Deterministic architectural styles aim to be the conspicuous canons of Architecture, authored Artifacts (Artifex), whereas collective hands built Gothic cathedrals and medieval towns, civil ground (Civitus). By codifying design, generative design takes the deterministic approach of the visionary architect; inscribing values of design parameters is an act of assigning values to different modes of design. By designing the codes, generative designers allow the evolutionary system to unfold architecture, just as the medieval pathways did.

1
While I wish it were true for singles out there, we can't connect to Elon's brain-computer interface and let Mark's metaverse give birth to a perfect match optimized by artificial intelligence just yet.

2
Across the three organizations in which I've worked, the attitudes of the two disciplines remained the same. Architects' answers would be 'it depends', and computer scientists' would be 'Of course we can'.

Truly, cities today are becoming too important to be left for the architects alone (Menges & Ahlquist, 2011). The urban future is becoming too complex for a single author to imagine with much certainty; meanwhile, participatory design has shown its shortcomings in its lack of accountability in the design process. Contemporary computational design aims to build an elegant system that leverages both modes of design. For example, Ratti wrote of a future in which we can branch, push, and pull as many software developers interact, synthesize, and build on top of each other.[3] In fact, millions of citizens around the globe create and maintain open-source platforms. In the spirit of citizen science and civil activism, platforms such as OpenStreetMap and Google Maps enable users to collectively share local observations with differing degrees of central governance. Other platforms, such as Google Earth and Matterport, allow us to access images and LiDAR data of our planet. Cities make urban data and planning processes more accessible through various GIS systems. How do we leverage the intelligences coming together as a 'triumph on a planetary scale' (Picon, 2017, p. 100)?

With today's complex information flows, an elegant generative design platform can empower designers and planners with more informed and inclusive decision points. We are building both an algorithmic system and a collaborative platform to find better answers to our built imagination. A traditionally opaque process of planning can become more transparent: accessible information makes not only the planning process efficient but also equitable and sustainable. Design options with lower carbon emissions will surface to all citizens and decision makers alike from the early phases of design. Ecological considerations can become easily available as design and development objectives. Ultimately, what we lack is not the quantity of data but the semantic structure, design intelligence and civic awareness of the built environment to inform a future that is equitable and sustainable to all.

WHAT'S WRONG WITH THE GLASS BOX?

Let us shift the scale from the planetary to the bricks at hand: what's up with the new developments worldwide? Do we find new towns inspiring? I'm bewildered: we pay handsomely for neatly stacked modernist grids only to flock back to the old inspirations. While we relish the conveniences of the latest developments for jobs and infrastructure, we long for the winding streets of mediaeval towns, sophisticated negative space of Roman plazas, and tree-lined civic alleyways in Beijing's hutong. In extreme cases, the new cities are completely abandoned: we need look no further than hastily built ghost towns around the globe: in China, there are numerous cases such as Meixi Lake new town outside Changsha, Kangbashi New District in Ordos, and Zhengdong New District outside Zhengzhou (Woodworth, 2020). In Spain, the city of Valdeluz has almost become an ever-unoccupied ruin from the 2008 financial crisis (Minder, 2019). In the United States and United Kingdom, conspicuous towers and condos soar up to house global capital rather than local citizens (Soules, 2021). New towns and towers are built as an aspirational utopia–or, as mere investment objects without the intention to be ever inhabited. Without the clear distinction between utopian

3
The connection between software and architectural systems is not novel or hidden; it is both an art and science; it is engineering and creativity. It supports lives: the former digitally and computationally, the latter, architecturally and urbanistically. It now is well-known that Christopher Alexander's Pattern Language inspired the canonical book in software engineering, Object-Oriented Software Construction. Even earlier than that, Metabolists and Cybernetics dreamed of a world in which the built dynamically adapts to the rich colours of the organismic life in constant flow. Even before computational design was founded as a field, the architects and thinkers of the protocomputational era pioneered the way in Modernism with its systemic foundations and modularity. However, we all have now seen their shortcomings; or rather, its journey has not come to full fruition yet.

> "How do we rebirth human design intuition with a computational framework?"

and capitalist objectives, these assets now stand as barren steel cages sans dynamic lives within them.

We humans are honest like that, and so too is our love. What differentiates cities that are loved and filled with lives from those that end up empty? The canonical A Pattern Language by the late architect and mathematician Alexander Christopher decodes the secrets in our selective sentiment(Christopher et al., 1977). Ratti and Claudel (2015) allude to The Timeless Way of Building when he juxtaposes demolished modernist projects with the vernacular hills of Italy (Christopher, 1979). In love, we find unexpected serendipity and moments of awe. Beyond the transient feeling, it is the state transition we experience when our values are validated and our existence assured in the commitment and perseverance of the common project. The barren grids of the modernist projects, in pursuit of de-risking asset values decades ahead of compounding interests, conveniently neglect to make a human-scale place suitable for living.

Designers and planners have long called for human-scale place-making to enable dynamic, urban lives. We all love Jane Jacobs's West Village, the tree-lined Haussmannian blocks of Paris, the footbridged canals of Amsterdam, and friendly alleyways in Seoul's Han-ok villages. This is the form of love we feel from our cities: thoughts and ambitions bigger than us. We navigate the acts of love evolved across many generations before us. Serendipitous encounters bring us the joy of discovery. The inconspicuous design of many anonymous hands and minds before us delight us in their thoughtful adaptations of the built environment to improve the everyday lived experience. 'Imperfections' add to what we call character, the myriads of local solutions that are inscribed on the civic canvas. What does it mean to retroactively build it? One cannot simply replicate as if in Disneyland. We must now hack the morphological systems of the urban fabric for livability, aesthetics, and any other values we cherish.

Admittedly, contemporary towers are revered for reasons: the economy of scale in urban developments enable structural stability and infrastructural sustainability. The large scale enables future growth and fosters connections for inhabitants. The challenge then is to combine the two: economies of scale in resilient infrastructure and human-scale place-making in lived experiences. In the end, only loveable cities are sustainable as people settle, invest, and make improvements. How do we map the current, let alone future, flux of populations, traffic, work, learning, living, and other fabric of life unfolding dynamically within our cities? To answer the question in the context of current everyday knowledge requires a distinct kind of design technique different from the tools that enabled architects before us.

BEYOND DIGITAL T-SQUARES

Architects have long expanded the mind–hand connections with the tools by which we think, design, and influence. Evolving architects' hands increasingly make push-and-pull requests on software version control systems more than clicking away point-bits on various CAD systems. Menges and Ahlquist (2011) contrast two ways of leveraging computing in design: computerized and computational. While we work with computerized geometric representation, we have not yet achieved an algorithmic way of working that maximizes computation in the design process and urban information architecture. As the relevant design space requires more precise and complex urban information, it is only fair for our contemporary techniques of design to aid designers as more than a mere digital T-square. A true computational turn in design, the discipline meant to bring forth the unknown, can only build on the design values encoded through social computation.

Generative models do not seek to find a simple global optimum, nor can such clearly optimizable critical points exist in the wicked problem of city-making, as our predecessors have written extensively (Buchanan, 2010). Beyond prediction, stochastic modelling, and scenario planning, design is a mapping of values: what kind of sustainable and equitable cities do we envision for our future? Mapping this space of problems, solutions, metrics, values, and vision belongs to the category of wicked problems that build on strong assumptions, dynamic interdependence, and conflicting stakeholderships (Buchanan, 2010). Ultimately, generative design is an explicit modelling of human-made values: What cities are we envisioning for us? It asks us to deliberately state the value system previously implicit in the practice of design and planning: for whom are we designing and building? What metrics of design quality do architects employ to design generative systems? From whose perspective should we measure quality? Computational design practice, in constructing a generative model, further 'requires us to rethink central disciplinary concerns' (Menges & Ahlquist, 2011, p. 8).

The need for a computational platform is not just a rational argument, but a poetic and aesthetic one. The beauty of a generative system lies in its conscious design for the unforeseen; the checks and balances between machine and human intelligences foster the organic, dynamic growth of the system to give birth to many serendipitous, synergetic creations by billions of hacker-creators, systems, aesthetics, logos, and pathos. How can our generative platform achieve the same kind of collaboration and intelligence as many designers, past, current and future, have thoughtfully created into the urban fabric? These questions help navigate issues confronting generative designers of late and open up discussions, because only through discourse and collaboration can we construct a meaningful generative system.

Towards social computational design

Ultimately, computational designers are not only driven by the technical complexity of design problems and solution space but inspired by the social, aesthetic challenges of the morphological system in urban design. Current generative design projects aspire to find a common ground across the long-held dichotomies in architecture and built environment: heroes and antiheroes, central platform and open source, collective and individuals, past and present, digital and analogue, machines and humans, quantitative and qualitative, heuristic and statistical, and deterministic and nondeterministic. Through generative systems, computational designers and engineers aspire to bridge the two polemics; to make a place where human and machine intelligences converse; to democratize the architectural heroes into everyday platforms; to elevate the vernacular into the canonical; and to allow collective intelligence, past and future, to thrive on one platform.

Beauty of a system resides on both the logical and emotional planes. It is in the orders of nature. It is in the complex systems of ant colonies. It is in the serendipitous connections we encounter, inexplicable in simple deterministic terms. We have called this quality sublime. It may just be the complexity, the refined simplicity, that we have not yet understood in full that we call sublime. Generative design pursues and dreams of an aesthetic system and aspires to design true beauty that is beyond the reach of an individual, a style, a mere optimization, but a complex system that is larger than the sum of the individual parts. As with the magical fairies of the gas-lit streets of Paris, we have been fascinated by machines for their power to bring automagical moments to life. How do we rebirth human design intuition with a computational framework? That is the task at hand.

Note
Opinions are my own and do not represent any affiliated organizations, past and present.

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Addis Abeba (photograph by Rasmus Hjortshøj).

ABSTRACT

The risk suddenly inherent in shared public interiors brought people to congregate in and rediscover outdoor public spaces. The pathogen drove people to depart from climate-controlled spaces to socialize and support personal well-being. The proliferation of such practice exposed issues of equity and accessibility to shared space by bringing to light the control exercised by authorities over the urban commons. In this work, we address the urban commons as a civic resource of open space, as summarized by Sheila R. Foster, and review the access to these spaces based on the aspiration of serving the public.

Similar challenges are discussed in contemporary climate adaptation practice and academia, because the cascading effects of climate change on the urban environment require municipalities to develop urban transformation initiatives. These efforts rely on public space for urban resilience. This reflective analysis will review how the recent pandemic and the climate crisis have exposed and strengthened the need to re-imagine urban commons and their mechanisms. This chapter will explore how functional space addresses climate needs and simultaneously provides recreation, health, and community benefits. What are the challenges to achieving this vision? Examining the mechanisms for funding and management can provide an opportunity to foster community and spatial resilience.

KEYWORDS

climate adaptation; environmental justice; urban commons; resilience; equity.

Chapter 11—The Urban Commons as a Remedy to Climate Change Vulnerabilities

Dalia Munenzon

As our understanding of the cascading effects of climate change on our urban environment grows, so does the complexity of the urban adaptation project unfolds. Potential impacts and extreme climate events require coordination between the spatial form and the infrastructure systems across scales (Kousky et al., 2021).

ON THE TANGIBILITY OF A VISION

For example, urban heat is addressed by the city's wind flow and formal thermodynamics at a greater scale and by the materiality of each building at a smaller scale. Strategies for pluvial flooding rely on both the capacity of the urban drainage systems and the green space networks of a city. Coastal flooding, whether tidal or storm surge, requires a continuous protection system along the waterfront. Moreover, all these impacts examined at the personal scale have consequences on health and well-being and demand social and community capacity solutions (Lotfata & Munenzon, 2022). Thus, the way to address the climate crisis is a transformative action that re-envisions the city's spatial organization by linking adaptation strategies to open and green spaces.

Burgeoning urban spaces are a desirable vision for many, an ethical and aesthetic setting for any future. Urban visions inspired by the spatial impacts of the COVID-19 pandemic were no different. The rapid shift in the urban experience sparked the appetite for lush futures (De Monchaux, 2020). While designers and urbanists fantasized about sustainable and less congested streets, thriving ecosystems in public parks, and vibrant suburban neighbourhoods, the world slowly returned to its pre-pandemic urban condition. Most new and temporary appropriations of public space failed to endure, and no fundamental transformation occurred to the urban realm. Moreover, nuances of control over public spaces materialized. What socio-spatial structure can allow such visions to be realized? This chapter argues that these aspirational visions require a more profound overview of how public space is managed and governed. Contemporary research and practice around urban climate adaptation can provide the tools and levers for this review.

Climate adaptation plans offer comprehensive strategies for urban resilience and propose public benefits and urban amenities as components of utilities and infrastructure. These proposals are near-term solutions and long-term visions for the built environment and illustrate the complexities inherent in implementing such plans. In particular, we contrast the Climate Ready Boston (CRB) initiative as a market-driven adaptation vision with large public works projects catalyzed by civic activism and implemented by the local government. These examples highlight the critical frameworks for public space and infrastructure at such scales.

Open space played a significant role in the pandemic and is an indispensable component of urban climate adaptation. New socio-spatial frameworks are essential as the design world is eager to implement adaptive visions. Urban and landscape practice embraced Olmsted's 19th-century strategies for ecological and social green spaces; he envisioned inclusive public spaces aimed at improving public health (Eisenman, 2013). Frederick Law Olmsted's plans were accomplished during a time of grand urban infrastructural investments. However, most city planning efforts today are driven by market-based initiatives and are aggregated across a densely built environment. Querying how we enable these open spaces to support social well-being and public health is critical to equity and the effort to achieve climate resilience. As a construct of collaborative use and management, the urban commons can expand the existing approaches to public space (Foster & Iaione, 2020; Huron, 2015). This chapter aims to ground the implementation of the urban adaptation project in the commons and stewardship to resolve issues of risk and equity.

FROM URBAN SPACE TO URBAN COMMONS

Publicly accessible urban open space is considered an invaluable amenity and component of public life. Studies have analysed its multiple public health and well-being benefits to residents. Until recently, discourse and practice explored opportunities to leverage the current market-based urban development patterns (Carmona, 2018). Open spaces provided an alternative for the contagious interiors, however with rising infection numbers, authorities tried to limit the groups congregating outdoors or created designated spaces for groups. At some point the pandemic even rendered public spaces dangerous. And access to these amenities was disrupted by the authority in charge. For example, in NYC, outdoor recreational areas (Kim, 2020) and privately owned public spaces (pOPS) (Department of City Planning DCP, 2021) were closed and limited in use. Constrained public exteriors had to limit access, and interior-based public services had to innovate and engage their community outdoors (Gendall, 2020). Market-based public-private partnerships and development initiatives that create publicly accessible private or privately owned spaces are essential in neighbourhoods with limited open space. However, the public-private partnership allows the owner a level of control over the use of space (Munenzon & Titelboim, 2020) and the potential legal liability in case a visitor is harmed (Hemel et al., 2020). Thus, during the pandemic, the operators and owners of such spaces sought legal solutions to relieve themselves of liability. The mechanism sustaining these areas can conflict with the community's needs in an emergency event or with events and local initiatives. How do we make public spaces more adaptable to extreme events and maintain fair access? And what does the current framework need to allow new forms of operation and stewardship?

This study hypothesizes that successful urban climate adaptation plans are directly linked to the privatization of sociospatial orders throughout modern history. We argue that robust social and urban resilience depends on urban commons and civic governance that allows equitable, climate-ready urban infrastructure projects to succeed.

Optimal urban strategies for a positive urban environment have not changed much since Cerdà coined the term urbanist (Sennett, 2018). Urbanists strive for spaces of spontaneous interaction, flexible use, the introduction of nature, and ecosystem services. However, the tools we use to build, govern, and regulate the urban realm have changed, from the technologies to the institutions and their capacity, aggregation of the city, and ownership structure. Some research reviews the potential parallels between the extreme events of the pandemic and climate events and suggests a general overview of overlaps (Kakderi et al., 2021). Others merely acknowledge the current urban realm's political complexity (Ramos, 2020); they overlook the proposals available and the main implementation challenges. It is commonly understood that to approach the climate crisis and adapt to the urban realm; the strategies should entail comprehensive open-space and green-space proposals. However, a gap in the discussion and analysis is in examining the mechanisms for implementation and the financial and governance frameworks that enable such spaces: What will catalyse the construction of such projects and what will ensure their success?

To examine these questions, this chapter analyses two categories of large urban projects: first, the climate adaptation plans for the City of Boston and the challenges that the implementation of these projects faces; second, successfully implemented large-scale urban projects. This review is followed by an analysis of theory and practice concerning the urban commons through mechanisms, benefits, and opportunities while focusing on the negotiation of public ownership, community agency, and commoning actions.

THE URBAN CLIMATE ADAPTATION PROJECT

The pandemic positioned open spaces as the facilitators of public health and the community's adaptive capacity. At the intersection of engineered urban infrastructure systems and convoluted property rights, forms of social interaction forced flexibility on traditionally rigid systems. Past pandemics affected the shape of cities in grand infrastructural gestures (Sennett, 2018) and were translated into architectural principles (Colomina & Wigley, 2016). As engineering solutions effectively addressed the spread of diseases with rigid and often immutable systems, Olmsted envisioned urban green spaces as opportunities for equitable social interaction and healthy respite from the city (Jones, 2018). Olmsted's comprehensive approach to urban green spaces embedded environmental planning and social cohesion in the systemic understanding and operations of the urban realm. Many strategies and solutions from his projects endured and transcended into today's resilience and climate adaptation planning (Masoud & Holland, 2021). Contemporary urban and social resilience design proposals apply similar principles to provide engineered adaptation and protection from climate impacts and strategies for improving the well-being of vulnerable populations.

To foster a transformative future vision, many municipalities are adopting and developing focused climate adaptation programs. The City of Boston has developed a long-term climate and social resilience planning strategy to understand that a comprehensive and transformative effort will be needed to adapt to projected coastal flooding that threatens a third of the City's landmass. The City's efforts capture contemporary, historical, and projected challenges and outline comprehensive implementation roadmaps for spatial, civil, and regulatory solutions (City of Boston, 2016). The proposed strategies span decades and will require a Herculean effort of financial investment, transformational infrastructure construction, and operation and maintenance institutions. The overarching Boston Harbor Vision rethinks the 47-mile waterfront as a public amenity intertwined with a multi-layered approach to provide redundancies in risk reduction and local community needs such as accessibility to public space. The Mayor's Boston Harbor Vision relies on a market-based approach to create this multi-billion-dollar protective barrier and waterfront park (Figure 1) (Walsh, 2018). Essentially, the Vision requires private investors, property owners, and philanthropy to build, fund, and maintain infrastructure for public use. The Vision is supported by the Climate Ready Boston (City of Boston, 2016) initiative, which provides district-specific strategies that will guide incremental implementation.

The privatization of public space and changes in how cities evolve and are governed have decreased the ability to pursue and accomplish aspirational large-scale projects. Large-scale urban and public works projects in the last century were often driven by transit infrastructure, engineering needs, and private development. Experience during the pandemic showed that access to urban spaces can easily be limited to populations that rely on them and thus impact their capacity to cope with extreme events (Lotfata & Munenzon, 2022). In his review of public space design principles, Carmona (2018) argues that the rights of public space use are often restricted by the management authority of the space and not necessarily by the owner. He suggests defining the responsibilities for and freedoms allowed in these spaces before development.

The Climate Ready Boston (CRB) for five district plans (East Boston, Charlestown, Downtown and North End, South Boston, and Dorchester) provide near-term solutions and long-term strategies for site-specific designs, policy proposals, and continuous physical transformation of the coastline (City of Boston, 2018) The Resilient Boston Harbor Vision details strategies to add 2.5 metres to the edge elevation using integrated berm and levee systems as part of public park space with recreational programs. The Downtown district plan identifies the extensive private ownership of properties along the coast, even including condominiums, as a challenge to implementation (Figure 2; City of Boston, 2020). The coastal strategy outlined weaves the properties together in a continuous liner system. A tool kit of design concepts offers three scales of edge: seawall, 3m wide harbour walk, and soft edge with the outboard park. All solutions require a certain level of collaboration, negotiation, and agreement between the property owners. The owners and the City will need to agree on who will own, operate, and maintain the new linear system. Potentially, the City will be able to lead the effort and assume ownership or public interest in the infrastructure to receive federal grants and coordinate the implementation efforts. This is only one option; however, action has currently stagnated. Two main questions lie at the centre of urban climate adaptation: (1) What will drive action? (2) Will this private-public ownership and management framework serve the need for equitable public space?

DRIVING IMPLEMENTATION

IMPLEMENTATION CHALLENGES

The Vision plan provides an opportunity to evaluate cascading impacts, explore systematic relationships, and outline the objectives of benefits and transformations to the urban realm. Gradually aggregating and detailing projects at a larger scale draws attention to the links missing from the urban planning system and thus create the long-term collec-

Figure 1 ► p. 186

Figure 2 ► p. 187

tive knowledge required for adaptation. The Vision's initial aspiration to be a market-based framework and to grow incrementally was supported by the City with steps such as the Coastal Flood Resilience Design Guidelines (City of Boston, 2019). However, even with a market-based effort, several actions need to be coordinated by the City. Spatially, this involves the continuity of the system between properties on the public right-of-way and its integration with the city infrastructure. In the long term, the components of such systems will have to be operated and managed by a public entity. A coordinated effort is required to define the system's governance framework, institutions, and financing.

The Sustainable Solutions Lab at the University of Massachusetts, Boston, conducted two studies to address these issues: Governance for a Changing Climate: Adapting Boston's Built Environment for Increased Flooding (Kruel, 2018) and Financing Climate Resilience: Mobilizing Resources and Incentives to Protect Boston from Climate Risks (Levy, 2018). The argument overarching these studies is that a centralized effort to align institutions facilitates the action of implementation by creating institutions, regulations, and taxation mechanisms. Any proposed means will need to be equitable concerning risk exposure, ability to pay, carbon footprint, transparent and engaged decision-making processes, and injecting money back into the public realm for public benefit.

If governance sets the framework for implementation, the question is still what will drive action and whether the most effective way for equitable management of these new spaces is institutional.

POLITICAL WILL AND ADVOCACY

Boston completed two massive public work projects in the last three decades: the Boston Harbor Cleanup Project and The Central Artery / Tunnel (CA/T). These projects required coordination between State and City operations, needed unique pressure to start implementation, and had a long-term transformative impact on the city, its economy, and the built environment. The Boston Harbor Project, aimed at rebuilding the urban sewer and water system, was overwhelmingly supported by the public and advocacy groups. Once the State realized it had to act, it established a new independent authority, which successfully drove the process (Berg, 2004). On the other hand, the CA/T, known locally as the "Big Dig" was an immense effort to transform the city and remove a massive, elevated highway. Public opinion shifted as the project extended in schedule and budget, and the message over the final benefit for the greater metro area community was not always coherent. The advocacy groups involved represented one group of Bostonians and not the voices of all residents (Miller, 2012).

By comparing these projects, we can summarize two significant takeaways about the complex and multidimensional efforts of urban transformational projects. The first is the driving of action by local advocacy. Such a project requires deep community connections and civic leadership support. There is an opportunity to envisage the possible benefits of this project and leverage the endeavour to meet multiple equitable community priorities (Lotfata & Munenzon, 2022). Residents are aware of their environments, geographic problems, and structural deficiencies, which may not be apparent to professionals. The knowledge and ideas they provide will promote creative solutions and strategies. The second is the need for new institutions and governance mechanisms to lead implementation and future use and operations. This project will require institutional arrangements and a change in the standard cultural perception; it will be a gradual transformation, a learning curve towards collective knowledge building. Stewardship and buy-in from the community are integral not only to the use of the space but also to the implementation of this effort.

“As our understanding of the cascading effects of climate change on our urban environment grows, so does the complexity of the urban adaptation project unfolds.”

NEGOTIATING PUBLIC OWNERSHIP AND AGENCY

The aim of the climate adaptation project is to create an equitable and accessible urban space that will provide for the local community daily at the aggregate level and formulate the financial and institutional framework to build and manage it. The urban commons allows us to discuss the management of such spaces in a more extensive system that ensures fair use and creates the conditions for stewardship and advocacy. The market-driven scenario for such an effort will require a better framework for stewardship of communities and their participation in the process to avoid scenarios that will lead to exclusion (Huron, 2015). Facilitating collaboration between the community, governance, and owners is crucial to securing rights and responsibilities for the resources of the urban commons (Foster & Iaione, 2020).

The civic advocacy needed to push the climate adaptation project can be leveraged to facilitate the urban commons. And the experience of gregarious open spaces, as Olmsted envisioned, can foster commoning. The act of civic stewardship can contribute to the ecosystems created around these urban commons, increasing their ecological capacity and contributing to their effectiveness as climate-adaptive infrastructure (Colding & Barthel, 2013). The ability to use the commons and manage them repositions the power balance towards the community and allows histories of inequities, discrimination, and environmental injustices to be addressed (Lamb et al., 2022; Lotfata & Munenzon, 2022). Asserting ownership will foster equity through stewardship and the act of commoning over the process of implementation, institution creation, and mainly the operations of open spaces. Moreover, it allows communities to co-create identity and build capacity through collaboration and value generation (Feinberg et al., 2020).

In Downtown Boston, the complex aggregation of ownership in coastal areas is considered a challenge for implementation. Assuming the urban commons strategy for the climate adaptation project can advance the creation of collaborative intuitions and cultivate a longer-term commitment from the residents. The balance needed between the City's centralized effort to build institutions and the localized creation of commons can be seen as an interpretation of James C. Scott's analysis of large-scale governance operation in his book *Seeing Like a State*. According to Scott, large-scale action lacks a certain sense of agility reliant on simplifying operations and technical knowledge. The "formally organized social action" required to sustain large-scale climate adaptation projects is unsustainable without a community-driven "informal process." Scott's proposed solution to the challenge is local knowledge and intuitive collective practices. He called this knowledge "metis"; it "represents a wide array of practical skills and acquired intelligence in responding to a constantly changing natural and human environment" (Scott, 2020).

Similarly, the concept of urban commoning is grounded in local culture, histories, and community practices. Therefore, if the Harbor Vision is the modernistic simplified aesthetic strategy created by the City. However, the aggregated commoning opportunities and the sense of community created through this practice are the "metis".

COMMONING AS METIS

This study aimed to understand how approaching the climate adaptation projects as urban commons will catalyse these projects and bring them closer to implementation. A review of the challenges in the Boston case study and of scholarly work presents opportunities to apply the principles of the urban commons. The community needs to participate beyond standard practice to foster public interest and drive action. The future threat of climate change and the uncertainty of extreme weather events can be complicated and daunting for many people. The Climate Ready Boston process needs to develop a deep learning strategy and long-term stewardship across all ages and community groups. The process informs, educates, and empowers the community to create ideas: it can bring people together and make social connections stronger. The research connects ideas from the literature about the management of public spaces and equitable futures and demonstrates how they can play a role in the practice of climate adaptation.

Note
Parts of this chapter are based on the author's publication Munenzon & Titelboim (2022).

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Figure 1
The Downtown section of the Resilient Boston Harbor Vision shows a green park around the coastal edge of the city with a component of a flood protection barrier (visualization from the City of Boston, by Landscape Architecture firm SCAPE).

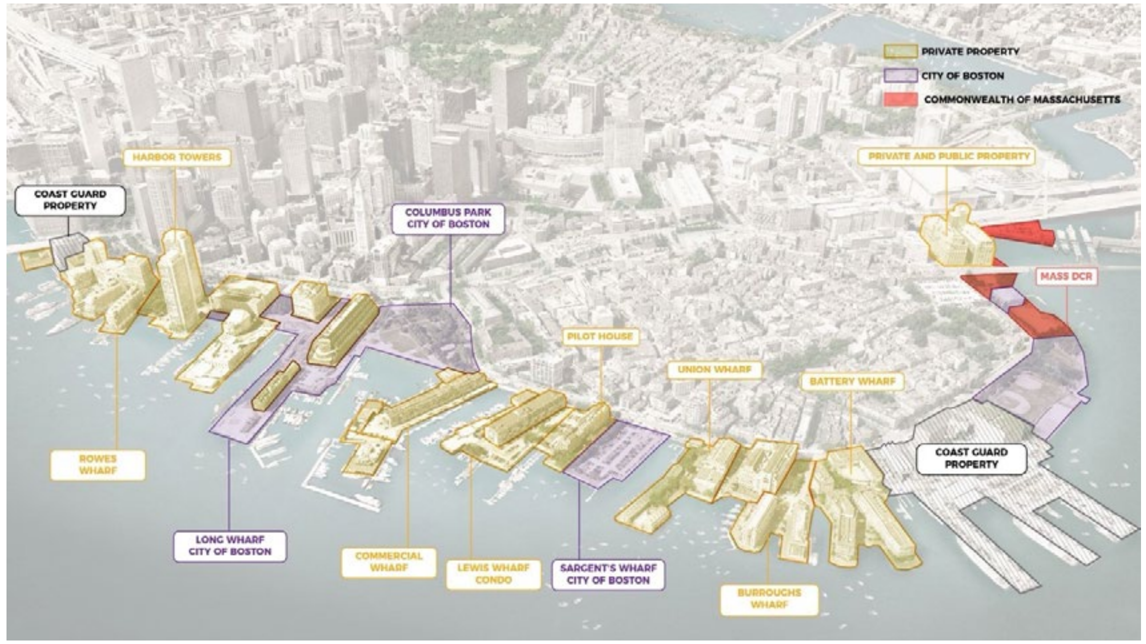

Figure 2
The Downtown Boston coastal property ownership diagram (visualization from the City of Boston Climate Ready Downtown and North End report, by STOSS landscape urbanism).

ABSTRACT

Inquiring into the use of the term 'magic' by the designers of social media platforms and network architecture, the chapter seeks to establish a deeper reading of the behavioural-management mechanics that sit behind contemporary high-tech architecture. The article argues that the so-called magical technique is in fact nothing new and can help us to clarify what has been fundamentally at stake for the figure of the architect proper since we emerged at the beginning of Empire and as the right hand of Imperial patrons struggling for control of labour and expansion of territory. The use of the term magic is indeed conspicuous because one of the first known architects in ancient Egypt was also known as a healer, magician, priest, governor, and builder. What remains core to any project of territorial conquest are the tasks of legitimizing authority and organising labour, which must always be deeply reflective and strategic about managing workers' emotional and psychological aspects. Through the design, construction, use, and maintenance of architecture, technology, and infrastructure, specific forms of order, social relationships and forms of life are produced, while concealing any explicit ideological aims. This chapter is an early effort that seeks to draw a clearer picture of these strategies of management and authority and begin inquiring how we might make them more transparent and thereby disseminate knowledge to architecture's inhabitants, empowering them to 'break the spell.'

KEYWORDS

architect; labour; bio-politics; social media; archaeology.

Chapter 12—Architecture, Behaviour, and Magic: On the Architect's Design of Forms of Life

Brendon Carlin

The term *future* is rooted in the Indo-European bee, which means *I am*, *to be*, and *to become*. The figure of the architect emerged as a specialized professional through divisions of labour and separations of designer and 'user' at least 5,000 years ago and in parallel to the rise of Empire[1] (Howe, 2002) in Egypt.

Since then, we have been tasked with designing and orchestrating spatial, ritual, 'functional' and representational mechanics for the reproduction of specific forms of future behaviour: specific social roles, relations, and order, forms of production, and forms of life. The term future behaviour has recently been used by those who are also now bestowed with the title architect, and often solutions or systems architects: the designers, engineers, and programmers of high-tech information and communication technologies and social media platforms or other programmes and software, not to mention a vast and expanding network infrastructure. Tristan Harris, a prominent former Google programmer, explains that social media is designed to work via a kind of magic that can provoke, predict, shape and capture your future behaviour; 'your future behaviour is the product' (Orlowski, 2020, 0:26:32).[2]

In response to threats which would destabilise and potentially destroy our current political and economic institutions, debates in centres of government like the United States Congress have focused on developing regulation or reforms on social media at the level of content (Flew, 2018). The real politics of this economic and ontological machinery though, can only be probed and theorised if we consider its deeper mechanics and its literal material dimensions

1 Broadly defined, Empire is a political organization composed of multiple territories and peoples, 'usually created by conquest, and divided between a dominant centre and subordinate peripherie' (Howe, 2002).

2 Ibid.

'Any sufficiently advanced technology is indistinguishable from magic.'

Arthur C. Clarke (Clarke, 2013, p. 36)

and the labour it organises. We must consider the way the spaces, machines and infrastructures that make it possible are designed, produced, or manufactured, used, and maintained. If we look beyond our own desks to, for example, the tech worker offices in Texas, communications networks under all oceans and in outer space, data storage in China, mining operations and miner housing in the D. R. Congo or Peru, computer assembly plants in India and so on—we can start to pick apart the way the social network takes a primary role in shaping forms of life, social relationships, and our architecture and cities globally. A deeper reading of these 'high' technologies might *make visible what has long been at stake* for the figure of the architect, and 'architecture proper'—namely buildings, parks, the city and so on—since the very emergence of the profession

Below we will develop a brief and preliminary comparative investigation of a kind of ritual mechanics of control or capture at play in the architecture of ancient Empire and the high-tech architecture of Empire today. The point of this investigation is to use certain terminologies and features associated with an analysis of each, to begin and unpack some of the key mechanisms through which a hidden governance of forms of life for extraction and expansion operates in the design, construction, use and maintenance of architecture. Through a few ancient Egyptian examples, read in parallel to recent 'high tech architecture' we will query the relevance of Harris' use of the term *magic*, and why an unpacking of this term might be central to a theory of architecture today. This investigation is compelled by a much larger ambition to develop practices through which architecture might begin to compete with Empire on the 'playing fields' of magic.[3]

EMPIRE'S ARCHITECTURE OF FUTURE BEHAVIOUR IS ANCIENT

Tristan Harris, who has now become a crusader for the ethical reform of high-tech and social media, has made abundantly clear what is at stake for tech 'Empire'. Through programming of symbols, effects, commands, links, and alerts, big tech's designs are focused on creating a perpetual increase in user activity and data collected from their platforms so that they can process patterns and sell predictable behavioural outcomes. Hence, the predictability and manipulability of user visits to and spending with their paying clients and advertisers increases. Harris studied cults, is a former magician, and attended Stanford Universities Persuasive Technology and Behaviour Design Lab (Thompson, 2018). He explained that over time, tech giants create a kind of 'voodoo doll' of the psychological, emotional, and physiological individual through surveillance and the collection and analysis of vast amounts of data (Aswad, 2020, p. 306). This allows algorithms and AIs to identify vulnerabilities which might be systematically triggered, provoking and guiding the user in increasingly manipulable and predictable ways (Harris, 2016). One of the key tricks to social media design is creating a 'manipulative environment that [taps] into the users' weaknesses' and disorients them. Big tech's knowledge is focused on developing techniques with names such as 'intermittent variable rewards' (Harris, 2016) which strive to systematically, rhythmically optimize the timing, format, and content of messaging and alerts (Neyman, 2017). The user should be both made to feel insecure, uncertain, and precarious, as if they might be left behind or out, but then 'therapeutically rewarded' as they engage with forms or a sense of protection, belonging, empowerment, and self-realization (Neyman, 2017).

Magic can be colloquially understood as illusion or trickery, forms of skilled deception that employ an art that involves *sleight of hand*. In the work of modern magicians, the design of artifice, architecture of the stage or prop which takes advantage of blind spots in perception and vulnerabilities, is the key to an often charismatic and entertaining spectacle.[4] One that must not only carefully consider

3
This phrase is taken and adapted from Tiqquns book This is Not A Programme. (Tiqqun (Collective), 2011).

4
See for example David Copperfield's passing through the Great Wall of China.

the perception and vantage points of the spectator but becomes all the more captivating when it asks the subject or audience to make choices and participate or seemingly 'take control themselves.' In order to construct an enthralling drama and establish a sense of supernatural power, the magician designs and stages the potential for disaster, but miraculously averts the threat and danger. Of course, the key design problem and task is to conceal the actual mechanics and give an 'option space' so as to give a perception of free will and choice, but of course land in an outcome which is under the control of the magician. With advances in technology the mechanics of the magic trick have become increasingly small and invisible.

Magic, on the other hand, and especially in anthropology of the pre-modern can be understood as concerned with rituals and spells involving the sequenced choreography of spaces, objects, bodies, affects and symbols. The magic spell or ritual has been used to allow the patient to confront the source of illness or existential threat, and even to some extent and in some examples, initiate them and teach them techniques and methods with which they might become magic practitioners, restore their presence (De Martino & Zinn, 2015, pp. 434–450) or protect or care for themselves. From another perspective, the magic ritual sequence and its effects can be used to uproot the patient or subject who, once vulnerable and disoriented, can be offered specific forms of relief, protection, and orientation through form, sequence, symbol, affects and narratives. Often these symbols and narratives serve to assign meaning, identity, threats, and ways of guarding against them that orchestrate the subject or user into specific roles, tasks, hierarchies, and forms of work and life in ways that reproduce the power, authority or system which condones, patronises, and designs them (Turner & Turner, 1970). Thus, we would argue that the patient, subject, or user is rendered at once mesmerised, enchanted and perhaps grateful, while also rendered to some extent, subordinate and dependent.

The design of the first pyramid and funerary complex, the superlative political, informatic, ritual and magic interface of Egypt's Old Kingdom, has been attributed to Imhotep, one of the very first figures historically identified as an architect and chief minister to the Pharaoh Djoser. Imhotep was also referred to in Egyptian and Greek historical records as a magician, high lector priest, healer and physician, and as the 'overseer of all stone works'. The 62-metre-tall pyramid, 125 metres by 109 metres at its base, was constructed of stacked *mastaba* platforms to become a clear symbol of the king's maintenance of *Maat*, the cosmos or cosmic order (Ezzamel, 2009, p. 83),[5] and an existential and practical orientational device in the landscape and the psyche. It was surrounded by a vast necropolis containing the bodies of subordinates who would continue to serve Djoser in the afterlife. Djoser's cult-ritual memorial temple contained libraries of written inscriptions of foreign conquests, spells, measures, accounting, processes of production, and practical knowledge: an ideological, archival, and actual tool for the organization of Maat and of the living economy, labour, and politics in Egypt. It has been calculated that at just one temple complex, at least 25,000 workers laboured for over 20 years in its construction as artisans, scribes, builders, food makers, and suppliers (Tyldesley, 2002).[6] We can only guess at the vast network of producers of food and sustenance needed to supply the assemblage of specialized workers. After construction, in addition to a regular priestly staff, mortuary temples employed a network of part-time 'hour-priests' so that the state and temple could provide titles, schedules, and a role in Maat, not to mention the redistribution of sustenance to a large section of the society (Haring, 1997, pp. 80–82).

Often called 'households of a million years', memorial temples' primary function was to maintain Maat through serving the deity housed within elaborate daily rituals: waking, bathing, clothing, and perhaps most importantly, feeding the god (Smith, 2010, p. 49). Vast amounts of produce, food, wares, and prestige items were ritually processed in external or small peripheral workshop facilities called the Shena. Shenas can be understood as a kind of proto-factory for the god's household, where bread, beer, pottery, and other wares was mass-produced by labour crews and provided to the temple, its staff, and magazines or storage (Smith, 2010, p. 49). For example, at the Ramesseum (1279–1300 BCE), mortuary temple to Pharaoh Ramses III, '2,222 loaves of various types, 144 jars of beer, and 50 other items' were produced and offered daily (Haring, 1997, p. 76). The temple is a vast complex remarkable because its ritual interface, laid out on a grid in hierarchical sequences of façades, courtyards, a hypostyle hall, and offering platforms, only compose about 30 per cent of the complex's 8,200 square metre area.

5
Inscriptions from a tomb at Hierakonpolis (3200–3100 BCE) depict the king or pharaoh standing between two animals of chaos, unrest, and unrule, charged with the maintenance of earthly architecture and material rituals to maintain Cosmos or Maat. 'Disorder entailed the collapse of cosmic order and Maat as the pristine condition of the world established since Creation; the inversion of social relations; and the dissolution of interpersonal bonds.'

6
Joyce Tyldesley of the University of Manchester wrote: 'All archaeologists have their own methods of calculating the number of workers employed at Giza, but most agree that the Great Pyramid was built by approximately 4,000 primary labourers (quarry workers, hauliers and masons). They would have been supported by 16–20,000 secondary workers (ramp builders, tool-makers, mortar mixers and those providing back-up services such as supplying food, clothing and fuel). This gives a total of 20–25,000, labouring for 20 years or more. The workers may be subdivided into a permanent workforce of some 5,000 salaried employees who lived, together with their families and dependents, in a well-established pyramid village. There would also have been up to 20,000 temporary workers who arrived to work three-or four-month shifts, and who lived in a less sophisticated camp established alongside the pyramid village.

Instead, the majority of the Ramesseum's area was composed of dozens of vaulted storage magazines that are asymmetrically distributed in the overall plan. Its grain storage alone could feed 17,000 to 20,000 people for a year (Kemp, 2018, p. 256). Temples were considered semi-autonomous 'sacred corporations' with a large hierarchy of management and staff: priests, scribes, soldiers, labourers, bakers, brewers, cleaners, and so forth (Jacobson & Holden, 2005). They also had ships, mines, proto-factories, and artisan and craft workshops and were endowed by the pharaoh with lands that were often rented to tenant farmers. Temples recorded, stored, and reproduced knowledge and ritual for political and economic Maat through their material order, space, and form. Additionally, they can be understood as literal data and processing repositories. As we have seen, their walls were inscribed with complicated and detailed information and programmes in which Maat was woven to social and economic relations, production of goods, role types, administration, and accounting (Smith, 2010).[7]

With 'massive stores of cereals and other products, temples functioned as an economic buffer, stabilizing supply (and hence, prices) on a national scale' (Haring, 1997, p. 20). The temples also organized opulent festivals as a 'reversion of offerings' up to 60 or more times a year. During the Ramesseum's use, one festival, called Opet, lasted for 27 days (Kemp, 2018, pp. 265–266). Opet, as detailed and depicted on temple walls, 'was celebrated by the distribution of 11,341 loaves, 85 cakes and 385 jars of beer. The core of the festival was an unusually long procession of images.' The images, deities, magical props, and barges were paraded down the Empire's infrastructural network of avenues, streets, and the Nile accompanied by musicians and dancers and lined with soldiers. Similar to inscriptions on architecture, battles with and the conquest of dark forces, deities, chaos, unrule, and the foreign were enacted to engage the crowd in spectacles of threats or dangers and their conquest by ruling figures and their patron gods. Carefully 'stage-managed halts at intermediate stations, and the occasional excitement of a "miracle": all this brought to the city as a whole a spectacle and munificence which regularly reinforced the physical and economic dominance of the temples' (Kemp, 2018, p. 266). The pharaoh attended the festival and was paraded by priests into the depths of the temple at Luxor, beyond the view of the crowds, to engage in a ritual union with the god Amun, during which his *ka*, or indestructible essence, was restored in a smoky ceremony. Afterwards he would re-emerge, completely transformed in appearance, costume, and props, to affirmational cheers (Kemp, 2018, pp. 265–267).

New Kingdom artisan and builder specialists in the production of ritual and

7
Divine order was woven on the walls that detailed divine order, exploits, glory, and conquests of the pharaoh, depictions of the cosmos in which everyone had a key role, specific protocols and ritual sequences, 'debts' of offerings to be paid and even described processes of production of, for example bread and beer.

processional architectures were housed in perhaps the first towns ever planned, designed, and built by a state, complete with repetitive housing types. One such example is Deir el-Medina (1500–1050 BCE), called by its inhabitants The Place of Truth. Temples as separate in type and location from tombs first emerged because mass surpluses of prestige goods and esoteric and practical knowledge, for instance secret magical spells for protection, were stolen from earlier mastaba and pyramid-type tombs. Thus, a new hidden type of tomb was devised in the Valley of Kings. Likewise, the workshops of artisans, scribes, builders and supporting labour were to be kept separate in a secret, planned, and built town (Lesko, 1994, p. 42). Because no one in the town produced food, they had to be supplied entirely through the labour and infrastructure organized by the state and temples. Though not lavishly compensated, they were provided housing, beer, bread, fish, oil, and fruits, and they had access to the best metallurgic tools, technologies, and prestigious titles and held the 'high security job of creating the magical means by which their god-king would achieve eternal life' (Lesko, 1994, p. 39).

In early dynastic architecture, aside from being depicted as the great balancers holding at bay the forces of unrule and chaos, the god Horus and kings are also depicted as destroyers, bearing a harpoon, mace, and 'hoe (for hacking down walls)' (Kemp, 2018, p. 85). As the right hand of the pharaoh, architects were mediums of this destruction and reassembly. They for the first-time separated conception from builders and users and took over the planning and design of others' architecture. Planned city settlements like Tell el-Dab'a (around 15th century BCE) were characterised by a strict orthogonal layout consisting of rows of identical house units ... separated by larger streets ... 2.7 m wide' (Moeller, 2016, p. 252) and oriented around the temple. The town was part of a project of internal colonization (Kemp, 2018) to convert nomadic or semisedentary peoples to farmers, which entailed destroying their previous world systems and modes of life, fragmenting them, and then networking them into the religio-social factory and infrastructure of the Empire. In their new specializations, they were rendered subject to and materially and existentially dependent upon the designs of distant architects, priests, and artisans. It is crucial to note that in Egyptian predynastic village-like settlements such as el-Omari, the dead were buried inside oval dwellings or within the village (Bard, 2005, p. 28), reflecting an intimate ritual, spiritual, material politics which might be negotiated and designed, and at the very least understood or agreed upon, by those involved.

REAL INNOVATION

Computers can be understood as abstract machines that carry out sequences, logics, and calculations, including arithmetical and non- arithmetical steps that follow a designed and well-defined algorithm or model. Early computers were composed of mechanical and then electrical parts which required physical reconfiguration to alter the programme. However, with Alan Turing's conception of the universal computing machine, they became capable of computing everything by executing instructions or programmes from a tape or memory device. This enabled rapid and eventually automated reprogramming (Turing, 1936). Accounting, which is closely associated with the origins of computation, was a primary institution in ancient Egypt and emphasized 'ritual, mythical and magical dimensions' (Ezzamel, 2009, p. 348). Its attendant instruments, writing, diagrams, measure, memory, information, and communication were as we have seen intricately woven to a particular and invented architecture, religion, economy, specific divisions of labour, social relations, and forms of life. Systems of logic, mechanical and informational organizations which we consider rational and nonideological, should be understood as instead contingent and concerned with the construction of highly specific realities which serve the interests of those who commission their design.

Computers have been fitted with peripheral devices such as user interfaces, surveillance, capture, and mass storage and networked into the vast information and communication technology that hosts social media and the majority of apps and tools with which we work and consume. The term *media* refers to the material, mechanical and informatic institutions, means and infrastructure for publishing and broadcasting information. The term *information* is rooted in Latin *īnfōrmō* and implies the moulding of or giving shape to something. It can be defined as a specific reduction of phenomena and data which resolves uncertainty: anything that answers the question of 'what a given entity is' and 'the act of informing or imparting knowledge'. Scholars have argued that computational, informatic, and social media procedures and machines, as mechanical organizations of material and programmes, hardware and software, act 'like witchcraft'. both producing uncertainty or risks and dangers, but also organizing 'complicated rituals in response to uncertainty' (Gambling, 1977; Sen, 2017).

The political philosopher Paolo Virno argues that because the human animal is uprooted by negation from a capture in 'original' animal being through the use of language and other technology, we lack specialized instincts (Virno, 2004, p. 98) and are perpetually disoriented in the world. Thus, we seek reassurance in specialized customs involving ritual and repetition and ultimately in forms of refuge which might 'guarantee an absolute and systematic protection of our existence' (Virno, 2004, p. 31). However, he stresses, it is the very forms of search for protection and forms of refuge which themselves produce the dangers, often spiralling into subjugation and horror (Virno, 2004, pp. 34–35).

The rise of a networked global and supra-global infrastructure has rendered us dramatically more uprooted from old forms of social relationships and life and more 'in-dependent' and fragmented than at any point in history. Paradoxically, though, we are simultaneously more connected, grafted into a total assemblage and utterly dependent on a technological and existential infrastructure. Compared to previous generations, we are increasingly losing any skills outside of hyper-specializations that nonetheless require that we all operate the same universal machines: computers and employ the most generic and common of human abilities. These tendencies have only amplified a real hollowing out of architecture's old mechanical, typological, and programmatic tasks. Although far from obsolete, architecture must constantly resurrect old types and strategies to avoid the psychological collapse of subjects but at the same time has acquired crucial new formal, phenomenological, aesthetic-emotional and ontological tasks.

One of the key paradigms of the early 21st century was already emerging in the mid-20th century in such examples as the Toyota Factory and Bürolandschaft studies (Carlin, 2022, p. 144). The open landscape operates by simultaneously creating a symbolic and, narrowly, actual 'free', user-controllable platform space as a new plane of reality that is analogous to the social media platform. It is open, because it would not be productive to restrict potential future configurations that will emerge via its cybernetic management; via the machinic assembly of humans, computers, surveillance, and algorithms that give feedback and optimize production while avoiding risk, uncertainty, and insubordination (Rumpfhuber, 2011). Harris explains that what magicians do is look for 'blind spots, edges, vulnerabilities and the limits of people's perception, so they can influence what people do without them even realizing it. "Once you know how to push people's buttons, you can play them like a piano." (Harris, 2016) Through 'architecting the menu' interface and options space, the magician "gives people the illusion of free choice so that no matter what the user or subject chooses" (Harris, 2016), the magicians and we should add, their patrons, win. Michel Foucault explained that post-sovereign, artificial governmental techniques were based in the naturalness and undeniability of human desire, both giving a 'free play' to desire but managing it as well to increase control and productivity simultaneously. It is about 'how to say yes to this desire' and how to allow the individual to spontaneously pursue their desire and interests while nonetheless binding them to profitable outcomes (Foucault, 2007, pp. 72–74). The open architectural platform manifests foremost a form of power, control, protection, and self-realization for the user, but also itself produces future uncertainty and a lack of any refuge. It is of course also an option space bound to an assemblage of social, legal, financial, productive, and technological protocols: moulding social relations and life in narrow and instrumental forms for extraction.

At the beginning of the 21st century, we entered the era of a kind of soft baroque architecture, perhaps best exemplified in SANAA's Rolex Learning Centre and Gehry's Facebook MPK20 (Eftaxiopoulos, 2020). These examples emphasize transparent, open, DIY, and playground or park-like aesthetics. As we are increasingly pressured yet free, dependent yet independent, and online all the time, architecture needs to become more natural, soothing, therapeutic, aspirational, 'authentic', motivational and generic and open for the taking. Not unlike Imhotep, Empire's contemporary architects are valued and elevated in proportion to their aptitude as priests, healers, and dark magicians.

In the past three years of the pandemic, we saw an acceleration of our tendency to spend most of our attention and time with instruments and machines of the ergonomic at micro- and nanoscales: the mobile, laptop, cameras, sensors, software, platform, desk, mouse, and keyboard, all the while perhaps cocooned by our fleece pyjamas, ergonomic chair, decorative cactuses, and leafy plants. Constantly distracted from endless 'work' by Instagram and YouTube, which increasingly also demand that we produce content to survive, thus blurring the boundary between work and leisure or entertainment. We witness an accelerated blurring of previously distinct and separate spheres, of differences between work and home, inside and outside, here and there, mine and yours, and so on. What quarantine made visible and amplified is that even in the opaque, closed, and spatially subdivided spaces of our housing, we are now encouraged, indeed obliged, to self-manage and actualize, play, 'misuse' and experiment, adapt and innovate, but we cannot change the option spaces' fundamental separations.

But Empire's increasing demands on our capacity to adapt, destroy, and create constantly exposes and suspends our capture in habits, environments, programmes, and so on: laying bare the fact that we are inessential beings who lack any preordained work, nature, or destiny. This is precisely why we have the possibility of politics and architecture. Therefore, we might push the innovation and 'misuse' much more deeply. As abstract machines, architecture and technology are in the end material assemblies and forms which are devoid of any proper or destined use. When they are stripped of programming and mythology, and when they lose their rhythm within the wider machinic orchestra of Empire's behaviour factory, they expose and suspend the witchcraft and functions for which they were designed.

Architects might work instead to open knowledge, conceptions, and practices of magic to the users. A magician is the one who, after 'initiation and through a clearly defined practice' (Tiqqun (Collective), 2011, p. 178) takes uncertainty and inessentiality of being to the limits. Only there might they break the spell of the ensnaring modes of fragmentation and assembly and the forms of refuge constructed by Empire and develop a simple but ambitious plan of their own. Another ritual, material, and territorial politics might be understood in its mechanics, negotiated, designed, and agreed upon by those involved.

A next stage in this investigation would start by following an assertion by the feminist theorist Sylvia Federici. She was critical of fervent optimism about the radical democratization expected with the rise of new digital tools and the internet, which was prevalent in the 1990s. Instead, she argued that any real politics and democratization could only be possible if fundamental assumptions, monopolies, separations and of course real material relations are reconsidered, challenged and experimented with. For her, this included atomization in the sphere of reproduction with, for instance, one kitchen per household.

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ABSTRACT

Continued urbanization and the need for mass housing require a rethink in urban planning. For future urban development and densification to be sustainable, this must not only be about growth and numbers. We need to create liveable urban spaces that allow communities to grow and cities to evolve over time. The traditional urban planning process is unlikely to deliver this. It follows a top-down model that focuses on the urban form and efficiency of transport and utilities with too little regard for future inhabitants. We need a clear understanding of the future demographic and engagement with the needs and desires of those who will live in the city, and we need to start our design process with performative outcomes that have quality of life at their core. From these precepts, Buro Happold have developed a design approach that captures these qualitative parameters through a set of connected analytic models that allow us to understand the interrelationship of the built environment and its outcomes. This enables meaningful stakeholder engagement and the investigation of scenarios of modified outcome requirements. This in turn helps us navigate difficult planning decisions and design an urban environment for sustainable growth and quality of life.

KEYWORDS

Wechselwirkungen*; urban planning; parametric modelling; human-centric; planning tools.*

Chapter 13—Wechselwirkungen: Rethinking Urban Planning and Densification

Wolf Mangelsdorf

The relentless migration toward urban living continues, with the result that most major cities have a shortage of affordable housing and face a clear challenge to build mass housing faster, better, and more economically.

INTRODUCTION

However, being able to build more and faster is only a partial answer to the problem, because providing mass housing at the scale at which it is needed will have a radical impact on our cities. Several of the extensive housing developments built in the second half of the 20th century have failed to create liveable urban spaces and have often fallen into disrepair or had to be replaced. We must avoid repeating these mistakes.

For this, we believe that urban planning and design will need to be radically rethought. We must shift the focus to criteria that define the quality of life rather than just the urban form. On this basis, we can then develop and shape the physical expression of the urban space and set it within the boundaries of locality, environment, cultural context, and existing urban fabric.

This restructuring of the design process results in defining its goals and measures of success at the outset and using stakeholder engagement to define, refine, and calibrate what becomes a set of performance criteria.

Engineering plays a key role in this. We have developed a computational modelling approach that translates these criteria into design parameters, connects them, and makes them measurable. This offers the possibility of evaluating multiple what-if scenarios for urban planning and socioeconomic development. Parallel futures can be tested with stakeholders, and the causal links between decision-making and outcomes can be evidenced.

We have called this Wechselwirkungen to describe how the often-hidden interrelationships of the seemingly unrelated become visible; this enables the design process to become transparent and more democratic.

MASS HOUSING AND THE URBAN CONTEXT

The development of mass housing in the second half of the 20th century is not a success story. Many of its concepts go back to the radical ideas of the modernist era and to the urban design approaches that emerged in the interwar years. Driven by rapid industrialization and urbanization and in search of an alternative to the overcrowded city of the 19th century, the focus of mass housing design was on reduced density, a loose urban fabric with interwoven green spaces, the separation of primary uses, and a blind and all-conquering belief in mobility, particularly the motor car.

Ludwig Hilberseimer's concepts of a vertical city (Hilberseimer, 1927) illustrate the mechanistic aspects of this thinking. While they may appear stark, cold, and utopian, they found themselves partially replicated in many of the developments that defined postwar reconstruction, most notably the industrially produced housing blocks of Eastern Europe. Utilitarian in appearance, they show an industrial approach to construction in which the production method, more than any other factor, determined the aesthetics as well as the proportions of the urban space.

However, mass housing of this kind is not confined to communist Eastern Europe. In Great Britain, several of these large-scale estates were constructed in the 1960s and 1970s, fell into disrepair only a couple of decades after their completion, and have recently been demolished or are being replaced with new buildings. Their relative inflexibility and often bland and scaleless architecture was heavily influenced by prefabrication, the total absence of any mixed use, and eventually demographic issues and ultimately led to their failure and replacement. This is not a sustainable model, and in many ways, it is the opposite of what is required to satisfy the need for affordable housing. The issues with these estates are multilayered. However, what all have in common is that the building-street interface and the quality of the public spaces did not work.

In the last 20 years, progress often appears superficial at best, and in numerous recent developments, we see groomed public spaces that are designed to aesthetic considerations, but rarely create a place of urban quality. The relationship of the residential buildings with the street space is poor; mixed use, the lifeblood of urban space, is reduced to a small number of secondary retail areas.

At the same time, we all seem to know intuitively what we expect from a functioning urban neighbourhood. Where street life and atmosphere are right, urban neighbourhoods become increasingly attractive places to live. Although we may not be able to replicate what has historically grown, the aim must be to introduce a comparable quality of life to those neighbourhoods where we have the space and opportunity to re-densify or simply the need for improvement.

In many ways, Jane Jacobs's four criteria for an urban environment to be successful, formulated in her struggle in the 1970s to preserve the liveability of New York City, provide a timeless, simple guideline for city design: mixed primary uses, short blocks, ageing buildings, and population density (Jacobs, 1961).

We are at a point where mass housing is once again required on a similar scale as in the postwar years. The debate has become a political one, and state-driven house building targets are becoming the norm in most developed countries.

"For our cities to have a sustainable future, we need to grow and shape them with a clear human-centric focus."

This will certainly result in the construction of more housing, particularly in price brackets in which the market currently has only limited interest. However, numerical targets carry the risk of becoming the only focus. We must not once again neglect the quality of the urban neighbourhoods we are going to build or radically alter, nor can we afford to disregard those who live there. In the following, we outline how we will address this.

REFRAMING URBAN DESIGN

Urban planning and design are highly complex. They must simultaneously bring together the need for buildings and their architectural qualities, infrastructure, transportation, economics, and several other, often conflicting factors. All require expert input from numerous disciplines. The regulatory framework that has developed around this over centuries is not always logical and, in many cases, is politically driven.

Our industry has developed safe and tested sequential processes to deal with this complexity. In simple terms, this entails a team of expert urban planners and architects developing a spatial arrangement for an urban quarter or the changes to it within a given framework, such as zoning, planning regulations, development targets, and the needs of the property developer, whether private or public. Experts test the urban design proposals within boundary conditions agreed for their acceptability and evaluate the infrastructural connections and improvements that are needed. This usually happens after the initial design proposals have been prepared. Any stakeholder engagement happens at the end of the sequence, when most of the key design decisions have already been taken and planning and design budgets have mostly been spent.

A refocus is required. The spatial arrangement, its appearance, and its functionality must be the endpoint of the process, not the beginning. Moreover, the desired outcome must not be defined solely as urban form. Creating spaces that enhance the quality of life should be the measure of success and developing the criteria to measure this should be the starting point of the discussion. In parallel, we need to understand the environment and context. These location-specific criteria are important and we can see them as constraints and as opportunities.

Ultimately, though, we are creating urban spaces, in most cases within existing urban fabric. Our cities are made of such spaces and of the flows of people, goods, money, and traffic that pass through them. We create and alter spaces and flows through urban design and infrastructure interventions.

Both, the input criteria that define the quality of life and boundary conditions, and the output, urban design interventions, spaces, and flows, are complex. They are dependent on several individual parameters combined in the right way, and neither of them can be described, modelled, or measured in simple one-variable equations.

Acknowledging this, we have developed a modelling approach that allows us to break the inherent complexity of the process down into simple modules. The underlying process becomes transparent and uses the same skills and techniques we deploy in the more conventional methodology that currently governs urban design. But the boundaries between individual design disciplines disappear, and a multidimensional net of interdependencies and influences starts to emerge.

INTEGRATED PARAMETRIC MODELLING

The idea of our modelling approach is simple. We acknowledge that parameters which describe quality of life or urban design interventions are dependent on a multitude of factors. We see them as what we term compound parameters (Fig. 1). But we can break them down into individual factors and look at each of these on their own.

To take an example on the input side: safety and security is an important issue for our quality of life and a key performance criterion for what we want to achieve with our design interventions. But no single parameter can simply describe safety and security in an urban context. However, we know which factors influence it. Thus, Safety and Security enters our model as a compound parameter. It is composed of several factors that we can model as part of the urban design process, including visibility, lighting, policing, walkability, mix of use, and hours of activity.

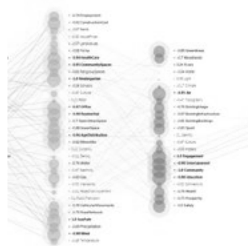

Figure 1 ▸ p. 205

Something similar happens on the output side. A lively street space, for example, is a desirable urban design outcome. This again cannot be simply modelled as a single entity, because it too depends on several influencing factors: Including the mix of uses, the hours of activity, lighting, visibility, public transport, density, street level retail, and walkability. Each of them can be modelled easily with the expertise and techniques that are commonly engaged in urban planning.

What we can see is that the individually modelled parameters relate to both the performance criteria and the urban design output. In the example case, the Safety and Security performance criterion shares a great number of its individual constituent parts with the Lively Street Space output.

We will not be able to model and measure everything in all situations. But our setup allows the model to be built up incrementally: parameters can be added in a modular fashion. Expanding the model does not require any restructuring. It just adds resolution. This characteristic makes the process resilient to future developments. Also, we do not have to predetermine all inputs and outputs as we can freely connect the various modelling steps into compound parameters.

Computationally, this is simple, and the main work of the designer and planner can focus on what is most important: the decisions about what we want to model to capture certain performance requirements or to arrive at certain outcomes. It allows cultural context and preferences to be considered. The process is transparent, and remains firmly in the space it should occupy: between science, art, and intuition.

BRINGING IN THE STAKEHOLDER ENGAGEMENT

The current sequential urban design practice outlined above, is strongly linked to a top-down approach to urban planning that is characterized by government directives, regulative planning, developer interests, and optimization of transport and utilities infrastructure. It is manageable and orderly but provides little space for meaningful stakeholder engagement. The contrasting bottom-up model, based on community engagement with the potential to be democratic and people-focused, borders on being unmanageable and in many cases simply does not converge. While the former can disenfranchise the community, the latter often stalls development altogether.

The design approach we have developed facilitates decisions to be tested in an evidence-based and outcome-focused design environment that can bring top-down and bottom-up together and create a middle way. It allows what-if scenarios and the evaluation of options to be explored. It is a curated process whose various open calibration steps enable true stakeholder engagement. The planning process becomes transparent while remaining manageable and orderly within the boundaries of the usual regulatory frameworks.

The parametric model can produce a theoretically infinite number of options, allowing the evaluation of a range of future outcomes. Desired, undesired, planned, and unplanned scenarios can all be assessed by producing the data necessary for informed decision-making. Unlike traditional more linear sequential processes, which tend to optimize for a known or prescribed outcome, the parametric model allows the prediction of results within bandwidths. This makes the idea of an evolutionary loose fit realizable and thus provides a key condition for future resilience and adaptability. It is a replicable data process that allows the assessment of development risks and, as a result, the creation of value and return on investment.

The model thus functions as a facilitating tool in the dialogue between the client, investor, and designer at one end and the community and stakeholder groups at the other. Both usually move within their own normative frameworks, which have few or no overlaps.

In all of this, the design process still requires the subjective intervention of the designer or other decision makers. The optimization of the parameters alone will not lead to a satisfactory outcome, because many conflicting goals require value-based decisions to be successful. However, the model predicts the solution envelopes that most closely fit the desired performance criteria. The outcomes of subjective interventions are transparent, and alternative options can be evaluated.

CONCLUSION

For our cities to have a sustainable future, we need to grow and shape them with a clear human-centric focus. This becomes even more important as we are looking to densify existing urban fabric and create much needed new affordable housing.

We have developed a technology-backed approach that enables this shift. By connecting the analytical processes that underlie urban planning and confirming them in computational models that allow the simulation of multiple futures, we can connect performative and physical outcomes and investigate their correlations. This in turn allows a much more transparent stakeholder engagement.

This process is complex, particularly in an urban context. In the development of the analytical approach, we therefore took initial steps at building level that enabled us to rapidly prototype multiple options through interconnected multidisciplinary analytic, with a client interface that illustrates the design process and outcomes. Subsequently, we translated this to the urban scale.

The results are the same in both areas: a more transparent design process that radically shifts the focus to the users and quality of life. Although climate change is the most pressing challenge of our time, only a human-centric perspective can generate truly sustainable outcomes with adaptability to future changes that provides resilience and, ultimately, the longevity of the built environment we create. For urban planners, this must be the overarching goal.

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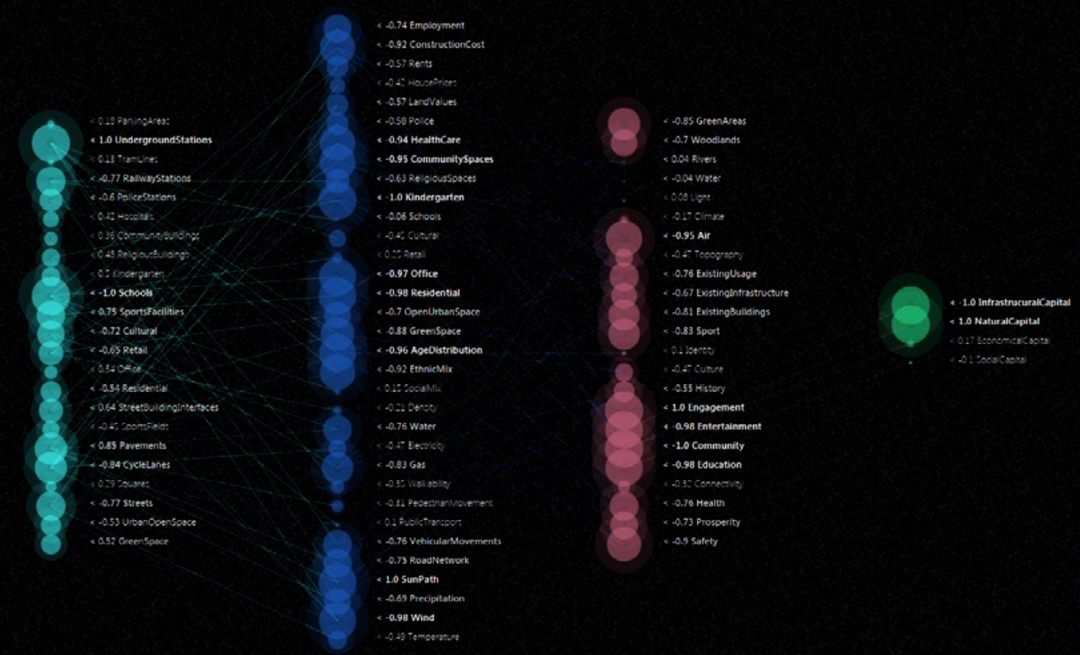

Figure 1
Compound parameters define input and output. They are based on a weighted combination of simple modelling steps (diagram by Buro Happold).

ABSTRACT

In this chapter, we set out to rethink the value of what we have named 'spaces of exchange' for future cities. In our reflections, spaces of exchange are not abstract categories of space, but concrete urban thresholds that enable social activities, acts of care, movements, physical activities, and more. In many cities, such spaces have become crucial for improved quality of life since the beginning of the COVID-19 pandemic. Spaces of exchange are interstices of the possible (Boano, 2022). This article explores such spaces with a household survey (N = 540) and resident consultations conducted in Beirut, Lebanon in 2021. This chapter attempts to unpack the uses and modalities of these spaces for future cities. The study finds that the creation and use of spaces of exchange is ranked as one of the most important coping mechanisms for dealing with multiple crises. For instance, in Beirut, residents have been tackling COVID-19 lockdowns, the 4 August port blast, and an escalating financial crisis. Self-support was found online from family and friends, by engaging with each other, and from bodies and encounters. Spaces in local neighbourhoods were used by more than half of respondents for self-support, emphasizing the significance of 'spaces of exchange' in this context.

KEYWORDS

urban; space; neighbourhood; belonging; well-being.

Chapter 14—Rethinking 'Spaces of Exchange' for Future Cities

Elisabetta Pietrostefani, Joana Dabaj, and Camillo Boano

Urban open spaces provide valuable services to urban populations, including recreational opportunities, aesthetic enjoyment, and environmental functions (Brander & Koetse, 2011). Traditionally, open public spaces are identified as parks, green spaces, playgrounds, squares, undeveloped land, and streets.

URBAN SPACE IN MULTIPLE CRISES

The multiple crises that Beirut has experienced since the Lebanese civil war, between 1975 and 1990, have affected its public spaces. In the absence of a postwar plan, the widespread privatization, securitization, and mismanagement of public space have resulted in the exclusion of communities from the right to public space (Fawaz, 2012; Fawaz et al., 2018; Mady, 2022; Saksouk-Sasso, 2019). However, since 2005 a civic awakening has emphasized the crucial role of public spaces as catalysts for social integration (Mady, 2022). This has also increased the importance of streets as important public spaces in the city. Amidst the pandemic and in the aftermath of the Beirut port explosion in August 2020, public spaces are now being included as an integral part of recovery plans, acknowledging their importance for recovering communities. Public spaces rehabilitation projects include public parks, playgrounds, squares, streets and stairs.

In this article, we adopt the phrase 'spaces of exchange' to define not abstract categories of space but concrete thresholds that enable social activities, care undertakings, and the movement of bodies, and encounters. Sometimes, these are spaces that resist abandonment and carelessness, while offering possibilities for protection, opportunities, and ecologies. Sometimes spaces, procedures, mediums, and relations settle in these spaces to make some forms of life possible and simultaneously re-appropriate protection in space and design (Boano, 2022). We find spaces of exchange to be enablers that have often proliferated as urban residents spend more time in their neighbourhoods (Mouratidis, 2021).

Beirut residents have recently been exposed to multiple crises including a political and liquidity crisis, which started in August 2019 and escalated with

"Spaces of exchange present multiple opportunities for community-based initiatives to help maintain and rehabilitate neighbourhood spaces for recovering communities."

1 The quantitative findings are based on two survey datasets. The first was collected by Dr. Elisabetta Pietrostefani between March and June 2018 within the project Geospatial analysis of housing insecurity and resident value of neighbourhood amenities in Beirut, Lebanon, supported by the Royal Geographical Society with the Institute of British Geographers. The second was collected between March and April 2021 for the project Assessing Vulnerabilities for urban recovery solutions in Beirut post-explosion, supported by UKRI GCRF and the RELIEF Centre. The 2018 and 2021 household surveys were both conducted for representative samples of the comprehensive population count of Mar Mikhael proportionally stratified by nationality (Lebanese and non-Lebanese).

the October 2019 revolution, the COVID-19 outbreak, and the port explosion on 4 August 2020 (Bolin & Kurtz, 2018). This chapter looks at the neighbourhood of Mar Mikhael in Beirut, an area affected by real estate pressures and the financialization of housing before these crises, and then heavily damaged during the Beirut blast (Krijnen, 2018; Pietrostefani et al., 2022b). The pronounced spatial pressures on urban settings have led to spaces of exchange being re-invented and developed by neighbourhood residents for many reasons, reshaping the neighbourhoods' landscapes. The research finds that the creation and use of spaces of exchange is ranked as one of the most important coping mechanisms to deal with multiple crises.

A mixed methods strategy was applied to develop a comprehensive understanding through urban analytics, mapping, and text analysis. Data from two original household surveys was used to identify socio-spatial patterns using descriptive statistics and comparing indicators between 2018 and 2021.[1] The surveys were administered across six areas within the larger Mar Mikhael neighbourhood: Hkmeh, Mustashfa el Roum, Qobayat, Jeitaoui, Mar Mikhael and Khodr. A consultation workshop on mapping spaces of exchange took place on 20 April 2021 to reflect with citizen scientists on the subjective representations of the neighbourhood and how residents and other users experience it. This participatory method was designed and deployed to ensure the utmost sensitivity to this vulnerable setting and reflect the realities of the lives people are living there. The research also incorporated a diversity lens to explore intra-community inequalities (Dabaj et al., 2020). This lens was based on Catalytic Action's c0-design approach and the RELIEF centre's Prosperity Index research, in which the concept of prosperity is explored as a lived experience in a context of large-scale displacement and multiple crises (Jallad et al., 2021).

URBAN THRESHOLDS

Considerable advances have been made in urban open-space research, influenced by a growing concern for the quality of urban environments and the importance of the role of open spaces in achieving sustainable neighbourhoods (Al-Hagla, 2008; Francis, 1987). This has been pronounced since the COVID-19 lockdowns restricted the use of public spaces and imposed social distancing, forcing people to stay at home. This unprecedented global restriction has led many to question the impact of COVID-19 on our relationship with public space and on designing the city more broadly (Honey-Rosés et al., 2020). In Beirut, the widespread privatization, securitization, and mismanagement of public spaces, the COVID-19 lockdowns, and the rethinking of city spaces following the Beirut blast have resulted in the re-adoption of many ad hoc spaces (Ghandour & Fawaz, 2010; Seidman, 2009). Not just parks and squares, but pavements, the edges of buildings, empty lots, and staircases become spaces of exchange: thresholds 'where the world and life intertwine, mingle, twist in a constant resistance—awkward and fragile' (Boano, 2022). They offer a productive alternative of space and recovery beyond the temporal and a socio-spatial arena that embraces the relational nature and dynamism of complex social processes such as disaster events and responses to special crises.

The triple crisis in Lebanon has taken a significant toll on the mental health and psychosocial well-being of individuals from all levels of society (Fouad et al., 2021). The triple crisis manifests in the country's entrenched socio-political dysfunctionality, but more evidently in the everyday life of residents, which has become a daily struggle in which trauma and violence intertwine: a battle for life itself and its space. Spaces of exchange are scenarios in accelerated transformation where forms of 'coexistence without relationships' are determined and at the same time resist abandonment and carelessness, allowing mediums and relations that settle in to make some form of life possible, some movement acceptable, and some relief thinkable. To consider these re-conceptions of space, we explore the changes in how residents value the social street life through questions about neighbourhood belonging, self-reported well-being, and life satisfaction in local neighbourhoods. In crises, space becomes a means to support different ways of living in extremes.

NEIGHBOURHOOD BELONGING AND WELL-BEING

A WEAKER SENSE OF NEIGHBOURHOOD BELONGING DESPITE A VALUED SOCIAL STREET LIFE

We start by exploring neighbourhood belonging to uncover partial meanings of spaces of exchange in Mar Mikhael. Neighbourhood relationships are a significant aspect of everyday life, and they represent how connected residents feel to their immediate surroundings and their local community. The degree to which residents feel a sense of belonging to their neighbourhood often reflects the strength of the local social networks and the emotional bond to the place (Pietrostefani, 2022; Young et al., 2004). These are important components of everyday life associated with a sense of community identity and well-being (Finney & Jivraj, 2013).

When asked what they preferred about their neighbourhood, Mar Mikhael residents most often mentioned 'memories', 'social streets', and their 'neighbours'. Mar Mikhael was characterized as a neighbourhood valued for its social street life. Indeed, most households reported social life (57.6 per cent) as being the main reason they chose to stay following the Beirut blast. In both 2018 and 2021 surveys, respondents were asked a set of questions regarding various ties and interactions they have within their neighbourhood. The neighbourhood belonging variables captured diverse forms of social connections such as friendships and associations, seeking advice, borrowing things, planning to remain a resident, regularly stopping and talking to people, willingness to help neighbours, and trust in neighbours.[2] We have aggregated the scores of these variables, hereafter referred to as the neighbourhood belonging score.

Findings reveal a significantly lower neighbourhood belonging score in 2021 than in 2018. With the highest differences present in Mustashfa el Roum and Qobayat areas whose scores went from 3.5 and 3.4 to 3.0 and 2.9 respectively. Of course, we cannot pinpoint which crisis may have affected this reduction the most, but we clearly identify a weaker sense of local belonging despite the area's valued social street life. Temporalities are experienced differently as spaces are continuously rewritten. The fear of and restrictions on going out and socializing during a pandemic may have also affected the relationship people have with their public spaces, especially for the elderly population, who represent 27.2 per cent of the survey participants. Reporting lower levels of attachment to the neighbourhood may also reflect weaker local social networks or heightened insecurity about the future of these relationships amid the post-explosion recovery of local communities. Displacement after the blast was also noted as contributing to this changed perception of neighbourhood belonging. Forms of urbanism are often generated by displacement, spatial processes that imply a continuous shaping of the urban, revealing its agency. Such urbanism is constituted of acts that create friction within an existing system of oppression and opportunities (Dabaj et al., 2022).

To further investigate the relationship between neighbourhood and well-being, respondents were asked to rate how happy, stressed, and safe they felt in their neighbourhood. Respondents' levels of happiness in their neighbourhood were higher in 2018 than in 2021: 73.1 per cent reported a high level of happiness in 2018 compared to 54.4 per cent in 2021. Resident responses to the question 'How safe do you find your local neighbourhood?' also disclosed significant differences, suggesting a decrease in inhabitants' sense of safety in their neighbourhood. About half of the respondents thought that their neighbourhood was safer before the multiple crises, both during the day (48.4 per cent) and during the night (51.6 per cent). Similarly, residents surveyed in 2018 revealed higher stress levels than those in 2021: 78.6 per cent reported a low level of stress in 2018 compared to 71.3 per cent of the respondents in 2021. Our findings suggest clear alternations in respondents' perceptions of space and sense of well-being in their local areas following the financial crisis, COVID-19, and the blast.

2
Respondents were presented with a total of eight statements, to which they were asked to respond to what extent they agreed or disagreed on a 5-point Likert scale. The statements were the following: I feel like I belong to this neighbourhood; The friendships and associations I have with other people in my neighbourhood mean a lot to me; If I needed advice about something I could go to someone in my neighbourhood; I borrow things and exchange favours with my neighbours; I plan to remain a resident of this neighbourhood for a number of years; I regularly stop and talk with people in my neighbourhood; People around here are willing to help their neighbour; and People in this neighbourhood can be trusted.

Figure 1 ▸ p. 215

FINDING COPING MECHANISMS IN THE NEIGHBOURHOOD

To identify socio-spatial recovery solutions that are meaningful to the residents of the area, we explored how people tend to deal with issues that affect local well-being and addressed the coping mechanisms that residents adopt or are more likely to use. Survey respondents were asked to indicate to what extent they use or have used certain coping mechanisms to deal with the stress, depression, or trauma they faced following the pandemic lockdowns and the blast. In general, findings suggest that people tend to cope with these issues mostly through self-support, support from family and friends and by engaging in outdoor recreation or sport activities. Although more than two out of three respondents (68.4 per cent) appear to rely on self-support and one in two (50.2 per cent) reported finding support from family and/or friends (Figure 1), encounters through outside activities were the third most frequent coping mechanism. No evidence emerged that these tendencies differ according to income, education levels, or other socioeconomic variables.

As shown in table 1, most self-support was found in the neighbourhood. Approximately half of surveyed residents (51.6 per cent) who choose to engage in outdoor recreation, sports activities, or other encounters tend to partake in such activities in their local areas. These responses highlight the role of the support that residents can find in their immediate environment and the importance of local social networks for coping with pandemic and post-blast effects on community recovery. These spaces are especially important as almost 50 per cent (45.9) of respondents had not visited a green space outside the city in the last year. In fact, reflecting the lack of traditional open or green spaces, the most visited places for recreational use were street and alleyways (28.19 per cent) or sidewalks (19.52 per cent). Streets were also the spaces in which most respondents said their children play when not at home (14.52 per cent). The elderly also reported using pavements (54.4 per cent) for recreational use, more than local parks (36.39 per cent) and vacant lots (9.47 per cent). These statistical findings set the stage for a qualitative understanding of spaces of exchange as the thresholds that enable social activities, acts of care, movement of bodies, and encounters.

CITIZEN SCIENTIST MAPPING

Citizen social science is based on a commitment to collaborative research in which residents who live in or around the sites of inquiry become members of the research team and are involved in all phases of the research process. As part of their research activities, we conducted a consultation with this project's citizen scientists to map and further understand the neighbourhood's spaces of exchange (Pietrostefani et al., 2022a). These spaces were defined as thresholds between private and public space, where social and economic activities happen and where people give and receive care and where people express themselves. Spaces of exchange were also identified as general spaces where people experience the city, cope with their issues, develop their skills, or simply exist.

Citizen scientists shared their observations of places where they saw people drinking coffee, and meeting their neighbours: on the building staircase and on balconies. They also noticed how some public spaces lost their original purposes, such as the Jesuit Garden, which was no longer used by its residents because of the NGO staff presence after the port explosion.

Spaces were grouped into four main categories:

1 Spaces of dialogue: spaces where we find chairs, people sitting, a table, a narghile, a bottle of water, a teapot, or pumpkin seeds shells on the floor.
2 Spaces of informal economic transaction: spaces that have small trolleys selling coffee, flowers, or water.
3 Spaces of care: places where residents water the flowers in front of their homes, feed stray animals, or keep an empty welcoming chair at a street gathering.
4 Spaces of expression: places where people have expressed their feelings and ideas on a mural, spaces where children have placed their drawings, or where they simply play.

Proximity and familiarity were recurring themes in the analysis of these spaces: children playing under their houses so their parents could watch them from the balconies; people drying their laundry on the Vendome stairs in front of their homes; elderly women watering their flowers on the balconies and using this moment to initiate conversations with passers-by. All these outside activities contribute to people's well-being. Care and maintenance were also a recurring theme. Citizen scientists observed residents cleaning the front of their houses as an act of care for the neighbourhood or caring for stray cats as part of their routine. Mutual support mechanisms between residents were clearly noticed throughout observations.

With rehabilitation works still underway, new spaces of dialogue had also appeared, such as spaces where workers meet for a break to eat and chat and where residents thank them for their hard work. Streets have also become places to linger and discuss the progress of rehabilitation work. The public stairs were mentioned as clear landmark spaces in Mar Mikhael, reflecting the history of the neighbourhood. Citizen scientists noted that although the activities on the stairs may have changed over time, they would always remain a landmark of the social infrastructure, where the neighbourhood meets and mingles.

RECOVERY: A MATTER NOT JUST OF TIME BUT OF SPACE BELONGING

Spaces of exchange in Mar Mikhael present multiple opportunities for community-based initiatives to help maintain and rehabilitate neighbourhood spaces for recovering communities. Recovery is a matter not just of time but of space belonging. The triple crisis in Lebanon has not only taken a significant toll in the city but has left neighbourhoods and their spaces at the forefront of imagining and practicing recovery. Although crises have left urban life and urban spaces exhausted, micro practices shaping life have created modes and mechanisms of coping in space that allow encounters and shape well-being.

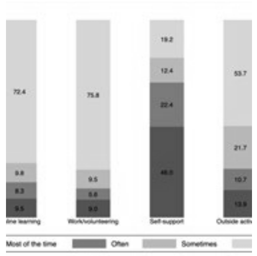

Figure 2 ► p. 214

	Online	In the neig bourhoo
y s	10.6%	54.2%
s	9.4%	51.6%

Table 1 ► p. 215

Note
Parts of the chapter are based on the authors' earlier publications Pietrostefani (2019) and Pietrostefani et al. (2022).

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Figure 2
Mapping spaces of exchange (photographs by the authors).

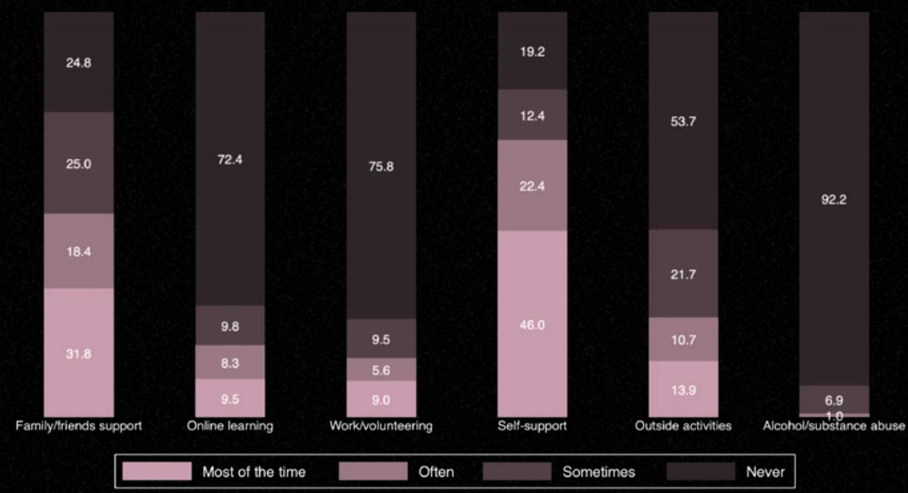

Figure 2
Coping mechanisms to deal with the effects of the blast (graph by the authors).

Table 1
Tendencies in self-support location (table by the authors).

	Online	In the neigh-bourhood	In Beirut (not neigh-bourhood)	Outside Beirut	Other
Support from family and friends	**10.6%**	**54.2%**	**15.5%**	**17.0%**	**20.3%**
Outside activities	**9.4%**	**51.6%**	**17.9%**	**16.8%**	**13.2%**

ABSTRACT

More than 25 per cent of global adults are insufficiently active, thus increasing their risk of developing noncommunicable diseases, which are responsible for the premature death of 41 million people each year. During the recent COVID-19 pandemic, intense and sudden changes in daily routines further exacerbated physical inactivity and thus emphasized the critical role that built environments play in promoting or hindering physical activity. Motivated to leverage the full potential of built environments to promote active movement choices, this paper outlines key principles and tools of 'choice architecture theory' to inform active urban and architectural design strategies and presents the concept of cognitive urbanism. Choice architecture, a theory grounded in behavioural economics, suggests that the presentation of choices, or the 'choice environment', greatly impacts decision making. A plethora of applications across policy-making and finance have employed this theory to design choice environments that 'nudge' individuals towards making certain decisions. Choice architects use various tools to design choices, including defaults, manipulating the order and number of choices, creative incentives and providing feedback. This brief paper elucidates the potential of applying systematically these tools to design built choice environments that promote physical activity, contributing to the generation of active buildings and cities. Finally, the use of spatial analysis, virtual reality, and cognitive-agent simulations is suggested as design aids that bridge the complexity of designing built choice environments, as opposed to non-built ones, and harness the full potential of architecture and urban design to promote physical activity in buildings and cities.

KEYWORDS

active buildings; persuasive urbanism; choice architecture; evidence-based design.

Chapter 15—Designing with Cognition in Mind: How Choice Architecture Theory Could Inform Architectural Design of Active Built Environments

Michal Gath-Morad

More than 25 per cent of global adults are insufficiently active, thus increasing their risk of developing noncommunicable diseases, which are responsible for the premature death of 41 million people each year (World Health Organisation, 2022).

INTRODUCTION

During the recent COVID-19 pandemic, intense and sudden changes in daily routines further exacerbated physical inactivity (Rahman, 2020). The closure of fitness facilities, restriction on mobility, and the shift to working from home resulted in an increasingly sedentary lifestyle, which is associated with various negative health outcomes (Woods, 2020; Pinto, 2020; Paoli, 2020; Ravalli, 2020).

These short- and long-term changes brought about by the global pandemic have emphasized the need for local opportunities to engage in physical activity (McDougall, 2020), and elucidated the critical role that built environments play in our physical activity and inactivity. Indeed, prior research highlights macro-scale urban features that affect physical activity, including density, diversity, design, destination accessibility, and distance to transit (Ewing, 2008; Cervero, 1997). Although this body of evidence is critical to informing urban design, we still lack a more nuanced understanding of peoples' local decision-making pro-

“A range of design aids from cognitive science may help architects and urban designers bridge this gap by predicting how their design decisions are likely to affect people’s local choices.”

cess in response to these factors and its effects on their physical activity choices.

To bridge this gap, we must begin by critically investigating how the design of decision points in everyday buildings and cities affects peoples’ spatial decision making and thus contributes to active or inactive choices. This brief paper seeks to address this topic through a behavioural-cognitive theory called ‘choice architecture’ (Thaler, 2008), a set of principles and tools that were originally developed in behavioural economics.

I begin by mapping the characteristics of choice environments and describing tools for designing choices in non-built environments such as paper-based forms and online websites. I then illustrate how classical principles and tools from choice architecture theory may be relevant to the design of active choices in built choice environments. Finally, spatial analysis, virtual reality, and cognitive-agent simulations are suggested as design aids that help manage the complexity of designing ‘built choice environments, as opposed to non-built ones. These analysis tools can be combined with principles from choice architecture theory to harness the full potential of architecture and urban design in promoting physical activity in buildings and cities.

WHAT IS CHOICE ARCHITECTURE?

Choice architecture, a term coined by Thaler and Sunstein (Thaler, 2008), reflects the fact that choices may be presented to decision-makers in many ways, and that the eventual decision greatly depends on the design of the choice environment. Key characteristics of choice environments range from the number of alternatives, the order in which alternatives are presented, and the default choices that are built into the system. Necessarily, no choice environment is neutral such that any way a choice is presented will influence people’s decisions.

The theoretical foundations of choice architecture theory are grounded in a profound understanding of the cognitive systems involved in decision making, especially unconscious ones. Thaler and Sunstein distinguish two systems of decision making; an ‘automatic’ system and a ‘reflective’ one, which largely correspond with the ‘fast’ and ‘slow’ decision-making systems outlined by Tversky and Kahneman (1992). Whereas the automatic system is effortless, fast, associative, and unconscious, the reflective system is effortful, slow, deductive, and conscious.

Choice architects, the people who design or are in charge of the choice environment, apply various tools to influence or ‘nudge’ our automatic decision making by directly changing the choice environment (Thaler, 2008; Münscher, 2016). Münscher (2016) groups choice architecture tools into three categories: (1) decision information (2) decision structure, and (3) decision assistance. Decision information tools include reframing, simplifying, making information visible, making the user’s behaviour visible as feedback, making external information visible, and providing social reference points such as descriptive norms. Decision structure tools include setting choice elements such as no-action defaults, prompts to choices, option-related effort, and the range and composition of options and categories, groupings of options, and option consequences (e.g., connecting decisions to benefits and costs and to social consequences). Decision assistance includes providing reminders and facilitating commitment.

A prime application of choice architecture is in voluntary organ donation. In this case, the decision-making environment is a paper or digital form, and the tool employed to affect decision making is the use of defaults. Simply changing the default choice in the decision-making environment, the form, from opt-in to opt-out, has been shown to have a massive effect on decision making: Countries in which citizens are asked to opt in by checking a box if they want to become an organ donor showed significantly lower rates of organ donation than countries that asked citizens to opt out by checking a box if they do not want to be an organ donor. Other applications of choice architecture tools have been employed to affect people's eating habits by making calorie information more visible in food menus and financial decisions about pension saving) and in policy making (Münscher, 2016).

HOW CAN CHOICE ARCHITECTURE THEORY INFORM THE DESIGN OF ACTIVE, BUILT CHOICE ENVIRONMENTS?

Despite the powerful potential of choice architecture to affect peoples' choices, the majority of choice architecture research has focused on non-built or non-spatial environments. Some examples of built choice environments exist, but these tend to be small and relatively simple, such as cafeterias (e.g., Thorndike, 2014), and the choices mostly comprise goods or other products.

In contrast, the choice environment in cities and buildings is the built environment itself, consisting of streets, plazas, corridors, doors, windows, and so forth. Unlike non-built choice environments such as an organ donation form or website where choice architects control the various stages of the decision making through presentation of information, decision structure, and decision assistance, built environments are far less controlled. Sounds, people, and vehicles that inhabit built environments act as social and auditory cues that may influence decision making. To complicate matters further, instead of ticking checkboxes, choices in the built environment tend to involve physical movements such as walking, looking, running, crossing, and entering and often entail physical effort. In this sense, the applicability of choice architecture theory to the built environment is not straightforward. The degrees of freedom that characterize buildings and cities are considerably greater than in the choice environments typically described in behavioural economics. This simple truth underlies the inherent difficulty of nudging peoples' choices when the environment is extremely complex and many choices and conflicting cues exist.

Overcoming this difficulty requires identifying where choices in built environments occur, what the characteristics of these local choice environments are, and which changes in the environment could nudge people towards active choices. For instance, a typical choice environment in buildings could be the entrance to a building, where people choose whether to move by stairs or by elevator and whether to use the main or secondary corridor. Choice architecture tools such as limiting the number of alternatives and changing the sequence in which choices appear, for instance by presenting stairs earlier, have the power to encourage people to make more active choices, such as walking up the stairs. Studies have confirmed that modest stair usage can have positive health outcomes: people who climbed at least 20 floors per week had a 20 per cent lower risk of stroke or death from all causes (Boreham, 2007; Paffenbarger,1997; Kerr, 2001; Coleman, 2001).

Additional applications of choice architecture to promote physical activity may encourage more standing or walking and less sitting in workplace settings. This may be achieved by manipulating the visibility and proximity of co-workers from individual work stations, features identified by Duncan (2015) as being positively or negatively associated with frequency of breaks in sitting in all office types. Other examples that could apply to outdoor urban spaces include increasing the visibility of active alternatives such as fitness facilities in public spaces.

HOW CAN WE KNOWINGLY DESIGN ACTIVE BUILDINGS AND CITIES?

Architects and urban designers have knowingly or unknowingly been nudging people's choices to become less or more active for centuries. The locations of doors, the framing of specific views, the hierarchy of corridors and streets,

Figure 1 ▸ p. 224

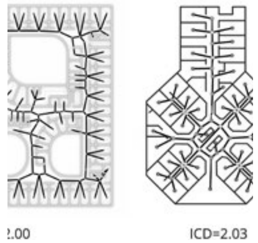

Figure 2 ▸ p. 224

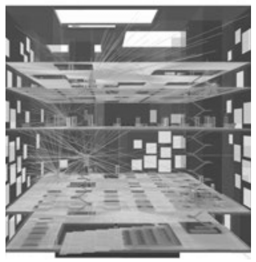

Figure 3 ▸ p. 225

and the differentiation of surfaces using colour and texture are all tools that influence people's decision making and behaviour. For instance, the decision to walk up a staircase or take the elevator is largely shaped by the location of choices relative to the entrance. If a staircase is more visually accessible from the entrance and perceived before the elevator, people may be nudged to walk up.

However, despite the massive potential of built environments to nudge people's behaviours, the more complex built environments become, the more difficult fully realizing this potential becomes. Architects, unlike behavioural economists, rely largely on their intuition and experience to design built choice environments, overlooking cognitive biases and individual differences. Furthermore, although a plethora of active design guidelines exist (e.g., City of New York, 2010), these guidelines mostly focus on macroscale features such as mixed land use and street connectivity and largely overlook the nuanced design of local choice environments from decision makers' perspectives (Zimring, 2015).

A range of design aids from cognitive science, computer science, and spatial analysis may help architects and urban designers bridge this gap by predicting how their design decisions about the built choice environment are likely to affect people's local choices. Examples of these tools' application to evaluating how architectural and urban design can affect active choices is showcased in Figures 1, 2, and 3.

The use of virtual reality is particularly useful for this purpose as it allows the effect of specific environmental features on behaviour to be isolated (Kuliga, 2015). Studies have employed VR to manipulate the visibility of the destination or the location of stairs and elevators (Gath-Morad, 2020; 2021; 2022) and to assess how spatial configuration affects users' walking behaviour in buildings and in urban spaces. (see Figure 1).

In addition, spatial analysis tools that capture the geometrical shape properties of visible space and the topological complexity of decision points (O'Neill, 1991) can be applied to analyse correlations between the configuration of the environment and the probability of making active choices (Dubey, 2022). Accordingly, the complexity of movement choices afforded by architectural configuration can now be analysed and compared across building alternatives (See Figure 2), providing insights into the complexity of choices inherent in the circulation network.

Evidence gathered with these tools can then be used in cognitive modelling to predict how different design alternatives may elicit different health outcomes (Grübel, 2021; Gath-Morad, 2020; 2021; 2022). An example screenshot from cogARCH (Gath-Morad, 2020; 2021; 2022), a general framework for cognitive agent modelling in architecture, is presented in Figure 3. These analysis tools, alongside principles from choice architecture theory, can harness the full potential of architecture and urban design to promote physical activity in buildings and cities.

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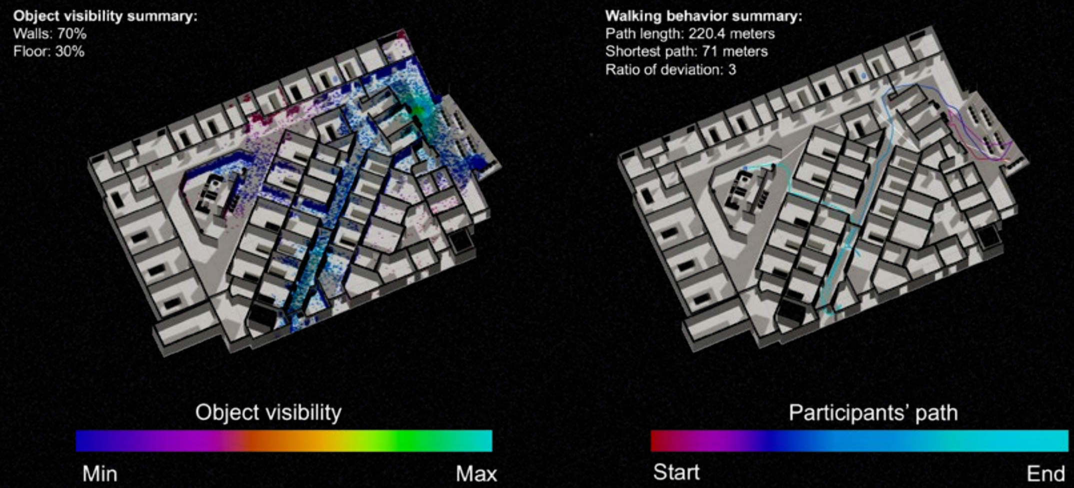

Figure 1
The use of a cognitive walkthrough in virtual reality to analyse the effect of spatial configuration on the walking distances and visual experience of potential users in a healthcare setting. This analysis and visualisation was done using the Evidence-Based Design toolkit co-developed by the author (diagrams by the author, 2022).

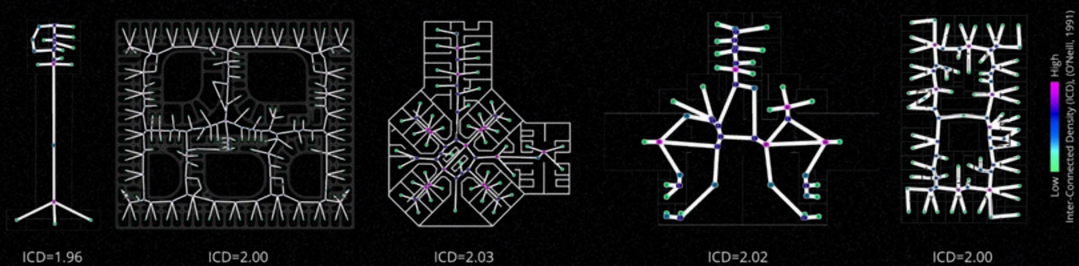

Figure 2
Spatial analysis to capture the complexity of movement choices afforded by architectural space. The analysis calculated interconnected density with the Evidence-Based Design toolkit (diagrams by the author, 2022).

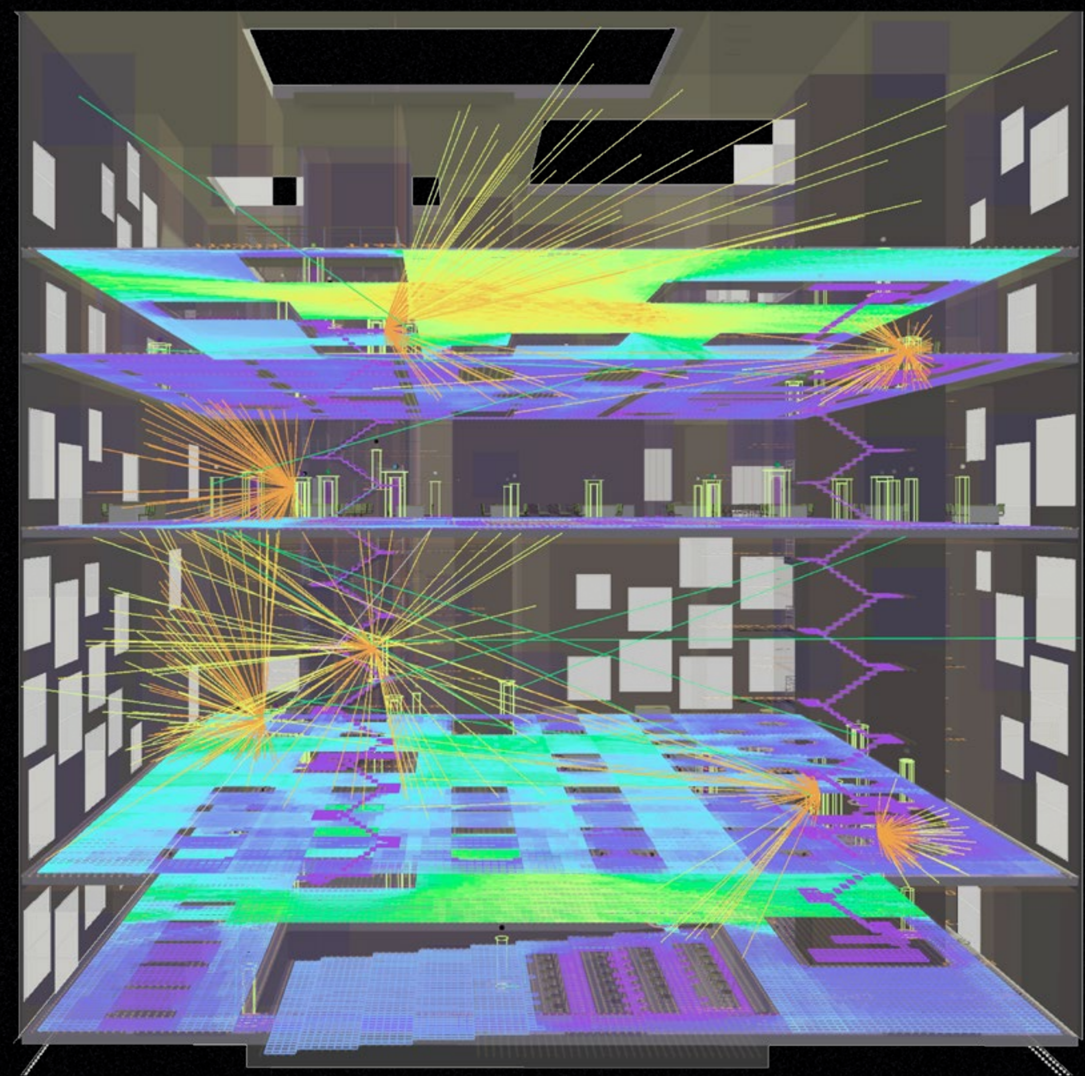

Figure 3
A vision-based cognitive agent simulating the effect of architectural design on active behaviour choices (diagram by the author, 2022).

ABSTRACT

Based on our research characterizing New York City (NYC)'s pandemic urbanism by exploring its new sidewalk ballet, this chapter ponders the future of NYC after the COVID-19 pandemic. We focused on this sidewalk ballet to capture the experience of being in the city during the first year of the pandemic and analysed changes to the sidewalk and urban lifestyle using a novel method of remote ethnography. The research combined the use of Zoom video conferencing and a GPS tracking application on smartphones to interview participants as they walked the city, which facilitated traversing it remotely without physically being there. After analysing the resulting three layers of data sets, derived from transcript, video, and location, we identified recurring themes and developed an online interface to plot the interview content and thematic markers on a geospatial map. Revisiting our findings more than a year later, this chapter observes the changes to the sidewalk and the urban lifestyle that we identified and considers which of them were temporary and have vanished with time and which are here to stay. This raises the question of whether the changes that defined NYC's pandemic urbanism have fundamentally changed the way we plan, use, and think about our cities.

KEYWORDS

New York City; pandemic urbanism; remote ethnography; the future of cities; urban lifestyle.

Chapter 16—Is New York City's Pandemic Urbanism Here to Stay? Thoughts on How COVID-19 Changed New York's Sidewalk Ballet

Sharon Yavo-Ayalon

In *The Death and Life of Great American Cities*, Jane Jacobs (1961) describes a 24-hour period on Hudson Street in New York City (NYC) using ballet and stage metaphors to describe the people's movement on the sidewalk. During COVID-19, the 'sidewalk ballet' of NYC came to a sudden halt, and the freedom to go outside and walk the streets became a highly sought-after privilege to which city dwellers were only gradually restored.

THE SIDEWALK BALLET DURING COVID-19

To understand how COVID-19 changed the sidewalk ballet of the city and its effect on the urban lifestyle. We developed a novel methodology of remote ethnography to collect, analyse, and visualize data. The idea has sprung at the first days of the pandemic, as part of the Future Automation Research Lab at Cornell Tech. An interdisciplinary team composed of data scientists, interactive design experts, and the author – an urbanist. We applied for and received an American NSF Rapid Grant to track urban mobility and occupancy under social distancing policy (Ju at el., 2020). As part of this research, we conducted walking interviews using Zoom to talk with people and observe the various sidewalk ballets being performed across NYC. Between December 2020 and May 2021, we walked and talked with 25 residents of NYC. During these interviews, the interviewer remotely observed the urban stage as the interviewees walked in a familiar area of their choice, capturing their route with a GPS application and live-streaming video from their mobile phone cameras, which were positioned to face the street. During the semi-structured interviews, the interviewees narrated what they saw in response to questions about things that had changed during the pandemic.

Second, we analysed the videos and texts pertaining to the routes and the neighbourhoods they described, which revealed recurring themes. By viewing the street through our interviewees' eyes , we were able to infer changes to the sidewalk (Jacobs, 1961; Whyte, 1980), and by listening to the interviewees' thoughts and experiences, we learned about changes to the urban lifestyle (Zukin, 1998). To visualize our analysis, we plotted 10 of the interviews on a geospatial map using the Mapbox Scrollytelling API. The individual Scrollytelling maps integrate the route, the video, and the audio and synchronize them on one screen. In this way, we combined the individual stories into an interactive web map that displays all the routes and enables viewers to move from one story to another.[1]

We elaborate our findings on the changes to the sidewalk and the urban lifestyle elsewhere (Yavo-Ayalon et al., 2022a) and, in a method paper, we also recommended that our novel methodology be used by others (Yavo-Ayalon et al., 2022b). As the world gradually adjusts to the new normal in this chapter, I revisit our findings almost two years into the pandemic and rethink the sidewalk and urban lifestyle changes that we identified. I now ask which changes were temporary and have vanished with time? Which are here to stay? And will the changes that define NYC's pandemic urbanism fundamentally change how we plan, use, and think about our cities?

THE STAGE AND CHOREOGRAPHY

NYC was one of the world's most severely hit cities. On March 20, 2020, New York's Governor Andrew Cuomo issued a 'stay at home' order, and by the end of March, with over 30,000 cases and over 2,000 deaths, the city had become the worst-infected area in the US Within a short time, the city had more confirmed coronavirus cases than China, the UK, or Iran. As we all know by now, it was a dramatic change as can be seen in Figure 1. By April, hundreds of thousands of New Yorkers were out of work, with billions of dollars in estimated lost tax revenue; significant impact on low-income jobs in the retail, transportation, and restaurant sectors; and a 13 per cent decline in commercial rents from the previous year. A year later, as the city reopened and the vaccination rate rose, the social distancing restrictions were gradually lifted. However, the pandemic has been the deadliest disaster in the history of NYC (NYC Health, 2022). This course of events has made NYC an epic urban stage to observe in order to understand pandemic urbanism.

As the stage experienced this earthquake, the choreography of course changed. The classic literature defines urbanism as the reciprocal relations between the city's physical structure and social structure (Park, 1915; Simmel, 1950; Wirth, 1938). Consequently, when we analysed our data to define pandemic urbanism, we divided our recurring themes into physical changes to the sidewalk and social changes to the urban lifestyle.

ACT ONE: PANDEMIC URBANISM DURING THE FIRST YEAR OF COVID-19

PHYSICAL CHANGES ON THE SIDEWALK

During the first months of the pandemic, the most notable change was the emptiness of the sidewalk and the fact that there were fewer people everywhere. On familiar streets, all the interviewees noted that 'this street is usually' packed with people going to work or with tourists. On the sidewalks, a new sign language emerged: new signs regarding social distancing, stickers marking where to stand and signs indicating the

1 The web platform can be found at https://www.socialdistancing.tech.cornell.edu/

"The most significant characteristic was the longing for the urban lifestyle."

maximum permitted number of people and the face-mask requirement. Other signs were those reflecting business closures, from restaurants, bars, and chain stores to day-care centres and after-school programmes. The videos also revealed substantial amounts of COVID-19-related rubbish such as gloves, masks, and fallen social distancing signs. The most distinctive new rubbish however, was discarded furniture. Some of our interviewees recounted seeing 'whole apartments dumped on the street' when people left in a rush during the pandemic.[2]

However, the primary and most notable change to the city's sidewalks was the new outdoor dining initiative that sprouted up in many places. The city encouraged outdoor dining in areas with lower infection rates and allowed restaurants to set up tables and chairs on the sidewalk or in parking spaces to enable more customers to dine while maintaining social distancing. Such outdoor dining, which had been illegal prior to the pandemic, dramatically changed the appearance and use of sidewalks throughout the city.

SOCIAL CHANGES TO THE URBAN LIFESTYLE

The urban lifestyle was the thing people missed most. Many interviewees spoke of cafes, restaurants, and bars, explicitly describing such sites as places to meet 'interesting people and have conversations with people from diverse backgrounds.[3] Others mentioned missing the opportunity to be in the same space with both friends and strangers, which for them is what makes New York so fascinating and attractive.[4] When explicitly asked what they missed the most, the recurring answer was cultural life: museums, galleries, theatres, live performances, and the like.[5] Many also mentioned a strong sense of solidarity[6] or a shared undertaking that was apparent through reassuring gestures to strangers on the streets. At the neighbourhood scale, some spoke of getting to know their neighbours better[7] or of how restaurants and bars were collaborating to stay afloat.[8]

All our interviewees had to work from home. This resulted in a renewed appreciation of their neighbourhoods. Interviewees mentioned that during their breaks they walked with no explicit purpose, and they discovered new parts of the city, local shops, and connections between areas of which they were unaware.[9] However, it also led to a shift in their work–life balance and blurred the boundary between professional and personal life. Foregoing the commute meant more time to work, greater efficiency, and more time to spend with their children.[10]

Many of our interviewees changed their living conditions during the pandemic. We referred to this as 'moving out' or 'moving up.' Moving out of the city meant that the person in question had a more flexible socioeconomic situation or had family elsewhere. Moving up refers to the ability to rent a larger apartment or move into a better neighbourhood in NYC.

There was a notable difference between Manhattan and New York City's other boroughs (our interviewees took place in Manhattan, Brooklyn, and Queens). As Manhattan emptied due to the outflux of the affluent population and the closure of offices, retail properties, restaurants, and cultural sites, the residential neighbourhoods came to life. Consequently, people walking in neighbourhoods outside of Manhattan said they could now see more people on the street than in 'normal' times, whereas people in Manhattan described the streets as 'so quiet.'

ACT TWO: NYC PANDEMIC URBANISM REVISITED

Whereas Act One was based on walking interviews, thematic content analysis, spatialization, and visualization, Act Two is a comparative discussion based on my observations as an experienced ethnographer. I remained in the city throughout this period; I walked the streets, observed people, and took notes. In this

2 Interview date 01.19.2021

3 Interviews date 01.20.2021; 12.23.2020; 01.20.2021

4 Interview date 01.19.2021

5 Interview date 01.29.2021

6 Interview date 12.16.2020

7 Interview date 12.23.2020

8 Interview date 12.16.2020

9 Interview date 01.26.2021

10 Interview date 12.23.2020

section, I return to the characteristics of pandemic urbanism we identified and discuss which were temporary and which are here to stay.

WHAT HAPPENED TO THE PHYSICAL CHANGES ON THE SIDEWALK?

As I write these words in the spring of 2022, the city's streets feel almost as packed as in pre-pandemic times. Midtown sidewalks are teeming with people. Central Park is buzzing. The Village, SOHO, and Chinatown are welcoming once again. Remnants of the COVID-19 sign language are still visible. Although two years have passed, many improvised stickers indicate that facemask requirements, social distancing, and handwashing recommendations have proven more permanent and have not been removed. Although I can still spot discarded gloves and masks on sidewalks, the COVID-19-related rubbish of almost-new furniture is back to its pre-pandemic levels. Recent signs indicate free COVID testing, especially in makeshift gazebos or vans that operate on nearly every street corner of the city. In a sense, these sites replaced outdoor dining as the most distinctive pandemic urbanism feature at the

What, then, happened to the outdoor dining initiative? The improvised structures are much less attractive than they were at the pandemic's peak. In the summer of 2020, outdoor huts, igloos, and cabanas became the hallmarks of NYC's pandemic urbanism. During the winter of 2021, New Yorkers celebrated and cherished what was then the only option for social and cultural activity. However, when indoor dining reopened in the winter of 2022, most outdoor dining structures were deserted. Over time, thousands of public complaints about rubbish, rats, noise, and fewer parking spaces incited a push to regulate outdoor dining (Adams, 2022). City planners are now developing a more regulated approach, tending towards a European streetscape of bistro tables and umbrellas that are removed at closing time (Diaz & Krader, 2022).

THE RETURN OF THE URBAN LIFESTYLE

When NYC became the global COVID epicentre, many New Yorkers fled the city, and speculation abounded about the death of the urban lifestyle and predictions that cities would be abandoned for safer suburbia (Pojani & Alidoust, 2021; Batty, 2022; Keil, 2022; Jasiński, 2022; Neuman et al., 2021). However, our interviews show that, even during the pandemic, cities and the urban lifestyle remained attractive and fundamental to human nature and that city residents found alternative ways to maintain them. 'This summer it's going to be crazy in the city, I predict it!',[11] declared one of our interviewees in the winter of 2021. Now, reports in local newsletters celebrate the return of the urban lifestyle. Culture has returned, and the tourism industry is bouncing back, along with jobs in hotels, restaurants, retail stores, museums, and other market venues (Gaudino, 2022; Barron, 2022; Davenport, 2022).

In the time that has passed, several quantitative studies have confirmed many of our qualitative observations. For example, reports by the Cornell School of Public Policy (Dean, 2022) and the Office of the NYC Comptroller (Lander, 2021) support our observation of an undercurrent of 'moving out' or 'moving up', revealing that between April 2020 to July 2021 NYC's population plunged by nearly 4 per cent. Most of those moving were from the higher socioeconomic deciles. We learned from our interviewees that these movements initially created the atmosphere of an abandoned city, leading to reduced rents and upward social mobility. Data from StreetEasy[12] reinforces these individual observations, showing that at the early stages of the pandemic, rent prices plunged and landlords were waiving amenity fees and/or granting free months. However, this period ended quickly. Between December 2020 and December 2021,

11 Interview date 01.29.2021

Figure 1 ▸ p. 235

the city's median rent made its largest year-on-year gain since the pandemic began, from $2,500 to $2,800. Similarly, the number of rental vacancies dropped from about 41,400 units to 24,413 (Rosenberg, 2022). Since then, rents in Manhattan have risen again and the competition has become fiercer (Spivak, 2022), to the point that some renters who left during the pandemic are finding it hard to return (Taylor, 2022). The pandemic seemed to be an opportunity to reshuffle the deck and provide more affordable housing in inner-city locations; however, with the return of the urban lifestyle, this window has closed. When thinking about the future of cities, this temporary deviation from the migration pattern of cities highlights the need to enable those who remain in the city to engage in upward social mobility, which was once one of the main advantages of cities.

The solidarity among those who remained in the city was a unique phenomenon linked to the time of crisis. From the vantage point of one year later, it is interesting to notice what has happened to those who left. Whereas many have returned, others decided to leave the city for good. Some have even expressed a feeling of having been betrayed by their 'native' New Yorker friends (Kaufman, 2022; Campisi, 2022).

Another theme worth reconsidering is the difference between Manhattan and the boroughs. Our interviews showed that people who lived in Brooklyn or Queens felt a renewed appreciation for their neighbourhood, which created a support network alternative to the urban lifestyle they were missing. Also supportive of these findings are numbers showing that the boroughs were severely hit by virus death rates and business closures, especially in Queens and the Bronx (Bowles & Shaviro, 2022), but that the same boroughs lost the fewest residents to moving out. While Manhattan shed 117,275 residents, or nearly 7 per cent of its population, and Brooklyn lost 95,022 people, the populations of Queens and the Bronx declined only 74,321 and 47,706 respectively (Dean, 2022). These numbers also reflect socioeconomic status, showing that residents with more resources have greater mobility and more options, while the working class remains in place and continues to work. Indeed, remaining in place is what allowed them to develop this solidarity and sense of community. The linkages between these themes indicate the importance of the neighbourhood unit and the need to think about strengthening neighbourhoods and small businesses that support the community.

As time passes, it is becoming increasingly apparent that working from home, with its increased flexibility, is here to stay, as is the resulting blurring of boundaries between professional and personal lives. Working from home has many urban advantages: it can ease congestion and lead to better quality of life. Most importantly, the empty office buildings can lead to new urban solutions. NYC has seen a growing push to convert Midtown and Downtown office space into apartments. This change has the potential to transform the nation's largest business district, and with its older and less desirable office space, into a very different kind of Midtown (David, 2022). It also highlights the need to strengthen neighbourhoods as living units and to invest in suitable open spaces in all locations.

ACT THREE: WHAT'S NEXT?

Although by now we all know that COVID-19 fundamentally changed our cities, it is nonetheless essential that we empirically determine how it did so. Our research sought to assess these changes and to propose a method for studying cities while maintaining social distance. Observing this method and the pandemic's urbanism characteristics one year apart was an opportunity to evaluate the validity of the themes we found.

The most significant characteristic was the longing for the urban lifestyle, and I am happy to observe its superb comeback; the tourist industry is recovering, the real estate market is fiercer than ever, and most importantly, the cultural scene is finding its way back. Within this urban lifestyle, a new feature that sprouted and is here to stay is the arrangement for outdoor dining. This element will be regulated and adapted but will nonetheless leave a mark on NYC's urban lifestyle. This change is more fundamental than simply arranging tables and chairs on the sidewalk. It is linked to a more profound change in social structures of privatization, commercialization, and securitization of public spaces that are immanent to American urbanities (Bodnar, 2015) and worth further research.

With the return of the urban lifestyle, some aspects the city's pandemic urbanism have reverted to their previous state: for example, the trend for moving out or moving up has returned to the 'normal' migration pattern of 'moving down or moving out', reflecting the pressures of the housing crisis in all major cities (UN Habitat, 2022). Another aspect that has changed over time is the newly formed solidarity. During the crisis, solidarity increased residents' sense of local identity and belonging; now, the sense of betrayal is more evident, and the search for the proper housing solution has commenced.

Other aspects of the city's pandemic urbanism that are here to stay and should be acknowledged and reinforced by urban planners to improve the well-being of people in their environment. For example, the gaps between Manhattan and the boroughs have intensified, as has the boroughs resident's renewed appreciation for their local neighbourhoods. These characteristics are linked to the change that I believe will affect the future of cities forever: increased working from home and a redefining of boundaries between professional and personal lives. The attractive midtown locations that have emptied can be utilized to develop new kinds of mixed-use urban environments.

At the present, New York's sidewalk ballet is gradually returning to its pre-pandemic pace, highlighting the importance of this study as invaluable documentation and analysis of an unprecedented time in the life of the city.

12 https://streeteasy.com/

Note
Parts of the chapter are based on the author's earlier publication Yavo-Ayalon et al. (2022a).

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Figure 1
Variations on improvised COVID-19 testing sites (photograph by the author).

GROWTH AND CHANGE [DENSITY]

GROWTH AND CHANGE [DENSITY]
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GROWTH AND CHANGE [DENSITY]

Dubai (photograph by Rasmus Hjortshøj).

ABSTRACT

This chapter explains the functions of cities and the shifts within these functions due to the Corona pandemic. Such shifts in functions have already occurred in past epidemics (or other shocks) and led to adaptation measures in urban development.

Based on a pan-European survey among real estate professionals, it can be deduced that the current health crisis is likely to result in outward growth rather than redensification of cities due to the expected higher demand for residential space. Challenges for cities include the redesign of public spaces and the transformation of existing properties as well as the reconstruction of transport infrastructures necessary to restructure, i.e. strengthen, neighbourhoods; this requires closer cooperation between private and public players.

For actors in the real estate market, an assessment of the different adjustment burdens and opportunities of the individual asset classes is given.

KEYWORDS

housing; commercial real estate; mixed use; 15-minute-quarter.

Chapter 17—Transforming Cities after the Pandemic

Sabine Georgi and Tobias Just

The pandemic was a big social and economic shock to all European countries. As of April 2022, cumulative Covid-related deaths have risen in consecutive waves to almost 1,300 per million inhabitants in the Netherlands, 1,565 deaths per million in Germany, roughly 2,200 deaths per inhabitants in France and Spain, and almost 2,700 deaths per million in Italy (Our World in Data, 2022).

Economically, the pandemic produced a significant supply-side shock, as workers were unable to go to their workplaces, many sectors had to limit their services, and health-related absences rose. This also negatively impacted demand, and people experienced a sharp increase of uncertainty in their daily lives.

These shocks had multiple implications for real estate and urban life. Production and service facilities were used less, urban amenities could not be visited, and the demand for space both inside and outside of buildings rose as the functions of cities were significantly disrupted.

Cities perform three economic functions: they enable economies of scale, a sharp reduction in transaction costs, and significant positive externalities (Just & Plößl, 2022). These principles enable higher productivity and better opportunities for the consumption of both private and public goods within cities. The pandemic has distorted these economic effects and thus depreciated the benefits. People have had to adjust to these shocks, seeking second-best alternatives for their daily routines at home, at work, and in leisure activities. In some cases, this has required investments in hardware and new know-how, and these physical and mental investments facilitated new institutions and path-dependencies; people have become accustomed to a new normal, gained new experiences, and made new cost–benefit comparisons which are set to impact the overall functionality of cities and thus also buildings within cities.

IMPACT ON REAL ESTATE

In a pan-European survey, Just and Plößl (2022) analysed the shifts in demand for space expected across various real estate asset classes: clearly, the pandemic has led to a pronounced asymmetry in risk perception for these real estate classes. Residential and logistics are favoured by risk-averse investors, while retail and hotels are expected to be watched particularly by investors actively seeking opportunities, risk-conscious investors (Figure 1).

For office properties, the picture is somewhat mixed, as the full impact of the shift to working from home cannot yet be assessed. Eisfeld et al. (2022) have developed seven possible outlooks on the future demand for office space, and even within their comparatively narrow set of assumptions, the scenarios reveal significant and ongoing uncertainties, both in quantity and in quality.

Furthermore, investors do not agree whether core city locations or satellite structures, which might be more easily accessed by people living in suburbs, will be required in the future. Nevertheless, real estate market participants broadly agree that, regardless of the exact location, there will be a functional shift in office buildings.

Offices will become a place to bring teams together to co-work, hold meetings, and welcome visitors, with less pure space for performing specific and separate tasks. While uncertainty about future developments remains elevated, a higher degree of flexibility in office space is essential. This holds for both organizational and physical flexibility: how to transform physical space and how to re-organize contracts as well as teams. Space that does not allow for this flexibility will likely be traded at discount (Figure 2).

Interestingly, the implications of these changes on office vacancy rates and office rents are not as straightforward as might be supposed: Morawski (2022) reports mixed results across Europe for the effect of working from home on rents and vacancies.

For residential real estate, many market analysts expected a strong and sustainable shift in demand out of the cities as demand for open spaces and more private spaces increased. Analysing Google Trend data and comparing market developments for Germany with a counterfactual scenario, Eisfeld and Just (2021) found that search volumes for peripheral space skyrocketed in 2020 and that peripheral prices in particular rose faster during the first waves of the pandemic than in the counterfactual scenario, which assumed no pandemic development.

However, these immediate and strong reactions did not endure, partly because people and administrations learnt that infection risks within cities did not necessarily imply higher fatalities than in peripheral locations (Carozzi et al., 2020). Thus, the sharp increase in internet search volumes for single-family homes and gardens has been fading in recent quarters, and the main cities have regained some of their attraction again.

IMPACT ON CITY STRUCTURES AND ORGANIZATION

The pandemic had a strong impact, especially on some city functions such as the provision of services, which resulted in a decrease in the importance of retail and to some extent workspace. Consequently, the future attractiveness of cities was questioned by many market observers throughout the pandemic. In addition, one of the key advantages of dense cities, lower transaction costs, has lost some of its thrust, because many transactions and conversations can now be done online.

After the pandemic, cities will have to replenish their specific sets of advantages by strengthening other functions, such as scale economies and positive externalities, spillovers between people and activities.

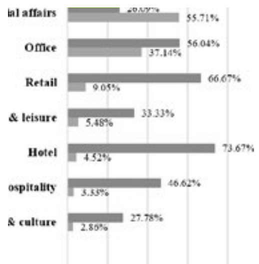

Figure 1 ▸ p. 247

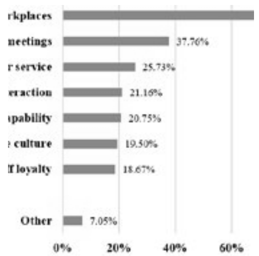

Figure 2 ▸ p. 247

Figure 3 ▸ p. 247

This is related to the concept of 'good density' (Clark & Moonen, 2015): a dense city can both enable and aggravate these positive spillovers. Fostering these effects will lead to a transformational push within the cities (Figure 3). In fact, this transformation was called for before the pandemic, as is documented in the Leipzig Charta (2020), but the pandemic shock has amplified demands on cities and the real estate industry today, so that the transformational process towards better and more successful places is likely to be accelerated.

In the end, cities that focus more on experiences and social interaction, and less on structures based on the division of labour will thrive. However, achieving this focus will take decades rather than years. Citizens, public authorities, and corporations within cities need to prepare for a marathon, not a sprint. The more that this focus is opposed, the stronger that centrifugal forces will tug at cities.

The facilitation of social interaction is key because it also strengthens a city's capacity to find new ideas and to become a hub of innovation. Innovation has always been a function of human interaction and mutual exchange.

In the future, cities will have to concentrate much more on their potential as "consumer cities" beyond mere supply and strengthen the social and interactive aspects of production. A consumer city in the economic sense is not only a retail city, a focal point to purchase a broad variety of goods; rather, a consumer city is a place that offers a broad mix of private and public goods that citizens can consume. This includes parks, theatres, walking paths, and museums.

This is why the additional space requirement also stems from a sought-after increase in communal experiences and meeting places in public and semi-public areas. Efficient space management of these scarce areas leads to the necessity for 'multicoding' using such spaces sometimes for trading, sometimes for meetings, sometimes as traffic areas. The importance of these public open spaces also increases the relevance of how buildings are linked and how they add up to more than just a set of buildings. This requires a neighbourhood or quarter approach that combines functionalities to minimize commuting time and maximize social interaction. Such an approach will also require close coordination between private and public actors and institutions, and it calls for commitment and engagement from building owners.

Cooperation between private and public stakeholders is essential for change to be initiated early and in a coordinated manner. Public city representatives play a central role in changing the planning law, but private knowledge and capital are necessary for their implementation and to enable cost-efficient organization.

In addition, the strengthening of quarters and districts can, if competitive freedom is indeed created, trigger innovative dynamics when districts are also conceived as laboratories for social and business innovation. In order to accelerate spillover effects, an urban platform could be created to bundle and channel learning experiences. Such a platform should represent all of the city's stakeholders. Furthermore, there is no reason to limit this learning process to narrow city limits. Just like the internet, which has crept like a second city network underneath our physical cities, cities should build tighter networks between each other to expand early experiences and allow larger economies of scale.

The idea of a district also means a mix of uses which should not be limited to individual buildings. Importantly, pushing this mixed use further into districts will help to clear cities as a whole of traffic areas.

This new mixed-use approach requires the inner-city traffic and technical infrastructure to be updated. The smart city arises at the building, district, and

"Re-densification of cities is necessary for fighting climate change and for managing scarce space. Thus, the scale of cities needs to be rethought in all three dimensions."

Note
This chapter is partly based on a pan-European survey by Just and Plößl (2022). We have no known conflict of interest to disclose. Correspondence concerning this article should be addressed to Tobias Just, IREBS Immobilienakademie, Kloster Eberbach, 65346 Eltville im Rheingau, Germany email: tobias.just@irebs.de

city level and as discussed above probably also at the level of city networks. The pandemic has increased motorized private transport. This has given rise to a new conflict between climate and health goals. This conflict may be resolved by strengthening districts, supporting traffic management technically, and promoting active movement. This is also easier to implement primarily within districts than in a big city complex.

CONCLUSION

Re-densification of cities is necessary for fighting climate change and for managing scarce space. Thus, the scale of cities needs to be rethought in all three dimensions. Given that some retail spaces might become obsolete, and given that this might imply a challenge for investors who need to update their properties, a suitable solution could be found in densification by building higher, as this could provide additional space on the upper floors to compensate for lost value at the ground. In addition, an attractive ground floor is important, especially in city centres: one advantage of the European city, with attractive streets and places, could be to transform into new conceptions of a place of innovation, social interaction, and experiences.

Additional mixed uses in more districts will also help shorten travel distances within districts. This is urgently needed to meet the challenges of climate change.

The image of the 15-minute city presented here is a simplification of what seems possible and necessary, but it can easily be questioned because in bigger cities such a solution might only be available for the happy few who can afford to live in the city centre.

Ultimately, the city of the future requires the greater relocation of central city functions, both production and consumption, from a few focal points to several locations, with the strategy of reducing traffic and thus the scarcity of space in areas that cannot be expanded. It requires a shift from a monocentric city to a more polycentric city.

Although this process has been ongoing in Europe for decades (Ahlfeldt & Wendland, 2010) and the call for stronger political support for polycentric structures is not new by any means (Gordon et al., 1986; Ortiz, 2014; Yin et al., 2013), the pandemic will accelerate this process. This does not contradict the idea that inner cities must retain core functions for the city as a whole in both production and consumption.

Furthermore, overall inner-city space requirements may even increase. This is especially true for vacancies that cannot be quickly reactivated. Prima facie, the pandemic might lead to centripetal forces on residential real estate if residents call for more space and more private green spaces. However, this would create new dilemmas, as a more dispersed population might lead to more traffic rather than less. Thus, it is crucial that the European cities of the future remain attractive for residents, too. The conversion of obsolete space into residential space within city boundaries is part of the transformation towards further 15-minute quarters. In our view, this implies that it is more appropriate to call for a 15-minute quarter than a 15-minute city, because a 15-minute city will inevitably aggravate gentrification processes.

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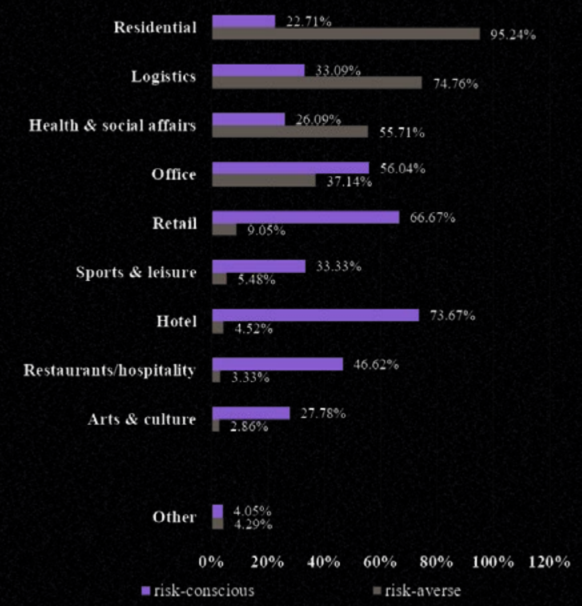


Figure 1
Focus on residential and logistics for risk-averse investors.Note: Responses to the question 'On which asset classes will the following types of investors focus after the pandemic?' Multiple responses possible (table by Just & Plößl, 2022).

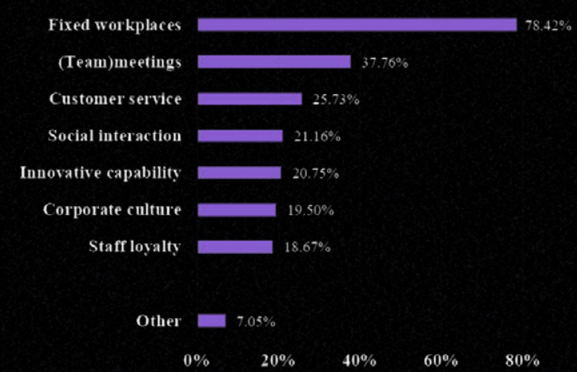


Figure 2
What aspects of offices can be replaced in the future? Note: Responses to the question 'Which aspects of office properties can be replaced for its users after the pandemic?' Multiple responses possible (table by Just & Plößl, 2022).

Figure 3
The imperative for density in cities (graph by Clark & Moonen, 2015).

ABSTRACT

The speed of knowledge dissemination and pandemic-accelerated shifts in social dynamics have given rise to a programmatic need for a more flexible approach to building. Architecture needs to respond to an on-demand society and provide solutions for more resilient and adaptable urban environments, which in turn have a positive impact on life quality and building planning, use and operations.

This chapter examines future planning and construction as an agile and flexible construct, not only in terms of the usability of finished buildings but also in terms of a pluralist and participatory planning process, and highlights tools that enable virtual co-creation and evaluation, which have been driven by the digital acceleration throughout the pandemic. The focus lies on social justice in the digital age, including co-ownership models and platforms for circular planning.

Examples of innovative design approaches by Urban Beta, BART//BRATKE and the author's applied research are included to validate the case for building within an adaptive ecology of construction. Design tools and co-creation processes that activate intuitive building blocks are introduced, reviewed, and put into the context of urban co-existence and transformative architectural development.

As a result, the shifting role of the architect is refined, departing from the creator of singular spaces and urban designs towards a system designer that enables co-creation processes in which multiple stakeholders become the creators of the future urban fabric.

The chapter and the use cases follow a 'research by design' methodology. This terminology was coined by Christopher Frayling to describe 'research into, through and for design' (Frayling, 1993, pp. 1–5). From this, Alain Findeli and Wolfgang Jonas designed further methods which were applied in the field of human–machine interaction (Findeli, 2004). When developing architectural principles, the author and the team from Urban Beta worked in iterative design steps to create digital and architectural applications with feedback from participating researchers and industry partners that connected an academic approach with practical implementation. The term 'beta', coined in our office, here implies a thought model of constant evolution through feedback loops.

KEYWORDS
spatial systems; building as a service; co-creation, circular architecture, on-demand.

Chapter 18—Circular Futures: Predictive Planning for Transformative Spaces

Marvin Bratke

Architects and urbanists plan the life cycle of buildings and infrastructure over a period of years or even decades and often struggle to make future-proof assumptions about technological progress, users' future needs, shifts in the socioeconomic environment, and legislative frameworks. It is a difficult task that requires room for spontaneity in the planning process and flexibility in subsequent use (Bart & Bratke, 2019).

CIRCULAR ARCHITECTURAL STRATEGIES FOR TRANSFORMATIVE CITIES

The pandemic has revealed a variety of shortcomings in our urban built environment: a housing shortage and lacking adaptiveness of buildings, the lack of automation and digitalization in the architecture, engineering, and construction industry, monofunctional urban quarters, and the slow move towards a circular economy (McKinsey Global Institute, 2017).

With rising inflation rates continuing into 2022 and a possible economic recession, the Covid crisis has crystalized the need for creating an underlying value system in the architecture, engineering, and construction industry. The pandemic also provided a seeding ground and accelerator for small start-ups with a focus on new technologies and business models, digitalization, and sustainability. The global community, urban planners, and real estate developers are seeding these new ideas for the transformation towards the smart city.

New architectural strategies can include interactive planning tools, such as configurators that enable co-creation processes, participation in planning through gamification, stakeholder involvement, and an automation chain to create affordable space. Adaptive spatial solutions profit from these new digital tools, including modular and discrete building technology with circular economy strategies that facilitate innovative approaches to sustainable construction, assembly, reassembly, and disassembly.

FROM AN OBJECT-ORIENTED, MONOFUNCTIONAL, AND STATIC CITY MODEL TOWARDS COLLABORATIVE PLANNING AND A CO-CREATED URBAN DEVELOPMENT

Conventional, linear economy construction methods are increasingly criticized for their climatic, energetic, and resource-related consequences: The acceleration of global resource consumption is leading to devastating environmental destruction, because consumption and production are not based on closed material and energy cycles, and thus, material and energy are not reused. The conventional construction of buildings and infrastructure plays a significant role in this: half of the material and energy consumption and a third of the waste generated by the manufacture of building products, renovation, maintenance, and demolition are in the construction sector, which is still a long way from sustainable development. The pandemic showed that the current linear development model leads to major outages in our urban fabric when abrupt changes are introduced. Building resilience urgently requires rethinking the direction towards a circular economy, resource-saving, and a thoughtful transformation of the construction industry (Drexler, 2021).

In times such as a pandemic, the combination of digital planning tools and open systems, and circular economy approaches to architecture can support the anticipation and creation of adaptable products that cater to often unforeseeable future change and generate adaptive models for co-creation. A holistic planning approach combining multiple innovations in digital, architecture, and project development can lead to accessible applications that are used by multiple project stakeholders and allow pluralist design approaches, bottom-up structures, and platform-based evaluation models in design and execution. Predictive planning can be a tool to create more resilience, multifunctionality, mobility, multimodality, and connectedness to impact our fast-changing lifestyles positively.

In 'Architecture for the Commons—Participatory Systems in the Age of Platforms', Jose Sanchez argues that in order to 'sustain a diverse and multi-actor economy, the field of architecture design needs to find efficient forms of collaboration and coordination between suppliers'. He opens a framework for the combination of discrete building parts with a capacity for recombination and possible multiple outputs that allows a pluralistic and non-monopolistic approach to production (Sanchez, 2021). This chapter describes the architectural and design parameters for the implementation of new planning and execution tools in use cases. These cases are sequenced into three categories and follow an order from digital planning to physical execution and from urban planning to architectural implementation:

- Beta Builder—planning automation for predictive co-creation.
- BetaHood—fundamental research for the urban implementation of nomadic quarters and circular spatial systems on-demand.
- BetaPort—open systems architecture with circular building technology.

The use cases of Beta Builder and BetaHood are evaluated through real-life application and testing with diverse stakeholders, experts, and project participants within the research groups. The BetaPort system was validated and received feedback with prototypes built in three locations in Germany.

CASE STUDIES

The case studies combine approaches from practice with applied research to investigate, analyse, compare, and evaluate architectural planning and building systems for future urban application.

Their influences on resilient urban planning, material lifecycles, and living conditions are examined. In addition to design methodology research, the project integrates recent architectural theory, universal design, circular economy, and the fundamentals of building law.

BETA BUILDER—PLANNING AUTOMATION FOR PREDICTIVE CO-CREATION

Beta Builder is a software package currently in development at Urban Beta and Morean that facilitates multiple stakeholder involvement in urban planning and visualizes otherwise invisible information streams in real time. The software is part of the BetaHood—mobile, sustainable and social communities on-demand research project and is used for interactive planning applications with the BetaPort system. Both are introduced in these use cases. Evaluation is enabled by comparable data collection and the integration of production data with file-to-factory applications. The configurator uses machine learning and custom algorithms and is designed for playful and efficient planning. It eliminates planning errors and anticipates building costs. Currently, the software is applicable at two scales: an urban scale for community planning in the BetaHood research and an architectural scale for the configuration of mobility hubs in the BetaPort project (Urban Beta & Morean, 2021).

The software's intuitive and easy to use interface makes planning approachable for a broad public and involved parties. Planning becomes a democratized platform-based process allowing pluralism and variants receiving feedback. Rhino and Grasshopper CAD software is used to create modular building blocks, which are transferred to the Unreal game engine. For this purpose, 3D models of predefined spatial catalogues were modelled and exported to enhance them with rule-based properties and interaction elements. An independent app is created, ready for browser and html implementation. The software can easily be accessed by smartphone or browser, thus enabling wide accessibility for future planning and user engagement. The open-source character of the software allows extension, modification, and user interaction, opening the planning process to the commons.

Real-time interfaces and a heads-up display track data such as user mix, footprint, material use, gross floor area, spatial program, and economic facts in real time and visualizes them for comparability. These UX integrations make individual and playful planning possible and allow interactive feedback from one or more users in an urban co-creation process. The application of such interactive software can make urban planning more resilient and predictive. Spaces can be pre-programmed with multiple functions for future use, making communities and urban quarters resilient to drastic changes such as those experienced during the pandemic. Multiple stakeholders can plan, replan, and reconfigure urban arrangements to anticipate their outcome and results for various user streams, functionality, energy income, and material sourcing. This opens the possibility of integrating platform-based crowdsourcing of architecture into the software. Material passport and blockchain integration with nonfungible tokens can create digital securities for physical applications and secure a value system for flexible buildings as material depots.

BETAHOOD—FUNDAMENTAL RESEARCH FOR THE URBAN IMPLEMENTATION OF NOMADIC QUARTERS AND CIRCULAR SPATIAL SYSTEMS ON-DEMAND

The BetaHood—mobile, sustainable, social temporary communities research project offers a new, sustainable, and social approach to combating housing shortages and integrating marginalized groups. The project uses existing and undeveloped urban spatial potential and a resource-saving approach to create mobile construction with a focus on self-building and co-creation. Beta-

Hood is a joint research project by Urban Beta, Arup, the Berlin City Mission, and the Bauhaus University Weimar and is based on an initial idea for nomadic living by Anke Parson, Florian Michaelis, and the author. At the time of writing, the research is part of Zukunft Bau (In English, Future Construction) a funding program initiated by the German government's Federal Institute for Research on Building, Urban Affairs and Spatial Development. The research aim is to develop a concept for mobile quarters in urban areas by using an open-source guideline and making the data available to the public and potential stakeholders. The project introduces tools for open knowledge transfer that allow hacks, local adaptations, and updates to established quarters and brownfields that can be implemented by various parties, developers, and future tenants (Figure 1).

Steadily growing pressure due to increased immigration rates and the consequent need for rapid housing construction make it ever more important to use urban areas efficiently and retain public services to foster sustainable and climate change-friendly urban development. BetaHood investigates circular and reversible land use models, which explore the inner-city brownfield potential for various planning and use phases and possible on-demand densification (WBGU, 2016, p. 181).

The pandemic left our economy with a restricted housing market, rising living costs, and the increasing loss of public and communal spaces, resulting in displacement and a life under precarious conditions for many socially disadvantaged people and communities. A high number of additional refugees, especially after conflicts in eastern Europe, are fuelling this social ternsion. The consequences include social segregation, a reduction in the social mix, and a perpetuation of the problems faced by fringe groups. As a reaction to these social developments, attempts are increasingly being made to move away from the previously unalterable forms of central accommodation and to develop new forms of housing with a focus on an intelligent social mix combined with ecological, circular, and economic aspects (Dalal et al. 2018; BBSR, 2019).

BetaHood's spatial programme provides a new form of urban quarter that allows flexibility and is built with mobility in mind, which caters to faster changes in the urban context. Therefore, the sustainable quarters create a post-pandemic environment for socially up-valuing developing sites from private and governmental owners alike, providing a circular business model with scalable architecture the highest ecological standard, a healthy user mix to reintegrate homeless people, diversity, self-realization, and new forms of co-living.

The research evaluated the possibilities of linking the central urban qualities of a heterogeneous, sustainable neighbourhood to a high-quality living space with a time-based component, as well as the possibilities for updating monofunctional quarters to heterogeneous ones that can be used in a 24/7 cycle.

BETAPORT—OPEN SYSTEMS ARCHITECTURE WITH CIRCULAR BUILDING TECHNOLOGY

BetaPort is a circular building technology that enables sustainable buildings that can change over time. Developed for commercial functions, such as mobility hubs, BetaPort caters to a variety of spatial programming and layouts. Transport is one of the fastest changing sectors today. Future urban development will be affected by its fast pace of innovation in micro-mobility, electrical charging infrastructure, and three-dimensional applications such as air taxis. The pandemic showed how whole infrastructure segments such as airports can cease functioning due to their monofunctional layouts. A traditional modern airport design is often limited to processing, security, waiting, and shopping functions, cynically making it nothing more than a shopping mall with adjacent aircraft. After a decline in airplane operation during the pandemic, large-scale

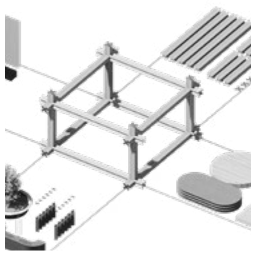


Figure 1 ▸ p. 257

> "From an object-oriented, monofunctional, and static city model towards collaborative planning and a co-created urban development."

airports were empty but still needed to be heated and maintained. Future mobility infrastructure must be designed differently. The requirement profile for future-proof hubs must have adaptability, sustainability, safety and resilience as its top priorities. Future buildings need to be able to adapt to ever faster changing infrastructural needs. The BetaPort system offers a solution which provides a kit of parts that can update existing buildings and build future infrastructure, versatile enough to assemble in challenging locations and lightweight enough to top-up existing infrastructure (Figure 2).

The structural system combines timber with recycled steel joints in a hybrid approach that cater to the strengths and durability of each material. The system incorporates circular aspects and design for disassembly, activated by simple connectors. The BetaPort system introduces a building-as-a-service model for adaptive spaces and introduces a digital platform with an internet of building parts: building parts are assigned values through material passports, which enables new financing models, servicing and architectural crowdsourcing. Parts can be exchanged inside a building structure and can be transferred between buildings. The modular construction system, made of reversible timber building blocks, can generate endless variety in building shapes and allows flexibility for multiple tenants' lifestyles (Figure 3). Predictive planning with the Beta Builder is combined with automated manufacturing and production chains.

Open systems with circular approaches contribute to a more transformative architecture for resilient cities that can react to their inhabitants adaptively. Systems like the BetaPort contribute to decarbonization and can create healthy environments, flexible to our needs.

PLURALISTIC PLANNING ENABLES ARCHITECTURE FOR THE COMMONS

Tools such as configurators and adaptable spatial systems can help to create a more engaging future for pluralist urban design. Creating an economy of building parts at an architectural level can increase the resilience and flexibility of buildings. With the introduction of building-as-a-service models, planners, developers, and financiers will have to redevelop existing linear economy models. Here, the whole lifecycle of not only one building is under examination but the lifecycle and identity of all building components in multiple structures. An economy of building parts can foster repairable buildings with exchangeable parts and components (Figures 4 and 5). The construction of these reusable building components and their endurance and material economy are researched at Urban Beta. Our current development state of reusable components for zero emission buildings can be applied to three-storey buildings with a multitude of layouts (Figure 6).

In contrast to existing linear economy approaches in urban development, real estate, and construction, this new model can accelerate the change towards resilient and participatory architecture and urban planning. Upgrading existing infrastructure and new construction must anticipate future changes and create multifunctional and evolving environments. The future urban fabric should be able to be upgraded and easily reprogrammed to be ready for fast and unforeseen changes arising not only from a pandemic but also from day-to-day changing lifestyles and needs.

PLATFORM-BASED URBANISM WITH COMMON STANDARDS

To accomplish more resilient urban quarters with flexible architectures that adopt a multitude of lifestyle decisions, programmatic functions, and socioeconomic streams, an update of the planning and execution process is needed at three levels:

1 Digital planning that uses automation to allow an understandable and easy-to-use participatory process.
2 Transparent urban planning provides the chance of interactivity and par-

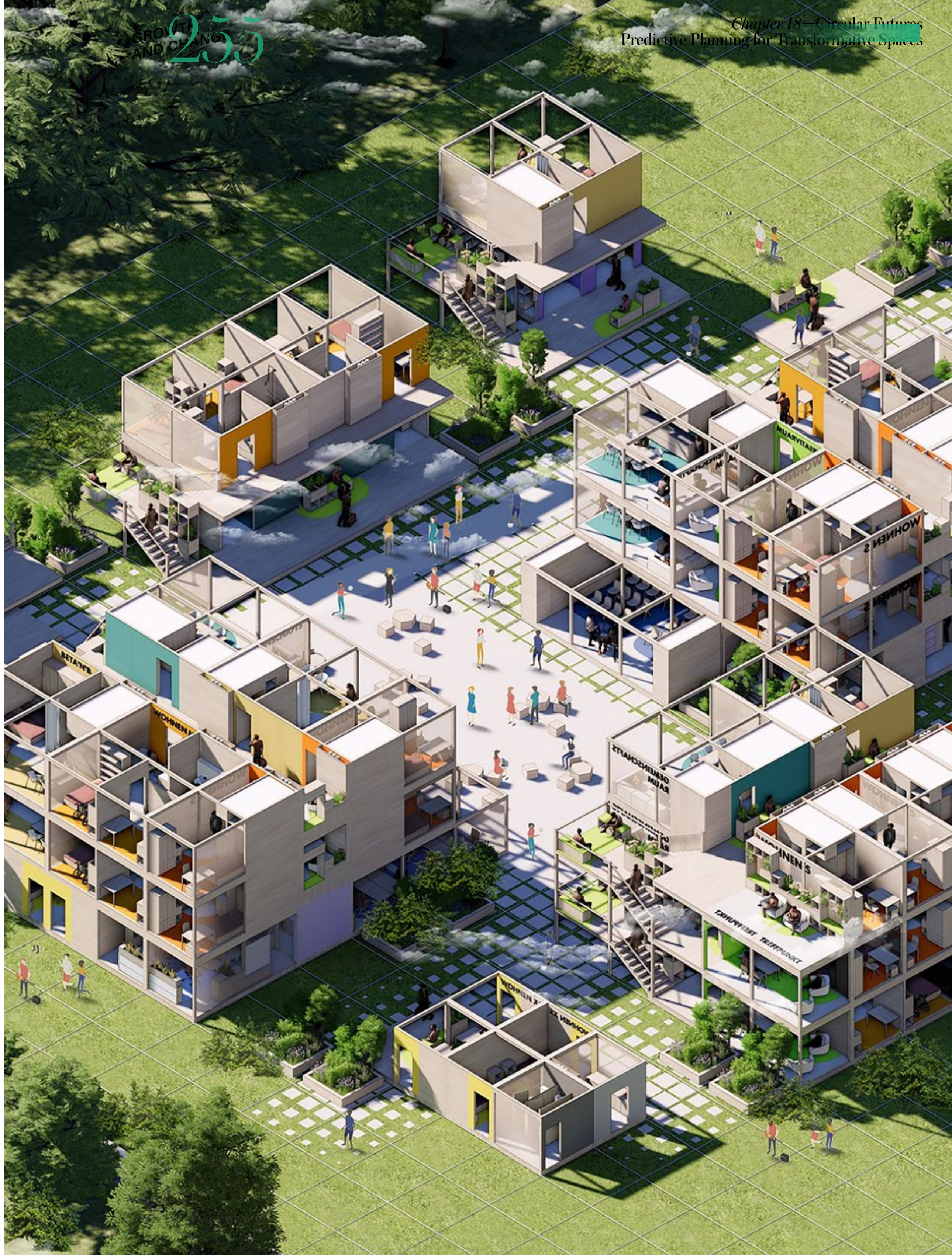
Figure 2 ▸ p. 257

Figure 3 ▸ p. 258

Figure 4 ▸ p. 259

Figure 5 ▸ p. 260

Figure 6 →
Isometric view of the Beta Village configuration, realized by multiple input from various stakeholders, future tenants, and project partners' feedback within the BetaHood research project. Site at Cottbusser Platz, Berlin (visialization by Urban Beta, Arup, Berliner Stadtmission, & Bauhaus University Weimar, 2022).



ticipation, while reducing steps and interfaces between all involved stakeholders.

3 Architectural systems cater to the highest standards in ESG, sustainability, and circularity to allow for new platform-based usage models.

Because this will involve a multitude of contributors and collaborators at all levels, it is crucial to introduce unified standards and certifications, which today often lack. Fast digitalization and the introduction of automation is key to one of the least digitized industries today (McKinsey, 2017).

THE ARCHITECT AS THE CURATOR OF PROCESSES

To update the processes of linear economy cycles and introduce a circular economy, architects and urban planners must become system designers and create interactive circular urban and spatial solutions that cater to the demands of an accelerated knowledge society and its fast-changing lifestyle models. Future urbanism will profit from the resulting role of planners as curators who enable pluralism in city planning and operations. The understanding and visual rendering of varying and often invisible streams of urban flows can generate a broader understanding of collective urbanism. The goal is an interactive architecture that allows multiple-use scenarios, fast adaptations, and catering to individuality. Opening planning processes and creating buildings and building parts that can be understood by their users and various project stakeholders becomes key in this development.

Note
This chapter relies heavily on the research results and inventions of Urban Beta and BART//BRATKE. I want to thank my co-founders Anke Parson, Paul Clemens Bart, and Florian Michaelis for creating a striving work environment in which we can collectively innovate in research and practice. Thank you to Lara Schönweiss, who managed our research and the BetaHood project, and to Klemens Sitzmann and Zvonko Vugreshek, who contributed state-of-the-art architectural and computational design solutions to the BetaHood research and the BetaPort building technology. Thank you to our development partners 'str.ucture' and to Julian Lienhard, Timo Claus, and Benedikt Neubauer for contributing engineering innovation to the BetaPort system. Thank you to the team at Morean and to Philipp Eckhoff for the collaboration on interactive configurators.

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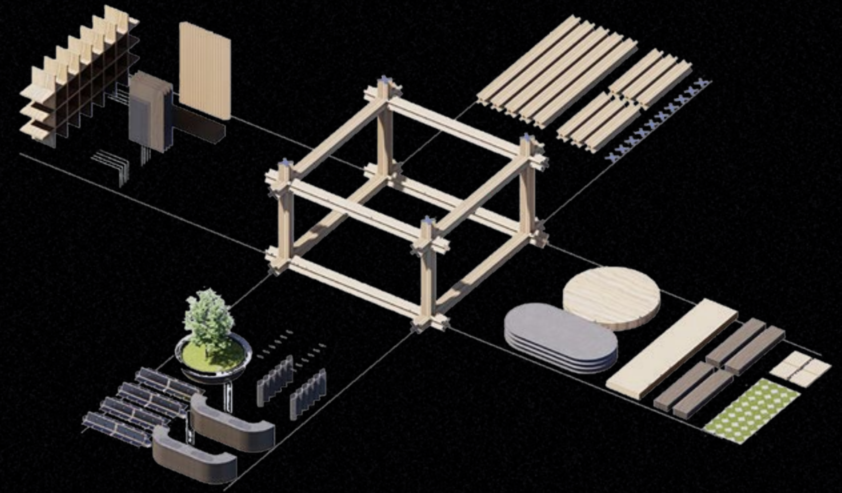

Figure 1
BetaPort Voxel: an adaptive kit of parts (visialization by Urban Beta, 2021).

Figure 2
Recombinatorial logics of discrete building parts in the BetaPort system allow endless building typologies (visialization by Urban Beta, 2021).

Figure 3
BetaPort One prototype at GreenTech Festival 2021, Berlin (photograph by Urban Beta & Naaro, 2021).

Figure 4
BetaPort One detail of a reversible building knot at GreenTech Festival 2021, Berlin (photograph by Urban Beta & Naaro, 2021).

Figure 5
BetaPort System case study for a mixed-use building application, Berlin (visualization by Urban Beta & Bitscape, 2021).

ABSTRACT

This chapter proposes a three-pillar framework to characterize a sustainable city. Drawing on the indicators of Sustainable Development Goal 11, this essay first reviews the academic and practitioner resources that define sustainability and the implications of this for defining a sustainable city. It proposes three key characteristics: low emissions; purposeful urban planning; and equitable distribution. In detailing the key component parts of each of the three pillars, particular emphasis is given to the first characteristic of low emissions. This is because research, notably the sixth assessment report and scenario analysis from the Intergovernmental Panel on Climate Change, suggest an existential challenge resulting from high emissions. The chapter concludes with a discussion on the implications of these characteristics for policymakers, in particular city mayors, and existing convening bodies that already provide support for cities in this transition. Although the implicit assumption is that no city is yet truly sustainable, this essay does address the extent to which current government actions are, or are not, satisfactory for us to transition to sustainable cities, and further analysis is needed to assess this.

KEYWORDS
sustainable city; sustainability; low emissions city; urban planning; equity, justice.

Chapter 19—Why Low Emissions, Purposeful Urban Planning, and Equitable Distribution are Critical in the Quest for a Truly Sustainable City

Hannah-Polly Williams

'If we are to solve the challenges of tomorrow, we must face up to them today, no matter how difficult they may seem. At NEOM, we are addressing some of the most pressing challenges facing humanity by bringing together a community of the brightest minds committed to reimagining what a sustainable future will look like in 20 to 30 years, and building it today. We are redefining the future now.'

"Welcome to the dessert," so says Nadhmi Al-Nasr (2022, July 16, Energy Newsline, p. 1), the Chief Executive Officer of NEOM, an ambitious idea striving to create a sustainable, smart city in the Tabuk Province of northwest Saudi Arabia.

WELCOME TO THE DESERT

Certainly, cities of the future need many of the sustainability credentials that NEOM seeks to deliver. The World Bank (2020) believes that 'cities consume two-thirds of global energy consumption and account for more than 70% of greenhouse gas emissions' (p. 1). Cities also put pressure on land and natural resources, and because almost 500 million city dwellers live in coastal areas, they are at increased exposure to climate and disaster risks.

Given this, it is not surprising that goal 11 of the 17 Sustainable Development Goals (SDGs) is titled 'sustainable cities and communities', and calls for making 'cities and human settlements inclusive, safe, resilient and sustainable' (UN, 2015; p. 18). The SDGs were developed and adopted by the UN in 2015, as a successor to the successful Millenium Development Goals. They are an ambitious collection of 17 connected aspirations designed to be a shared blueprint for delivering economic and social development for people across the globe whilst protecting the planet. Alongside the eradication of poverty and hunger, the inclusion of a goal dedicated to sustainable cities is indicative of the importance of this topic in the minds of global policymakers.

This need for our cities to be more sustainable arises against the background of more geographical spaces becoming urban. From Guangzhou to Abuja and Florida to São Paulo, this drumbeat of urbanization grows ever louder. Over the last 40 years, city-dwellers, those living in 'high-density places of at least 50 000 inhabitants'[1] (OECD & European Commission, 2020; p. 10) have more than doubled, with 3.5 billion people in 2015, up from 1.5 billion in 1975. Now, almost half the world's population (48 per cent) live in cities and by 2050, this is expected to be 55 per cent of the world's population, 5 billion people (OECD & European Commission, 2020).

This chapter is organized as follows. It will first explore the key concepts, briefly assessing the extent to which there is consensus about these definitions, and then propose a working definition of a sustainable city using three key characteristics: low emissions, purposeful urban planning, and equitable distribution. It will then explore these three key characteristics and propose some examples of cities that are already demonstrating strong progress toward this vision. Finally, the chapter concludes with a discussion of the implications of this analysis for regional, national, and international policymakers, with a particular focus on city mayors.

LITERATURE AND CONTEXT REVIEW

Before defining a sustainable city, we will touch first on the definition of sustainability itself, since there is a large and growing quantity of research related to sustainability and the distinct but related concept of ESG.

Sustainability is arguably one of the most hotly debated topics of the decade, and given both the importance of and challenges to significantly curbing global emissions from their current trajectory, it seems set to retain its place as a leading topic for the remainder of the decade and beyond. Many terms imply similar concepts, such as sustainability, resilient, green, and smart. From a business perspective, which this essay will not address in any detail, we can add ESG, triple bottom line (Elkington, 1999), conscious capitalism (Mackey, 2013) and many more to the list. Here, we explore the first four terms as they relate to cities.

Starting with sustainability, it is worth noting that the concept is so ambiguous that full books and papers have been written to do justice to the rich articulation and deep discussion of the definition; for example, Moore et al. (2017) dedicate a research paper to the topic. This essay leans heavily on that paper and on the view that sustainability 'includes five constructs: (1) after a defined period of time, (2) the program, clinical intervention, and/or implementation strategies continue to be delivered and/or (3) individual behaviour change (i.e., clinician, patient) is maintained; (4) the program and individual behaviour change may evolve or adapt while (5) continuing to produce benefits for individuals/systems' (Moore et al., 2017, p. 1). Put simply, for an entity such as a city to be sustainable, it needs to be able to be maintained at a certain rate into the future in a way that benefits society.

The OECD (2022) defines a resilient city as one that has 'the ability to absorb, recover and prepare for future shocks (economic, environmental, social & institutional) [and] promote sustainable development, well-being and inclusive

1 This is according to the OECD definition of a city, which uses the degree of urbanization to classify the entire territory into three categories:cities; towns and semi-dense areas; and rural areas. 48 per cent live in cities, a quarter live in rural areas (24 per cent) and a little more than a quarter live in towns and semi-dense areas (28 per cent).

growth' (p. 1). The Resilient Cities Network, established in 2018 as a legacy of the Rockefeller Foundation's funding of the 100 Resilient Cities initiative, has a comparable definition and believes that resilience goes beyond the shocks—such as earthquakes, floods, disease outbreaks etc. but also the stresses that weaken the fabric of a city on a day to day or cyclical basis. Therefore, this essay is sympathetic to the concerns of Elmqvist et al. (2019) that 'many sustainability goals contrast, or even challenge efforts to improve resilience' (p. 1) and therefore uses sustainability and resilience distinctly, as opposed to interchangeably.

Although commonly used, 'green' is too broad and colloquial to have an agreed definition. We use 'green' as a very general term which is a subset of sustainability when referring to the environmental characteristics of sustainability but largely excluding the social ones.

Finally, although related, sustainable cities should not be conflated with smart cities. This essay uses Sengupta and Sengupta's (2022) definition of smart cities to refer to 'government-supported projects involving substantial investments in Information and Communications Technology (ICT) infrastructure and ubiquitous computing projects for real-time monitoring, management and regulation' (p. 2). Although most analysts agree that making cities smart will be a necessary condition of sustainable cities, this is a tool not a characteristic and is therefore discussed here as such.

With these overall concepts in mind, we can use SDG 11, introduced in the previous section, to outline what a sustainable city means in practice. This goal emphasizes affordable transport systems, sustainable urbanization, cities that reduce the adverse effects of natural disasters, cities that reduce their environmental impact and manage resources efficiently, and cities that provide citizens with access to safe and inclusive green spaces (United Nations, 2015, p. 26).

Taking these criteria together, although imperfect, this chapter will define a sustainable city as one that has three characteristics: (i) low emissions that help meet recommendations to keep global temperatures to 'well below' two degrees of warming (IPCC, 2022); (ii) purposeful urban planning; and (iii) justice through an equitable distribution of the costs and benefits.

The next three sections will explore each of these characteristics in some detail, with particular analysis of low emissions, given the global prominence and existential nature of this issue.

LOW-NO CITIES

In 1992, the four-year-old Intergovernmental Panel on Climate Change (IPCC) issued 'pathbreaking [emissions scenarios] [...] which were the first global scenarios to provide estimates for the full suite of greenhouse gases' (IPCC, 2000, p. 5). Since then, the IPCC has released a full assessment report with its climate scenarios every six or seven years, and it is currently in the process of releasing its sixth assessment report in six tranches throughout 2021 and 2022. These reports are significant because they bring together the collective perspectives of hundreds, if not thousands, of the world's best scientists representing all countries and using a comprehensive, transparent, and iterative peer review process.

Net-zero emissions is an important concept introduced by the IPCC to galvanize governments and to an important but lesser extent business around a goal that was aligned to the science yet very simple. The IPCC (2018) describes net-zero emissions, often referred to simply as 'net zero', as 'achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period' (p. 1). For governments, this simple equation means that the single most effective way to achieve net zero is to not release any emissions, thereby removing the need to balance emissions with carbon removal. In reality, as we

"For new cities this means that whilst the blueprint for what a sustainable city looks like is clear, the question of how to implement this blueprint is much less so."

will see, it will be virtually impossible to have a completely zero-emission city, so cities in the future will need to have very low emissions and robust offset arrangements to capture the residual emissions that could not be avoided.

Consequently, cities need to reduce both their production-led emissions, which are emissions associated with transport, buildings, energy, and waste that are emitted within the city, and their consumption-led emissions, those arising from the production of the goods imported from other places.

How a city produces its energy is, of course, a critical component of production-led emissions. Although the composition of energy production is generally a nationally-led policy area and therefore not something that cities have a huge degree of influence over, as we see in the section on purposeful urban planning in a city, opportunities are increasing for urban planning within cities to enable them to produce renewable energy.

Buildings, and in particular skyscrapers, are a topic on which cities can take meaningful action to reduce production-led emissions. Since 2000, 'the world has added 12,979 tall buildings (100+ m) to the 7,804 buildings they previously built' (Al-Kodmany, 2022, p. 1). Consequently, a study of sustainable high-rise buildings identified several examples that leverage the design and construction of skyscrapers to deliver

creative green solutions. For example, the Bank of America Tower, a 55-storey commercial skyscraper in New York, uses an air filtration system that removes 95 per cent of airborne particulates and a sophisticated water management and recycling system and was built with 87 per cent recycled materials for its steel and cement containing 45 per cent recycled materials for its concrete. The 128-storey Shanghai Tower in Shanghai divided the building 'into nine vertical neighbourhoods with 12-to-15-story-tall sky-gardens, which act as buffer zones between the inside and the outside and form a Double Skin Façade' (Al-Kodmany, 2022, p. 7) and installed wind turbines which produce power on site and save power transmission costs. Both skyscrapers earned Leadership in Energy and Environmental Design (LEED) Platinum status, which means that they secure maximum credits on factors such as carbon, energy, water, waste, transport, materials, health, and indoor environmental quality (USGBC, 2020).

On the consumption-led side, recent research has shown that '85% of the emissions associated with goods and services consumed in C40 cities are generated outside the city' (C40 Cities, Arup & University of Leeds, 2019, p. 16). As we explore in the concluding section on policy implications, C40 is a group of close to 100 cities, including most megacities, which together comprise 20 per cent of the global economy. We need to keep consumer goods in mind when evaluating sustainable cities because these goods typically involve substantial emissions. For example, they use extracted raw material and are produced in factories and transported on freight that relies on fossil fuels.

Cities can influence consumption in a range of categories that have a material impact on emissions. Food is an important example because it was the biggest contributor to emissions of the C40 cities in 2017 with 13 per cent of emissions from consumption categories. Of all food emissions, around 75 per cent are from the consumption of animal-based foods and 25 per cent from the consumption of plant-based foods. The C40 research found that 'if C40 cities change their food consumption habits in line with the identified progressive targets [reducing meat consumption to a third of 2017 levels], the category's emissions could be cut by 51% between 2017 and 2050' (C40 Cities, Arup & University of Leeds, 2019, p. 76). Cities can act on this data by encouraging the provision of affordable raw vegetables, and in the section below we will briefly discuss urban planning solutions that would also support this. As the awareness of climate change grows amongst the public and the willingness to change behaviour increases, cities can play a transformative role in influencing and guiding the behaviour and decisions of their inhabitants toward substantial green activities. For example, the C40 study omitted recommendations to reduce consumption habits related to packaging because its impact on emissions was negligible.

In summary, the science is clear about the need for cities to reduce their emissions, and green buildings and provision and encouragement of more vegetarian food choices are two areas where a city can clearly take action.

PURPOSEFUL URBAN PLANNING

Purposeful urban planning lowers emissions but is also a feature of a sustainable city in its own right due to the social implications of better land use, conservation of natural resources, production of food and energy, and protection of biodiversity. Purposeful urban planning refers to deliberate efforts by city planners and legislators to design and use land in a way that contributes to their goals. As the World Bank (2020) emphasizes, 'once a city is built, its physical form and land use patterns can be locked in for generations, leading to unsustainable sprawl' (p. 1). And because increases in urban land use are outpacing population growth, this is 'expected to add 1.2 million km^2 of new urban built-up area to the world in the three decades' (World Bank, 2020, p. 1).

As mentioned in the previous section, in general, the production of power is the domain of national governments. However, research suggests that several of the main transformations in the power generation sector, for example, rapid growth in the use of renewables due in part to technological advancesdriving down costs, create a 'strong impetus for the deployment of renewables at the city level, as many of these disruptive technologies are enabling the scale-up of a renewable-based decentralised energy system' (IRENA, 2020, p. 7). Therefore, many of these developments can be classified as moving toward a smart city. Over a thousand cities have stepped up to seize this opportunity, setting various renewable-related targets of all types (ibid.). The cities that participated are mainly medium-sized cities in Europe and North America, but also include some large and megacities, and some cities in Asia and Africa (ibid.). Cities mainly use hydropower and waste-to-energy, with increasing use of solar and some progress in wind. Malmö is a great example of a city that is that is both setting and meeting ambitious targets: it plans to run entirely on renewables by 2030 and was at 43 per cent in 2020. Since 2012, its Western Habour District has operated entirely on renewable energy, and the central heating system in Augustenborg, its industrial area, has solar thermal panels (WEF, 2021).

Transport design is another critical area of purposeful urban planning. In addition to electrifying public transport, directly reducing emissions, cities can promote the use of public transport by making it safe, affordable and clean, and encourage cycling and walking by redesigning existing roads and providing preferential access to cyclists with designated cycle paths and pedestrians with increasingly pedestrianized city centres. Countless cities, in particular Amsterdam and Copenhagen, have undergone transformative pro-bicycle infrastructure development in recent years and have seen modal increases in cycle usage as a result (Chen et al. 2022). Cities can also 'encourage businesses to consolidate deliveries, so that there are fewer vehicles each carrying more goods on the roads, [and] seek opportunities to shift freight off the roads and onto other modes of transport, such as rail or boats' (C40, 2021).

Access to green spaces is also a critical aspect of a sustainable city. This is because, in addition to improving air quality and reducing temperatures, evidence is growing that it positively impacts well-being (Hartig et al., 2014; Kwon et al., 2021; Nguyen et al., 2021; Röbbel, 2021). Research indicates that access to green space may even be more influential to happiness than GDP increases for the richest countries (Kwon et al., 2021), and other research suggests that the quality of the green space, defined as having some degree of design and being well maintained, is also important. For example, Nguyen et al. (2021) found that 'health benefits were more consistent in populations with more tree canopy, but not more grassland' (p. 1). For purposeful urban planning, this represents a strong motivation to ensure city dwellers have better access to quality green spaces. Examples of cities doing this well include Singapore, Sydney, and Vienna, of which 47 per cent, 46 per cent, and 45 per cent respectively are given over to public green spaces (World Cities Culture Forum, 2019).

Finally, cities can foster several smaller-scale urban planning initiatives, for example vertical farming, which enables people to grow vegetables and fruits within their flats and in small allotments. The sustainability benefits are clear: less transport, better quality produce, and less waste. But these initiatives also depend in part on broader sustainability within the city's ecosystem, most notably its power generation and sustainable irrigation systems.

Therefore, in summary, purposeful urban planning should particularly focus on renewable power generation, transport systems, and access to green spaces to transition to a sustainable city.

EQUITABLE DISTRIBUTION

Finally, we turn our attention to our third but no less important characteristic, which is a just city.

This chapter certainly does not attempt to review or discuss normative theories of justice, on which the literature is extensive and has been centuries in the making, about what ought to be the distribution of benefits and risks in a city. Instead, revisiting our definition of sustainability, this essay takes the view that for a city to be truly sustainable it must endure over the very long term. History has shown us that where deep and pervasive inequalities exist, for example, if the distribution of benefits and risks is inequitable, new power structures emerge eventually to rebalance this (Dalio, 2021). Public policy tools in cities should ensure that the distribution of benefits and risks is equitable and does not exacerbate existing inequalities.

One way to ensure that marginalized groups are not excluded from benefits and/or exposed to greater risks is to ensure that no one group predominates in any region of a city. If people are distributed evenly throughout a city with no clustering of race, ethnicity, socioeconomic status, or age, exposure to benefits and risks should be equitable at the aggregate level. Oakland is an example of a city that has started to assess the extent to which certain populations do not benefit equally from developments, and in 2021 it commissioned a racial equity planning and policy justice report. Oakland is an interesting example because of its proximity to the affluent Silicon Valley and its history as one of the most diverse areas of the United States, especially in East Oakland. The spillover from Silicon Valley is leading to gentrification, but instead of the existing residents of East Oakland benefitting from the increased investment and access to jobs, studies have shown that 'long-term residents have lost their homes and many continue to be pushed out by newer, higher income residents' (Just Cities, 2021, p.12).

Sengupta and Sengupta (2022) outline another example of problems of distributive justice for sustainable cities. Their exploration of failed smart city initiatives adopts a social justice perspective and finds institutional failures 'due to the lack of consideration given to the equitable distribution of risks and formal accountability mechanisms' (p. 1). For example, they note that the implementation of tech-enabled projects, which are crucial to supporting better monitoring and reduction of power consumption, for example, do not take place in a vacuum and typically perpetuate existing power inequalities rather than dismantling them.

A renowned urban justice academic, Fainstein (2010), offers a good summary of what is and is not possible in the quest to create a just city. She notes that whilst 'there are obvious limits to what can be accomplished at the metropolitan level, at the very least, however, a concern with justice can prevent urban regimes from displacing residents involuntarily, destroying communities and directing resources at costly megaprojects that offer few general benefits' (p. 183).

CONCLUSION AND POLICY IMPLICATIONS

Creating sustainable cities that have the three characteristics of low emissions, purposeful urban planning, and equitable distribution may seem like a tall order for policymakers at the international, national, and city levels, but there are several reasons to be optimistic.

There are several mechanisam that policymakers can turn to. These include direct public policy, consortia, including public–private partnerships and subsidies to influence private sector enterprise. Although as yet only imperfectly, we can cluster government action according to our three characteristics of a sustainable city. For example, whilst subsidies and public-private partnerships are often most effective in creating low-carbon cities, protecting and creating green space is likely to be best delivered through direct regulations and city planning. Similarly, even though subsidizing or otherwise incentivizing businesses to develop smart city devices is an effective way to create the technologies that make low-carbon cities more likely, some degree of government intervention may be required to ensure that access to and implementation of this technology is fair and avoids further entrenching existing inequalities.

Throughout this chapter, various consortia have been referred to, and two are particularly important and worthy of distinction because of their proven success in pooling the insights and experiences of city planners and leveraging this collective learning. Firstly, the C40, which was initially convened by Ken Livingstone in 2005. C40 is a leading initiative that uses science-based urban planning and direct engagement with city mayors to bring together large cities across the globe. It aims to halve the emissions of its member cities within the decade, and with its membership of close to 100 cities and representing 20 per cent of the global economy, includes most of the world's largest cities and puts particular emphasis on megacities (C40, 2022); it has a chance to really move the needle.

Secondly, the Resilient Cities Network is the result of a five-year large-scale program which ran from 2013 to 2018, called 100 Resilient Cities. Analysis of what worked and what did not from 100 Resilient Cities provides helpful insights for policymakers, architects, and town planners. This high-profile, ambitious initiative sought to use deep engagement with communities, companies, and city leaders to enable transformational change in cities through the support of resilience plans. Its impacts on sustainable urban planning, particularly although not exclusively in developing countries, are significant because this was a case of its intervention. Ultimately, whilst acknowledging that city borders are less distinct in reality than in theory, the researchers concluded that the legacy of 100 Resilient Cities was positive. They emphasized the participatory decision-making processes, the benefits of deep and sustained knowledge sharing, and the provision of 'useful tools for understanding, assessing, and improving their capacity to cope with different stresses and shocks' (Galderisi et al., 2020, p. 19). The Resilient Cities Network now exists to further that mission.

This chapter sought to identify the key features of a sustainable city and offer examples of cities that have already implemented aspects of this model. Although we know that over time, all cities will need to transition toward these three factors, we do not have any examples of cities that already meet the full brief. For new cities, such as NEOM, this means that whilst the blueprint for what a sustainable city looks like is clear, the question of how others look to design and implement this blueprint is much less so.

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Terminal 3, Copenhagen Airport (photograph by Rasmus Hjortshøj).

ABSTRACT

This chapter examines the role of digitalization in building resilient cities to adapt to the combined threats of COVID-19 and climate change. Cities have been hubs of socioeconomic activity in the modern world. The design of the urban environment has traditionally followed prevailing economic paradigms of specialization and division of labour. However, cities today are facing a triple disruption: the COVID-19 pandemic, the climate emergency, and digital disruption. Conceptually rooted in Schumpeterian (1942) creative destruction, 'disruption' can also be a generative force by enabling reimagination of how we organize socioeconomic activity. In this respect, the convergent forces of COVID-19, the climate crisis, and digital disruption offer opportunities to invest in sustainable and resilient cities. Adopting a dialectical view of disruption, this chapter discusses how digital disruption could be an enabler of resilient and sustainable cities. A specific example of renewable energy systems is used to illustrate. The chapter concludes by discussing issues of the ethical and inclusive use of technology.

KEYWORDS
disruption; smart cities; digitalization; renewable energy.

Chapter 20—Digital Disruption and the Future City

Samsurin Welch

Cities in modern times have been centres for socioeconomic activity. By 2020, cities comprised over 55 per cent of the global population and generated approximately 80 per cent of global GDP (World Bank, 2020). The design of urban environments has generally reflected prevailing economic, technological, and energy paradigms (Angelidou, 2015), which over the past several decades have been characterized by hyperspecialization of global supply chains powered by fossil fuels and motorized transport, rooted in Adam Smith's notions of division of labour and the pursuit of speed, quality, and cost efficiency (Malone et al., 2011). This paradigm has shaped modern Euclidean, monofunctional zoning of cities such as central business districts versus residential zones.

This paradigm of the urban environment is now facing a triple disruption from convergent forces: the COVID-19 pandemic, the climate challenge, and digital disruption. COVID-19 has more broadly revealed fragilities in the prevailing paradigm of hyperspecialization and the relentless pursuit of efficiency through complex global supply chains. With respect to cities, this triple disruption has drawn attention to the importance of greater flexibility and responsiveness by, among other factors, leveraging robust and reliable data and systems for evidence-based planning and interventions, which was found to be widely lacking especially at granular local and subnational levels (UN, 2020). Conversely, the spurt of digital adoption has opened new opportunities such as flexible and remote working, online commerce, virtual ways of connecting and socializing, and access to services such as telelearning and telemedicine. Yet, inequities were also acerbated, as was the digital divide with communities that lacked digital access and literacy.

The second disruptive force, the climate challenge, is now seeing a new resurgence in the public and private zeitgeist, after taking a back seat during the height of the pandemic. Cities and the climate are inextricably linked. The urban environment contributes over 75 per cent of global energy consumption and 60 per cent of global emissions (UN Habitat, n.d.), as well as over 2 billion tons of municipal waste annually (Kaza et al., 2018). The 6th Assessment Report by the United Nations Intergovernmental Panel on Climate Change, IPCC (2021) also stressed the substantial threats cities face from anthropogenic climate change in the form of extreme weather, waste and pollution, sea-level changes, instability of food, water, and energy systems, and other risks. On the flip side, considerable attention and billions in capital are flowing into climate-related sectors in areas that will directly impact cities, such as energy, mobility, carbon management, and food and water systems. Given the substantial link between cities and the climate, tackling this agenda will inextricably involve rethinking how cities are designed and operate. The Sustainable Development Goal 11: Sustainable Cities and Communities defines 10 targets that could serve as a north star (United Nations Department of Economic and Social Affairs, n.d.).

The third force is the wave of digitalization that is disrupting models of organizing across almost all sectors. The fundamental shifts in how we live, work, socialize, and govern through technologies will impact the role of urban places, infrastructure, and services. A notable facet of the digital revolution is the rapid pace of change, accelerated even further by the pandemic. More directly, utopian visions of how cities can be made better through technological progress date back over a century (Angelidou, 2015). This evolved into the concept of digital or ICT-enabled smart cities with the Internet boom in the early 2000s, based on promises of how data, knowledge, and innovation can fundamentally improve cities. However, smart city initiatives in the two decades since have been criticized as overly technocentric or supplier-push siloed solutions, with questionable systemic benefit to stakeholders beyond (Hollands, 2008; Kleinman, 2016; McFarlane & Söderström, 2017). Nonetheless, the growing emphasis in recent years towards more holistic, citizen-centric approaches to smart cities as socio-technical systems (Mora et al., 2017) also presents opportunities for more sustainable and resilient cities.

IMPERATIVE FOR SUSTAINABLE AND RESILIENT CITIES

The convergence of these disruptive forces raises the urgency of elevating urban sustainability and resilience. But what constitutes sustainable and resilient cities? Although definitions abound, the following by OECD and United Nations International Telecommunication Union (ITU) reflect the main themes:

> *'[Resilient cities] have the ability to absorb, recover and prepare for future shocks (economic, environmental, social & institutional). Resilient cities promote sustainable development, well-being and inclusive growth' (OECD, n.d.).*
>
> *'A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental, as well as cultural aspects' (ITU-T, 2016).*

Common themes underpinning these concepts are the need to be more attuned and responsive to the needs and conditions of stakeholders, including citizens as well as the natural environment. Given the rapid rate of change in today's world, the ability to rapidly sense, adapt, and transform will be paramount.

Overall, this triple disruption poses not only substantial challenges but also opportunities to 'reflect and reset how we live, interact and rebuild our cities', in the words of UN Secretary-General António Guterres (2020). As cities emerge post-COVID, the trillions of dollars in public and private funding offer opportunities to both stimulate post-pandemic economic recovery and catalyse more

sustainable and resilient urban development by investing in green, equitable, and smart infrastructure.

To unpack this further, the next section draws on theoretical frameworks on disruption and digital innovation and discusses implications for future cities.

CONCEPTUALIZING DISRUPTION

While often used colloquially, 'disruption' to strategic management and innovation scholars refers to specific forms of change that bring fundamental alterations to how social systems are organized (Anderson & Tushman, 1990; Kaplan & Tripsas, 2008; Kumaraswamy et al., 2018). The term draws conceptual roots in Schumpeterian (1942) creative destruction, where radically innovative economic systems emerge from the dismantling of previous regimes. Thus disruption, while deleterious for some, can generate revolutionary progress. Disruption compels critical reflexivity of taken-for-granted assumptions, biases, and institutional arrangements that otherwise pose inertial barriers against radical change (Eggers & Park, 2018; Gilbert, 2006; Raffaelli et al., 2019; Tripsas & Gavetti, 2000), thus enabling innovative and entrepreneurial actors to reimagine new forms (Santos & Eisenhardt, 2009). For instance, the prototypical disruptor Uber, took advantage of technological and social trends to reimagine urban mobility services.

Given the complex and emergent nature of the process (Garud & Munir, 2008; Ozcan & Hannah, 2020), the disruption view suggests that predicting the post-pandemic future is futile. However, a dialectical view (Van de Ven & Poole, 1995) suggests the new normal will neither be entirely pre-pandemic norms nor pandemic-era extremes. Rooted in Hegelian traditions, the dialectical perspective conceptualizes social change as emerging from the interplay between opposing forces, from which a novel, previously unforeseen synthesis emerges (Benson, 1977; Van de Ven & Poole, 1995). Referring to our prototypical example of Uber, the ride-hailing paradigm has notably evolved from its peer-to-peer origins (e.g. anyone can drive) into a novel synthesis of old (e.g. licensed and permitted drivers) and new practices (e.g. app-based and algorithmic organizing).

EXAMPLE: DIALECTICS AND THE FUTURE OF WORK

These dynamics can already be observed in the evolution of the future of work. Despite early declarations of the death of offices, companies across sectors are instead seeking to discover new work arrangements that form equilibria between in-office and remote work. Indeed, recent field studies by Choudhury and colleagues (2022, p. 1) suggest that hybrid arrangements combining remote and in-office work offer the best of both worlds by balancing employee-coveted flexibility with ensuring strong organizational social ties that are crucial for innovation, collaboration, and professional development.

Such hybrid arrangements would blur the conventional lines between work and social life, and in the context of cities, between commercial, local neighbourhood, and home spaces. Whereas a mass exodus from urban environments is likely overstated, local neighbourhoods could gain in importance as live-work-socialize zones. Recent research by the Brookings Institute, for instance, reported tech-sector employment growth in smaller and mid-sized 'quality-of-life meccas' (Muro & You, 2022). Less need for daily commutes to business districts may motivate escape from high costs, congestion, and other quality of life challenges endemic in large cities, in favour of alternative urban areas promising proximity, infrastructure, and quality of life. This trend would elevate the need for development of responsive local infrastructures such as connectivity, social and working spaces, and energy and mobility systems to support new patterns of work. Newman (2020) refers to this emerging trend as 'globalized localization', with greater value attached to local places and communities while being connected to global economies.

CONCEPTUALIZING DIGITAL INNOVATION AS A SOCIOTECHNICAL PROCESS

Scholars have also increasingly examined the impact of the digital age on organizing socioeconomic activity (e.g. Bailey et al., 2022; Hanelt et al., 2021; Menz et al., 2021; Nambisan et al., 2017). 'Digital technologies' and 'digital artifacts' refer to technologies such as mobile devices, Artificial Intelligence, blockchain, robotics, drones, and others. By contrast, 'digital innovation' also termed 'digital transformation' is conceptualized as dynamic socio-technical processes that emerges through interactions between technologies, individuals, communities, organizations, and other actors (Bailey et al., 2022; Nambisan et al., 2017; Yoo et al., 2012).

Extensive research has been dedicated towards elaborating the novel characteristics and potentialities of digital innovation. With advancements in algorithms and copious quantities of digital trace data from human and nonhuman systems, digital technologies are increasingly autonomous and continuously learning systems that can augment or replace human behaviour (Bailey et al., 2022). Internet of Things (IoT) technologies such as connected sensors extend these potentialities to physical assets such as vehicles, buildings, and energy grids.

As a socio-technical process, digital innovation is considered more open and ecosystem-centric, because new solutions can continuously emerge from wide-spanning groups of innovators who can build on and recombine modular digital components through standardized programming language and interfaces (Nambisan, 2017; Nambisan et al., 2017; Yoo et al., 2012). For instance, developers could build new applications by combining Google Maps components, open-source machine learning algorithms, sensor data, and open data sets, and distribute these applications through web-based and mobile platforms. Zittrain (2006) refers to this effect as 'generativity': unlocking greater creativity through participatory innovation to solve problems that were not conceivable by a system's original creators.

DIGITAL DISRUPTION AND RESILIENT, SMART SUSTAINABLE CITIES

Digital technologies are key enablers of adaptive, responsive cities that are more attuned to the needs of constituents, not only human but also natural systems. Cities can become treasure troves of data. Combinations of smart sensors, control systems, and intelligent, autonomous learning systems promise more flexible, resilient, and adaptive urban systems that improve quality of life across domains, such as energy, mobility, safety, waste management, environmental protection, health and wellness, public services, commerce, and governance. At a tactical and operational level, real-time data from various sources and algorithms could be leveraged to optimize city services to respond to needs in real time, such as transport patterns. At a strategic and policy level, these insights can be harnessed for evidence-based urban planning, such as mobility services strategies.

Nonetheless, smart city systems must be designed around the goal of improving quality of life and well-being of stakeholders, as reflected by the UN ITU definition above, rather than technocentricity. Citizens' needs cut across bureaucratic domains, warranting whole-government approaches that include breaking down data, process, and system siloes. Additionally, cities should strive to harness generativity in digital innovation, leveraging broader creative potential through open innovation, public-private-academic partnerships, and collaboration across cities. For instance, a holistic digital picture of city services could be enhanced with - and indeed may not be possible without - public and third-party private-sector data. Ride-hailing companies such as Uber, for example, share aggregate data with the City of Boston, a requirement

> "The paradigm of the urban environment is now facing a triple disruption from convergent forces: the COVID-19 pandemic, the climate challenge, and digital disruption."

enshrined into Massachusetts state law (Mass. gov, 2019), providing valuable insights into congestion, transport patterns, parking and zoning needs, and other factors.

Leveraging digital infrastructure can facilitate generativity through participatory innovation, engagement, and collaboration, such as platforms for open data and sensor networks, crowdsourcing, living labs, and information sharing (Bakici, 2011). As Zittrain (2007) further argues, the potential for generativity can only be harnessed if systems are designed for it. One such example is the Eurocities' Sharing Cities Platform, which aggregates real-time data from varieties of city sources such as sensors, energy, and mobility systems. Its open data backbone enabled city officials, private companies, and individual residents to collaborate, engage and develop technology-enabled solutions for urban challenges (EU Sharing Cities, 2020).

To illustrate further redesigning cities for sustainability and resilience and the potentialities of digital technologies, the next section discusses an example of renewable energy systems.

EXAMPLE: CITIES AND THE FUTURE OF RENEWABLE ENERGY SYSTEMS

Cities are deeply interlinked with energy systems, consuming over 75 per cent of global energy (UN Habitat, n.d.). However, the prevalent fossil-fuel-dominated energy system is a factor of urban fragility. In addition to environmental risks from greenhouse gas emissions and air pollution, reliance on fossil fuel energy exposes cities to potent economic and geopolitical risks such as commodity price fluctuations, supply shocks and geopolitical tensions. Recent attention towards energy decarbonization affords opportunities for cities. Advancements in renewable energy, fuelled by billions in public and private funding coupled with conducive policy environments have driven the cost of solar, wind, and ancillary services down exponentially over the past decade, making them increasingly viable options. According to the International Renewable Energy Agency (IRENA, 2022), renewables constituted 81% of global power capacity additions. A study by the University of Oxford Martin School further highlighted the economic upside of energy decarbonization, at least US$12 trillion in economic benefits from a shift to renewable energy by 2050 (Way et al., 2022).

However, adoption of renewable power generation requires the redesign of energy systems. Unlike fossil-fuel generation, solar and wind are intermittent, being subject to weather patterns, and non-dispatchable – unable to flexibly respond to fluctuating market demand. This is illustrated by the 'duck curve' problem: an imbalance between energy demand, which typically peaks during mornings and evenings and solar energy generation, which peaks around midday. The need to balance supply and demand for renewables' grid stability requires more decentralized and smart energy systems that combine grid-scale renewables with smaller-scale, distributed generation and ancillary services closer to consumption, such as on-site building and community solar, and energy storage.

Here, digital technologies play central roles in enabling more intelligent and sustainable energy systems. Renewable-based energy systems must possess demand-responsiveness, where consumption also responds and adapts to intermittent energy generation patterns to enable greater efficiency, stability, flexibility, and resiliency. For instance, digital building management systems combining smart metres, sensors, controls, grid connectivity, and predictive machine learning could automatically regulate energy consumption through time-of-use management, where power use such as appliances or electric vehicle charging could be scheduled during times of peak renewable generation, or power can be stored during these periods for later use. Such solutions can be coupled with automated energy efficiency management based on monitoring and adapting to occupant behaviour. Additionally, behavioural interventions could help occupants reduce energy footprints through information provision, nudges, gamification, and economic incentivization through multi-tariff systems. The UN IPCC (2022) indicated that demand-side mitigation options can reduce energy demand by 73 per cent.

Digitalization can also enable the emergence of innovative business models. For instance, combinations of IoT, algorithms, and blockchain technology could allow consumers to monetize onsite solar or energy storage assets by selling surplus capacity to the grid or peer-to-peer energy markets. As-a-service business models could further lower the barriers to adoption of renewable systems, where home and building owners pay for energy consumption and avoid significant upfront capital costs. Another novel business model innovation that is emerging is vehicle-to-grid (V2G), where spare battery capacity on electric vehicles are turned into distributed energy storage resources for the grid. Software systems monitor vehicle utilization patterns and communicate with the energy grid, utilizing machine learning models to predict optimal charging and discharging levels. Most electric vehicles on the market come with hundreds of kilometres of range, yet the average car owner in Europe drives less than 20 km per day (Eurostat, 2021). V2G enables owners to monetize underutilized assets, while leveraging the capacity of millions of vehicles to balance the city and national energy system. Finally, open data and system architectures would enable cities to take advantage of generativity, where innovators can bring new and unforeseen solutions to the market. These participatory business models could incentivize and empower city residents to contribute to scaling up renewable capacity.

Overall, decentralized and distributed renewable energy systems, a critical enabler of resilient and sustainable cities, would not be possible without effective use of digital technologies. The examples above require complex and dynamic coordination between energy systems at the individual, local, city and national based on real-time data. The expansion of flexible working arrangements would increase time spent at home and in local neighbourhoods and escalates the criticality of local energy efficiency and resiliency. Furthermore, decentralized renewable power systems also reduce single points of failure and localize production, thus diminishing the economic and geopolitical risks associated with dependence on energy and fuel imports. Nonetheless, more investment is still required in this space. The IEA (2021) estimates that by 2030, demand-responsive capacity needs to grow by 12.5 times from 2020 levels to meet net-zero emissions goals.

ETHICAL, INCLUSIVE USE OF DIGITAL TECHNOLOGIES

Any employment of digital technologies must be mindful of potential trade-offs and strive to mitigate negative consequences. Angelidou (2015) argues that deployment of technology must be coupled with advancements in human and social capital, including informed, empowered, and agentic citizens, digital inclusion and social sustainability, and responsiveness to the diverse needs of communities. A non-exhaustive number of considerations are discussed below.

First, ensuring inclusivity must be considered for all constituents, as barriers to access to digital solutions can exacerbate inequalities. Addressing this potential digital divide requires investing in not only hard infrastructure such as connectivity but also soft infrastructure such as knowledge and social equity (Angelidou, 2014). User empathy is also crucial to considering how solutions can be designed to meet their needs in their context. In some cases, less complex and costly solutions may be more inclusive and effective. This was demonstrated by the success of MPESA mobile banking in bringing financial inclusion in Kenya by initially leveraging basic SMS-based technology that was widely used by rural and unbanked communities.

Second, use of data and intelligent systems must be mindful of potential issues such as embedded biases and prejudices, acerbated by lack of explainability and black-boxing of algorithms. For instance, recent studies on predictive policing (e.g., Alikhademi et al., 2022; Selbst, 2017), have revealed how racial biases implicit in data can become embedded in machine learning algorithms. Such risks are central to the emerging domain of Artificial Intelligence (AI) safety. Careful consideration of how data is collected, curated, and used to develop and train algorithms is warranted, as well as investing in AI explainability.

A third, related concern is threats to privacy in the era of data intensity. Privacy by design should be a fundamental principle. Moreover, data anonymization methods could allow data to be harnessed while reducing risks. Emerging models such as data trusts (Open Data Institute, 2018) could also be explored for more robust stewardship and governance over shared data. Relatedly, priority must be placed on cybersecurity to protect against and respond to attacks, especially given the growth of cyberattacks and data breaches. Growing digitalization and connectivity of critical city infrastructure such as energy systems increases attack surfaces and the potential for catastrophic impact of breaches.

Finally, it is critical to view both disruption and digital innovation as emergent processes that, as discussed above, are impossible to predict. Kumaraswamy et al. (2018) argue instead for a performative approach that involves continuously acting, learning, and adapting as a new normal unfolds. Systems and structures need to be incorporated to enable ongoing engagement and feedback loops for continuous learning and improvement.

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ABSTRACT

The trend for better use of data and technology in our urban environments has been gathering pace, but as 2020's global pandemic took hold, we saw new combinations of people, technology, and data enable innovative approaches to the crisis. The COVID-19 pandemic has encouraged us to rethink the future of cities. The increase in remote working has already affected office space, transportation patterns, and consumption habits, whilst the adoption of artificial intelligence (AI) and the increase in automation continues to reshape the way we live and work. Unsurprisingly, therefore, the idea of a future city is often related to the smart city concept.

The starting point of a smart city is frequently a technology-first approach that often neglects the role of active citizen participation and the need to put citizens' rights, values, needs, and aspirations at the core of planning future cities. Through the exploration of some of the key dimensions of the smart city, this paper argues that whilst cities have become the laboratory of smart technologies, we also need to start addressing how the social and spatial intelligence of cities has reacted to such technologies. Building on this, the paper elaborates on the concept of urban artificial intelligence as a form of collective intelligence in cities that can help move forward to rethink the idea of 'smart' in cities and their future development.

KEYWORDS
smart city; artificial intelligence; urban planning; design.

Chapter 21—Urbanizing Smart Cities: An Initial Approach to the Concept of Urban Artificial Intelligence

Laura Narvaez Zertuche

Cities play a pivotal role in both sustainable growth and human-focused digitalization. With over 50 per cent of the world's population residing in cities today, the United Nations projects this figure to rise to 75 per cent by 2050 (UN SDG Goal 11, 2021). Cities possess many of the elements vital to digital transformation, including innovation ecosystems, data, and digital infrastructure.

WHAT MAKES A CITY SMART?

By using digital technologies, cities can grow while preserving the environment and enhancing quality of life. It is believed that cities worldwide will benefit greatly from these advances as they contain vast amounts of data, computing power, and digital innovation ecosystems (Allam & Dhunny, 2019).

However, practitioners and experts increasingly believe that smart urban technologies can mark a major milestone in human history (Tomitsch & Haeusler, 2015). This technology-driven approach to resolving urban problems has led to the concept of 'intelligent cities', also known as 'smart cities' and 'geographies of disruption' (Yigitcanlar & Kamruzzaman, 2018, p. 51). These cities utilize digital technologies to bring about new possibilities, shape the urban landscape, and enhance the performance and quality of urban areas (Yigitcanlar & Inkinen, 2019).

The potential of smart city technologies is vast, from expanding infrastructure to creating new services, enhancing decision-making, and boosting the performances of businesses and cities. The most prominent smart city technologies include autonomous vehicles, the internet of things, virtual reality, digital twins, robotics, big data, blockchain, and artificial intelligence (AI). AI is considered the most transformative (King et al., 2017; Tegmark, 2017); while each of these technologies has played a crucial role in making our cities smarter, the integration of AI with these technologies has enormous potential to tackle the challenges of urbanization in cities.

With the growing interest in the application of AI for urban innovation, this article explores how urban technologies largely embedded in the development of AI intersect with the development of cities. Essentially, what is proposed as urban artificial intelligence is what AI brings to cities and what cities bring to the advancement of AI.

WHAT IS URBAN ARTIFICIAL INTELLIGENCE?

AI's positive impact on cities depends firstly on comprehending what AI is and what its current applications can achieve. The definition of 'artificial intelligence' remains a matter of debate among scholars. Some consider its origins to date back to a 1956 workshop held at Dartmouth College, where Marvin Minsky, John McCarthy, and other pioneers of the field predicted that machines could become as intelligent as humans and capable of performing various tasks. According to Anyoha (2017), AI refers to the effort by scientists to teach machines to learn on their own, essentially automating cognitive such processes as pattern recognition, language processing, and planning.

Notably, AI is not a singular technology but a collection of technical processes, most of which rely on machine learning (Bostrom, 2017). These processes involve incorporating data and learning algorithms in software models, with which decisions are made using probability-based interfaces and powered by advanced hardware. To further clarify, 'artificial' refers to the fact that this technology is man-made and not a result of natural processes (Cave et al., 2020), and 'intelligence' refers to the ability to acquire and apply knowledge and skills by learning in a particular environment (Bishop, 2006). This ultimately leads to autonomous decision-making, which can be considered as 'thinking' (Bostrom, 2017; Warwick & Shah, 2016).

The prevalence of AI has become ubiquitous in our modern world and appears in such various forms as Amazon's Alexa and internet-based recommendations. However, cities are more than just collections of technology; they are complex systems of human interactions, economic activities, and the innovations that result from them (Batty, 2009, 2018). The role of AI in urban development has until now primarily been in the development of the technology, but the true impact of AI in cities lies in its implementation in urban planning and design. This is where AI can make its greatest mark and where the concept of urban artificial intelligence emerges.

An extensive report by Hubert Beroche (2021) sought what urban artificial intelligence meant. Exploring 12 cities and with more than 130 actors involved (urbanai.fr), the research pioneered by Beroche's research sought answers to questions about how AI can help build sustainable cities and whether technology has had the effect of dissolving urban identities to some extent.

Stemming from Beroche's definition of urban AI as 'the crossroads between AI and the notion of Smart Cities' (ibid, 2021), this paper argues that urban artificial intelligence is also about thinking of cities in terms of embodying AI in their functionality and performativity, and how cities respond to the urban technologies invested in them. In other words, it is as much about artificial intelligence as it is about 'civic intelligence' in cities (Sassen, 2021; Openshaw & Openshaw, 1997).

URBAN ARTIFICIAL INTELLIGENCE AND THE SMART CITY: WHEN TECH BECOMES URBAN

By exploiting the potential benefits of AI, cities can improve the full range of services they provide to their citizens and organize them in a more transparent way. For example, the need to install additional sensors to generate data can

"By exploiting the potential benefits of AI cities can improve the full range of services they provide to their citizens and organize them in a more transparent way."

give cities the chance to optimize their infrastructure. The continual collection of data, combined with the potential to make monitoring systems more comprehensive and effective with AI, can make urban planning more efficient and more evidence-based as well as extending the lifetime of technical infrastructure. For designers and city planners, this involves looking at city planning not just two-dimensionally but three-dimensionally.

Although AI applications are often considered individually, they are frequently combined and integrated into smart systems within cities. As cities strive to become more intelligent, they seek to improve liveability and increase responsiveness (Colding et al., 2020). Data management plays a crucial role in the development of urban AI systems, and the most valuable source of data is people. Smart city initiatives should prioritize people over technology. Urban intelligence is not merely about incorporating digital technology in traditional infrastructure or optimizing city operations but also about using technology and data effectively to make informed decisions and enhance quality of life. This is what makes cities truly smart.

Quality of life encompasses various aspects from air quality to feeling safe when walking around. Real-time data enables agencies to monitor events as they happen, understand how demands are changing, and respond quickly and cost effectively. Smart cities augment the urban environment with digital intelligence to tackle public problems and enhance quality of life. Urban AI can be applied to smart city planning in three ways: technology based, with a critical mass of sensors and smartphones connected by fast communication networks; specific applications, through which technology providers and app developers offer urban digital technologies; and widespread adoption and behaviour change, in which cities, companies, and the public use applications that encourage practices such as using public transit during off-peak hours, changing routes, conserving energy, and promoting preventative self-care to reduce the burden on healthcare systems.

Thus, intelligent solutions aim to improve multiple aspects of the quality of life in cities. Today, a wide range of applications are already being used to help cities improve the services they provide to their populations. Several applications of urban AIs can be seen across a number of sectors in cities. Some examples, including but not limited to physical and social infrastructure, are listed below.

The key point about these diverse urban sectors is that urban AIs talk to each other as a response to the specific technologies applied to them. This is where tech begins to become urban (Figure 1). Urban AIs form a collective intelligence in which social innovations are as much needed as technological ones.

- Mobility sector includes intelligent traffic management, autonomous and electric vehicles, data-driven route choices, and public transit apps;
- Energy, water and waste management includes energy use optimization, water and waste tracking to local requirements, intelligent re-use materials and natural resources;
- Safety includes surveillance in public spaces, data-driven policing, optimized emergency response, and traffic safety;
- Financial services and telecommunications includes face recognition-based payment systems;
- Environmental footprint includes air-quality monitoring and climate and weather forecasts;
- Governance includes apps connecting the public to local government, apps that connect neighbourhoods, and census data management;
- Cost of living includes digitized land-use and permitting processes, dynamic electricity pricing and usage tracking;
- Employment includes data-driven education, digital administrative processes for start-ups/small businesses, and online retraining;
- Health and Wellbeing includes data-driven public health interventions and digital tools for better patient experiences.

Urban AIs are embedded in the layers that compose every city, and essentially what every smart city aims to achieve is a system that embodies the physical and digital infrastructure by retrofitting various city systems and networks with technologies that measure, count, record, and connect.

The challenge for smart cities is to make the technologies they deploy more responsive and more available to the people whose lives they affect. In recent times, the tendency is to make technologies almost invisible, or as urbanists would say, a 'seamless experience', instead of putting them in dialogue with their users. What is important is to start acknowledging that any smart city needs to be 'open sourced' (Sassen, 2012) as a new urbanism that resonates with what people make of the city.

WHAT CITIES CAN SAY ABOUT AI: REFLECTING ON THE SOCIAL AND SPATIAL INTELLIGENCE OF URBAN ENVIRONMENTS

The integration of artificial intelligence (AI) in urban digital technologies can bring enhanced efficiency and effectiveness to cities, facilitating their sustainable growth. AI can optimize processes and result in cost savings, but its improper use can also have detrimental effects. The goal of urban technology is to optimize the functioning of cities by promoting citizen engagement and innovation in the delivery of services and functions. AI can help cities become more sustainable and self-sufficient and allow the creation and management of sustainable urban environments.

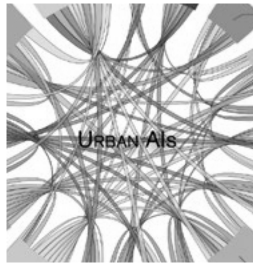

Figure 1 ► p. 293

However, the employment of urban digital technologies is not a panacea for all problems. There is a significant 'digital divide' between high-income and low-to-middle-income countries, with unequal access to essential services such as health, education, and transport (Yigitcanlar et al., 2020). Although 80 per cent of the population in developing countries own a mobile phone (GSMA, 2021), many people still do not have access to digital technologies. The increasing digitization of human activity generates large amounts of data, which is necessary for urban AI applications.

One of the greatest opportunities for urban AI is to integrate human ability into its solutions. For example, in agriculture, augmenting the capabilities of extension workers with AI can help support more farmers and improve productivity, according to the UN Food and Agriculture Organization (2021). However, successfully applying and innovating urban Ais requires a deep understanding of the problems and a study of them from the perspective of those in low-income countries. Additionally, attention must be paid to the physical and social responses of cities to AI and urban digital technologies, so that the 'smartness' of cities is urbanized, and the sense of urbanity is preserved for the future.

Urban technologies have the potential to deliver far-reaching impacts, such as those seen in developed nations. However, cities are not passive recipients of technology and can resist or respond in unexpected ways (Sassen, 2013). To effectively apply and innovate with AI in urban areas, we need to approach it as reverse innovation. This means gaining a thorough understanding of the problems first, viewing the issues from the perspective of those in lower-income countries, identifying the gaps where technology can help, and monitoring how cities respond physically and socially to AI and urban technology applications. This will enable us to improve and address challenges in creating smart cities while preserving the desired sense of urbanity for the future.

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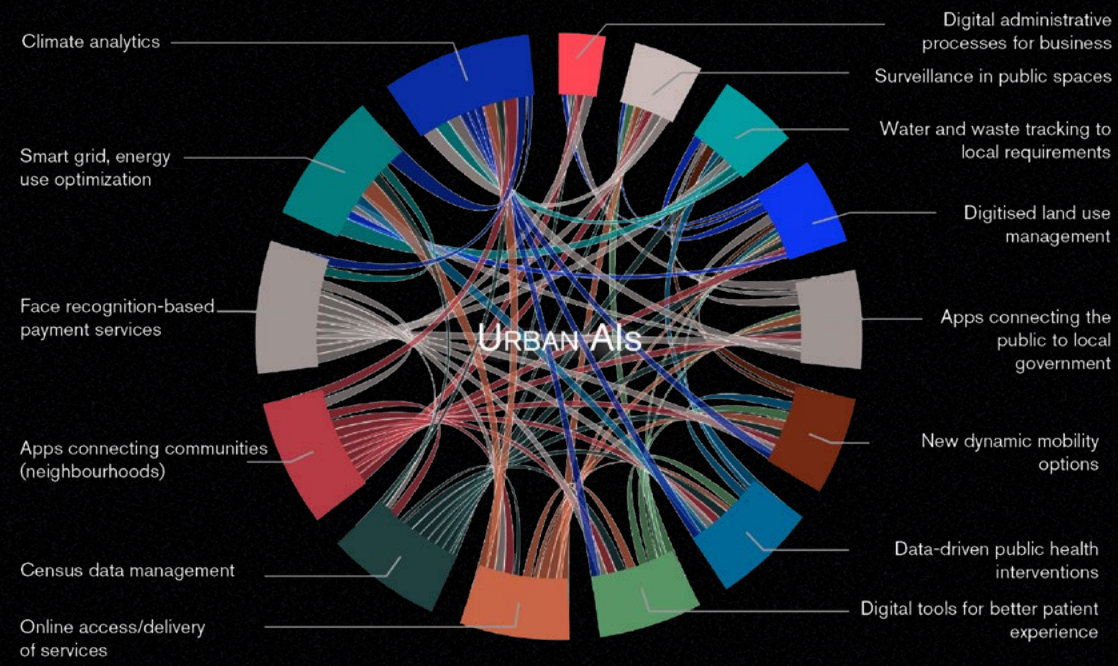

Figure 1
A taxonomy of urban artificial intelligences in cities as a process resulting from smart city planning (diagram by the author).

ABSTRACT

Cities are multidimensional, multiagent, and multiobjective artifacts with a complex, convoluted, and unexpected life hard to disentangle. Open and participatory approaches to city-making face the challenges of coordinating divergent opinions and agendas, informing all parties effectively, and avoiding manipulative legitimacy misappropriation. Computers can help in this endeavour to create more sustainable and resilient built environments. However, it involves issues of representability and accuracy, trust and accountability, and accessibility and applicability. Here, the aim is to combine the navigational capabilities of computer models with a sociotechnical focus on the complexity of cities and their dwellers embedded in the visionary thinking of architecture and urban planning to evoke alternative scenarios. These urban simulations can expand human capabilities and explore alternative sustainable and resilient futures of cities collaboratively. They can enhance participation by transparently and comprehensively informing us about the effects of our choices to help behavioural change. Instead of relying completely on machine automation, natural intelligence is complemented with machine intelligence to take account of the difficult-to-quantify factors of complex socio-technical systems in urban life. This chapter illustrates this future through three tales about reformulating the way we occupy, design, and use space at different scales, based on new realizations of urban digital twins not as deterministic predictors, but as exploratory and participatory tools.

KEYWORDS

urban digital twins; cities simulation; citizen participation; cities speculative design; design fiction; hybrid intelligence.

Chapter 22—A Tale of Three Cities: On Digital Twins

Javier Argota Sánchez-Vaquerizo and Adriana Zurera Gómez

We approach our cities in contradictory ways. On one hand, we aim to control, predict, and design them top-down (Gaffron et al., 2005). On the other hand, cities are complex entities (Portugali, 2000) in constant change whose functioning is extremely hard to grasp.

MOTIVATION

This means that they are ill-suited to traditional control approaches. Problems and conditions are always evolving with every single change or after a solution is provided. Understanding the manifold interactions between the built environment and its inhabitants requires powerful tools (Fink, 2018) beyond traditional practice and purely human skills.

Digital abundance (Hovestadt et al., 2017) enables the most recent iteration of incorporating computational tools for city-making: smart cities. However, their promise of hyper-efficient management of cities (Picon, 2015) falls short (Greenfield, 2013). They are mostly disconnected, ad hoc, utilitarian, and technical single-dimension optimization processes (Wilson, 2018) with very limited impact on the expected overall quality of life in our environment (Batty, 2020). They focus mainly on the 'high-frequency' city. Its changes we experience in real time, at the scale of seconds, minutes, days, and months (Batty, 2018; Wildfire, 2018), while disregarding longer-term planning. Simultaneously, the abundance of data and digital resources enhances participation and commoning processes (Cardullo & Kitchin, 2019; Mainka et al., 2016) that counterbalance top-down and technocratic visions for the production of cities (Lefebvre, 1974). But such a counterbalance cannot be taken for granted, as unbalanced power and information-sharing capabilities among parties may hinder the quality of this participation (Pateman, 1970).

Underlying both approaches is the inherent difficulty of grasping and measuring the components of urban life (De Nadai et al., 2016): from geometric and physical features of space to interactions and cognitive processes that are hard to quantify, as is the case with the qualitative aspects of any human-related system (Helbing et al., 2021).

This situation suggests a need to reformulate the role and scope of city planning (Cuthbert, 2006; Ratti & Claudel, 2015), as already anticipated by more open-ended dynamic, systemic, and participatory approaches such as those embedded within planning support systems (pSS) (Geertman & Stillwell, 2020). In contrast to the postulates of the end-of-history (Fukuyama, 1992) and end-of-science (Anderson, 2008; Carpo, 2014), which assume the steadiness of our world in combination with some sort of technological determinism (Lanier, 2013), the constant changes in our environmental conditions require permanent revision and adaptation. Crises cause our planned cities to come apart at the seams. Rigid functional planning proves to be segregating and detrimental to cities and leaves little room for change and adaptation (Jacobs, 1961; Mäntysalo, 2005; Verebes, 2014). Unsurprisingly, this shortcoming permeates everywhere in the built environment: homes are too inflexibly designed to cope with the changing needs of their dwellers, and streets are forced to cope with peak hour traffic while hindering any alternative or unplanned uses (Bereitschaft & Scheller, 2020; Southworth & Ben-Joseph, 1997). We barely give a chance to people to determine their own preferences and use these preferences for the benefit of spatial planning. Hence, we need to find ways of embedding adaptability and resilience in city-making processes by design.

Therefore, this text introduces three visions of how future policy and decision-making for city co-creation could use comprehensive urban simulations. More than for their predictive, deterministic power, in these visions, urban digital twins (Batty, 2018) are valuable because they enhance the collaborative exploration of 'what-if' scenarios (Dembski et al., 2020) that could inform more resilient and adaptable cities through unbounded multiobjective optimization (Deb, 2014). This means identifying alternatives that effectively consider several goals simultaneously. At different scales, components, and cycles, (Gaffron et al., 2005), three future cities are described where computational approaches and machine intelligence are merged with human preferences and skills to articulate new strategies of urban planning able to cope with the complex interplay of stakeholders' agencies involved (Quan et al., 2019) in an unpredictable and changing world. This means, altogether, more informed, more diverse, more uncertain, and more flexible cities existing after our time.

THE CITY OF UNBOUNDED STREETS

It is 8 am. In this city, the streets leading to transit stations, offices, and schools show a calm, packed, and incessant stream of vehicles of different shapes and sizes for those who are not working remotely today. They do not necessarily move fast (Gershenson & Helbing, 2015), but in an intertwined, satisfactory, and coordinated fashion, avoiding stop-and-go waves and making the most of the space available on streets. They leave just enough room for opposing traffic and pedestrians heading somewhere else while seamlessly merging with them when needed as converging flocks (Jiang et al., 2006).

At 10 am, as the morning hustle and bustle comes to an end, street life diversifies. Fewer vehicles are around, and they move differently and more unpredictably: some of them stop here and there to pick people up or to drop goods off. Small delivery vehicles squeeze between larger cars and people (Camara et al., 2020) to accomplish their last-mile service. A group of school students crosses the street and the traffic rapidly adapts, slows down, avoids them, and keeps running.

At 5 pm, kids play on the street after school while people enjoy some after-work gatherings in front of bars and restaurants. The vehicles of those who need to return home or go somewhere else sense the environment: they detect where the people are, anticipate their movements, and know how humans react in their presence to neither scare

Figure 1 →
The city is a result of the active, collaborative, and co-learning process between physical (in red) and virtual agents (in green) (visualization by the authors).

them away nor hamper traffic flow (Ackermann et al., 2019; Millard-Ball, 2018).

At 6 pm, there is enough space on the street for people to sit outside, grab some drinks, and meet family, friends, and strangers, for kids with their parents to take a walk, and for the evening traffic of people doing the last chores before dinner (Ruiz-Apilánez et al., 2017).

After midnight, the streets, mostly empty, show their real backbone. There is no signage, marking on the surface, or obvious sidewalks, just a flat, step-free (Meyboom, 2018) surface and some greenery, where traffic directions, lanes, and rights-of-way can be created, removed, adapted, and reversed on demand (Papageorgiou et al., 2021; Rieland, 2018). The streetscape becomes a whiteboard that adapts dynamically to diverse occupation patterns and uses at different moments of the day. There are no more fixed segregations between different uses and speeds throughout the day, and no more roadways oversized inefficiently only for peak times or for parking spaces (Norton, 2008). It results simply in a new social contract on the use of the public domain with different sensorial, behavioural, and semantic rules (Fernández-Abascal & Grau, 2019).

This city, its streets, and its 'inhabitants' have been simulated endless times before. Its artificial city dwellers can anticipate what humans are going to do. They leave room for people and find the best way of adapting their behaviour while leveraging efficient movement with perceived and measured safety. These prosthetic urban inhabitants have learned from simulations in virtual worlds how to be simultaneously efficient in their tasks of transport, assistance, and maintenance and to be social machines able to interact safely and usefully with humans (Bauer et al., 2009). In fact, humans in this city have simulated the interactions of heterogeneous groups of artificial and natural city dwellers using virtual environments as safe sandboxes (Fujii et al., 2017). These immersive simulations have captured the cognitive and emotional responses of people facing thousands of different situations (Dubey et al., 2016; Liu et al., 2017). It means that they have simulated, anticipated, and tested virtual worlds before implementing them for real. Even further, they have led people to change how they behave for more coordinated and efficient use of common resources (Theodorou et al., 2019). Each time an artificial city dweller, whether a full-size car, a bus, a small delivery vehicle, or a droid-like personal assistant, goes along a street, it senses its physical environment. Then, the artificial city dweller projects its physical environment into a full digital twin that simulates possible scenarios to anticipate the appropriate and safe behaviour that, ultimately, will apply in reality. And it repeats this procedure again and again, hundreds and thousands of times (Brooker & Van Patten, 2017).

THE CITY OF PRUNING STREETS

In this city, not every street is designed to make the circulation of vehicles easier, faster, and safer. When traffic jams happen, they do not build new roads (Duranton et al., 2011). They do just the opposite: they close roads or reduce the number of lanes. Over the years, the traffic in this city has not worsened, and the environmental quality of the streets has improved while making space for other activities and alternatives for mobility (Rueda, 2018).

People in this city rebelled against how things were decided before. First, they learned. They could not ignore the complex counterintuitive effects (Braess, 1969; Roughgarden, 2005) of planning decisions made by experts around the world (Cairns et al., 2002; Chung et al., 2012; Kolata, 1990, 25 December). Second, they changed citizens' roles. They were not satisfied with simply being consulted about predefined plans designed by experts (Jones et al., 2005). People wanted to be informed and participate, not be persuaded (Cardullo et al., 2019).

It took them some time to tune their city-making processes and combine

Figure 2 ▸ p. 306

Figure 3 ▸ p. 306

the understanding of urban complexity with people's desires and preferences to inform decisions in actionable, effective ways. Their planners became coordinators, facilitators, and systems designers and not mere makers of visionary prescriptions (Ratti & Claudel, 2015). They leveraged the knowledge and goals of the various people and organizations involved in the wicked problem of designing their city (Rittel & Webber, 1973) by expanding techniques of planning support systems (Geertman & Stillwell, 2020) into hybrid human-machine simulations (Licklider, 1960; Negroponte, 1970) with the support of artificial intelligence (Lock et al., 2021). They brought people into the loop. Everybody in this city can now experiment with their future simulated visions in such a way that they can reflect on and inform their opinions and images of their city (Lynch, 1960) and let the computer intelligence learn to help them.

Planning in this city is a serious game (Beirão, 2012; Dodig & Groat, 2019). Its citizens, developers, investors, and designers, among other stakeholders interact with highly accurate simulations of their environment in a safe sandbox. There, they explore alternatives, learn from the outcomes of their own actions, and sometimes adapt their opinions and preferences according to their experience (Burr et al., 2018). The use of artificial intelligence in this interactive decision-making system expands the capabilities of this city's inhabitants to know, share, negotiate, and agree (Engelbart, 1962). They can communicate their preferences, aggregate them with fellow citizens, update possible scenarios, and hybridize them to offer new alternatives. More importantly, this system allows people's opinions to be elaborated and coordinated in an actionable way. This framework is a collaborative development environment whose best versions are deployed for updating the real city as needed, as if it were an operating system (Marvin & Luque-Ayala, 2017).

In this creative generative loop, people experience and experiment through simulations of their desired city while the computer intelligence learns from them and helps to coordinate these human preferences in actionable ways to configure the new city (Koenig et al., 2018). In a sense, it is much closer to a continuous, augmented, collaborative, and AI-mediated, even generative, dev-ops scheme with many humans-in-the-loop (Chirkin & Koenig, 2016; Scott et al., 2002; Veloso & Krishnamurti, 2021). This city's people have replaced their previous rigid and static planning with new dynamic city operations based on hundreds of cities simulated and wished for by humans in almost real time. Nowadays, they can adapt to the very rapidly changing conditions of their world, hit by overheated extreme weather and unstable ecosystems. What is more impressive, they can maximize their strategies with minimal intervention. They get more done by doing less.

THE CITY OF REMOTE(D) STREETS

Alex and Lynn moved with their children 3 hours' journey away from the city. They still keep the same jobs that they had when they met for the first time, by chance in a hyped cafe in the city centre. Now, with a family, they have other needs: additional expenses, a bigger house to maintain, and more time together. The possibility of working remotely and visiting the headquarters of their employers once or twice a month allows them to live outside the city and use the train for the occasional 3-hour commute. Now, they can spend more time at home, spend less money on transport, and revitalize a sparsely populated area far from the dynamic urban centres (Johnson, 2003; Zenkteler et al., 2019).

Meanwhile, in the city centre, the original large headquarters, over 47,000 square metres, of Lynn's employer, a finance company, was built to cope with its rapid growth. Now, it is a constantly reconfigurable architecture (Steen-

“There are alternative futures to be explored in this conversational relationship with virtual versions of our environment.”

Figure 4 ▸ p. 307

son, 2017) comprising small offices and rooms to rent by the hour for local workers and occasional commuters, apartments with transparent views over the city's roofs, hydroponic farms, gardens on the rooftop, stores, and restaurants. And space is still available for any unexpected need that might arise in the area (Schneebeli, 2021).

The dwellers of this city have very different needs, ways of thinking, and modes of behaviour now from when this massive headquarters building was opened. They adapted their lifestyle following several public health shocks, economic crises, increasing energy costs, and various aspects of deprivation that led to restrictions on daily habits (Bradley & Altizer, 2007; Dobkowski & Wallimann, 2002; Meadows et al., 1972). Separating working from living no longer makes sense for many of them. Neither is it sustainable nor even the most resilient alternative (Belzunegui-Eraso & Erro-Garcés, 2020). They can contact anybody and retrieve any information from anywhere. They can project themselves and meet remotely in virtual environments (Townsend, 2013). They still move, meet, and travel (De Abreu e Silva & Melo, 2018; Zahavi, 1974), but they prioritize when and where to move. They live in hybrid cities, distributed physically but united and connected via the digital realm (Lim et al., 2022). Their focus is not solely or even mainly on productivity and efficiency but on care and well-being (Amann Alcocer, 2005; Dominoni & Scullica, 2022). This new focus does not mean neglecting physical reality (Geraci, 2010) but prioritizing how to make better use of its resources.

Living in the centre of the large city does not pay off for many of them. What is valuable is being able to access it physically or virtually as needed. Concurrently, the city becomes more accessible for those who need or decide to stay. It dissolves the concentration and rise in costs of services, resources, and housing (Bettencourt et al., 2007). Technology and the freedom to be remotely present counterbalance the distance rule. The former infrastructure and buildings designed for crowds needed to be repurposed like Lynn's employer's headquarters, giving more room for larger, more flexible, and more affordable spaces for housing and changing activities (Pask, 1969). Rather than large central facilities, people prefer a distributed, flexible network of small units for working, shopping, gathering, and leisure close to their homes (Camocini, 2011; Garavaglia, 2020; Moreno et al., 2021; Zenkteler et al., 2019).

This city's inhabitants plan and design it very differently than they used to. They have transformed a modernist, segregated, and functional territory. They have taken into consideration these pre-existing facilities, buildings, and infrastructures and retrofitted this construction stock to the new demands of fragmented spatiotemporal habits. To avoid pushing suburbia even further (Nilles, 1991) across every hinterland around the world (Brenner & Schmid, 2012), they decide on policies and urban strategies with a dynamic model (Acheampong & Silva, 2015; White et al., 2015) fed by data gathered continuously from the inhabitants' preferences and needs for transportation, the affordability of the environment, available floor space, economic flows, and so on. The citizens influence the model that is designed to raise awareness about, and then avoid, inequalities and inefficiencies from social, energetic, economic, spatial, and environmental perspectives.

DISCLAIMER FOR AN UNCERTAIN POSSIBILISTIC FUTURE

The future is hard to predict. Most likely, it will be different from any of these tales. Some of the elements will resonate in future cities, but in different ways and with different interactions and implementations. Each of these new technologies will have effects on culture, society, and ultimately the environment that are hard to anticipate (Berkhout & Hertin, 2004; Gao et al., 2014). Some of them will be undesirable too. They are not complete visions either, as they do not lay out every detail. Nevertheless, all of these visions agree on the importance of the exploration of 'what-if' scenarios as planning tools to envision more resilient cities supported by conversations and discovery processes with computer intelligence. These approaches match architecture and urban planning aims to change the way we think about how things work and how things could be in alternative scenarios rather than how they are now (Doucet & Cupers, 2009; Simon, 1969). There are alternative futures to be explored in this conversational relationship with virtual versions of our environment (Pask, 1976) beyond purely physical-digital interactive feedback for management (Fuller et al., 2020), endless detailed 1:1 mirrors (Borges, 1946), solely data-driven approaches (Arcaute et al., 2021; van Dijck, 2014), and transhumanist escapes from the physical realm (Kye et al., 2021).

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Figure 2
*The streetscape is a tabula rasa (blank canvas) whose digital layer enables simultaneous uses and interactions learned from digital mirrors of the environment (**visualization** by the authors).*

Figure 3
*Physically distributed, virtually connected (**visualization** by the authors).*

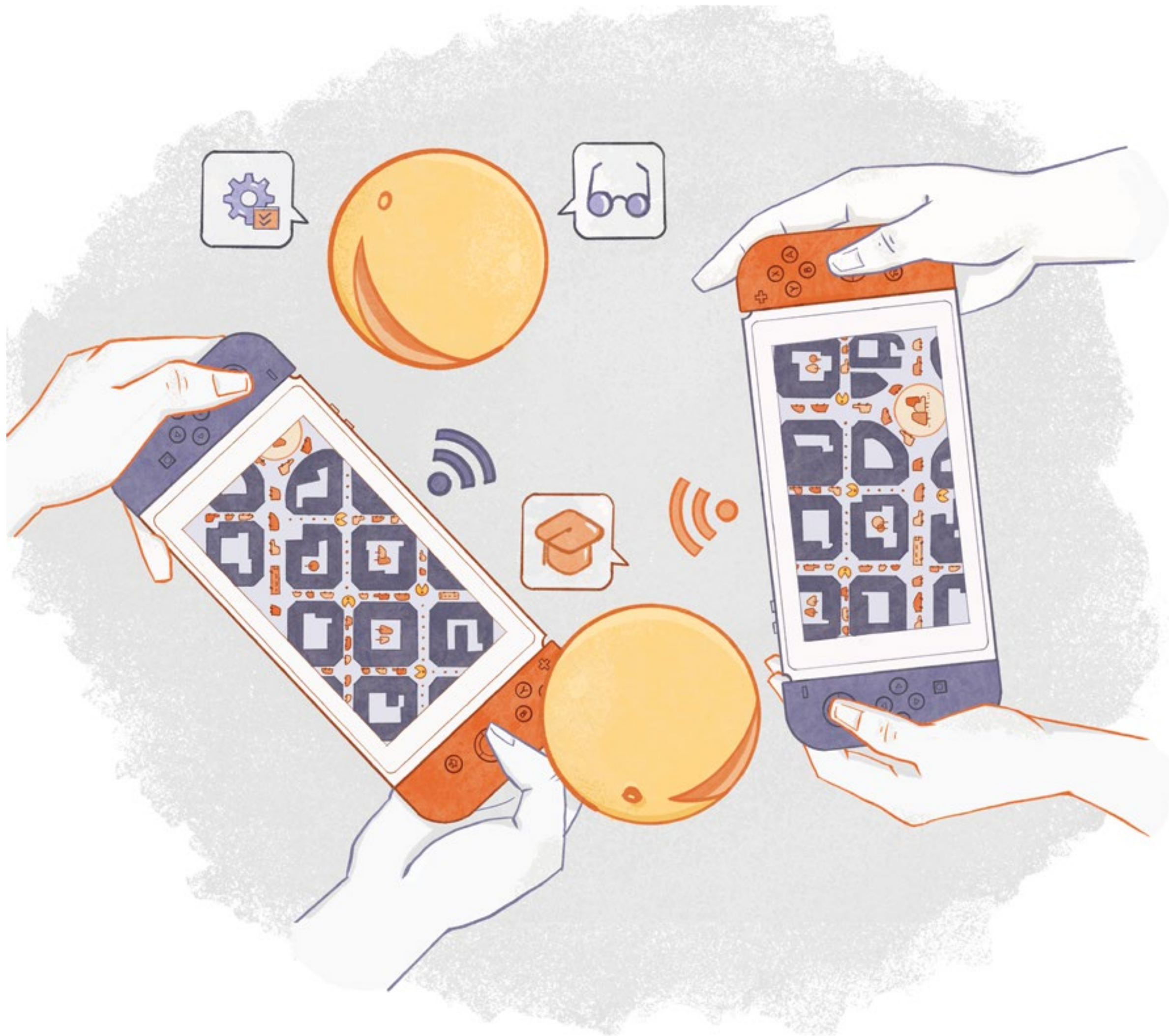

Figure 4
*Computer intelligence pairs with people and enhances communication and coordination (**visualization** by the authors).*

ABSTRACT

As new carbon regulation and changes to urban policy and planning practices target the embodied carbon of building projects, architecture, engineering, and construction (AEC) professionals require better tools for keeping track of and reducing carbon emissions during design processes. It is the thesis of this chapter that the concept of carbon budgets can serve as a helpful design tool for supporting AEC professionals and teams in diminishing the carbon footprint of buildings. The chapter deals with how to apply carbon budgets to processes of building design through an allocation of overall targets for individual buildings to building layers based on available benchmark data. The possibilities and challenges to this approach to carbon budgeting is discussed with the case of an early-stage design project from the office of 3XN and GXN.

KEYWORDS
architecture; building design; decarbonization; carbon budget; construction.

Chapter 23—Balancing the Carbon Budget: Applying Carbon Budgeting to Architectural Design

Kåre Stokholm Poulsgaard, Ann-Britt Vejlgaard, and Lasse Lind

The Earth's atmosphere comprises a thin layer of gases extending from the surface of the planet to the edge of space. The Earth is a sphere roughly 12,000 kilometres in diameter, but the planet's atmosphere is less than 100 kilometres deep. This thin layer is unique in the solar system and plays an indispensable role in sustaining life on Earth.

INTRODUCTION: BALANCING ACT

It provides living beings with oxygen, it protects us from solar radiation, and it maintains the barometric pressure necessary for water to stay liquid on the planet, amongst a host of other desirable features.

The concentration of gases such as oxygen, carbon dioxide, nitrogen, and methane in the atmosphere plays a critical role in regulating global temperatures and the Earth's climatic systems (Baede et al., 2001). For the past 10,000 years of Earth's history, these climatic systems have been remarkably stable, with a global average mean temperature of around 14 degrees Celsius (NOAA, 2021). This 10,000-year period is dubbed the holocene epoch by the International Commission on Stratigraphy (ICS), the geological organization dealing with sedimentation of rocks and the aging and naming of Earth's eons, eras, periods, and epochs.

On the timescale of global evolution, the holocene is but a tiny blip in a much longer 4.5 billion-year history, but this tiny blip, with its stable atmosphere and climatic conditions, has supported the explosion in human life, culture, and prosperity. However, the headline news for the holocene is that the delicate atmospheric balancing act that has supported this nurturing stability is undergoing dramatic changes.

The human species has become a force for global change. Our 10,000-year holocene run of relatively stable temperatures and climates is coming to an end, and the ICS (Syvitski et al., 2020) suggest that we have entered a new ep-

“We expect that project-specific carbon targets will soon be imposed from a variety of sources, both regulatory and market driven and become a matter of fact.”

och, the anthropocene, or the age of man (Crutzen & Stoermer, 2000).

Currently, we are putting more than 55 gigatons of CO_2 into the very thin atmospheric layer surrounding our planet every year (IPCC, 2022, p. 4), with cities accounting for up to 72% of these emissions (IPCC, 2022, p. 8). The scientific consensus is unambiguous (IPCC, 2021): the total of these anthropogenic CO_2 is upending the delicate balance of our protective atmosphere. The recent Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2022) concluded without a sliver of doubt that these anthropogenic CO_2 emissions and other greenhouse gases are causing widespread and accelerating global warming with vast consequences for our climate and planetary support systems; the accelerating accumulation of greenhouse gases in the atmosphere is causing the world to warm as global emissions continue to grow year on year (ibid.).

OUR GLOBAL CARBON BUDGET

Climate scientists continuously model how much greenhouse gases, such as carbon dioxide, we are emitting into the atmosphere and how these emissions will change global temperatures, weather, and climate systems.

This climate modelling is at the core of the concept of carbon budgets used by the IPCC and others (Rogelj et al., 2018). Climate models show likely changes to the atmosphere based on specific greenhouse gas emissions, and the carbon budget is a way to quantify how many more greenhouse gases we can emit if we want to stay within certain atmospheric and climatic boundaries.

During the last 50 years, our emissions of greenhouse gases into the atmosphere have changed the concentration of CO_2 from 350 parts per million (ppm) to more than 400 ppm, and we are rapidly heading beyond that (Jones, 2017). As the latest IPCC (2022) Assessment Report concluded, the higher the concentration of CO_2, the higher the global warming above pre-industrial levels, and the more dramatic its adverse effects. The one piece of good news in the IPCC report is that there is a solidifying scientific consensus that if we can halt emissions, we will also most likely be able to halt the rise in temperatures.

With this in mind, the question we now face as architecture, engineering, and construction (AEC) industry professionals and researchers can be put quite bluntly: how much more CO_2 are we planning to put into the atmosphere, and at what cost?

This is where the carbon budget comes in. The carbon budget works on a global scale, and current estimates by climate scientists suggest that if we want to maintain a 50 per cent chance of avoiding temperature rises of more than 1.5 degrees Celsius above pre-industrial levels, which is the target set out in the Paris Agreement (United Nations, 2015), we have a carbon budget of around 500 gigatons of CO_2 emissions left (IPCC, 2022, p. 5). As we are currently releasing some 53–65 gigatons of CO_2 a year, we are down to less than 10 years of business as usual before we lock in at least 1.5 degrees of warming (IPCC, 2022, p. 4).

We have less than 10 years to radically change our ways in all areas of society if we want to retain any hope of staying within the Paris Agreement targets. Cities are on the frontlines of this immense global challenge. Not only did cities emit 29 gigatons of CO_2 in 2020 (IPCC, 2022, p. 8), but they are also battered by some of the worst effects of climate change, including severe flooding, deadly heat waves, crippling droughts, and uncontrollable wildfires (Short, 2021).

The decisions we make today as AEC professionals and researchers have profound consequences for the future of our cities as well as for the future of our atmosphere and planet. Although the immensity of the challenge is astounding, the lessons of the COVID-19 pandemic and the temporary 8.8 per cent drop in global emissions resulting from governments and people imposing wide-reaching lockdown procedures during 2020

(Liu et al., 2020) indicates that societies can mobilize at the scale necessary to reduce emissions significantly.

CARBON BUDGETS FOR BUILDING PROJECTS

It is the thesis of this chapter that the concept of carbon budgets can serve as a helpful design tool for supporting AEC professionals and teams in bringing down the carbon footprint of buildings. This thesis is based on an approach developed across several recent projects undertaken by GXN in collaboration with 3XN and a wider team of consultants and collaborators.

For carbon budgets to become applicable for ongoing design projects, they must be adapted from the planetary scale to the building scale. According to current research into carbon budgets for the built environment (Lützkendorf, 2020; Habert et al., 2020), this involves defining a method for disaggregating the global carbon budget to the scale of individual buildings and an accounting principle for determining how much carbon can realistically and fairly be emitted by an activity such as construction (Habert et al., 2020). Through these measures, specific budgets for individual buildings can be defined by working from the global to the local scale (e.g., Priore et al., 2021; Steining et al., 2020; Brejnrod et al., 2017).

However, the present chapter is not concerned with the important and difficult issue of how to translate absolute limits across global, sectoral, and building scales to establish absolute limits for individual building projects. Instead, the chapter deals with how to apply carbon budgets to processes of building design once these limits are set, whether by disaggregation of scientifically agreed boundaries (Brejnrod et al., 2017), global agreements (United Nations, 2015), national regulation (Danish Government, 2021), urban policy (GLA, 2018), or the sustainability briefs of specific clients or projects.

The approach to carbon budgets advanced here seeks to turn any building-specific carbon target into a workable budget that can guide design development and decision-making for project teams to allow them to lower project-specific carbon emissions during design phases.

SETTING UP THE BUDGET

This approach to carbon budgeting for building design has recently been applied by GXN during early-stage design of an 80,000 m² tower project with high aspirations to sustainability and carbon reduction. To address these aspirations, GXN worked with the construction client and the design architect 3XN to set overall upfront targets for carbon emitted by the project (lifecycle stages A1–A5).

These targets were defined considering the building typology in question, in this case a tall building and office development, and by specific expectations from the client in their sustainability brief. Targets were then cross-referenced with current industry best practices and benchmarks as advanced by carbon design guidance (LETI, 2020).

This assessment set a total upfront carbon target of 600 kg/CO_2e/m² was set for the project.[1] To determine the viability of this target in relation to building typology and use, GXN carried out an early assessment of the upfront carbon impact of the design advanced by 3XN during the concept design phase. This showed that the target was highly aspirational considering the proposed massing, yet appropriate when considering reduction opportunities afforded by known reduction strategies and the general ambitions for driving down the CO_2 footprint of the development.

Having settled on the target of 600 kg/CO_2e/m² for A1-A5, the wider team now had an overall numerical indication of the ambitions for the project. However, although helpful as an informed indicator for overall project ambitions, this number did not offer much guidance on how to achieve emissions savings in daily design, detailing, and specification during concept and schematic design.

1 This metric describes the estimated weight of carbon dioxide equivalent emitted per square metre per year and is emerging as a shared reporting format in the built environment.

The 600 Kg/CO_2e/m² target had to be further disaggregated into sub-targets for building elements to help the project team develop and apply reduction strategies within their areas of responsibility. In addition, this process would have to allow team members to measure their progress continuously.

To develop the target of 600 kg/CO_2e/m² for the whole building into something more workable for day-to-day practice in a distributed team, GXN divided the total allowance into a carbon budget for individual building layers. With notable exceptions (Röck et al., 2022; LETI, 2020; Röck et al., 2020), few benchmarks exist that break down total building emissions into building typologies. The London Energy Transition Initiative's embodied carbon benchmark for commercial offices (LETI, 2020, p. 30) was applied to divide the target for upfront embodied carbon across five building layers: superstructure, substructure, internal finishes, façade, and machine electrical and plumbing (MEP) (Figure 1).

Following this allocation of the overall carbon target into a distributed budget for building layers, a life cycle assessment (LCA) model was then developed for the building and scoped according to local guidance and future planning requirements. With the budget allocated for individual building layers and the assessment methodology and criteria agreed on across these, GXN could manage the budget for the full project team, thereby allowing individual project disciplines to feed information into the assessment for the building elements covered by their scope of work.

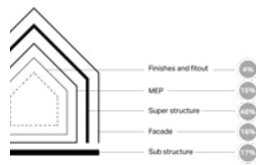

Figure 1 ► p. 317

DISCUSSION: USING THE CARBON BUDGET TO INFORM DESIGN

Disruption is occurring in the AEC industry as it begins a long overdue course correction with respect to operational and especially embodied carbon emitted into the atmosphere by construction projects. Regulatory and policy changes are rapidly reshaping the conditions for the industry, for example through new Danish regulation enshrining carbon limits for building projects from 2023 (Danish Government, 2021), Amsterdam's roadmap for 55 per cent reduction of city-wide carbon emissions by 2030 (City of Amsterdam, 2020), and the new London Plan's requirement for net zero developments (GLA, 2018). Meanwhile, the EU Taxonomy for Sustainable Investments is promising to reshape project financing with new demands for transparency and reduction in carbon emissions (EU, 2021).

Despite these ongoing changes, AEC professionals lack practical tools for estimating and reducing carbon emissions during day-to-day design practice, and few of these professionals have a clear overview of the field of action relating to their disciplines (Habert et al., 2020). The project-specific version of carbon budgeting advanced here proposes a tool for combining and expanding the expertise of diverse professionals on carbon reduction to guide design development and decision-making within teams. Specifically, it enables the disaggregation of project-wide carbon targets into individual building layers by typology-specific benchmarks, which enables individual professionals to develop and test strategies for their areas of work and to continuously compare their results with both disaggregated and overall carbon targets.

In the case discussed above, the distribution of the budget across five building layers provided the team with an overview of where high-impact materials were generally used in the building design. GXN and the team used this benchmark overview to conduct an early LCA of the carbon impacts of the design, applying reference values from benchmark data where limited detail in the design restricted quantification of actual impacts. As can be seen from the populated budget (Figure 1), superstructure, façade, and MEP all scored higher than their allocated budgets, and so became the design team's first targets for reduction strategies.

For all these building layers, variation studies were conducted at component level to test various design choices and materials and help inform decision-making. For example, a variation study was conducted to test potential emissions from structural systems in the superstructure. The analysis showed that a smaller structural grid could produce significant reductions in the carbon emissions. Similar studies were conducted for various types of façade cladding materials and build-ups and for the material intensity of various MEP systems. The results of these LCA studies were utilized to populate iterations of the project's carbon budget and thus inform design decisions that helped bring environmental performance of particular layers closer to their targets.

CURRENT CHALLENGES: HOW TO BALANCE THE BUILDING CARBON BUDGET

The efficiency of the carbon budgeting approach discussed here rests on the availability and accuracy of adequate benchmark data. This data is vital in allocating emission targets to individual building layers and in testing the viability of disaggregated targets against current industry standards. The overall disaggregation of total building targets into individual building layers critically frames the work of the project team and enables individual consultants and disciplines to engage with carbon reduction in their areas of expertise and responsibility. This allocation effectively sets the targets for each discipline, if the targets do not adequately reflect the carbon allocation for both building typology and function, the work of the team may suffer Although some benchmarks exist that are helpful for allocating budgets and critically reviewing targets (Röck et al., 2020, 2022; LETI, 2020), the industry requires ever more granular benchmarks to inform ongoing design work. Crucially, these must be continuously updated as projects become more efficient and baselines move.

For the project discussed above, a more granular breakdown of carbon targets allowed focused design interventions by the project team in building layers that exceeded their budget allocations. This helped guide early work to improve reduction strategies by foregrounding high-impact decision areas during concept and schematic design phases. Crucially, this was informed by the expertise of all relevant project disciplines, who were actively involved in the budgeting exercise to ensure that the environmental impacts of the building design were in line with targets defined for their areas of expertise and focus. More granularity in the benchmark data would allow further disaggregation of carbon targets across building layers and components, which would provide both further insight into where to focus reduction strategies and data against which to evaluate the efficiency of such strategies.

Another key challenge at present is the temporal aspect of benchmarks. We are missing benchmark data on the development of carbon emissions assessed throughout the design and detailing process; such data would aid understanding of how accurately early LCA results indicate the performance of the finished building.

Continuous LCA and benchmarking against targets are key to integrating carbon budgeting into the design process. Managing team and client expectations is a challenge as LCA results develop and likely grow as more detailing is added to the architectural models. From ongoing projects, we have seen a tendency for the calculated carbon impacts to increase as the level of detail in a design increases. To account for this increase, a level of contingency can be added to the calculations in the early stages of the assessment model. This contingency should reflect the degree of uncertainty in the model at early design stages and would naturally be defined by temporal benchmark data. However, the amount of temporal data that would enable close definition of realistic contingencies is currently lacking.

CONCLUSION

AEC professionals require practical tools for keeping track of and reducing carbon emissions during day-to-day design practice. This chapter has outlined first steps in a pragmatic approach to carbon budgeting for early architectural design. Although inspired by wider discussions about the global carbon budget and how to disaggregate it into viable targets for sectors and individual buildings, the approach presented here is agnostic with respect to how project-specific carbon targets are derived. We expect that project-specific carbon targets will soon be imposed from a variety of sources, both regulatory and market driven and become a matter of fact.

The budgeting approach outlined here seeks to divide an overall numerical carbon target for a specific building into targets for individual building layers by utilizing benchmark data. We discuss the utility of the resulting carbon budget for combining the expertise of multiple professionals for carbon reduction in day-to-day design development and decision-making. This approach has shown promise in several recent GXN cases, one of which we discuss in this chapter. Further development is required to formalize the approach and establish efficient workflows for aligning the requirements of carbon transparency with existing team-based design processes.

Better benchmarks and temporal data are also required to qualify goal setting and allocation across all phases of architectural design projects as they develop over time.

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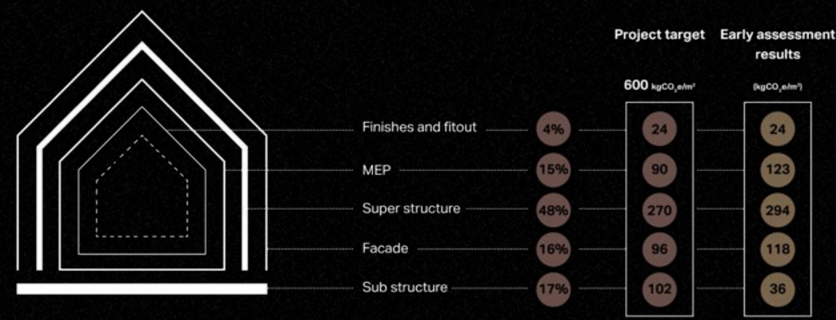
Figure 1
Subdivision of overall building carbon target into five building layers utilizing available benchmark data (LETI, 2020), early LCA of building design across individual building layers. Superstructure, façade, and MEP all scored higher than their allocated budgets. Substructure scored significantly lower as large parts of an existing building's substructure were retained and reused on site (diagram by the authors).



ABSTRACT

The latest generation of timber products enable complete multi storey neighbourhoods to be built from sustainably sourced softwood.

This chapter explores how a large-scale transition to timber building in urban environments could contribute to solving the three major global crises we are currently facing with climate, natural resources, and health. If key external determinants are used to set the right preconditions, by 2030, the combined forestry and construction sectors in Europe could mitigate 23 per cent of greenhouse gas emissions and provide sufficient timber to sustainably meet housing demand in Europe while contributing significantly to the well-being of urban citizens.

KEYWORDS

mass timber; biobased building; climate; circularity; health and well-being.

Chapter 24—The Potential of Mass Timber Building for Future-Proof Cities

Pablo van der Lugt

The pivotal role that cities play in relation to the mental and physical health and well-being of their inhabitants has become extremely clear from the COVID-19 pandemic. Meanwhile, cities also play a crucial role in meeting global climate and circularity goals.

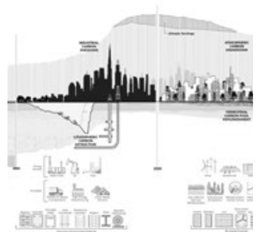


Figure 1 ► p. 328

FUTURE CITIES: A HEALTH, CLIMATE AND RESOURCE CHALLENGE

Because of increased urbanization, about 68 per cent of the global population will live in cities by 2050 (UN DESA, 2018), which emphasizes the need to develop diversely planned, multifunctional, and nature-inclusive cities. Building with regenerative, biobased materials, particularly mass timber, could help to shape our future cities in a healthy, climate-proof, and circular manner.

HOW BIOBASED MATERIALS COULD HELP SHAPE FUTURE CITIES

In the Middle Ages, renewable materials such as timber, reed, and straw were the predominant building materials. During the Industrial Revolution, these were largely substituted by minerals and metals due to their high level of industrialization and consistent and superior performance. However, they are responsible for a considerable proportion of the global carbon footprint, currently accounting for about 11 per cent of total global greenhouse gas emissions (GABC, 2019).

Consequently, increased urban development will become a threat to sustainable resource management and climate ambitions when largely executed in non-renewable, abiotic materials such as concrete, brick, and steel. A viable alternative is provided by mass timber: large industrially engineered timber products made from strength-graded softwood, such as cross-laminated timber (CLT), glue-laminated timber (glulam), and laminated veneer lumber (LVL). Because of their very consistent and high performance, these can directly substitute abiotic materials in the bearing structure of buildings up to twenty storeys high.

Because of their low weight and good workability, mass timber construction systems are very suitable for prefabrication, including adding storeys on top of existing buildings. When executed well, this results in significantly fewer transport movements and very quick installation on site, with lower emissions and less disturbance to the surroundings.

Moreover, an increasing body of evidence shows that visible application of natural materials in the built environment has a positive impact on the health and well-being of the occupants (Suttie, 2019). This is very relevant to the mental health issues that have arisen from the lockdowns during the COVID crisis, particularly in high-density urban areas.

THE POTENTIAL IMPACT OF TIMBER BUILDING ON FUTURE CITIES

HEALTH AND WELL-BEING

Trees and other vegetation are known to have a positive impact on various social, physical, and mental aspects of well-being in the urban environment (Elmqvist et al., 2019). For example, urban vegetation and greenery can have a positive effect on social cohesion in neighbourhoods (De Vries et al., 2013), significantly lower the heat-island effect in cities (Steeneveld et al., 2011), and improve air quality by filtering pollutants from the air (Hartig et al., 2014). However, their positive effect on the health and well-being of the inhabitants, such as better concentration and lower stress levels (Hartig et al., 2014), may prove especially crucial. Currently, this is particularly relevant for high-density urban areas with a high incidence of physical and mental illnesses such as anxiety, depression, and stress as a result of the COVID crisis and the related lockdowns.

THE HEALTH EFFECT OF TIMBER BUILDINGS

It is generally known that exposed timber is a hygroscopic material that creates a comfortable indoor climate by absorbing or releasing moisture depending on the indoor humidity. Furthermore, several studies have shown that the visible use of timber in buildings fits very well with the principles of biophilic design.[1] This philosophy suggests that mankind has a natural tendency to connect to nature. When applied to the built environment, this approach can contribute to healthier buildings through visible natural elements and increased exposure to daylight and water (Grinde & Patil, 2009).

The visibility of timber and other biobased materials is suggested to lead to lower stress levels, increased mental and physical well-being, higher productivity, and lower absence levels. This offers clear advantages in office, educational, and health care environments. For example, it may lead to quicker recovery rates in health care situations (Fell, 2010). In the study 'School Without Stress' (Kelz et al., 2011), students in a timber-furnished classroom showed lower stress levels and heart rates (8,600 beats less per day) than the control classroom featuring plastered walls.

The same biophilic design rationale raises the expectation that visible timber in outdoor urban environments will have a similar positive impact; additional research is required to validate this hypothesis. Together with greening the city, this should help to achieve more nature-inclusive urban environments, which may well have a beneficial impact on the mental and physical health of their inhabitants.

CLIMATE

We are quickly spending the carbon budget we have if we are to stay within the 1.5°C cap of the Paris Agreement. In the Netherlands, for example, this budget will be spent by 2029 (DGBC, 2021). The building industry is a major factor, responsible for 39 per cent of global anthropogenic greenhouse gas emissions, of which about one-third is directly related to materials production (GABC, 2019).

Climate change can be mitigated through sustainable forest management and timber building through three levers.

Carbon stored in sustainably managed forests

Global forests play an important role in the carbon cycle: negatively through deforestation, particularly in tropical areas and mainly driven by land conversion for cattle pasture and large-scale agriculture; and positively through reforestation and afforestation, particularly in temperate regions. During growth, trees absorb CO_2 from the atmosphere and convert

Figure 2 ▸ p. 330

1
An excellent overview is provided by Suttie (2019)

it by photosynthesis to oxygen and glucose, from which the wood grows and forms cellulose and lignin. Oven-dry wood consists of about 50 per cent biogenic carbon. European forests are predominantly under sustainable management, and their total area is growing each year, which makes them a net CO_2 sink that reduces CO_2 emissions in the EU annually by about 10 per cent, which is 435 Mt CO_2/year (Nabuurs et al., 2015).

Carbon stored in timber buildings

When wood is used for biomass energy production, the biogenic carbon it stores is released by incineration as CO_2. However, when wood is turned into high-value construction products such as mass timber, the biogenic carbon remains stored in the built environment. The amount of carbon stored in a timber building, also known as construction-stored carbon (CSC), is relatively easy to calculate following European norm EN 16449 when the wood species and the quantity of timber used are known (Climate Cleanup, 2021). Through circular design practices and 'cascading' (see below), mass timber elements can be reused multiple times. This locks in the biogenic carbon for even longer across consecutive useful lives, potentially well beyond the hundred-year time limit defined by the Intergovernmental Panel on Climate Change (IPCC).

Carbon savings in timber buildings through substitution

When mass timber replaces carbon-intensive abiotic building materials such as concrete and steel, 2.2 tons of CO_2 emissions are avoided per ton of timber applied (Leskinen et al., 2013). Combined, the CSC and the CO_2 emissions avoided can lead to significant carbon savings in multistorey buildings. Thus, a large-scale transition to timber construction in cities worldwide could lead to very significant climate benefits. Churkina et al. (2020) estimated that in a radical 90 per cent timber construction scenario in 2050, the total benefit could total 111 Gt CO_2, which is a significant proportion of the 400 Gt CO_2 budget within the 1.5°C cap.

Additional carbon benefits through densification

Besides these three levers, the lightness of mass timber buildings, approximately five times lighter than concrete, provides various possibilities for densification, such as in topping up, refurbishment, and floating constructions, and increased flexibility, such as allowing open-building floor plans. This is important, because denser cities have a considerably smaller carbon footprint and higher productivity (IRP & UNEP, 2018).

RESOURCES

The increasing scarcity of natural resources worldwide (e.g., various metals are expected to be depleted within decades) together with the expected doubling in materials use by 2050 (from 92.1 Gt to 177 Gt in 2050, with 44 per cent related to the built environment[2]) means that transitioning to a more circular economy is crucial. However, only 9 per cent of resources are being recycled or downcycled, revealing an immense 'circularity gap' (Circle Economy, 2019). This will particularly affect urban areas, which are expected to grow by 60 per cent by 2050 (UNEP, 2013).

Although priority selection of circular strategies following the R-ladder (refuse, rethink & reduce, redesign, reuse, repair, recycle, and recover) is desirable for any material, mass timber has several distinct advantages.

First, mass timber buildings are very suitable for design-for-disassembly approaches, using dry, reversible connections in contrast to wet approaches such as casting concrete. Thus, mass timber elements such as CLT panels and glulam beams used in an indoor environment retain their technical quality and keep their value. If designed well, they can easily be reused in second or third or even fourth high-value lives. Only after that does it

2
The largest task for the building industry lies in fast-developing economies such as China, India, Africa, and South America. For example, by 2015, the building stock in China was already double the size of that in Europe, and it is expected to be five times higher by 2050: 562 Gt versus 107 Gt of raw materials. Of this quantity, more than half (323 Gt) still has to be built (Circle Economy, 2019).

make sense to chip the mass timber elements to produce panel products and finally incinerate the material for bio-energy production, or better, use it for biochar or biochemistry purposes. With this 'cascading' approach, biogenic carbon can theoretically be locked in for over a hundred years. In the meantime, sustainably managed forests will be able to produce a surplus of wood for producing new timber, thus making timber building 'double circular'.

Churkina et al. (2020) made a projection of the global timber supply from forests and plantations to 2050. They concluded that unexploited harvest potential should provide enough wood to meet demand, even for a radical scenario of 90 per cent timber use in global cities by 2050.

Figure 4 ► p. 330

In Europe, annual growth in forests is 1,000 Mm³, and harvesting accounts for 600 Mm³. This means there is an additional annual capacity of 400 Mm³ in the European forests (Nabuurs et al., 2021). Assuming 25 per cent additional harvesting of this capacity annually (100 Mm³) and a conversion rate of 50 per cent from sawlog to timber, an additional two million apartment units of 25 m³ timber could be constructed each year—enough to meet the annual European housing demand.

Figure 5 ► p. 331

DISCUSSION: KEY SUCCESS FACTORS FOR A MASS TIMBER URBAN TRANSITION

Although the potential of mass timber building to help solve the three global crises is very significant, there are several key external determinants that will influence the adoption rate of timber building concepts in future cities. The most important are briefly highlighted below.

BUSINESS CASE

The material costs of mass timber building are still considerably higher than traditional construction, by up to 10–20 per cent. This means that for many projects with a tight budget, the traditional route is often still chosen. A total costs of ownership approach provides a fairer comparison by weighing such other aspects of the building process as faster and cleaner construction, lighter foundations, and quicker return on investment against life cycle factors such as higher residual value, lower environmental, social and governance risks, and positive value development. If a carbon tax on building materials were introduced, or at least a voluntary carbon credit system that values carbon storage, this could shift the balance in favour of mass timber.

LEVEL OF INDUSTRIALIZATION AND DIGITALIZATION

Mass timber building systems are very suitable for industrialized, modular housing production. Through improved value chain integration and increased digitalization, construction time could be reduced by 20–50 per cent and eventually total investment costs for projects could be reduced by 10–20 per cent, further helping the business case (Barbosa et al., 2017; Bertram et al., 2019). This requires significant investment in new mass timber building system factories and further upscaling of mass timber plants.

POLICY AND LEGISLATIVE INCENTIVES

Climate and circularity targets are already actively stimulating the application of timber building in several areas of Europe, for example through financial, policy, and legislative incentives.

This is sometimes at the municipal level: for instance, the Metropolitan Region Amsterdam has committed to 20 per cent timber building by 2025. Regional and national levels are also active: for example, the French government has prescribed 50 per cent use of biobased materials by 2023. Increasing the adoption of such policies in other places will help the mass timber industry scale up and attract the investments it requires.

MISCONCEPTIONS AND LACK OF KNOWLEDGE

Many common and unjustified prejudices against mass timber building still

← *Figure 3*
The carbon stored in 1 m³ of cross-laminated timber is almost ten times higher than the quantity emitted during production (Nina Rundsveen/ Moelven) (photograph by Tomorrow's Timber, MaterialDistrict).

Figure 7 ▸ p. 331

← Figure 6
The 80-meter-high Sara Cultural Center in Sweden (design White Arkitekter) features over 13,000 m³ of mass timber, resulting in a carbon benefit of over 22,000 tons CO_2 (~10,000 tons of stored CO_2 plus ~12,000 tons of avoided CO_2 emissions). At a CO_2 price of 125 euro/ton, this represents a climate value of 2.75 million euros (photograph by Patrick Degerman).

hamper its large-scale adoption, for example involving fire safety, the availability of timber, and durability. Furthermore, higher education support at universities and professional consulting in such fields as engineering, building physics, and costs are still underdeveloped in many countries. This can sometimes lead to wrong choices in construction, which raise costs and damage the reputation of mass timber.

CONCLUSION—BIOBASED CITIES, A PROMISING PERSPECTIVE

This chapter has shown that a large-scale transition to timber buildings in urban environments could provide a significant contribution to the three global crises we are currently facing.

The Climate Crisis—In a radical 90 per cent urban timber scenario, a total of 75 Gt CO_2 could be stored and 36 Gt CO_2 emissions avoided by 2050, apart from additional carbon stored in new forests planted to fuel this potential timber revolution.

The Resource Crisis—In the same scenario, additional production capacity and increased harvesting in global temperate forests should provide enough timber to meet the increased demand. This is particularly the case in Europe, with an annual additional forest capacity of 400 Mm³, potentially enough to meet the European housing demand.

The Health Crisis—Besides the broad consensus on the positive social and health effects of green urban environments, the benefits of applying biophilic design principles in indoor and outdoor built city environments are complementary. However, more research is needed to know the magnitude of the well-being benefits of visible timber.

Various urban regions have recognized the potential of mass timber building. For example, cities such as Amsterdam, Copenhagen, Trondheim, and Toronto have already presented large-scale plans for complete neighbourhood developments built with biobased materials.

Meanwhile, the forestry supply side should also be actively stimulated to achieve increased afforestation, reforestation, and improved forest management following 'climate smart forestry' principles (Nabuurs et al., 2018). If this is done well and a higher portion of the harvested wood is turned into mass timber to replace CO_2 intensive materials, the climate mitigation effects of the combined forestry and construction sectors in Europe could reduce European greenhouse gas emissions by up to 23 per cent by 2030.

This could even go further than forestry alone, if cattle lands used by the dairy and meat industry are converted to cropland for the production of biobased fibres such as hemp, flax, miscanthus, bamboo, and straw. These raw materials can be used for construction applications in panels, insulation, and suchlike with similar carbon storage and substitution effects.

Ultimately, large-scale implementation of mass timber building in urban environments will lead to significantly lower carbon emissions in the land-use and construction sectors while overcoming resource scarcity and creating a more pleasant, climate-resilient, nature-inclusive environment for urban citizens with substantial health and well-being effects.

“Ultimately, large-scale implementation of mass timber building in urban environments will lead to significantly lower carbon emissions in the land-use and construction sectors ...”

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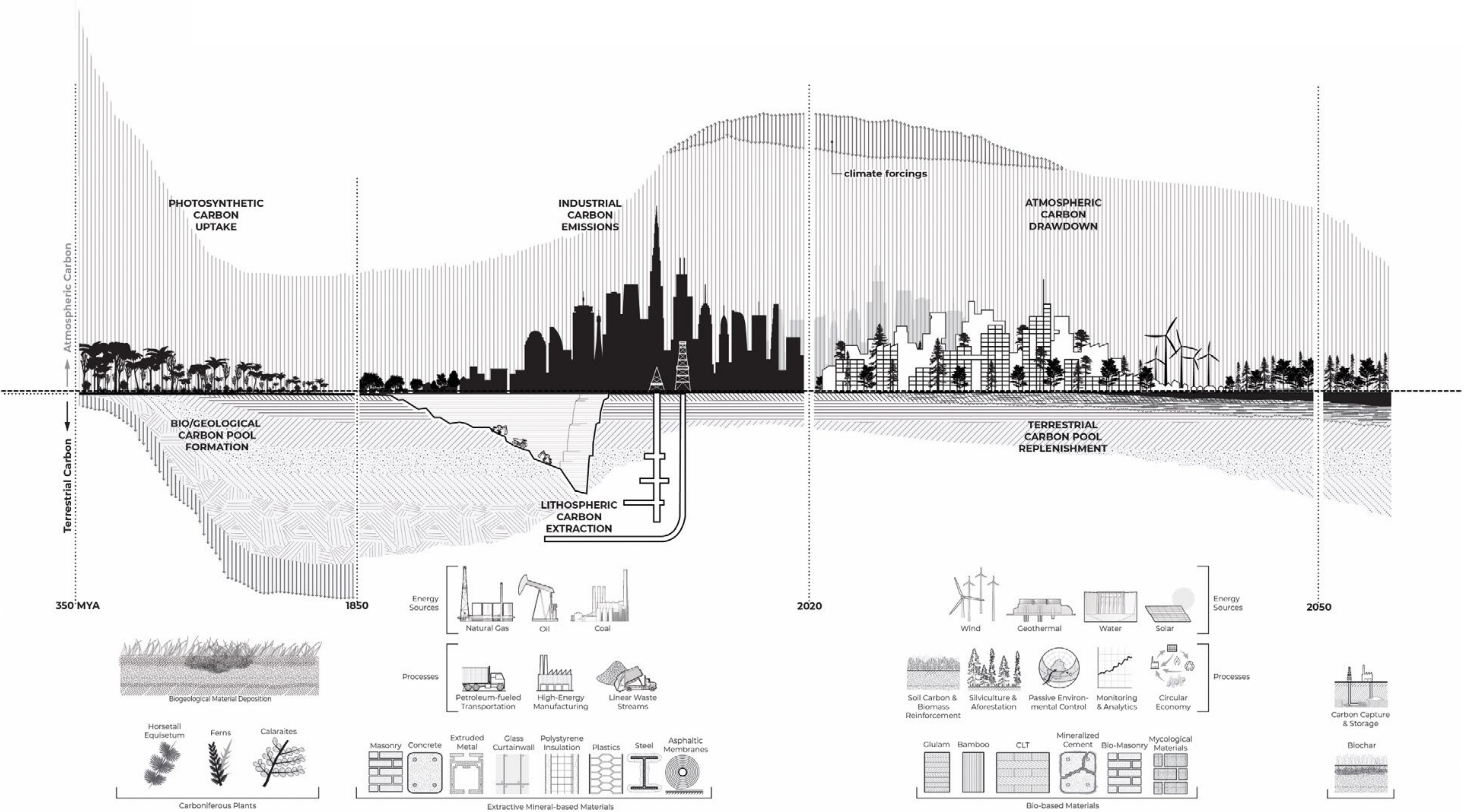

Figure 1
The imbalance between atmospheric carbon versus terrestrial carbon over time. Reforestation and mass timber building could help regain the global carbon balance (Kuittinen et al., 2022). Courtesy of John Wiley & Sons, Inc.

Figure 2
The Edge Olympic office building (design: Eric van Noord, de Architekten Cie.) is a successful redevelopment in Amsterdam (Well Platinum certified), where two storeys were added to the existing two-storey concrete building using a glulam post and beam construction (photograph by Ossip van Duivenbode).

Figure 4
Where possible building on water utilizes otherwise neglected surface area and is future-proof, even with rising sea levels. The floating office featuring amongst others the Global Centre on Adaptation (design: Powerhouse Company) in the harbour of Rotterdam is the largest floating office in the world (3,600 m²) (photograph by Marcel IJzerman).

Figure 5
WThis school in Rotterdam (design: SeArch) was built within a very low budget and designed for disassembly with timber modules. It is planned to be rebuilt in five years in another location (photograph by Ossip van Duivenbode for SeArch).

Figure 7
Modular mass timber housing factory (20,000 m²) in the Netherlands, set to produce 1,500 houses a year (photograph by Lister Buildings).

ABSTRACT

This chapter presents a speculative framework for the creation of a novel and sustainable business model for architecture and urban design practices in line with the circular economy (CE). The considerable scale of efforts and resources needed for urban building and construction raise the question central to circular design: how to decouple urban growth from finite resource depletion. Here the focus is how to define the relevance of design and concurrently the competences of architects for CE.

The background of this chapter is a selected seminal literature review on circular economy and circular business models relevant for the construction industry. The chapter reflects on the current discourse of both academics and practitioners and focuses on the micro-economic level of CE towards the regenerative design of buildings and cities. The chapter addresses CE principles both globally and specific to construction. It then discusses an array of approaches for architecture and urban design to contribute to a resource-efficient CE. CE strategies for design are developed at three scales: circular materials, circular buildings, and circular cities. The study concludes by proposing a speculative framework for a circular business model for architecture and urban design practice. This high-level framework serves two purposes: it identifies the regenerative capacity that circular design provides for the construction industry, and it provides a call to action to architects and urban designers to identify and to embrace growing responsibility and largely untapped business opportunities.

KEYWORDS

circular economy; circular city; circular building; circular material; architecture practice; urban design; business model innovation.

Chapter 25—Circular Design: Business Model Innovation for Architecture and Urban Design Practices

Christian Veddeler

The circular economy (CE) aims to enable economic growth without incremental pressure on the environment (Pomponi & Moncaster, 2017). CE has gained significant attention, with growing awareness that current patterns of production and consumption embedded in a traditional linear economy (LE) exceed the planet's environmental capacity (Brundtland, 1987).

Kate Raworth, in her book Doughnut Economy (2017), portrays the last two centuries of industrial activity based upon a linear system as 'inherently degenerative' (p. 212). The inadequacy of LE is pronounced by its limited lifetime perspective, which entirely disregards the end-of-life stage of any product after consumption or use (Çimen, 2021).

Today, the construction industry is firmly embedded in LE practices. It is one of the largest sectors of today's global economy and represents a global annual market size of US $10 trillion (Barbosa et al., 2017). At such a scale, construction is a key contributor not only to resource depletion but also to waste generation, air and water pollution, global greenhouse gas emissions, soil degradation, deforestation, loss of biodiversity, and anthropogenic climate change: currently, buildings account for 36 per cent of total global energy use and consume 40 per cent of all material resources (Santamouris & Vasilakopoulou, 2021). Cities cause 60–80 per cent of greenhouse gas emissions (EMF, 2022c). The construction sector in the EU is respon-

'Everyone designs who devises courses of action aimed at changing existing situations into preferred ones.'

Herbert Simon. The Sciences of the Artificial (Simon, 1969, p. 130)

sible for more than 35 per cent of its total waste generation, caused largely by construction and demolition activities. Some 10–15 per cent of building material is wasted during construction (Arup & EMF, 2020). Only a fraction of building materials is currently reused or recycled (EC, 2020b). In addition, conventional building materials, in particular cement, steel, and glass, are among the most energy and carbon-intense industrial products.

Even though urban agglomerations take up no more than 2 per cent of the global landmass (EMF, 2022b), currently 55 per cent of the world's population lives in cities. This number is expected to reach up to 68 per cent in 2050 due to projected global population growth (UN Habitat, 2020). Associated large-scale urbanization will result in substantial demand for construction: by the 2050s, 230bn square metres of new buildings are expected. This more than doubles the current global building stock (IEA, 2017), and in scale and effort is equivalent to building an area the size of New York City every 35 days for the next 30 years (EMF, 2022a). Even if this expanse of building is feasible, such growth following the logic of the prevalent LE system will exhaust scarce resources such as land, energy, and raw materials. It will drastically increase the human ecological footprint.

ARCHITECTURE AND URBAN DESIGN PRACTICE

Architecture and urban design only account for a small fraction of the construction industry's activities. Far from all buildings are designed by architects. However, the urgencies described above provide the opportunity for them to play a more fundamental role in CE, first and foremost in circular design (Veddeler, 2021b): The focus on the whole building life-cycle, instead of on building design alone, here forms the basis for a novel business model for architecture and urban design practice.

To date, traditional architecture services are typically limited to designing buildings and masterplans. In stage-gate planning phases, architects integrate and coordinate the client's predetermined design brief requirements. Evolving planning information is provided by selected project stakeholders such as engineering consultants, surveyors, and planning authorities, and used in the design and construction process. Architecture fees are typically defined as a per centage of overall construction costs and are often determined and capped at the beginning of a project. Cost, and not necessarily value criteria, dominate the procurement. This practice often favours lowest-cost bidders, not highest-value providers, with intense competition for cost leadership and consequently low margins (Veddeler, 2021b). This commoditization of design bears the risk that sustainability measures are traded off at the expense of short-term cost savings.

Architects and urban designers have insufficient incentives to undertake the additional efforts required to engage in circular design and the associated improvement of building quality and performance (Veddeler, 2021b).

Furthermore, the separation and linear progression of activities, responsibilities, and stakeholder expertise have explicit consequences: the alignment of individual input, values, and emerging objectives is often deficient throughout the various project phases. Real-estate investors and developers, building clients, planning authorities, contractors, and finally architects and designers do not necessarily share the same goals. Others, such as prospective users and the larger public, have limited or no influence on projects.

Planning efforts habitually stop with the delivery of a built project. The entire life-cycle of a building beyond its initial delivery is still largely ignored. Neither the usage nor the end-of-life stage of a building are anticipated in design and construction. Consequently, building operations, facility management, and building maintenance, reuse, and recycling are largely disregarded. The fragmentation of project activities and responsibilities, the lack of wider stakeholder integration, and the absence of a life-cycle perspective cause a disintegration of the value chain. In this context, services offered and reflected in the traditional business model of architecture are inadequate, because they do not deliberately address the overarching goals of long-term positive environmental, economic, and social impact (Veddeler, 2021b).

CIRCULAR ECONOMY PRINCIPLES.

The Ellen MacArthur Foundation (EMF, 2013) suggests that CE has three main pillars. These are the avoidance of pollution and waste, the aim of keeping products and materials at their highest value in use for as long as possible, and the regeneration of natural systems alongside the restoration of finite materials for reuse. Geissdoerfer et al. (2020, p. 3) define CE as

> *an economic system in which resource input and waste, emission, and energy leakages are minimised by cycling, extending, intensifying, and dematerialising material and energy loops […] achieved through digitalisation, servitisation, sharing solutions, long-lasting product design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling.*

Current production and consumption patterns in construction, however, routinely still follow the opposite logic of 'take-make-dispose' (Esposito et al., 2016, p. 5). Ideas of abundant resources, economies of scale, and short-term profits (EMF, 2013) are prevailing and produce unprecedented environmental, economic, and social pressures: the example of the predominant model of real-estate finance illustrates how assets in short timeframes are depreciated to zero in accounting value, which results in artificially reduced building lifespans. Devaluated assets are subsequently considered expendable regardless of their technical fitness. Premature demolition, reinvestment, rebuilding, and reselling provide recurring routines for profit generation (Abramson, 2020). Such 'built-in obsolescence' (Bocken et al., 2016, p. 314) provides no sensible incentive to establish elongated building life-cycles. The same is true for the reduction of waste generation, environmental pollution, and resource consumption. Consequently, the overexploitation of resources increases scarcity, causes rising prices of building materials, and impairs future building activity and affordability. The damaging effects of such a course of action are significant, yet economically remain largely hidden as 'negative externalities' (Raworth, 2017, p. 143): Environmental and social costs are largely suspended outside of economic activity, company balance sheets, and economic growth models. Natural capital is used at the expense of others while damage is socialized.

However, the transition from a linear cradle-to-grave to a circular cradle-to-cradle model, as coined by McDonough and Braungart (2003) presents a possible way out of the deterministic logic of LE. CE for design and construction aims for a building life-cycle perspective, including design and development input, in-use stage, and end-of-life output (Köhler et al., 2013). In line with EMF's three pillars of circularity (EMF, 2013), this perspective extends the buildings' useful lifetime while designing out waste (EC, 2020ab). Circular design ranges across various building scales from construction materials and building components to entire buildings and cities (Pomponi & Moncaster, 2017). For architects and urban planners, this means no less than extending the conventional focus from the project to the product of buildings once delivered to the end-user (Çimen, 2021).

Four fundamental circular strategies across phase and scale dimensions, are employed throughout this research: They follow the terminology introduced above by Geissdoerfer et al. (2020, p. 3), and include (1) recycling measures,

“Circular design is regenerative and helps to decouple urban growth from finite resource depletion and to preserve and enhance natural capital to create thriving buildings and cities.”

termed Cycling; (2) use-phase extensions, termed Extending; (3) an intensified use phase, termed Intensifying; and (4) the substitution of products by service and software solutions, termed Dematerializing. For better readability, the recurring terms Cycling, Extending, Intensifying, and Dematerializing will be presented with initial capitals throughout the text but without repetitive referencing of the original source.

CIRCULAR MATERIAL, BUILDINGS, AND CITIES

The opportunity for architecture and urban design to contribute to CE is significant, as up to 80 per cent of a buildings' environmental impact is determined at the design phase (EC, 2020b). Circular design considers not only the development of design and construction but also the usage and end-of-life stages of buildings (Pomponi & Moncaster, 2017). Circular design of materials, buildings and cities systemically enables adaptive reuse, sharing, and recycling.

As suggested by Evans et al. (2005), shifting the focus from the overemphasized initial capital cost (CAPEX) of design and construction to the total lifetime expenditure of buildings (TOTEX) allows the appreciation of the value of buildings beyond accounting terms and a recalibration of the ratio of building cost and the life-cycle's utility value. Using the example of a metropolitan office building, Evans et al. (2005) demonstrate this with their striking cost ratio of 1:5:200. Over the lifespan of a building of only 20 years, the factor of construction costs is identified as 1, that of building operating costs as 5, and business operating costs as 200. Even if these numbers are broadly generalized, this benchmarking exemplifies the relative impact of building costs against usage and ultimately business productivity. Since the TOTEX of a building is many times higher than the CAPEX, the recognition of the positive impact that value-enhancing design and superior construction quality will have, is significant. The allocation of an appropriate design and construction budget for circular building will proportionally reduce lifetime costs. Superior building use and performance through durability, longevity, flexibility, and adaptability save operating expenses, improve, and extend the building's life-cycle value, and contribute to overall business productivity.

The reuse of building material and components throughout a building's life are essential prerequisites for a built environment to become circular. Instead of depreciation and disposal, material value is kept in value cycles. This implies recovery and conservation of building components at the end-of-life stage. The same goes for the redundant inflow of virgin resources (Stahel, 1994). Design for repair, reuse, refurbishment, repurposing, reversibility, remanufacturing, redistribution, reverse supply chain management and logistic networks (Lewandowski, 2016; Lüdeke-Freund et al., 2018) is required to consequently transform buildings into material banks (EC, 2020c). Arora et al. (2020) suggest that urban mining provides an overarching framework of city-wide building material Cycling, organized in purposive material indexing, stocking, and flow.

Cycling in replenishing loops, as suggested by Stahel (1994) for building design and construction, anticipates change. Design for adaptability, durability, and longevity (ARUP, 2016) goes hand in hand with modular building systems for easy disassembly and reassembly (EMF, 2012). The separate access to building layers that all have a distinct lifespan (Brand, 1994), allows purposive maintenance, repair, and exchange at different rates (Bocken et al., 2016).

Extending the lifespan of buildings and its components to retain value demands design for extended utility. It aims for the prolongation of in-use stages of buildings, and the protection of material value. Extending prevents or limits material degradation and decay and encourages employment of durable and long-lasting building components.

Bocken et al. (2016, p. 309) differentiate between designing for 'slowing' and 'narrowing' material loops: The former provides elongated use of buildings over time; the latter implies reduced resource usage for construction. Design for maintenance, repairability, and upgradability makes buildings adaptable. It allows future change and prevents premature obsolescence.

Intensifying involves amplifying material and building usage through sharing, pooling, renting, and leasing (Geissdoerfer et al., 2020). It implies design of flexible, multifunctional, and durable buildings and neighbourhoods to avoid the asset underutilization (Harrison & Donnelly, 2011) that often is caused by nine-to-five routines. Intensifying, according to McDonough and Braungart (2003), not only reduces the negative effects of waste and pollution but also provides positive outcomes: beyond its primary use, a building or neighbourhood can become productive by, for instance, harvesting its own energy, sequestering carbon, producing oxygen, creating microclimates, and contributing to meaningful urban life.

The application of a digital building information model (BIM) and of digital twins of buildings and cities allows Dematerializing, a partial substitution of building components and utility by a virtual model. The digital twin enables material and building analysis in both the preoccupancy development stages of design and construction and post-occupancy of a realized building in use: in design and construction, it operates as an emerging and integrative platform collecting, processing, shaping, and updating all building information considered relevant. At the material level, digital simulation of desired material capacities and performance in building design supports deliberate material selection. The digitally driven design process can help to augment and predict the optimal solutions for the life-cycle performance of a building (Bernstein, 2018b). Outcome-based design supports complex problem-solving issues and makes tangible prototypical design options at building and city levels generated to evaluate against established value criteria. It facilitates feedback loops and iterative steps of improvement (Veddeler, 2021b).

Once a building is realized and in use, the digital twin is best understood as a building's virtual replica that can mirror the actual building components. The digital twin is continuously updated with data from its physical counterpart. Sensor-enabled material monitoring provides dynamic data for material life-cycle management. Access is provided to continuous evaluation, real-time assessments, and diagnostics of tangible material condition and performance. Digital updating and upgrading improves the building's condition and performance. Facility management, maintenance, and repair can be coordinated accurately through the data provided. Digital material passports, tagging, watermarks, and building log books index and trace material through the supply chain and the entire building life-cycle (EMF, 2014). On-site repair and component replacement are executed only when necessary (EC, 2020b). Dematerializing during the entire building life-cycle helps to avoid resource losses, costly planning mistakes, construction damages, and unsatisfactory building performance (Arup & EMF, 2020).

CIRCULAR BUSINESS MODEL

Architects will continue to design buildings, also when fully embedded in CE. The application of circular principles beyond the delivery of a designed project will allow a transformation of the current business model of architecture and urban design alike. The implication of a building's life-cycle design perspective provides ample opportunities for extended scope and new types of services. Both supplementary services and the achievement of desirable project outcomes provide untapped revenue streams and potentially increased profit margins (Veddeler, 2021b).

Once architecture includes services for building design and building life-cycle design, its value proposition significantly broadens. The incorporation of supplementary services for Cycling amplifies end-of-use strategies and considers reverse logistics for building systems that are fully reusable or recyclable. Design for Extending aims at closing resource loops and longer-lasting building utility enabled by durability, longevity, flexibility, and adaptability. Design for Intensifying improves the use efficiency and productivity of buildings. Anticipated in design phases, the provision of sensor-enabled monitoring optimizes building performance and material conditions in operation. It facilitates not only target-oriented maintenance but also real-time occupancy schemes for additional and alternative uses of typically underutilized assets. Design for Dematerializing for both pre- and post-occupancy phases virtually enables simulation and real-time measurement of desired and actual building performance and condition against a metrics of criteria for Life-Cycle Assessment (Van Stijn et al., 2021). The services proposed for building design and life-cycle building design facilitate anticipation of future change and reverse supply chain management.

Value creation and delivery address both expanded architecture competencies and integration of all project stakeholders and their goals and objectives. It also includes those affected but not considered in a traditional linear process (Veddeler, 2021b). Next to real estate clients, consultants, authorities, contractors, and suppliers, the approach also recognizes the objectives of building operations, facility management, maintenance, logistics, end-users, and the larger public.

Circular design creates value from waste recovered (Leising et al., 2017). It optimizes material and energy efficiency and building performance. The adaptability, repairability, and upgradability of buildings avoid value loss of underutilized space, depreciated materials, and premature demolition (Arup & EMF, 2020). Instead, use is prolonged through Intensifying and Extending. The resilience of assets is increased by the ability to adapt to alternative uses, facing both persistently changing market conditions and social expectancy.

At the end-of-life stage, Cycling enables recovery of building material that has a residual value and is tradable. Dematerializing building information allows simulation of superior design solutions and for buildings of optimized utility. It allows remote sensing, steering, enabling, managing, controlling, feedback, and automation. Life-cycle design establishes long-term client and user relationships alongside potentially valuable building life-cycle service contracts (Geissdoerfer et al., 2020). Architects and urban designers might not want to play the role of a building's life-cycle manager, but they oversee its design, integration, and coordination and are thus in the position to adopt a stewardship role (Leising et al., 2017). Within the value chain of building, architects are enabled to provide a framework for building life-cycle services. Making suitable data available helps to reduce planning and operations uncertainty. Digitally generated real-time measurements, analysis, and evaluation of both design and building performance help to mitigate risks and to optimize costs and qualities while intensifying the efficiency of materials and assets in use.

Value capture identifies such incentives as economic benefits, new revenue streams, recurrent revenues, and increased profit margins for design practices (Lewandowski, 2016). In addition to conventional design fees, which are typically per centages of construction costs, the expansion of services throughout the life-cycle of buildings presents opportunities for new income streams. Bernstein (2018b, p. 169) describes four dimensions of 'value opportunity' that go beyond the traditional delivery of a building design. The dimensions are applicable for circular design initiatives: 'Design for exchange' allows extended services in a vertical and reversed value chain and across stages, disciplines, and expertise. 'Design to production' defines services that allow project data to be utilized for the manufacturing and supply logistics of building materials. 'Design to asset performance' enables the use, reuse, and recycling of a building and of building components. 'Design to lifetime goals' improves overarching and positive project impact.

Accordingly, both direct and indirect revenue streams are identifiable. Direct revenues are generated by typical but extended architecture services such as design, integration, and coordination: Architects claim premium fees for circular building design that minimizes the costs of material acquisition and provides additional revenues from end-of-use material value. Additional fees are associated with supplementary services, including redesign, design for Extending, adaptability and reuse, disassembly, reassembly, and coordinating repair, reuse, refurbishment, recycling, and reverse supply chain management. Dematerializing allows the digital twin model to be exploited by selling access, use, and data from design and usage stages. This data, originally in the hands of the architects, is used for simulation and measurement of performance, use, re-design, and coordination of operations and supply. It is valuable to all stakeholders and may be sold through tailored long-term use or service contracts (Geissdoerfer et al., 2020).

Indirect revenues are generated by performance-based contracts. Desirable building performance is incentivized, designed for, and finally rewarded. Performance procurement through 'product service systems' (Bocken et al., 2016, p. 312) aligns the capacities of the digital twin model as virtual product with expanded design services. Instead of coordinated planning documents for the realization of a physical building, the architect and urban designer sell outcome-based design solutions and building life-cycle performance. Design data is leveraged vertically across the supply chain. The concept of product as service allows potential revenue streams that are based on outcome delivery, subscription, and usage (Lüdeke-Freund et al., 2018). Income is generated by pay per use, rent, periodic fees, and performance bonuses. Examples of such performance-based revenues are such achievements of efficiencies as energy reduction and production, intensification of use, and the extension of the building life-cycle through adaptability, durability, and longevity, including rewards for the recovery of building materials' residual value (Arup & EMF, 2020).

Revenues such as result-based and performance fees and bonuses do not depend on the number of consulting hours provided but the achievement of project outcomes (Bernstein, 2018a). For the architect and urban designer, this means embracing shared risk-taking in a stakeholder network (Bernstein, 2018b) and accepting a role as entrepreneur (Veddeler, 2021b).

CONCLUSION

Architecture and urban design practice possess a huge potential to support the construction industry's transition to circularity. Architects and urban designers are well equipped to play a key role in this shift because of their expertise in design and abilities to integrate and coordinate diverse stakeholder inputs. The implementation of CE principles across the scale of circular materials, buildings, and cities offers the opportunity to create a framework for an innovative and sustainable business model of architecture: instead of providing building design services alone, the integration of services for life-cycle building design creates and adds value in the logic of CE.

Accordingly, the revenues generated supplement the conventional value proposition. Exploiting digital tools such as digital twin models for both pre- and post-occupancy stages allows the creation and capture of value that is performance and outcome based and replaces cost as the key criterion of project evaluation. The business model framework outlined here has significant implications for architectural practice and the roles of the architect and urban designer. The consideration of in-use and end-of-life stages of buildings and the deliberate integration of all stakeholders shifts architecture and urban design practice from a firm-centric to a network-centric activity, from a project-centric to a process-centric view, from a short-term CAPEX to a long-term TOTEX perspective, and from a building design to a building life-cycle design approach.

Circular design of materials, buildings, and cities, above all, has significant benefits not only for design practice but for the environment, the economy, and society. Circular design is regenerative and helps to decouple urban growth from finite resource depletion and to preserve and enhance natural capital to create thriving buildings and cities.

Note
This book chapter extends previous research of the author. It is based on the unpublished essay 'Circular by Design: A Speculative Framework for a Business Model of Circularity for Architecture Businesses' (Veddeler, 2021a), developed as part of the Circular Economy seminar at Judge Business School, University of Cambridge.

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EPILOGUE

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Panama City (photograph by Rasmus Hjortshøj).

Epilogue—Towards a Transdisciplinary Discussion on Future Cities and City Futures

Michal Gath-Morad
Iris van der Wal
Christian Veddeler
Joran Kuijper

This book expresses the visions of urban thinkers, each through their own unique lens. Emerging themes concern the current challenges faced by cities worldwide, including the climate crisis, increased urbanization, limited natural resources, health and healthcare challenges, and changing social structures. Similarly, various themes recur as opportunities to tackle these challenges, including the use of information and communication technologies, hybrid workplace models, and ideas of circular economies.

Unsurprisingly, it appears that authors from diverse backgrounds each tend to envision city futures that are grounded in their training, education, and daily practice. For instance, some architecture, engineering, and construction practitioners and urban designers envision a speculative future for the city, while others focus on designing with the aid of human-centric planning tools or propose novel business models fit for architects within the circular economy of the future city. Differently, amongst academic authors, we see how the future of cities draws on research across a profusion of fields, including neuropsychology, cognitive science, environmental

← Israels Plads, Copenhagen (photograph by Rasmus Hjortshøj).

'Cities are, above all, physical spaces which produce surprising things, reacting like a catalyst for the unexpected.'

Antoine Picon (as cited in Leonard, 2018, section Mapping the Unexpected)

psychology, real estate, urban economics, healthcare, and computer science. It is therefore not surprising that these authors make use of a broad range of methods to hypothesize what the future city will be like and how it will perform. The methods range from historical and literature research to observations, behavioural experiments, case studies, agent-based modelling, and computational simulations. This collection creates a broad image of what the city of the future could be or how it may function. Some authors are not easily categorized within each of the former groups their backgrounds and education are diverse and include the arts as well as real-world experience of urban imagination and policy making. In these chapters, themes from the natural world tend to be at the forefront of the future city, highlighting notions of circularity, biobased materials, and the social aspects of sustainability.

To further visualize how these authors from diverse backgrounds envisage the future city, we conduct a meta-analysis with network analysis methods to capture the underlying textual structure of each chapter separately and all chapters combined. The themes emerging from this analysis reflect how rich and fertile is the ground for urban research and practice. Recognizing this diversity, we aim to adopt an inclusive approach and facilitate a pluralistic discussion that will ultimately contribute to the design of 'good' cities in the face of complexity. To conduct our analysis, the text composing each chapter is processed and represented as a network graph. From this graph, key topics are mapped using InfraNodus (Paranyushkin, 2019; 2011), and the relationship between words comprising each chapter is visualized using Gephi (Bastian et al., 2011). Each network graph is made from nodes that represent words and from edges that represent relations or connections between these words.

By representing each chapter and the prologue as a network graph (see Figures 1–26), we can begin to analyse how these chapters resemble or differ from one another in their textual content and structure. The network graph provides instant visualization and insight into the vision each author has. The size of the words in each graph depends on the frequency of appearance in the text, and their degree of connectivity to other words. The colour of the nodes depends on the connectivity of each word. More connected and central nodes are coloured in warmer red or orange tones, whereas words that are less connected or more peripheral appear in cooler blue tones. In addition, we have created a single network graph (Figure 27) from all chapters combined to analyse the connections between the different chapters. This reveals how the words used in various chapters relate to one another, forming a sort of shared mental model between authors and reflecting the prospects of our transdisciplinary discussion for the design of future cities.

Within the scope of this epilogue, we refrain from analysing the chapters with quantitative network analysis measures such as in-degree, out-degree, degree, eccentricity, closeness centrality, and betweenness centrality. Instead, at this point, we qualitatively analyse the high-level qualities of the network graph for each chapter to allow a multiplicity of interpretations of the differences and similarities between the various perspectives comprising this book. For instance, a key quality that is instantly reflected in these network graphs is the 'centre of gravity', which is formed by the most connected nodes within the text. These nodes form a sort of neighbourhood or community that can be mapped to the topical clusters generated for each network graph using InfraNodus (Paranyushkin, 2019; 2011).

The network graphs reflect the unique lenses of our authors. As can be seen, the central node, which represents the most connected word in each chapter, is often the word 'city' or related words such as 'urban', 'planning', or 'building'. Yet, noticeably, the neighbourhood surrounding these central words differs dramatically between authors and reflects the diversity of centres in each chapter. For instance, in Figure 24, we see that the words connecting to the central word 'building' relate to themes of natural construction, and in Figure 3 to specific sustainability-related terminology around carbon footprints. In contrast, some of the network graphs do not follow this logic, and their 'centre of gravity' highlights other concepts, such as Figure 15, where the most connected word is 'choice', reflecting choice theory in behavioural economics and its potential for designing active buildings and cities. Finally, Figure 27 shows a network graph composed of all chapters in this book and thus visualizes the discourse emerging from the book. Unsurprisingly, the same words that were central in the individual chapters, such as city, urban, planning, architecture, design, and building, remain central in the joint network graph. Yet, this holistic, systematic view provides insights into the grouping of themes. By calculating the modularity (Bastian et al., 2011) of this network graph, we are able to visualize the structure of groups, clusters, or communities of words that are predominantly interrelated across the different chapters. This visualisation shows six main clusters of words colored in red, orange, pink, purple, blue and green. Each cluster emphasises different themes. The red cluster highlights words related to architectural design process, the orange cluster

seems to focus on words related to urban life and urban design, the pink cluster is centred around the recent pandemic, the purple and blue cluster focus on sustainability and climate change, and finally the green cluster emphasises the topic of health and healthcare.

The resulting epilogue is very much a visual one, allowing readers, authors, and editors alike to visually inspect and compare the different chapters, hoping to encourage individual insights and reflection in our effort to foster a transdisciplinary discussion. We see *Future City—City Futures* as the starting point for a much-needed discussion between thinkers, researchers, practitioners, and policy makers. How do you envision the future city? Is your voice heard? The discussion this book intends to facilitate is an open-ended one, and through the layering of perspectives we hope to honour the complex problem that the city remains (Jacobs, 1961). The launch of this book is also an invitation to make your urban voice heard. It is the diversity of voices that will help cities tackle the challenges that lie ahead. Following the launch of this book, we will initiate a series of gatherings and outreach activities seeking to extend and expand our discussion to include additional emerging voices. If you feel that your voice should be heard, you are welcome to join us.

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Chapter 1—The Interconnected City: Imagining Our Urban Lives in 2050

Tamara Streefland

GRAPH 1

Network analysis and visualisation of Streefland, T. (2023). The Interconnected City: Imagining Our Urban Lives in 2050. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 61–71). TU Delft OPEN..

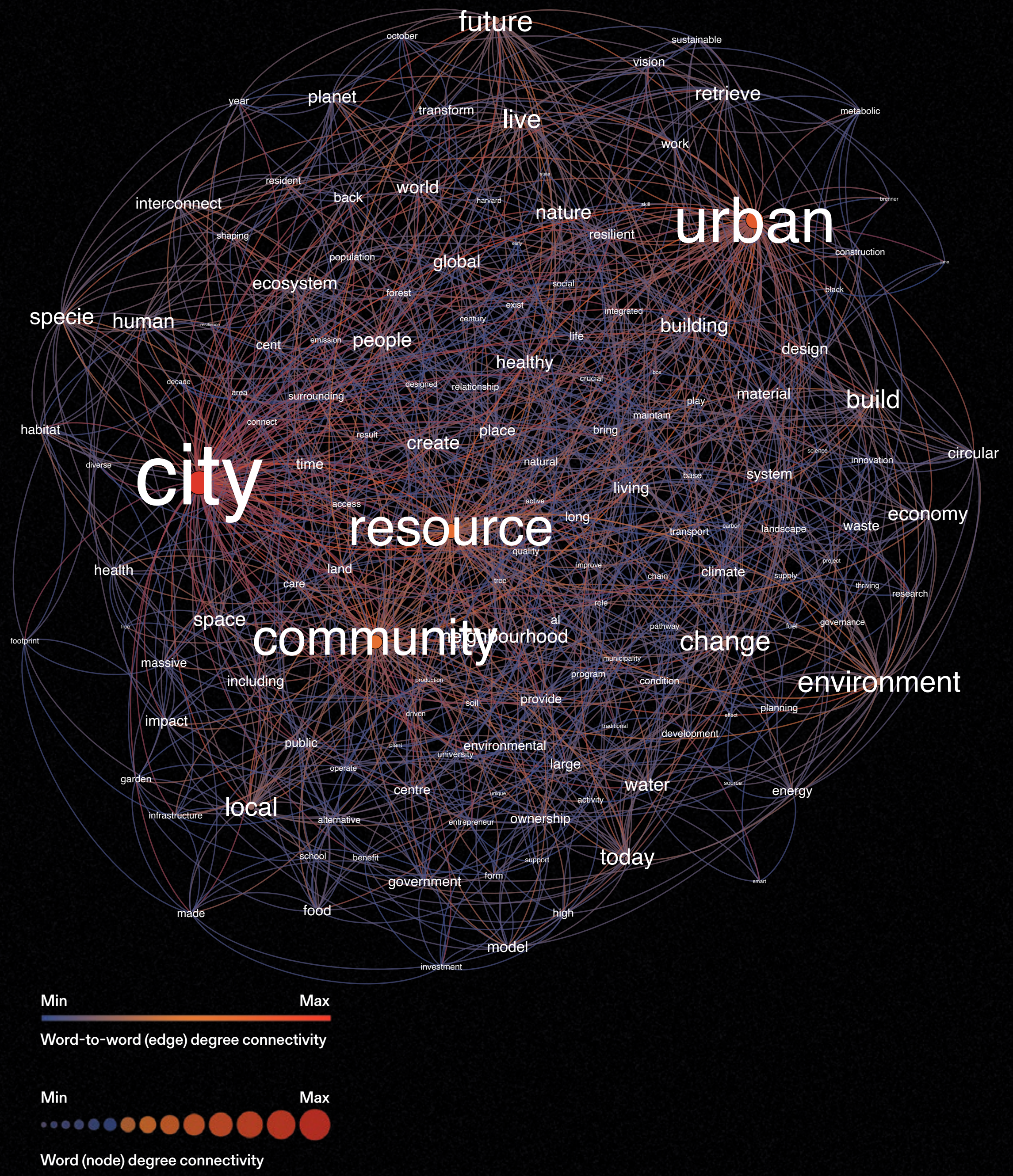
MAIN TOPICAL CLUSTERS

1 Water infrastructure;
2 Sustainable transport;
3 Urban soil health;
4 Circular economy;
5 Natural resources;
6 Biodiversity;
7 Neighbourhood design;
8 Climate change;
9 Construction waste

KEYWORDS

interconnectedness; urban; future; nature; resources.

Graph by Michal Gath-Morad →



Chapter 2—Gardening the City: Superhospitality–Envisioning a Symbiotic Urban Future

Jolijn Valk

GRAPH 2

Network analysis and visualisation of Valk, J. (2023). Gardening the City: Superhospitality–Envisioning a Symbiotic Urban Future. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 73–81). TU Delft OPEN.

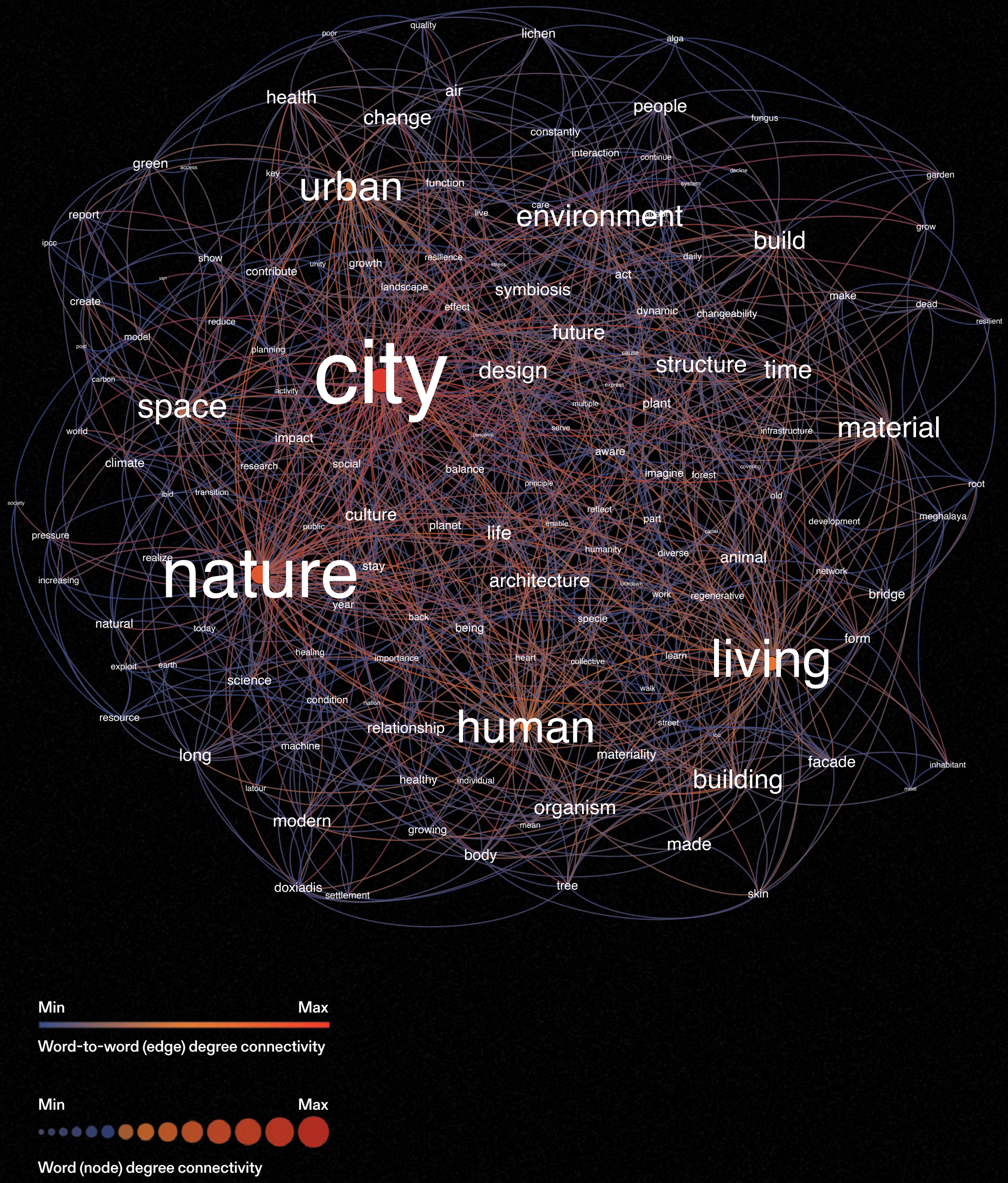
MAIN TOPICAL CLUSTERS

1 Nature;
2 Architecture;
3 Science;
4 Environment;
5 Symbiosis;
6 Urban design;
7 Infrastructure;
8 Regenerative architecture

KEYWORDS

variety; living architecture; city future; biodiversity; diversity; culture–nature; lichen.

Graph by Michal Gath-Morad →



Chapter 3—Urban Decarbonization: Destranding Cities for a Postfossil Future

Paolo Cresci, Francesca Galeazzi, and Aurel von Richthofen

GRAPH 3

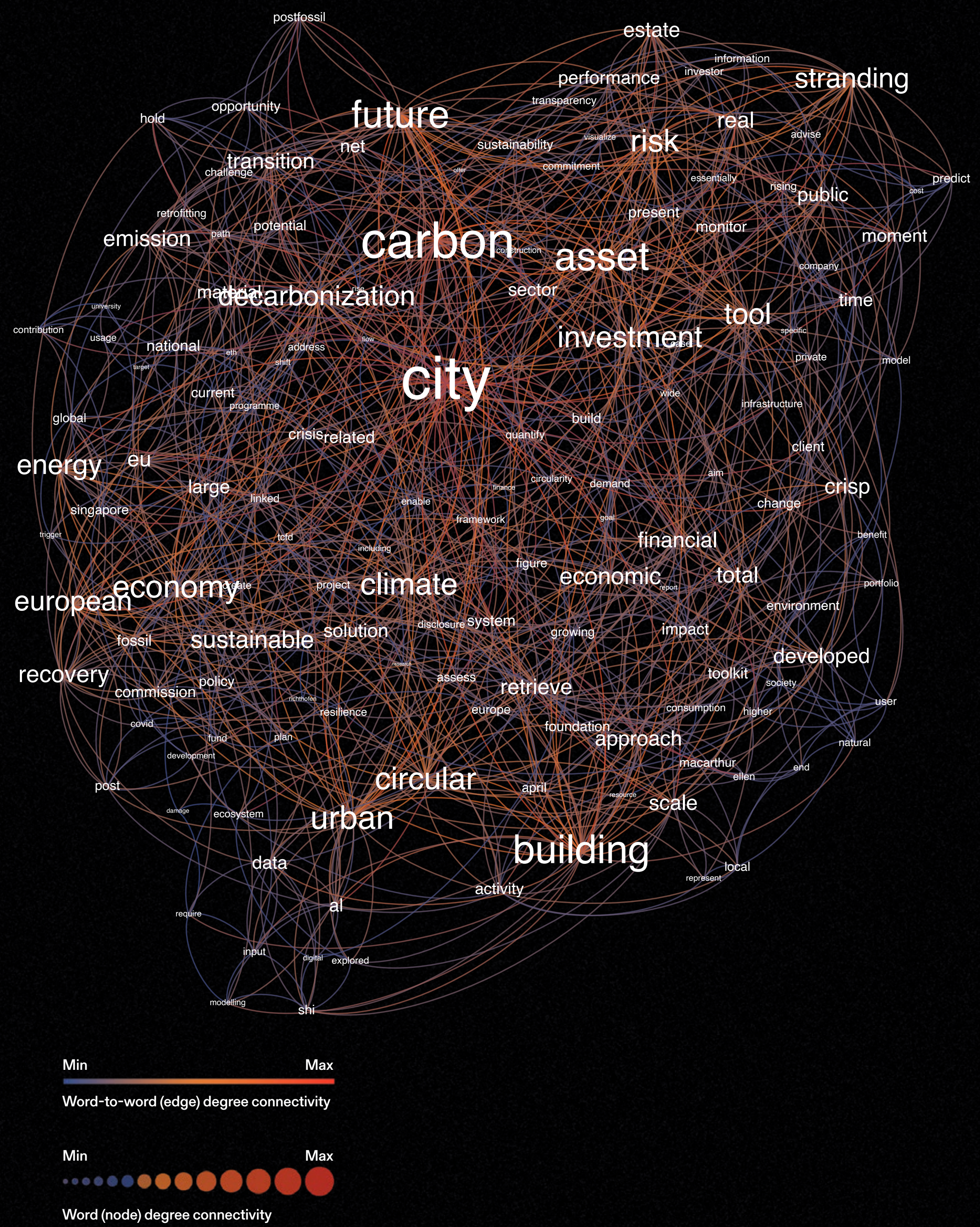
Network analysis and visualisation of Cresci, P., Galeazzi, F., & Von Richthofen, A. (2023). Urban Decarbonization: Destranding Cities for a Postfossil Future. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 83–89). TU Delft OPEN.

MAIN TOPICAL CLUSTERS

1 Climate change;
2 Carbon emissions;
3 Circular economy;
4 Sustainability;
5 Arup tool;
6 City transition;
7 Infrastructure;
8 National research programme

KEYWORDS
decarbonization; carbon risk; stranding; postfossil futures; cities.

Graph by Michal Gath-Morad →



Chapter 4—Heart, Health, Habitat: An Inextricable Relationship between Population Health and the Built Environment

Bola Grace

GRAPH 4

Network analysis and visualisation of Grace, B. (2023). Heart, Health, Habitat: An Inextricable Relationship between Population Health and the Built Environment. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 91–97). TU Delft OPEN.

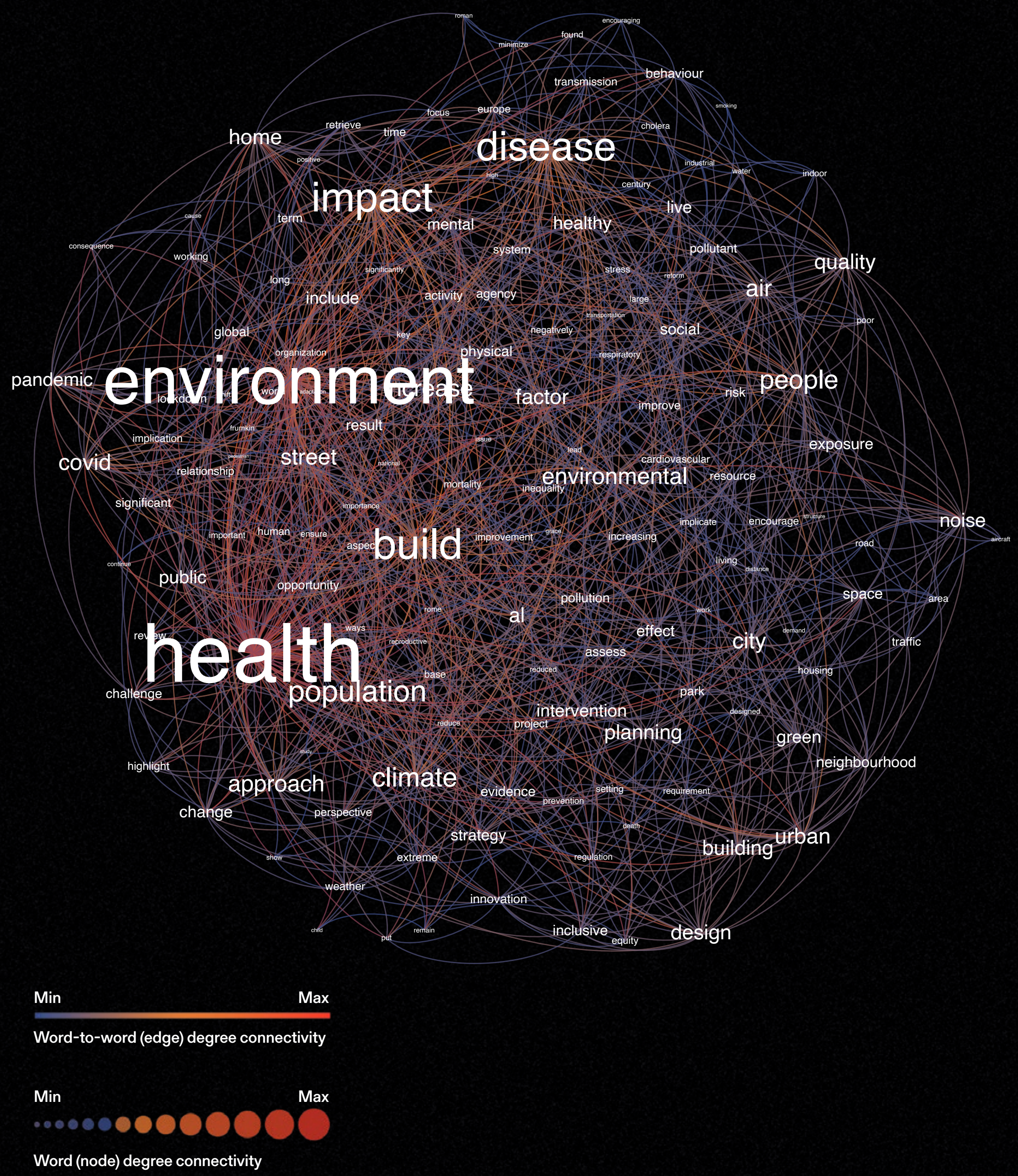
MAIN TOPICAL CLUSTERS

Disease transmission;
1 Health equity;
2 Urban design;
3 Air pollution;
4 Industrialization;
5 Pandemics;
6 Climate change;
7 Healthy streets

KEYWORDS

population health; built environment; well-being; health equity; inclusive innovation.

Graph by Michal Gath-Morad →



Chapter 5—Future Cities Healthcare Ecosystems: Digitally Enabling Hybrid Care Models across Physical and Virtual Environments

Nirit Putievsky Pilosof, Eivor Oborn, and Michael Barrett

GRAPH 5

Network analysis and visualisation of Putievsky Pilosof, N., Oborn, E., & Barrett, M. (2023). Future Cities Healthcare Ecosystems: Digitally Enabling Hybrid Care Models across Physical and Virtual Environments. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 99–105). TU Delft OPEN.

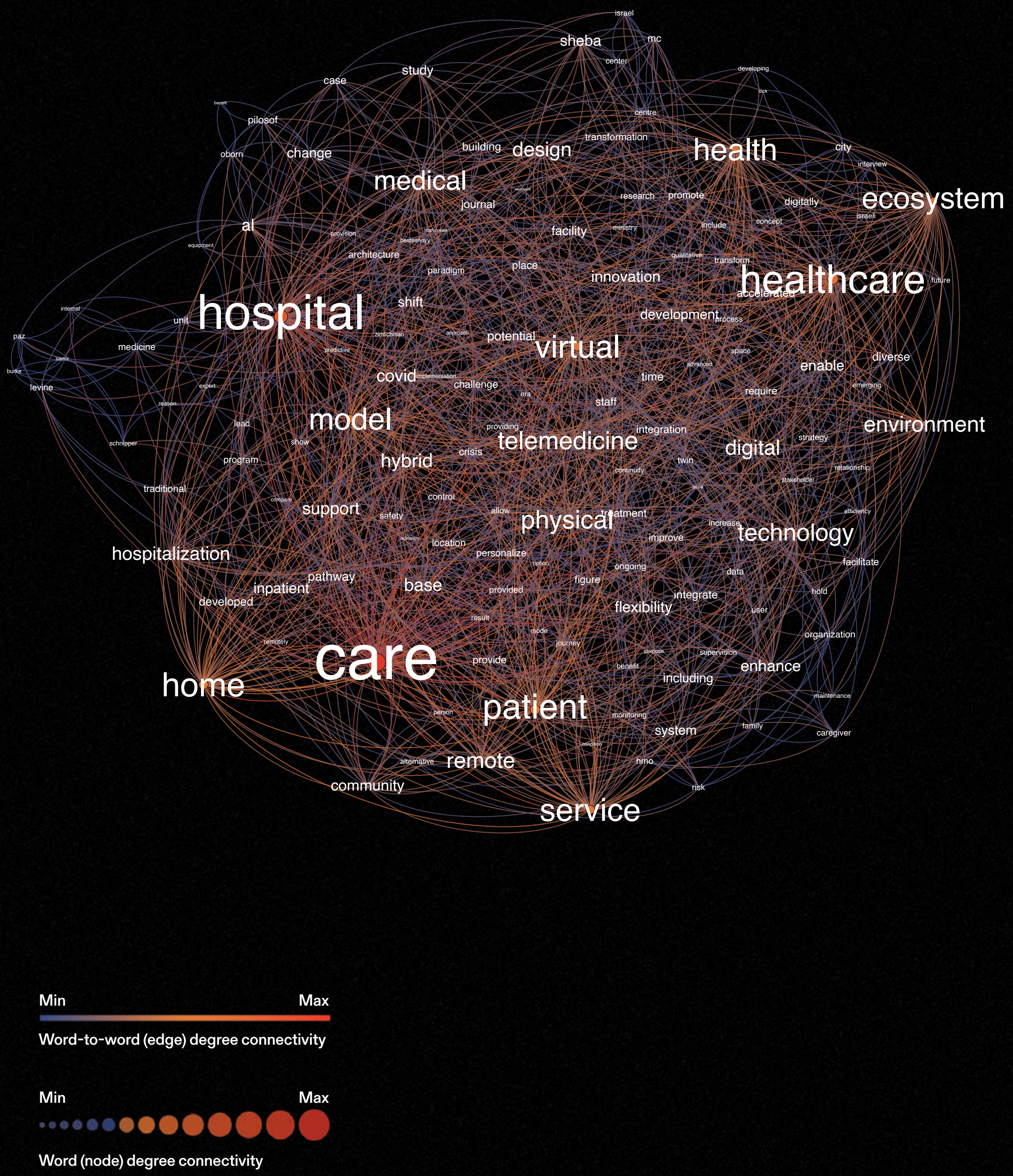
MAIN TOPICAL CLUSTERS

1 Hospital care;
2 Telemedicine;
3 Service design;
4 Medical change;
5 Healthcare ecosystem;
6 Virtual environment

KEYWORDS

healthcare ecosystem; digital health; hybrid care model; virtual environment; telemedicine.

Graph by Michal Gath-Morad →



Chapter 6—Cities of the New Real

Els Verbakel

GRAPH 6

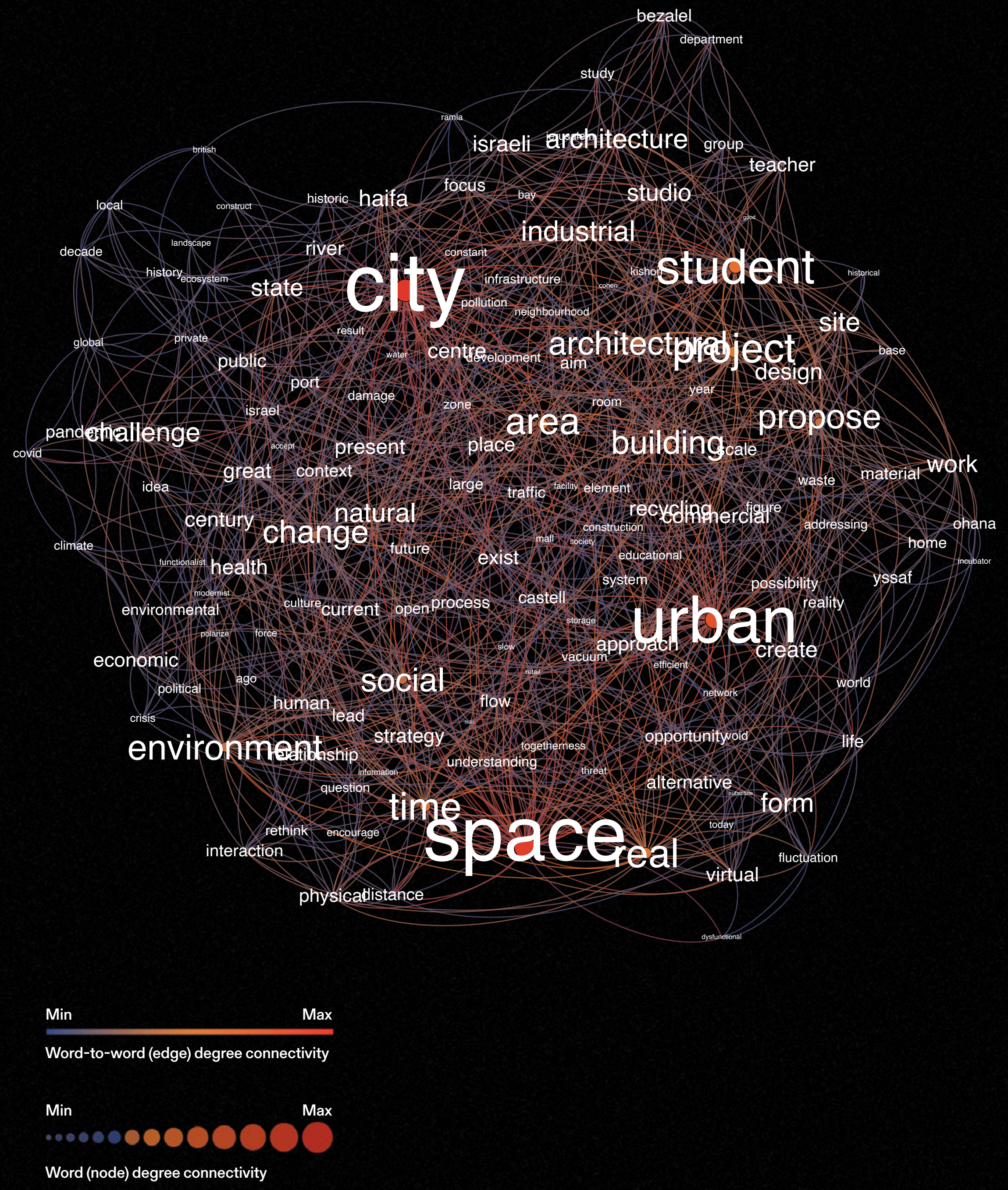
Network analysis and visualisation of Verbakel, E. (2023). Cities of the New Real. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 107–127). TU Delft OPEN.

MAIN TOPICAL CLUSTERS

1 Social change;
2 Urban recycling;
3 Space and time;
4 City state;
5 Student project;
6 Environment and health;
7 Industrial area;
8 Architectural design

KEYWORDS
urban design; resilience; tactical urbanism; virtual space; density.

Graph by Michal Gath-Morad →



Chapter 7—The Importance of Being Earnest: About Pandemic-Driven Changes in the Function and Valuation of Workspaces, and the Financial Interests Underlying Real Estate Markets

Filipa Pajević

GRAPH 7

Network analysis and visualisation of Pajević, F. (2023). The Importance of Being Earnest: About Pandemic-Driven Changes in the Function and Valuation of Workspaces, and the Financial Interests Underlying Real Estate Markets. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 133–139). TU Delft OPEN.

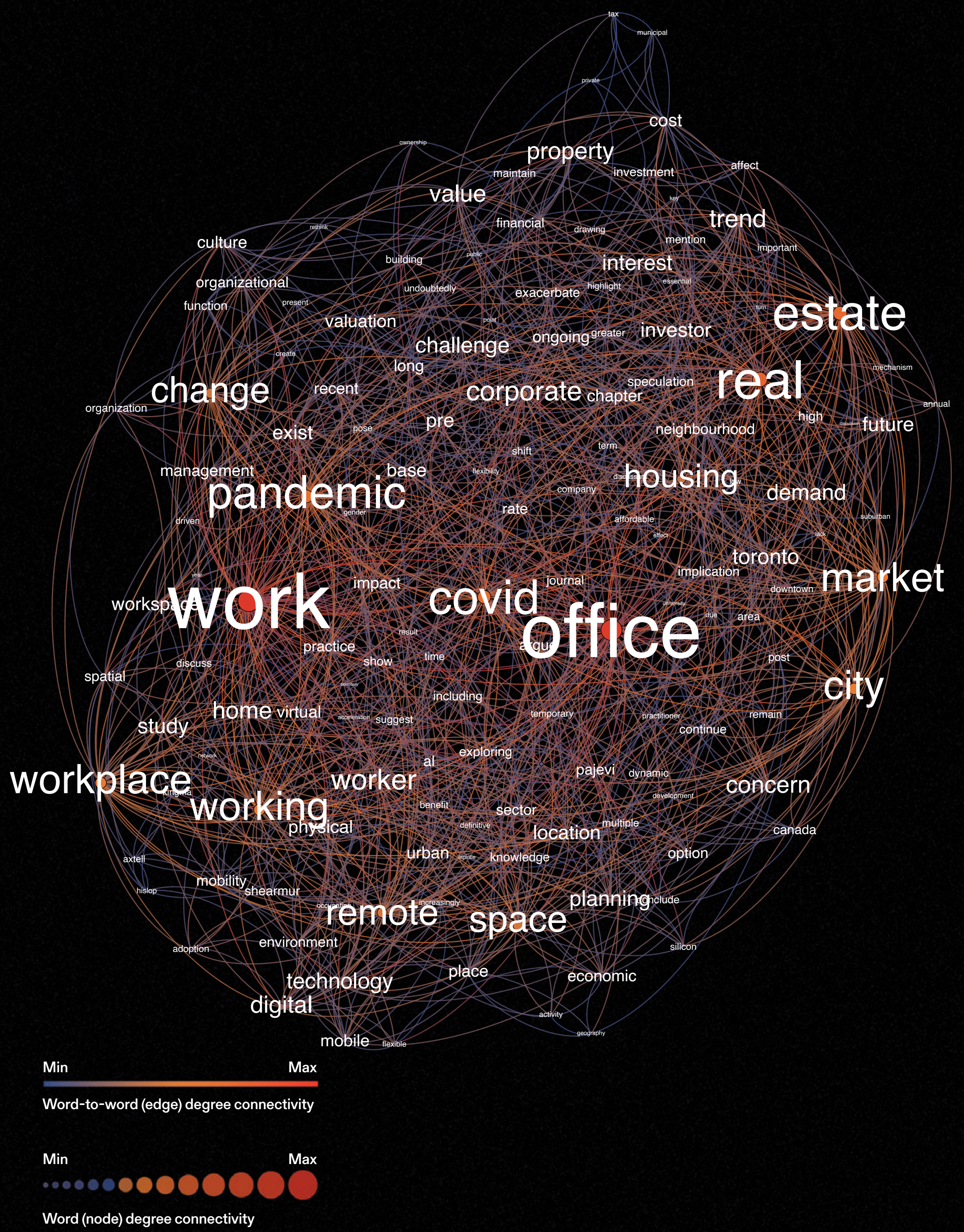
MAIN TOPICAL CLUSTERS

1 Real estate investment;
2 Workplace flexibility;
3 COVID-19 pandemic;
4 Toronto real estate market;
5 Working remotely;
6 Urban studies

KEYWORDS

COVID-19; corporate office; real estate; remote work; urban planning.

Graph by Michal Gath-Morad →



Chapter 8—Disentangling the Social from the Aesthetic: Neuropsychology for Urban Design

Panagiotis Mavros, Agnieszka Olszewska-Guizzo, and Dominique Makowski

GRAPH 8

Network analysis and visualisation of Mavros, P., Olszewska-Guizzo, A., & Makowski, D. (2023). Disentangling the Social from the Aesthetic: Neuropsychology for Urban Design. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 141–151). TU Delft OPEN.

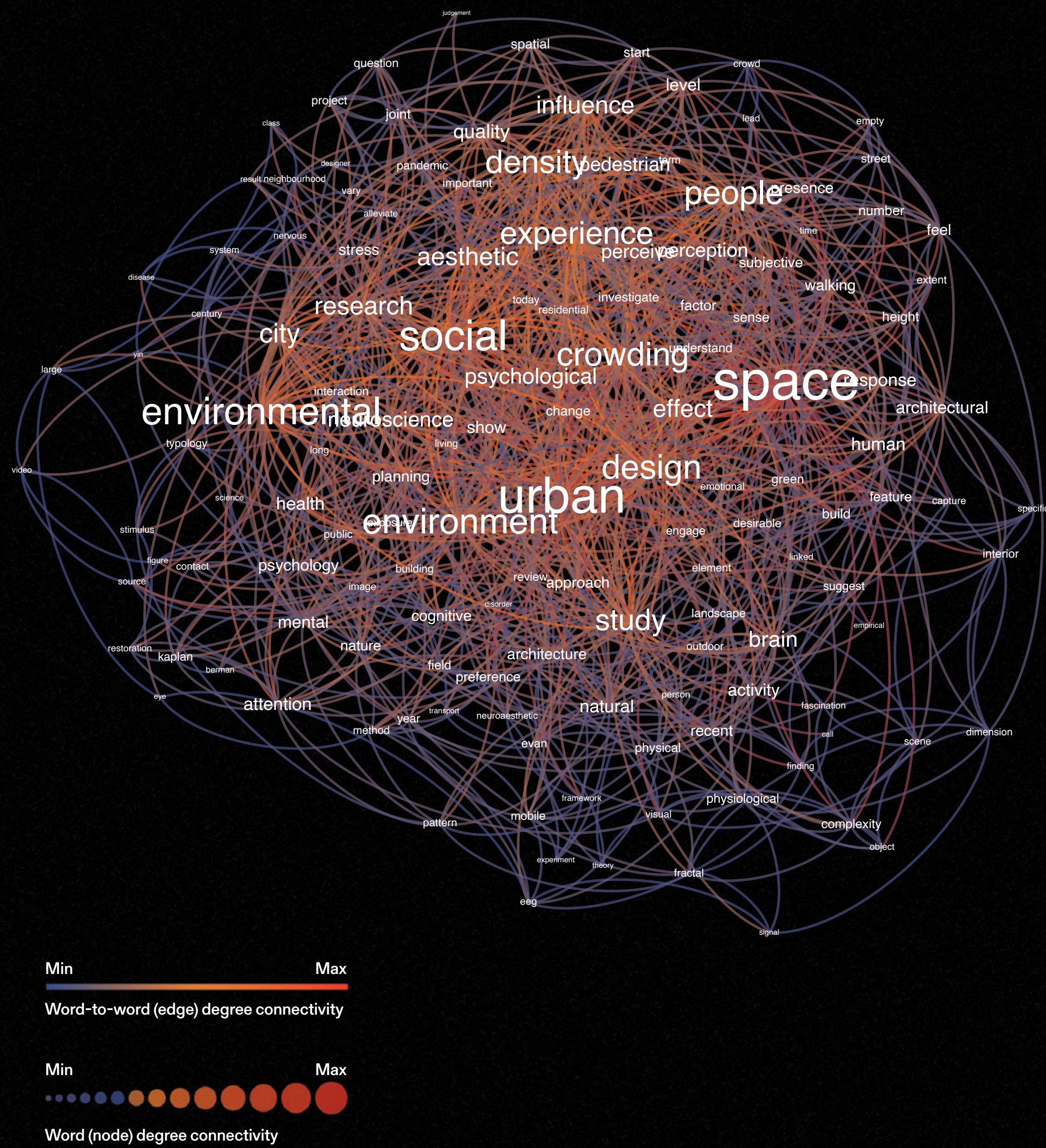
MAIN TOPICAL CLUSTERS

1 Environmental neuroscience;
2 Environmental psychology;
3 Neuropsychology of urban design;
4 The psychology of space;
5 The neuroscience of crowding;
6 The social psychology of crowding;
7 The pedestrian density of cities

KEYWORDS

urban design; social density; aesthetics; environmental neuroscience.

Graph by Michal Gath-Morad →



Chapter 9—Designing for Urban Health and Well-being by Revisiting Proximity, Walkability, and Accessibility

Achilleas Psyllidis

GRAPH 9

Network analysis and visualisation of Psyllidis, A. (2023). Designing for Urban Health and Well-being by Revisiting Proximity, Walkability, and Accessibility. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 153–163). TU Delft OPEN.

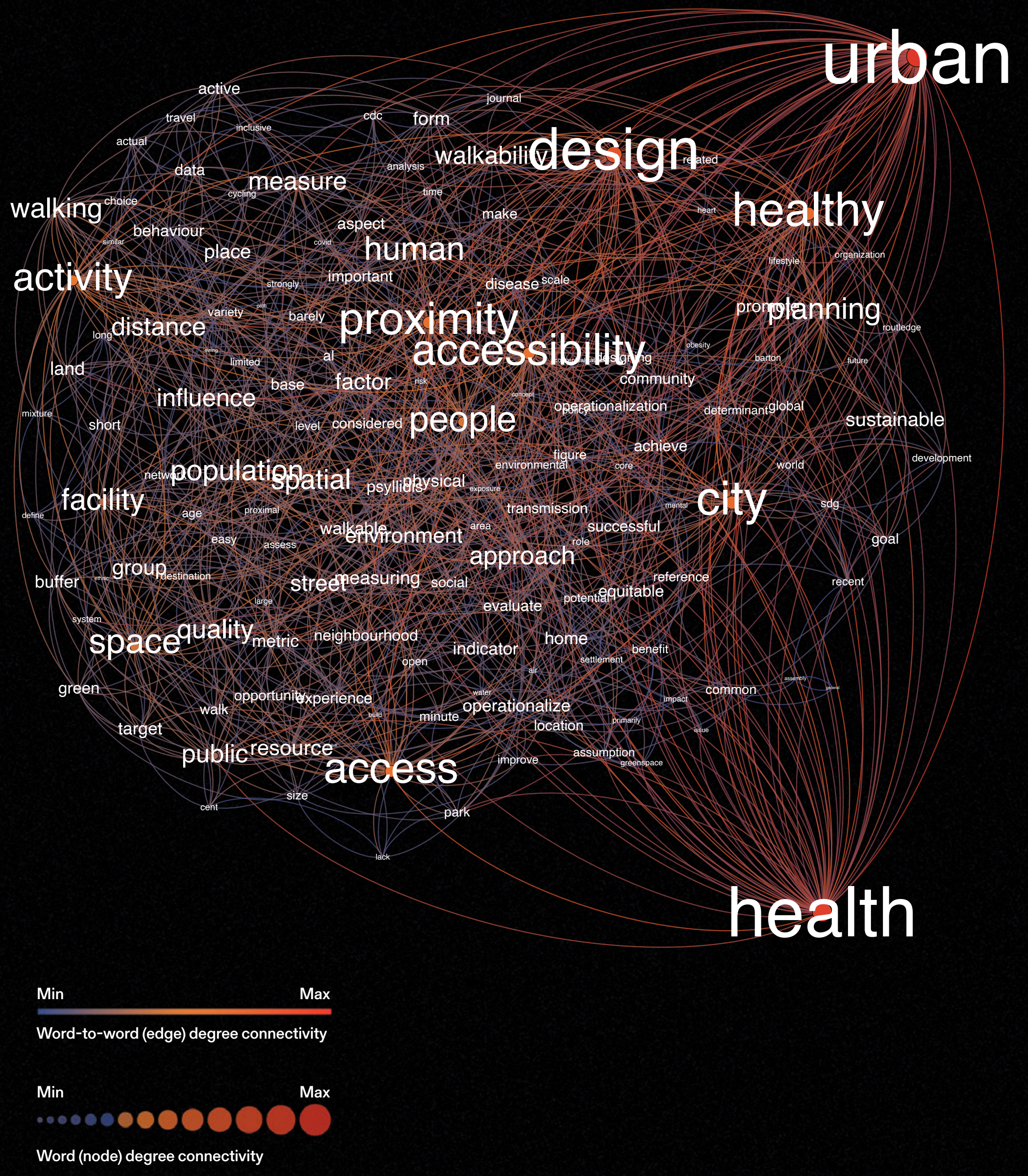
MAIN TOPICAL CLUSTERS

1 Urban health;
2 Activity and health;
3 Walkability;
4 Access to resources;
5 Population and health;
6 Healthy cities;
7 Public space;
8 Disease transmission

KEYWORDS

urban health; well-being; proximity; walkability; accessibility.

Graph by Michal Gath-Morad →



Chapter 10—Cities and Love: Generative Design as Mapping of Human Values

Gia Jung

GRAPH 10

Network analysis and visualisation of Jung, G. (2023). Cities and Love: Generative Design as Mapping of Human Values. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 165–382). TU Delft OPEN.

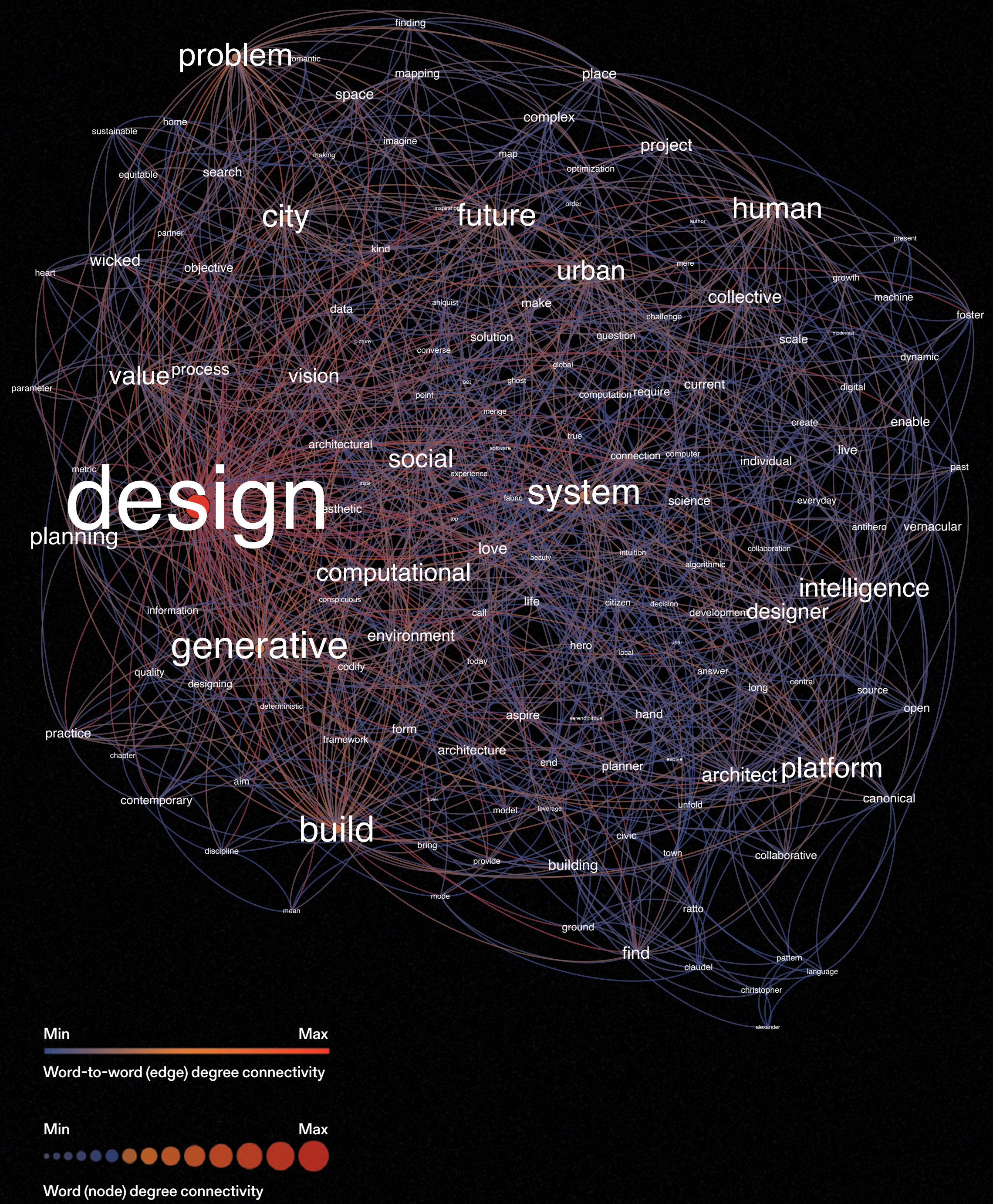
MAIN TOPICAL CLUSTERS

1 Civic life;
2 Designing quality;
3 Sustainable growth;
4 Open source architecture;
5 Urban data;
6 Digital mapping;
7 Optimization

KEYWORDS

generative design; wicked problem; computational design; sociotechnical system.

Graph by Michal Gath-Morad →



Chapter 11—The Urban Commons as a Remedy to Climate Change Vulnerabilities

Dalia Munenzon

GRAPH 11

Network analysis and visualisation of Munenzon, D. (2023). The Urban Commons as a Remedy to Climate Change Vulnerabilities. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 177–187). TU Delft OPEN.

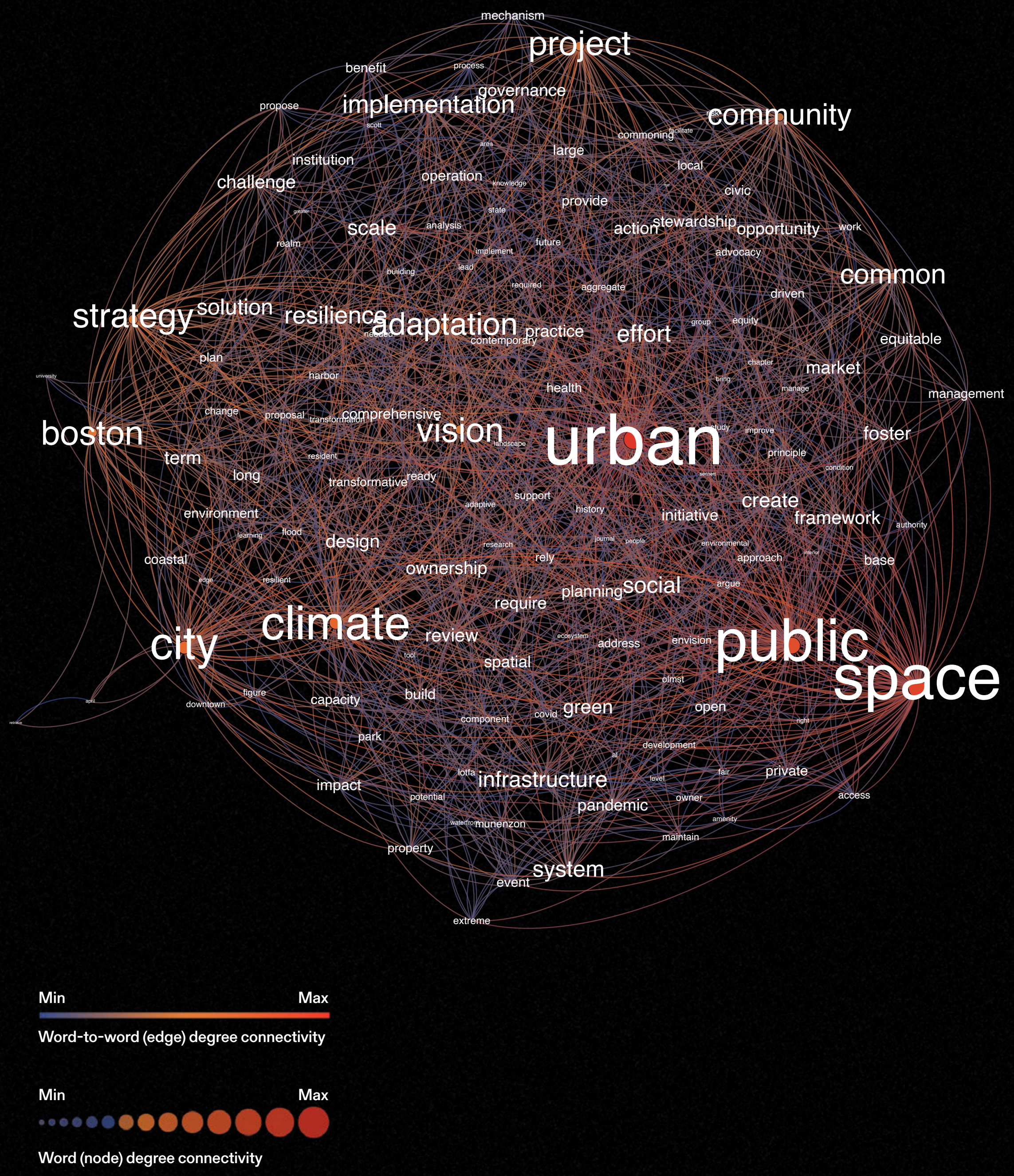
MAIN TOPICAL CLUSTERS

1 Space planning;
2 Urban resilience;
3 Property development;
4 Community action;
5 Solution-oriented thinking;
6 Large-scale planning

KEYWORDS

climate adaptation; environmental justice; urban commons; resilience; equity.

Graph by Michal Gath-Morad →



Chapter 12—Architecture, Behaviour, and Magic: On the Architect's Design of Forms of Life

Brendon Carlin

GRAPH 12

Network analysis and visualisation of Carlin, B. (2023). Architecture, Behaviour, and Magic: On the Architect's Design of Forms of Life. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 189–197). TU Delft OPEN.

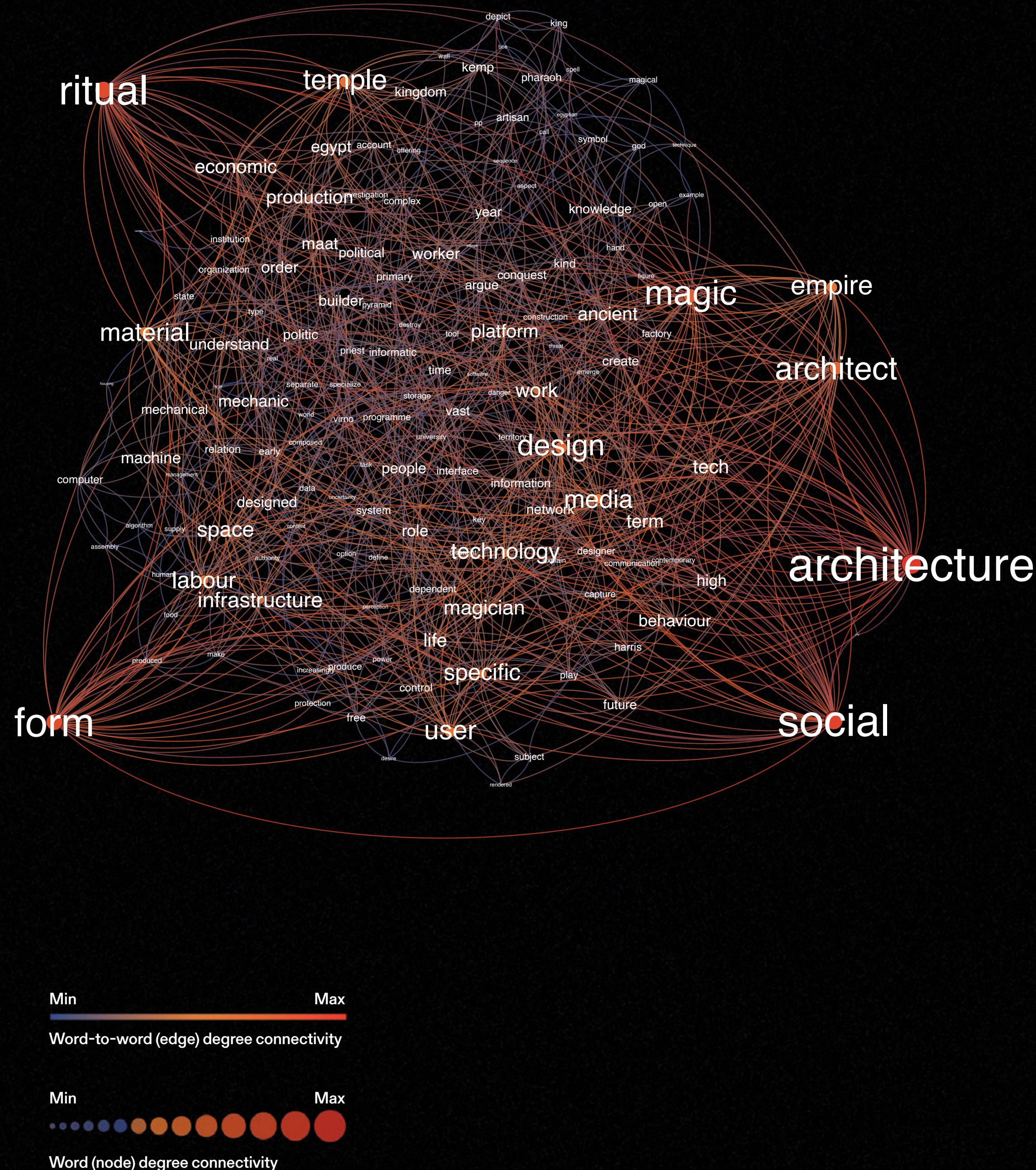
MAIN TOPICAL CLUSTERS

1 Architecture;
2 Rituals;
3 Temples;
4 User Interfaces;
5 Computers;
6 Social Media;
7 Magic;
8 Infrastructure

KEYWORDS

architect; labour; bio-politics; social media; archaeology.

Graph by Michal Gath-Morad →



Chapter 13—Wechselwirkungen: Rethinking Urban Planning and Densification

Wolf Mangelsdorf

GRAPH 13

Network analysis and visualisation of Mangelsdorf, W. (2023). Wechselwirkungen: Rethinking Urban Planning and Densification. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 199-205). TU Delft OPEN.

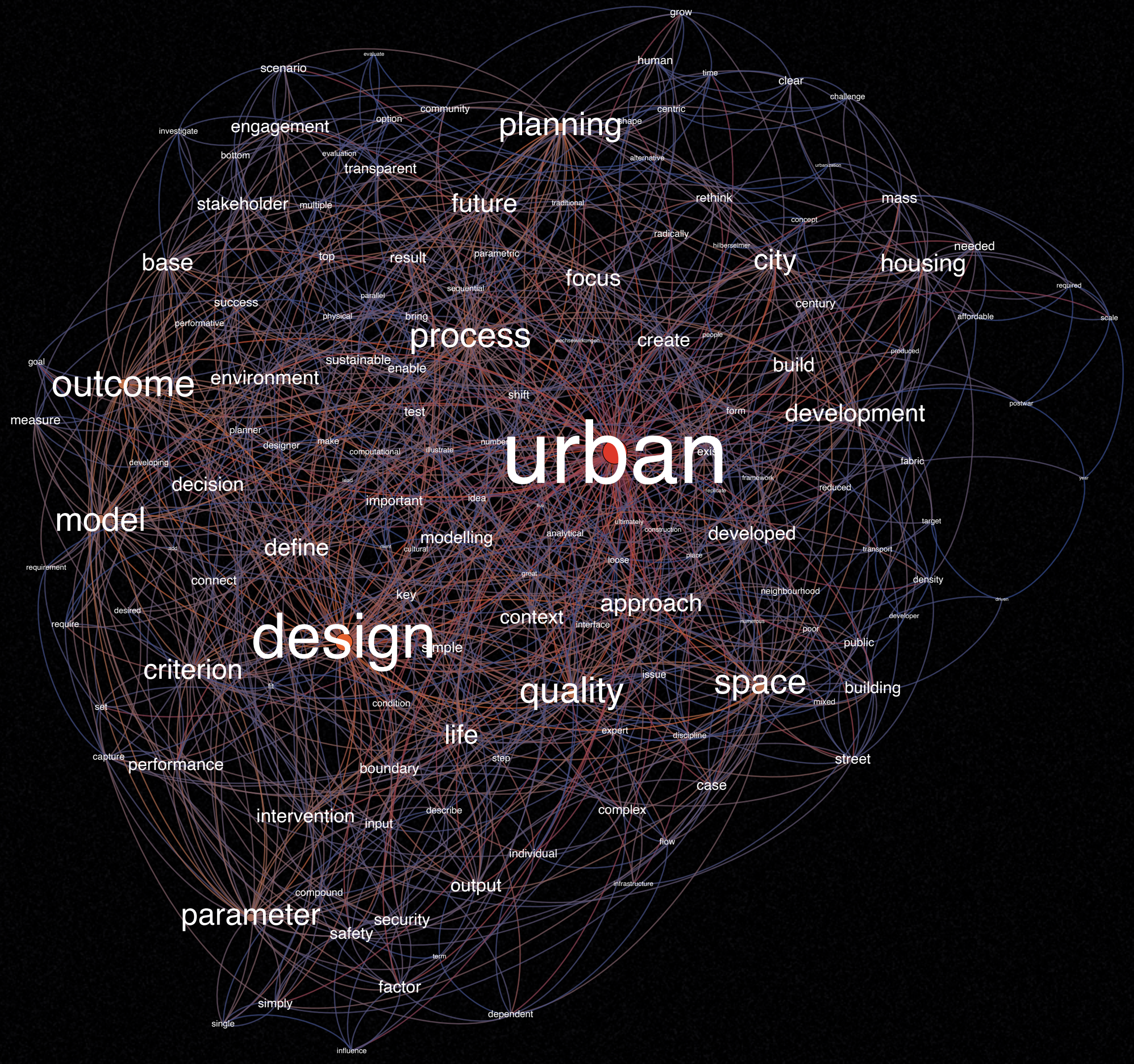
MAIN TOPICAL CLUSTERS

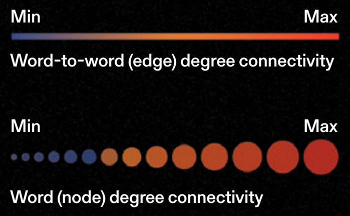
1 Urban design;
2 Future planning;
3 Safety and security;
4 Modelling and construction;
5 Housing and environment;
6 City design;
7 Life quality;
8 Community engagement

KEYWORDS

Wechselwirkungen; urban planning; parametric modelling; human-centric; planning tools.

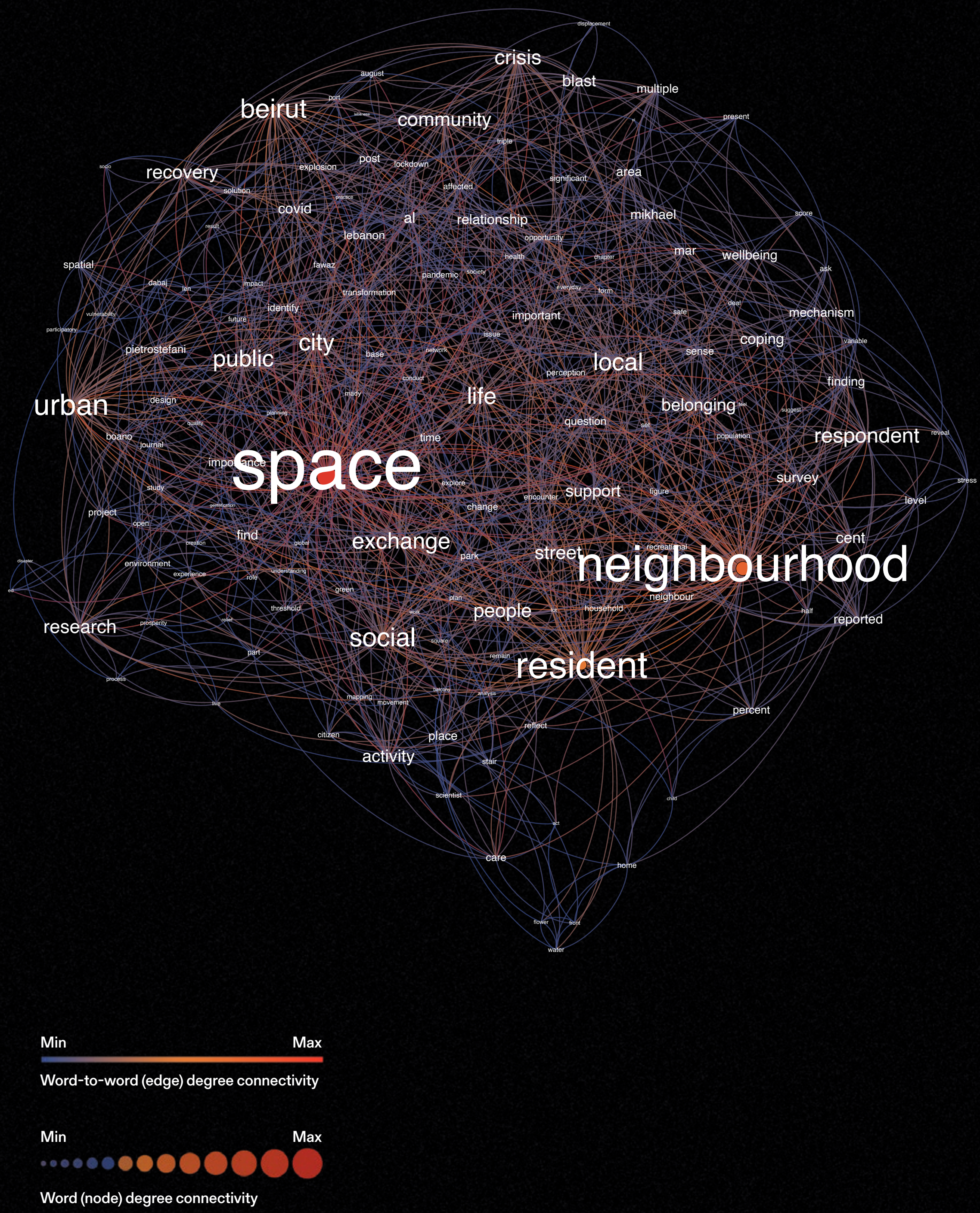
Graph by Michal Gath-Morad →





Chapter 14—Rethinking 'Spaces of Exchange' for Future Cities

Elisabetta Pietrostefani, Joana Dabaj, and Camillo Boano



GRAPH 14

Network analysis and visualisation of Pietrostefani, E., Dabaj, J., & Boano, C. (2023). Rethinking 'Spaces of Exchange' for Future Cities. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 207–215). TU Delft OPEN.

MAIN TOPICAL CLUSTERS

1 Community well-being;
2 Urban environment;
3 Social life in the city;
4 Community crisis and design;
5 The Beirut Blast of 2020;
6 Disaster research and relief;
7 Coping mechanisms

KEYWORDS
urban; space; neighbourhood; belonging; well-being.

Graph by Michal Gath-Morad →

Chapter 15—Designing with Cognition in Mind: How Choice Architecture Theory Could Inform Architectural Design of Active Built Environments

Michal Gath-Morad

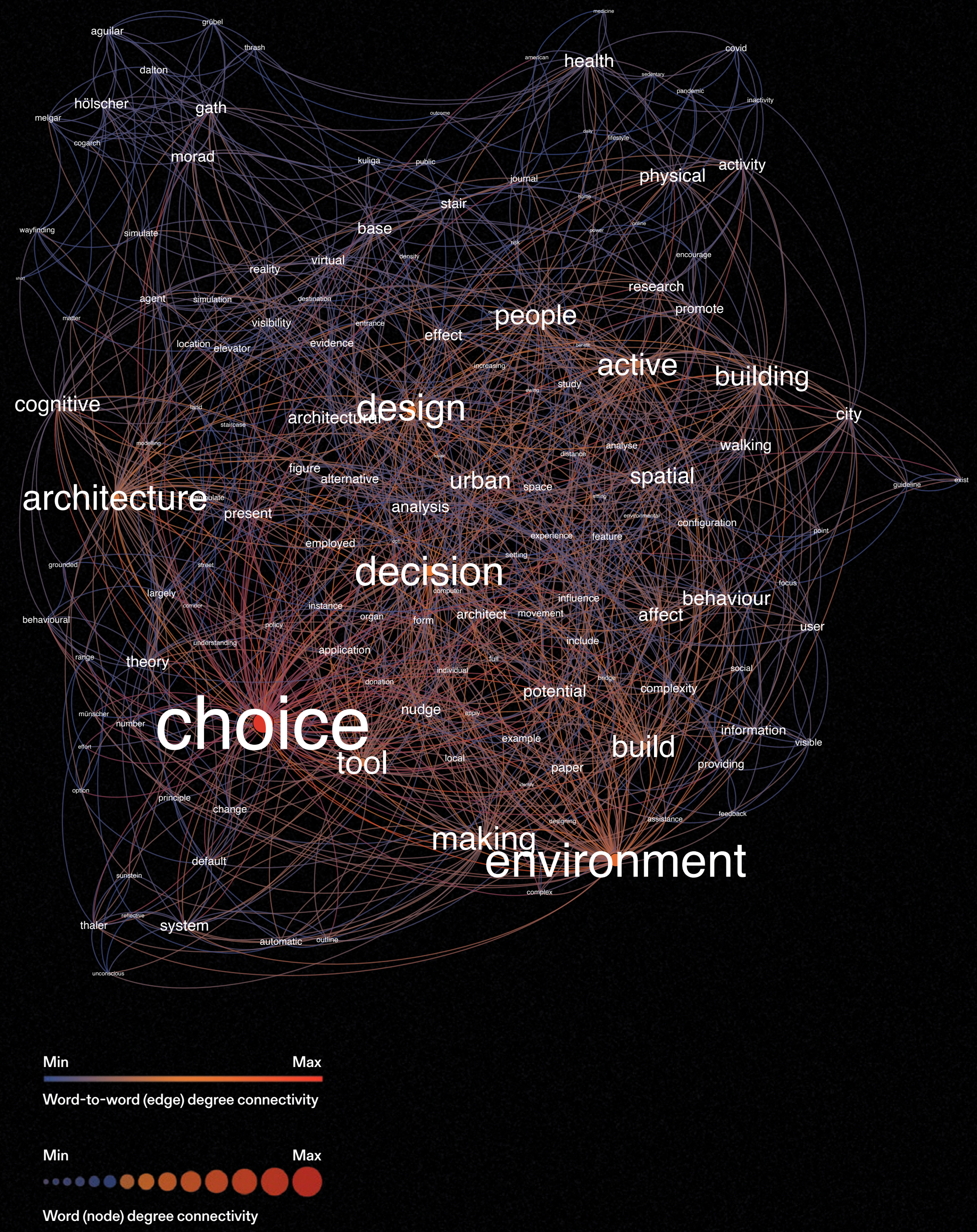
GRAPH 15

Network analysis and visualisation of Gath-Morad, M. (2023). Designing with Cognition in Mind: How Choice Architecture Theory Could Inform Architectural Design of Active Built Environments. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 217–225). TU Delft OPEN.

MAIN TOPICAL CLUSTERS

1 Decision making;
2 Choice architecture;
3 Building health;
4 Wayfinding;
5 Simulation;
6 Active design;
7 Alternative design

KEYWORDS
active buildings; persuasive urbanism; choice architecture; evidence-based design.



Graph by Michal Gath-Morad →

Chapter 16—Is New York City's Pandemic Urbanism Here to Stay? Thoughts on How COVID-19 Changed New York's Sidewalk Ballet

Sharon Yavo-Ayalon

GRAPH 16

Network analysis and visualisation of Yavo-Ayalon, S. (2023). Is New York City's Pandemic Urbanism Here to Stay? Thoughts on How COVID-19 Changed New York's Sidewalk Ballet. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 227–235). TU Delft OPEN.

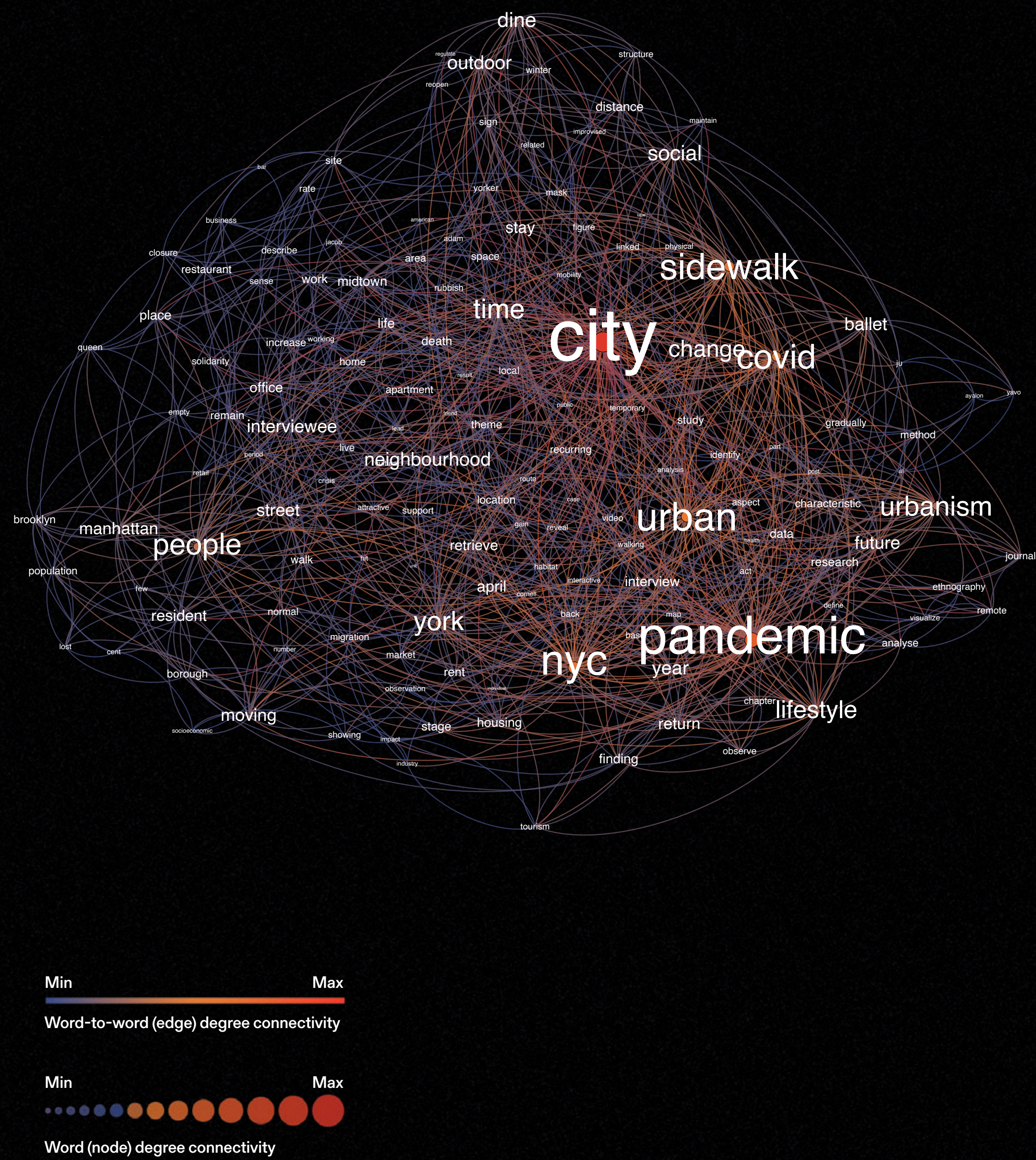
MAIN TOPICAL CLUSTERS

1 Pandemic research;
2 People and migration;
3 Life and death in the city;
4 Urban observation and study;
5 Social distancing in the city;
6 City housing and crisis;
7 Neighbourhoods and community;
8 Working from home

KEYWORDS

New York City; pandemic urbanism; remote ethnography; the future of cities; urban lifestyle.

Graph by Michal Gath-Morad →



Chapter 17—Transforming Cities after the Pandemic

Sabine Georgi and Tobias Just

GRAPH 17

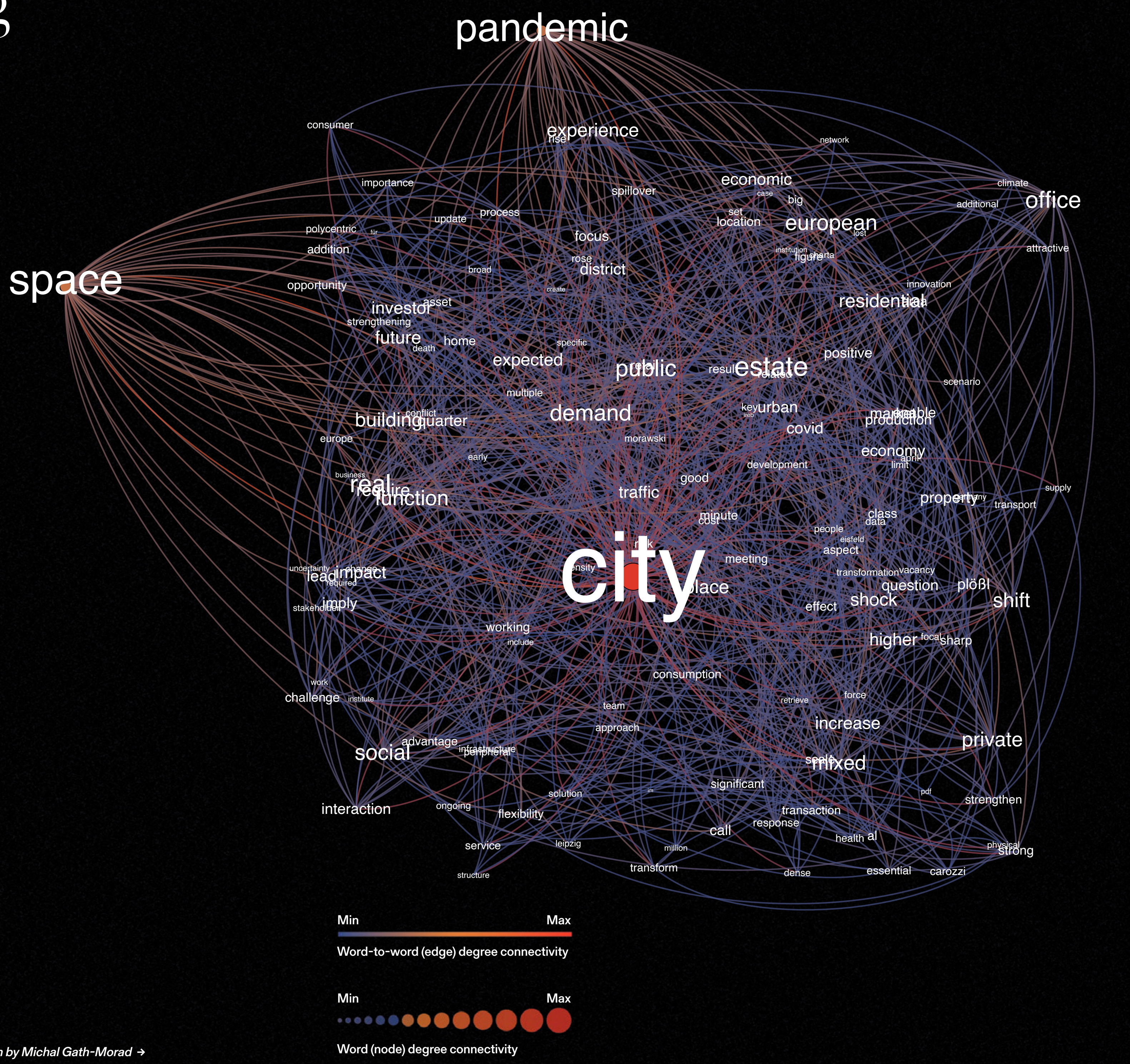
Network analysis and visualisation of Georgi, S., & Just, T. (2023). Transforming Cities after the Pandemic. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 398–247). TU Delft OPEN.

MAIN TOPICAL CLUSTERS

1 Space public vs. private;
2 City pandemic's impact;
3 COVID challenges & results;
4 Shock economy positive & negative effects;
5 Real estate future & investor focus;
6 Mixed-use benefits & challenges;
7 Office space working from home;
8 Social interaction key to innovation.

KEYWORDS
housing; commercial real estate; mixed use; 15-minute-quarter.

Graph by Michal Gath-Morad →



Chapter 18—Circular Predictive Planning for Transformative Spaces

Marvin Bratke

GRAPH 18

Network analysis and visualisation of Bratke, M. (2023). Circular Predictive Planning for Transformative Spaces. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 249–261). TU Delft OPEN.

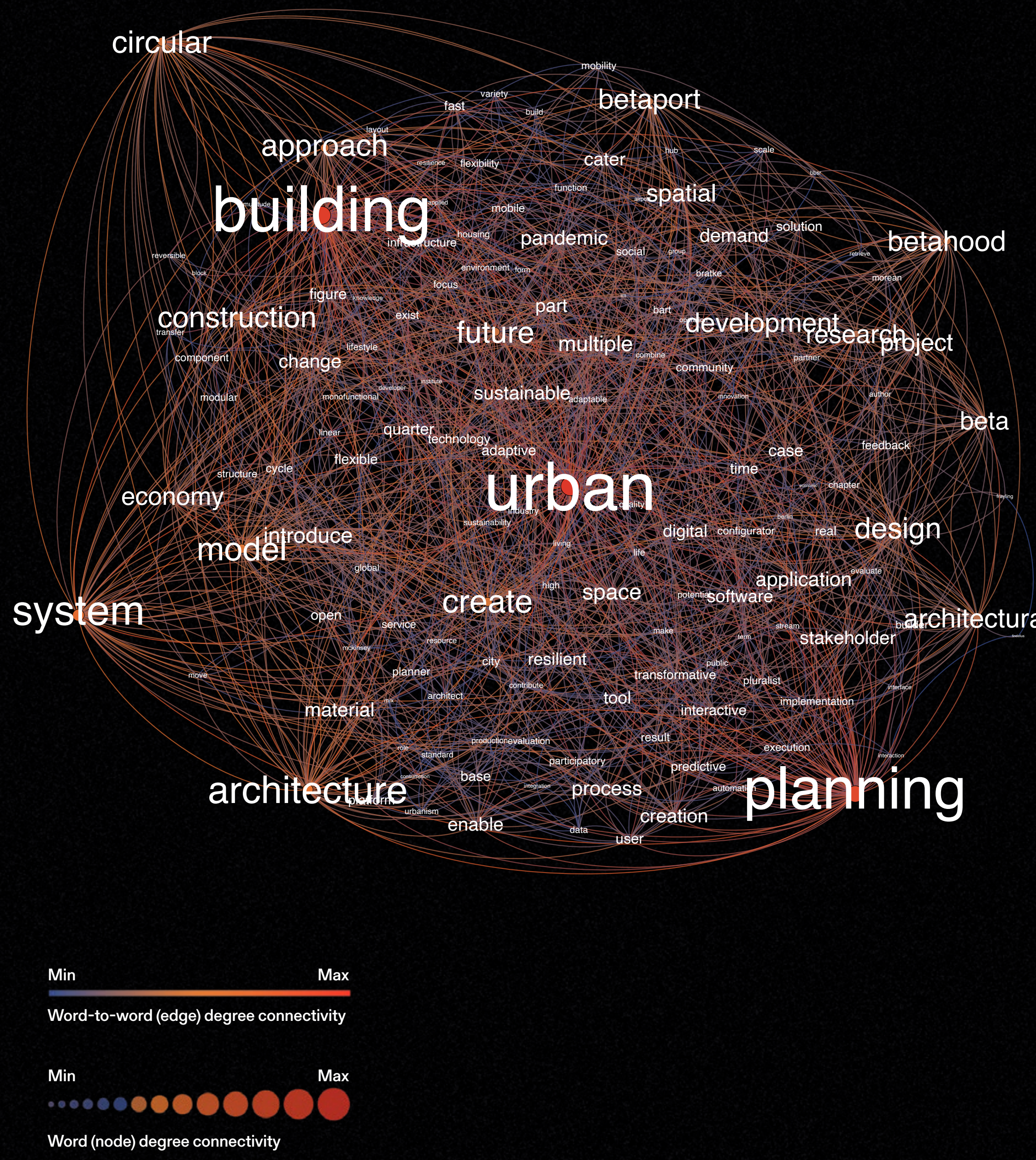
MAIN TOPICAL CLUSTERS

1 Application Processes;
2 Betaport;
3 Building Models;
4 Real-Time Planning;
5 BetaHood;
6 Circular Economy;
7 Design Research;
8 Construction Pandemics

KEYWORDS

spatial systems; building as a service; co-creation, circular architecture, on-demand.

Graph by Michal Gath-Morad →



Chapter 19—Why Low Emissions, Purposeful Urban Planning, and Equitable Distribution are Critical in the Quest for a Truly Sustainable City

Hannah-Polly Williams

GRAPH 19

Network analysis and visualisation of Williams, HP. (2023). Why Low Emissions, Purposeful Urban Planning, and Equitable Distribution Are Critical in the Quest for a Truly Sustainable City. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 263–271). TU Delft OPEN.

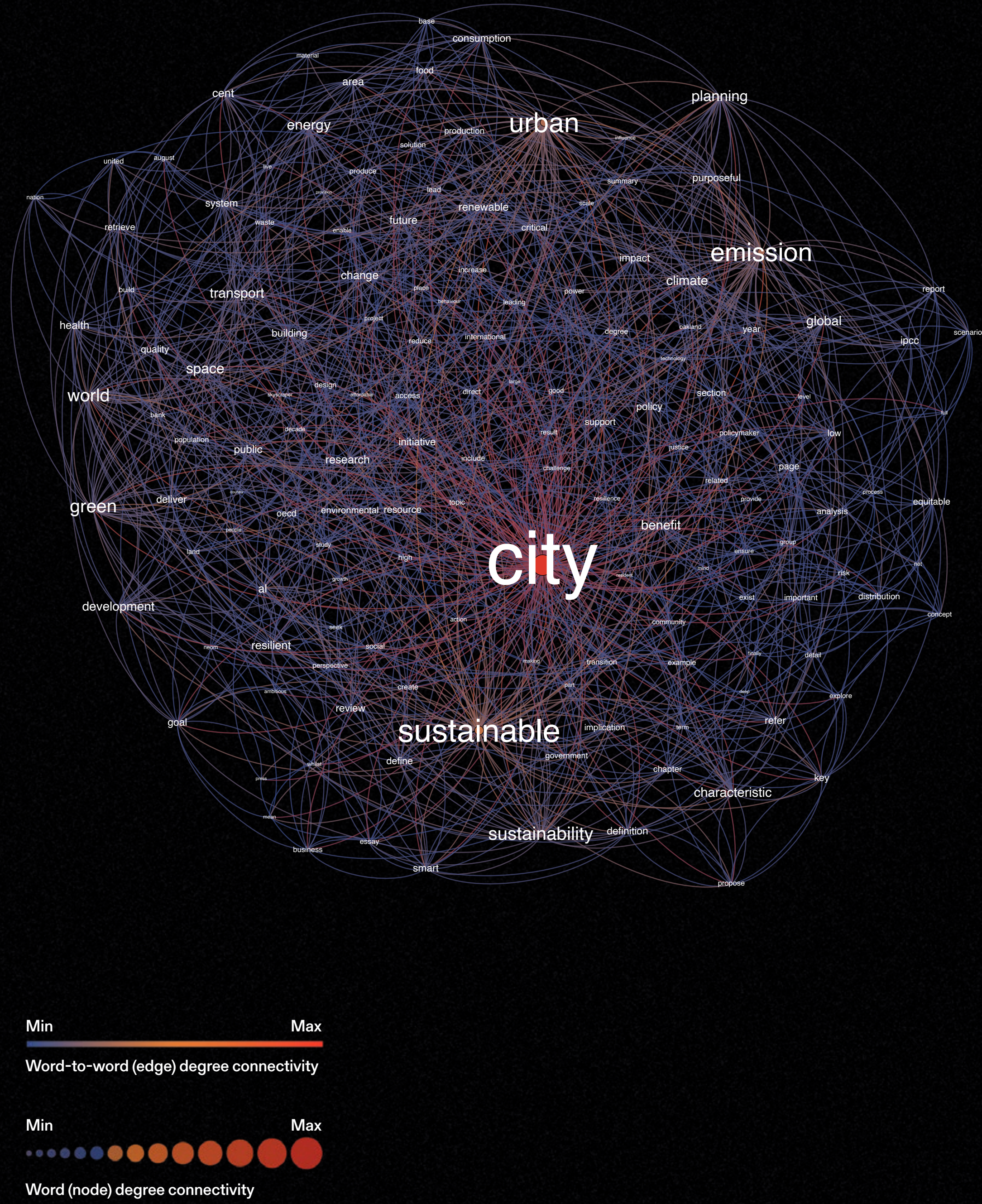
MAIN TOPICAL CLUSTERS

1 Sustainable development;
2 Green energy;
3 Climate change;
4 Emissions;
5 Urban planning;
6 World resources;
7 Food consumption;
8 United Nations

KEYWORDS

sustainable city; sustainability; low emissions city; urban planning; equity, justice.

Graph by Michal Gath-Morad →



Chapter 20—Digital Disruption and the Future City

Samsurin Welch

GRAPH 20

Network analysis and visualisation of Welch, S. (2023). Digital Disruption and the Future City. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 366–374). TU Delft OPEN.

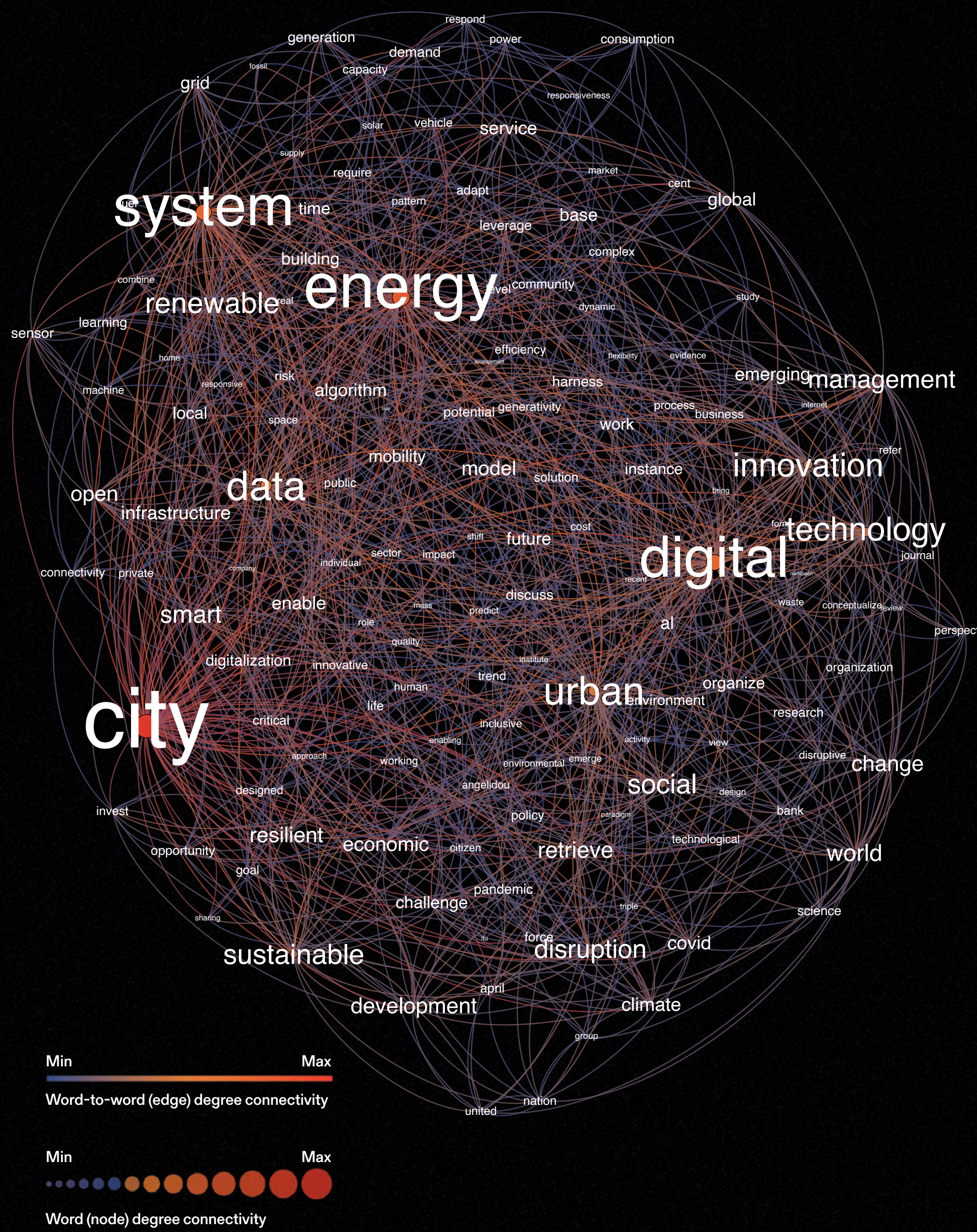
MAIN TOPICAL CLUSTERS

1 Renewable Energy;
2 Smart Cities;
3 Digital Innovation;
4 Economic Trends;
5 Open Data;
6 Climate Change;
7 Urban Environments;
8 Waste Management

KEYWORDS

disruption; smart cities; digitalization; renewable energy.

Graph by Michal Gath-Morad →



Chapter 21—Urbanizing Smart Cities: An Initial Approach to the Concept of Urban Artificial Intelligence

Laura Narvaez Zertuche

GRAPH 21

Network analysis and visualisation of Narvaez Zertuche, L. (2023). Urbanizing Smart Cities: An Initial Approach to the Concept of Urban Artificial Intelligence. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 368–372). TU Delft OPEN.

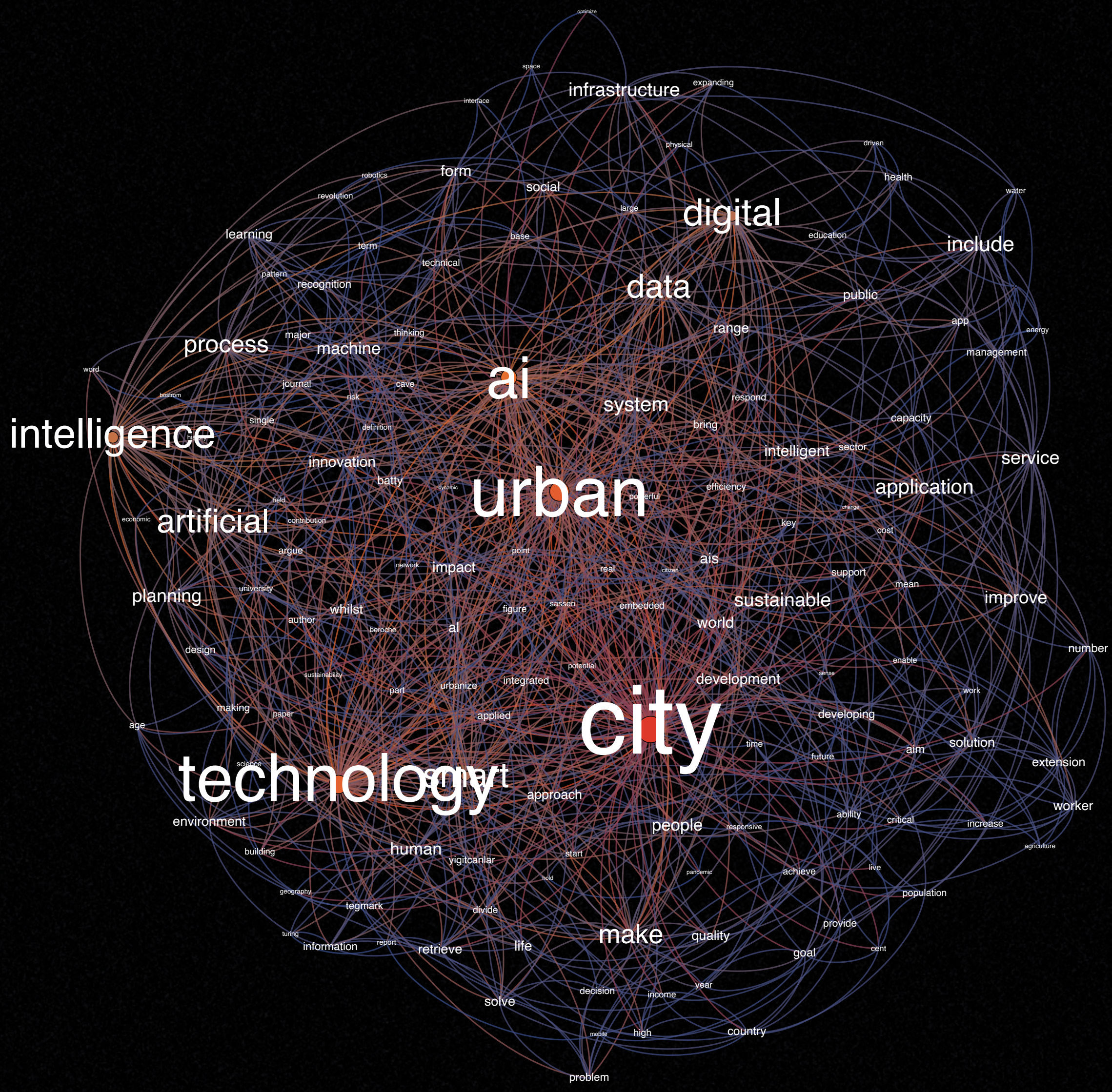
MAIN TOPICAL CLUSTERS

1 Urban technology;
2 Artificial intelligence;
3 Smart city;
4 Intelligent data;
5 Service quality;
6 Human workers;
7 Infrastructure;
8 Sustainable development

KEYWORDS

smart city; artificial intelligence; urban planning; design.

Graph by Michal Gath-Morad →



Min Max
Word-to-word (edge) degree connectivity

Min Max
Word (node) degree connectivity

Chapter 22—A Tale of Three Cities: On Digital Twins

Javier Argota Sánchez-Vaquerizo and Adriana Zurera Gómez

GRAPH 22

Network analysis and visualisation of Argota Sánchez-Vaquerizo, J., & Zurera Gómez, A. (2023). A Tale of Three Cities: On Digital Twins. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 374–307). TU Delft OPEN.

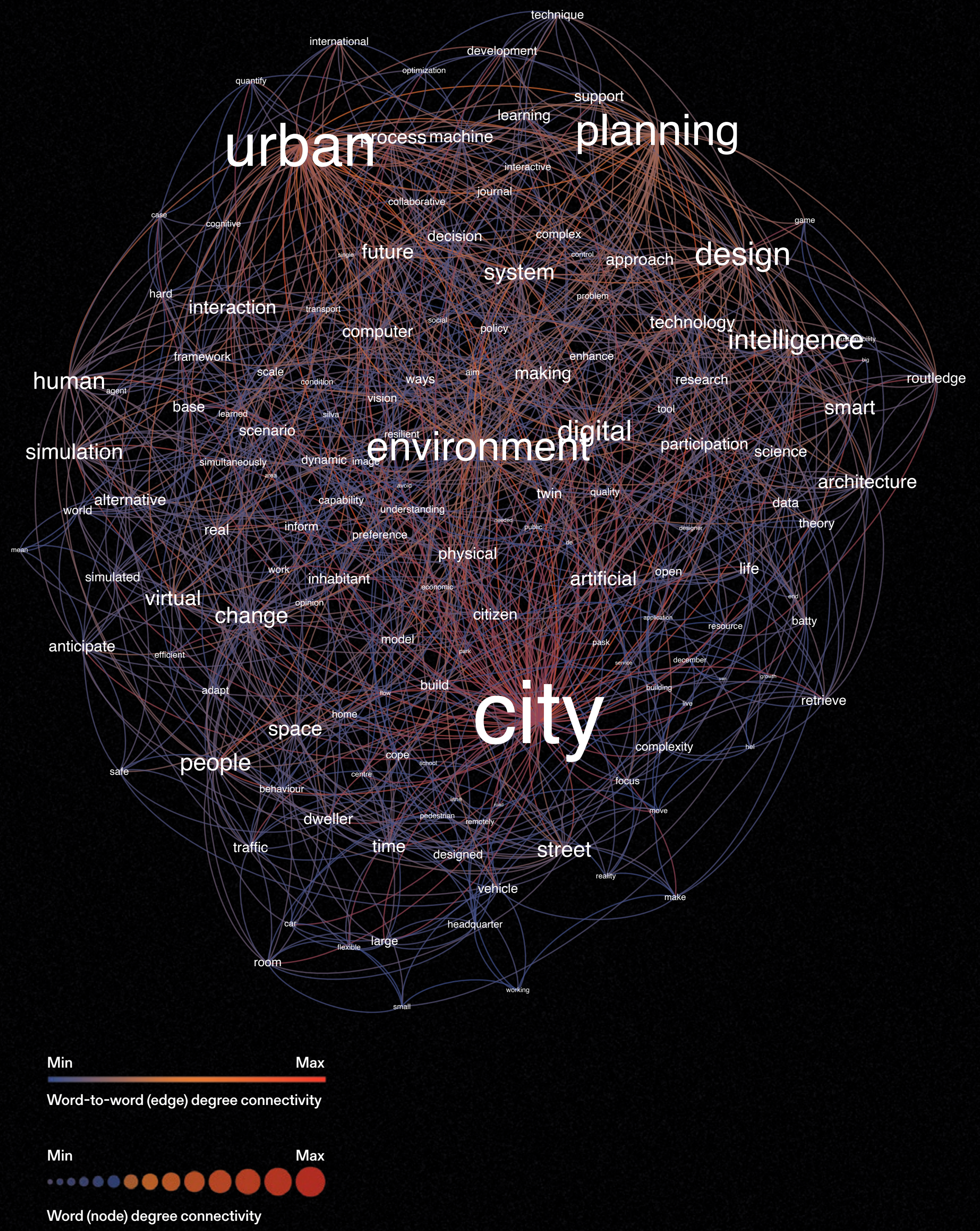
MAIN TOPICAL CLUSTERS

1 Urban planning;
2 Environmental design;
3 Transportation planning;
4 Economic development;
5 City planning;
6 Digital technology;
7 Artificial intelligence

KEYWORDS

urban digital twins; cities simulation; citizen participation; cities speculative design; design fiction; hybrid intelligence.

Graph by Michal Gath-Morad →



Chapter 23—Balancing the Carbon Budget: Applying Carbon Budgeting to Architectural Design

Kåre Stokholm Poulsgaard, Ann-Britt Vejlgaard, and Lasse Lind

GRAPH 23

Network analysis and visualisation of Stokholm Poulsgaard, K., Vejlgaard, A., & Lind, L. (2023). Balancing the Carbon Budget: Applying Carbon Budgeting to Architectural Design. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 370–317). TU Delft OPEN.

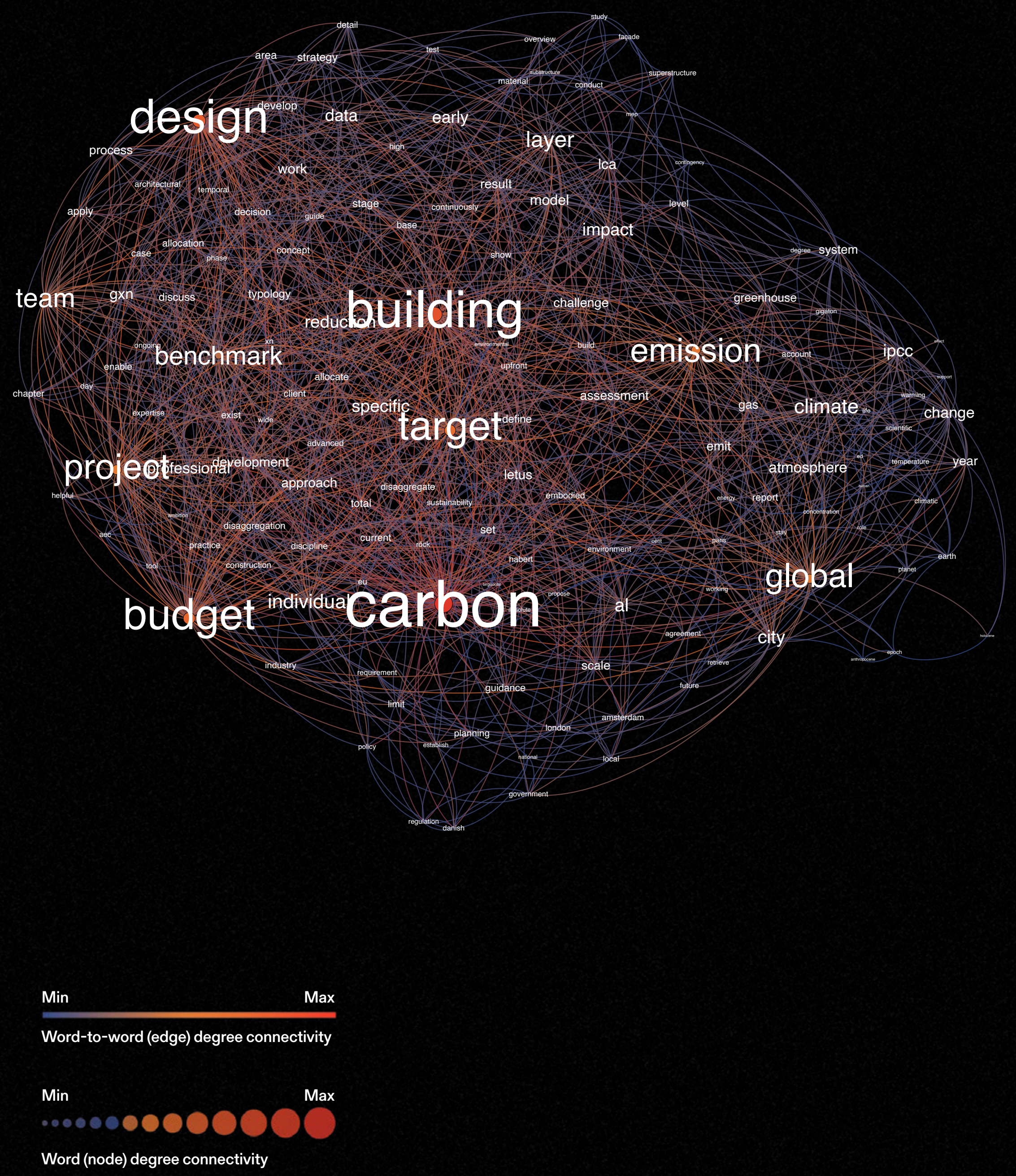
MAIN TOPICAL CLUSTERS

1 Climate Change;
2 Design Process;
3 Building Typology;
4 Project Management;
5 Life Cycle Assessment;
6 Planning Policy;
7 Building Data

KEYWORDS

architecture; building design; decarbonization; carbon budget; construction.

Graph by Michal Gath-Morad →



Chapter 24—The Potential of Mass Timber Building for Future-Proof Cities

Pablo van der Lugt

GRAPH 24

Network analysis and visualisation of Van der Lugt, P. (2023). The Potential of Mass Timber Building for Future-Proof Cities. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 319–331). TU Delft OPEN.

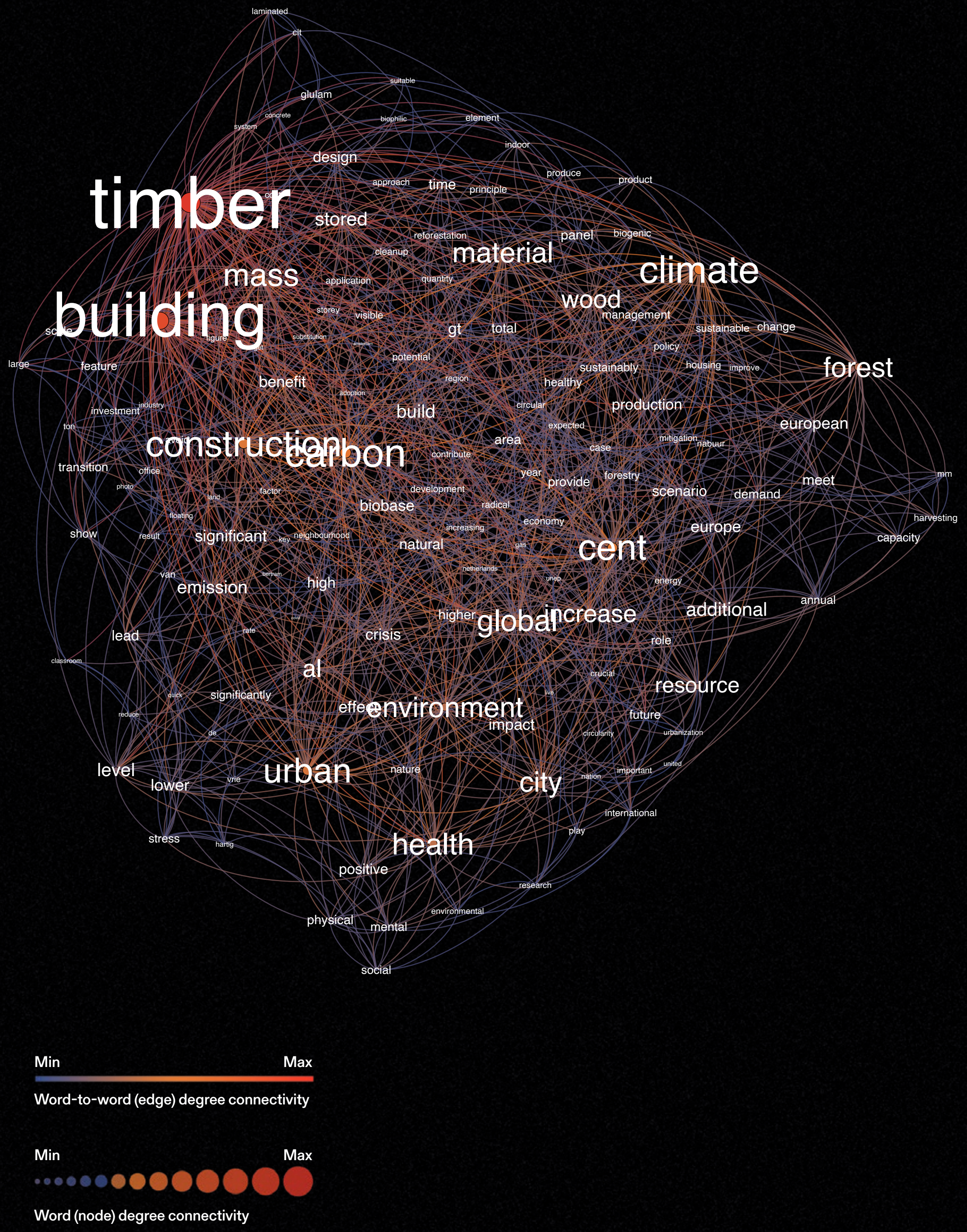
MAIN TOPICAL CLUSTERS

1 Carbon emissions;
2 Timber construction;
3 Climate change;
4 Forest management;
5 Biophilic design;
6 Urban wood;
7 Nature's health benefits

KEYWORDS

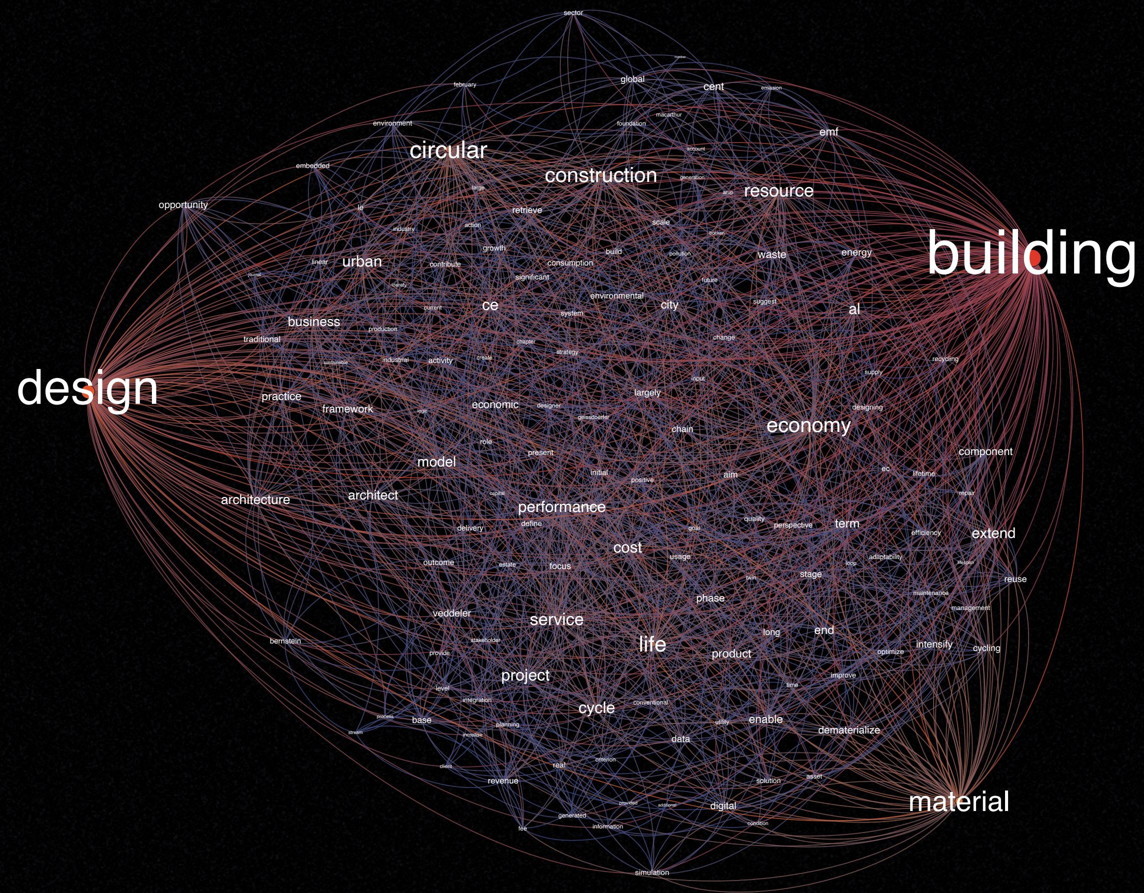
mass timber; biobased building; climate; circularity; health and well-being.

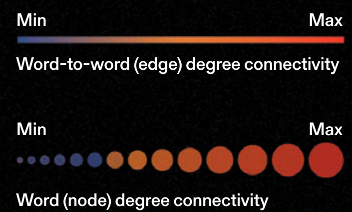
Graph by Michal Gath-Morad →



Chapter 25—Circular Design: Business Model Innovation for Architecture and Urban Design Practices

Christian Veddeler





GRAPH 25

Network analysis and visualisation of Veddeler, C. (2023). Circular Design: Business Model Innovation for Architecture and Urban Design Practices. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 333–343). TU Delft OPEN.

MAIN TOPICAL CLUSTERS

1 Resource management;
2 Building design and materials;
3 Urban design and planning;
4 Circular economy;
5 Real estate management;
6 Product life cycle;
7 Initial capital

KEYWORDS
circular economy; circular city; circular building; circular material; architecture practice; urban design; business model innovation.

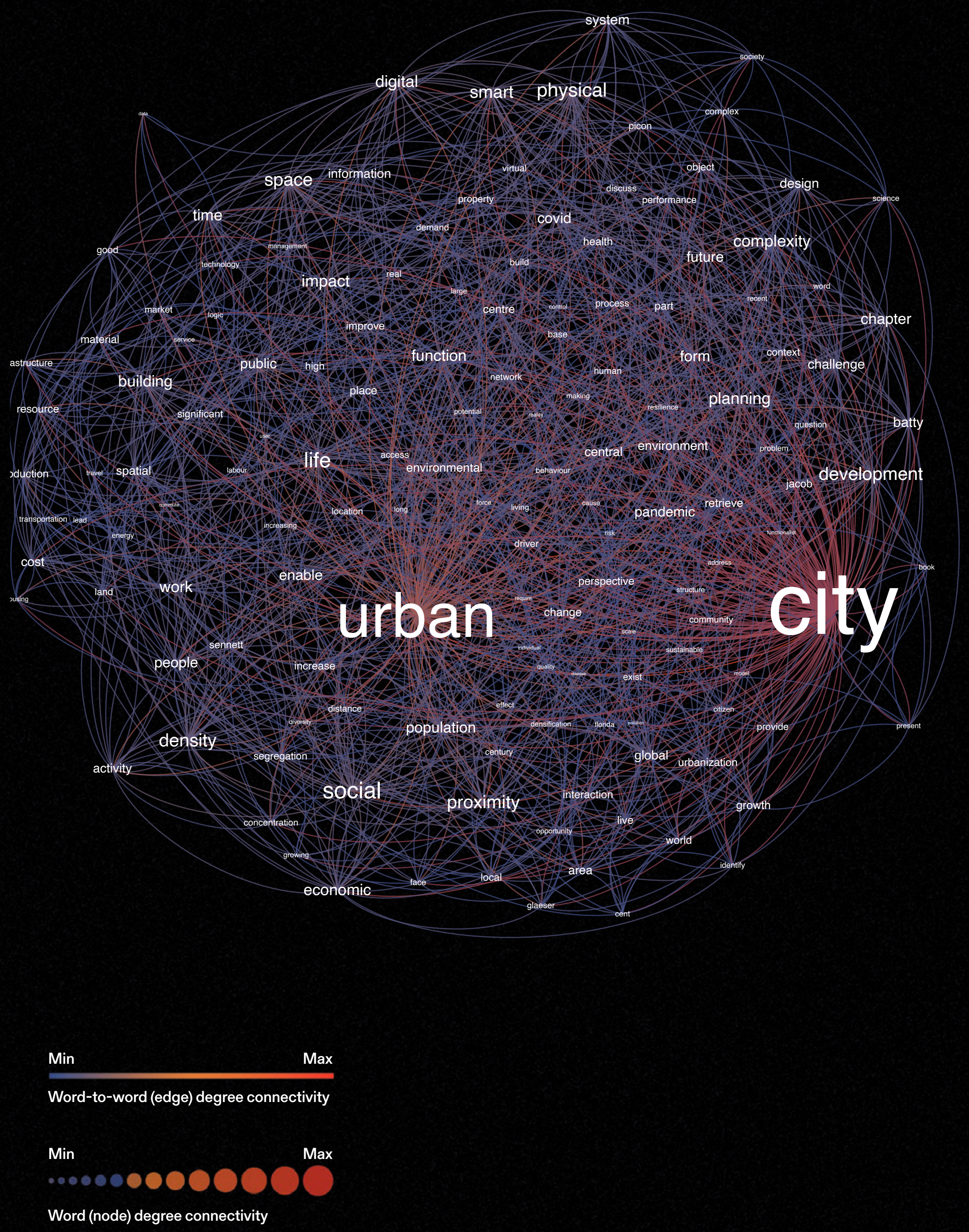
Graph by Michal Gath-Morad →

Prologue—Future Cities—City Futures

Christian Veddeler, Joran Kuijper, Michal Gath-Morad, and Iris van der Wal

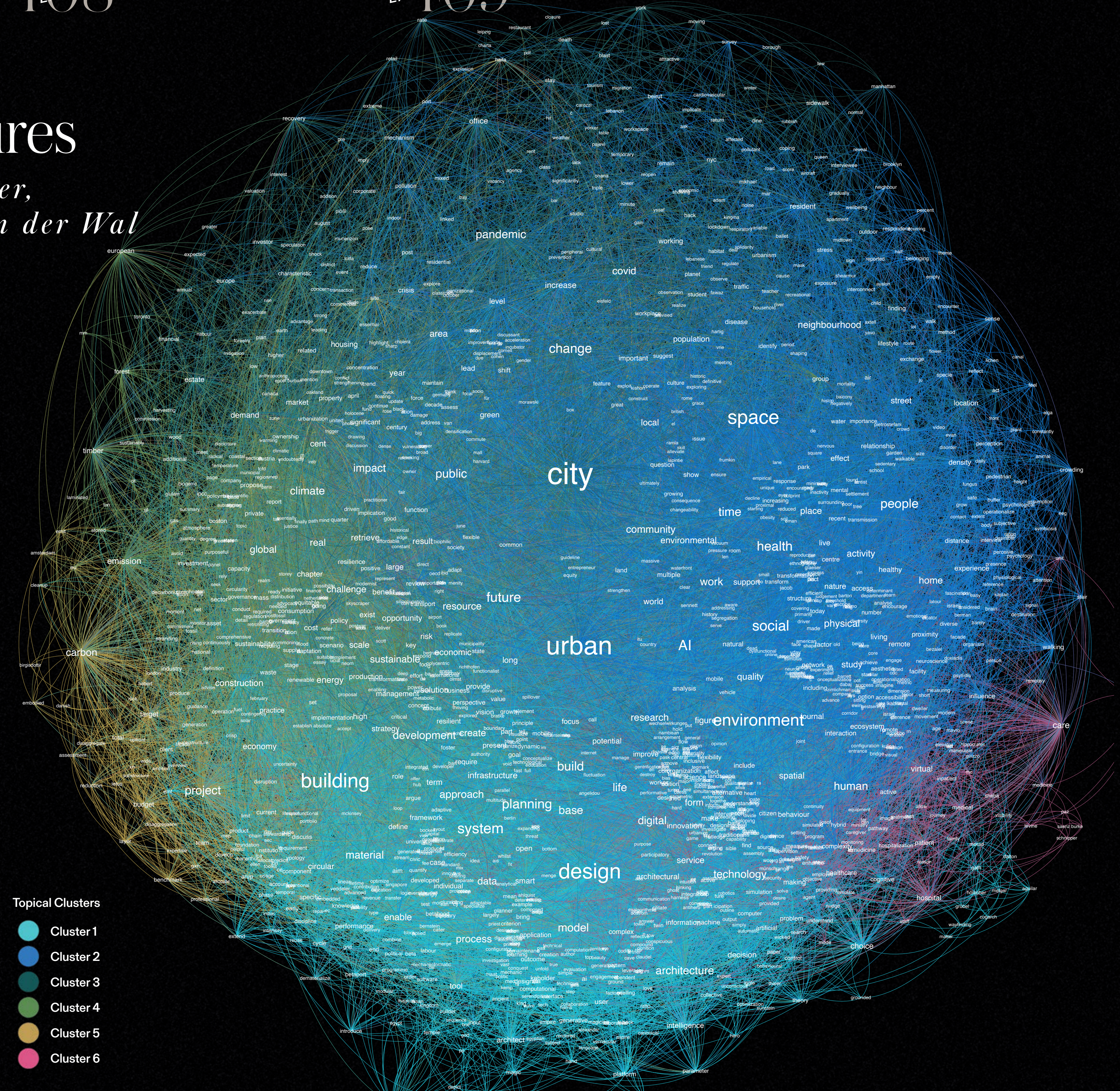
GRAPH 26

Network analysis and visualisation of Veddeler, C., Kuijper, J.A., Gath-Morad, M., & Van der Wal, I.A. (2023). Prologue. In C. Veddeler, J.A. Kuijper, M. Gath-Morad, & I.A. van der Wal (Eds.), *Future Cities—City Futures: Emerging Urban Perspectives*. (pp. 15–55). TU Delft OPEN.



All Articles— Future Cities—City Futures

Christian Veddeler, Joran Kuijper, Michal Gath-Morad, and Iris van der Wal



Graph by Michal Gath-Morad

GRAPH 27
Network analysis and visualisation of all chapters of Veddeler, C., Kuijper, J.A., Gath-Morad, M., & Van der Wal, I.A. (Eds.). (2023). *Future Cities—City Futures Emerging Urban Perspectives*. TU Delft OPEN.

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Contributors—

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is a Doctor of Science candidate and has been at the Chair of Computational Social Science of ETH Zürich since 2020. His work in the Co-Evolving City Life European Research Council project focuses on the use of urban simulation as a proxy to foster collaborative and participatory approaches in urban planning and design. Previously, he researched new computational techniques to capture novel microscale insights into public space utilization; this was the core of his work at Carnegie Mellon University, where he obtained an MSc in Computational Design as a Fulbright Scholar in 2018. In 2017, he collaborated in the improvement of the biking infrastructure of Atlanta as an assistant researcher at Georgia Tech. Previously, he co-founded the JARD architecture and design office (1st prize 'Lounge COAM', 2nd prize 'Museo del Capricho') while being an assistant professor and academic manager at the Polytechnic University of Madrid. In 2015, he won the Archimedes Prize for best predoctoral research for his work on data-driven urban planning at the School of Architecture of Madrid, where he obtained his MArch in 2014. His projects have been published and shown in international venues and institutions such as the Venice Biennale, CAAD Futures, and Het Nieuwe Instituut.

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is Professor of Urban Design and Critical Theory at the Bartlett Development Planning Unit, UCL, UK, and Professor of Architecture and Urban Design at Politecnico di Torino, Italy. He is Co-Director of the UCL Urban Laboratory. Working in Latin America, Southeast Asia, and the Middle East on urban infrastructures, habitability, and displacement, Camillo's research has centred on the encounters between critical theory, radical philosophy, and urban design. He has worked and published with Joana Dabaj on several research projects in Lebanon.

MARVIN BRATKE

is a German architect turned entrepreneur and founding partner of the spatial innovation agency URBAN BETA and the architecture studio BART//BRATKE. At his studio, Marvin works on participatory methods to create inclusive, innovative, and transformative spaces through predictive planning. Urban Beta and BART//BRATKE work collaboratively on new ways of social inclusion and participatory approaches to co-design, both virtual and physical. Marvin's work fuses emerging technologies, spatial innovation, future mobility, and computational design in one holistic design approach. Urban Beta's research is backed by the Federal Government of Germany and covered by the Zukunft Bau programme: the research project BetaHood has become a model project for the New European Bauhaus initiative, and the ecological mobility hub BetaPort and its circular building-as-a-service model is on display at various conferences and events. Marvin is actively engaged in the profession's discourse and teaches at various universities, including the TU Graz, UCL The Bartlett, and the AA Visiting School program. He has held visiting professorships at Muthesius Academy of Arts in Kiel and UISEK in Quito. He frequently lectures as an invited speaker on spatial strategies, circular building, architectural innovation, and the studio's research. Marvin received his diploma in architecture at the Technical University Munich and the NTU in Singapore. His award-winning work is widely published and frequently exhibited: at the Architecture Biennale Venice, Experimental Architecture Biennale Prague, Munich Design Week, and Forward Festival. He has been invited as an expert and consultant to various universities, including the University of Innsbruck, TU Delft, and the École Spéciale d'Architecture in Paris.

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PAOLO CRESCI

is an Associate Director at Arup. Based in Milan, he is Head of Sustainable Development for the country across several businesses. Paolo has developed relevant international experience leading multidisciplinary teams in the delivery of innovative and highly sustainable projects across city, masterplan, and building scales. He is a lecturer at several universities and regularly participates in conferences as a speaker promoting an integrated and digital-driven approach to sustainable development. In 2017 he started his collaboration with the international architectural magazine Domus for which he curated the annual sustainability issues of Domus Green 'People and Nature in the Age of Technology' in 2017 and Domus EcoWorld 'The UN Global Goals in Practice' in 2019, investigating the paradigm shift required to develop a post-anthropocene approach to urbanism, architecture and design.

JOANA DABAJ

is the co-founder of CatalyticAction, a charity that works to empower vulnerable children and their communities through participatory built interventions. She holds an MSc in Building and Urban Design in Development from the Development Planning Unit at University College London. She is an architect and researcher who works closely with displaced and host communities to co-design interventions; this includes participatory research, co-design, and community engaged implementation of built interventions with a focus on play and the public realm. She has over 8 years of experience in using participatory design and research methodologies.

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MICHAL GATH-MORAD

Michal is a postdoctoral fellow at the University of Cambridge (Behaviour and Building Performance group, Martin centre, Department of Architecture), and at University College London (Space Syntax Laboratory, Bartlett school of Architecture). To realise her core mission of connecting science, pedagogy, and praxis, Michal holds a visiting researcher position in the urban design team at Foster + Partners in London and has lectured at ETH Zurich since 2019, where she leads a graduate course on evidence-based design in architecture. Michal holds a BArch and MSc in architecture (summa com laude) from the Technion-Israel Institute of Technology, and a PhD in cognitive science from ETH Zürich. Michal's interdisciplinary research and teaching seeks to develop, critically evaluate, and creatively experiment with methods of evidence-based co-design in architecture to promote health and well-being. Michal's research has been published in leading international conferences, including SimAUD and EDRA, and in prominent scientific journals such as Nature Scientific Reports and Automation in Construction. Michal is the recipient of the Swiss Government Excellence Fellowship for outstanding PhD students and has recently been awarded a Swiss National Science Foundation (SNSF) grant to pursue her postdoctoral research at Cambridge and UCL.

SABINE GEORGI

is Executive Director of ULI Germany/Austria/Switzerland. A BA graduate in business administration specializing in real estate and a Certified Real Estate Investment Analyst (CREA), Sabine has worked in the industry for 25 years. Before joining ULI, she was Country Manager at RICS in Frankfurt. Other roles have included Head of Real Estate and Capital Markets at ZIA Zentraler Immobilien Ausschuss. At the BBT Group management consultancy, she advised companies operating in housing and real estate and also headed the marketing department. Sabine began her professional career as a consultant to the board at the Association for Berlin-Brandenburg Housing Companies (BBU). While studying, she held professional positions at various companies in the real estate industry. Sabine lives with her family in Berlin.

BOLA GRACE

has extensive experience in population health across multiple sectors, providing consulting and advisory services on a range of health topics including digital health, population health management, medical devices, and the application of data science to research and practice. She has over a decade of leadership experience in industry, providing strategic and technical direction to highly skilled cross-functional teams on complex programmes, pioneering new systems and processes to bring greater value, and delivering numerous innovative award-winning products. She founded Orishi, a company delivering inclusive innovation solutions. Within academia, Grace holds honorary and visiting faculty roles, where she lectures and supervises undergraduate and postgraduate research projects, presents at (inter)national conferences, and publishes peer-reviewed articles; with extensive research on population health, gender, and health inequalities. She also sits on various scientific committees and boards. She enjoys mentoring and is passionate about helping underrepresented groups in STEM. Grace is currently a Royal Academy of Engineering Visiting Professor of Inclusive Innovation. She holds an Executive MBA from The University of Cambridge Judge Business School. She is a Fellow of the UK Higher Education Academy, Fellow of the Royal Society of Public Health, and Fellow of the Chartered Management Institute.

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is an architect and photographer with a PhD in architecture and urban studies. Rasmus specializes in the representation of space, architecture, and urban environments through photography. He uses architectural and interior photography to portray the work of leading practices and institutions in the field of architecture and design. Within territorial photography, he combines visual mapping with the aesthetic framing of our urban spaces and territories. COAST is the research and design branch of the studio, where Rasmus engages in a range of collaborations in practice and academia around architecture, planning, and the environment. A variety of approaches, media, and collaborations all gravitate around the representation of architecture, design, and territories. Rasmus lives in Copenhagen, Denmark.

GIA JUNG

is a computational designer and design engineer. She is currently at Google with the Delve team working on generative design software in the Google Geo, Knowledge & Insights Group. Previously, she served as an Irving Fellow at the Department of Architecture, Harvard University. Her research area is in design technology, human–computer interaction, and computational design with a focus on AI application in design. Her projects include Digital Platform in Virtual Collaboration within GSD's Innovation Task Force and research on AI in Architecture at Laboratory for Design Technologies. She graduated with MArch I from Harvard GSD with the Digital Design Award for her thesis, titled 'Automatic Affinities: Human-Machine Framework for Designing Urban Hybrids'. As a designer and graduate researcher at Harvard, she worked on architectural and urban design and research projects across Europe, America, and Asia. Outside academia, she has worked in the design and technology sector at Fortune 500 companies and start-ups such as Dell and Spacemaker AI (acquired by Autodesk), designing and developing physical and digital media and computational AI software platforms for virtual design collaboration.

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is Managing Director at the IREBS Immobilienakademie and Professor of Real Estate at the University of Regensburg. Tobias has published more than 200 papers in professional and academic journals and books. Until 2021 he was President of the German Society of Property Researchers and is the editor of ZIÖ – the German Journal of Real Estate Research. In 2018, Tobias became Fellow of the RICS by nomination. Tobias studied economics in Hamburg, Germany, and Uppsala, Sweden. Tobias worked at Deutsche Bank Research from 2001 to 2011. He headed the unit's sector and real estate team and was a member of Deutsche Bank's group-wide Environmental Steering Committee. In 2006, Tobias was Research Fellow at the American Institute of Contemporary German Studies at Johns Hopkins University. In 1997, he started to work at the University of the Federal Armed Forces Hamburg. His PhD dissertation was awarded the University Science Prize in 2001.

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is a lecturer and researcher in the group of Architectural Design Crossovers at the Faculty of Architecture and the Built Environment, Delft University of Technology. In the academic environment, he has been a member of several editorial teams, for example in 2012 for the international conference titled 'New Urban Configurations' and for the publications 'Stations as Nodes' in 2018, and 'Mapping Wuhan' in 2021. He is a tutor in Bachelor and Master architectural design studios and is preparing his PhD research *Learning from Disneyland: Urban Architecture in Disney's Theme Parks*. Joran graduated from Delft University of Technology in 2014.

LASSE LIND

is an architect and partner at GXN, a strategic design and innovation consultancy founded by 3XN architects in 2007. Lasse has led many of the company's research and praxis projects, among others the New Sydney Fish Market and the Green Solution House. He holds a master's in architecture from the academy of arts in Copenhagen and is a multiple-time recipient of the Danish art foundations grant as well as numerous other grants for traveling and publishing. Lasse spends his time between research and praxis and has taught architecture at several universities in Europe and the United States.

WOLF MANGELSDORF

is a partner at Buro Happold, where he leads Design, Technology, and Innovation globally. After training as an architect and civil engineer at Karlsruhe University in Germany and Kyoto University in Japan, Wolf worked for a number of architectural and engineering practices before joining Buro Happold in 2002. He has worked with some of the world's most well-known architects and led the engineering design on a wide range of high-profile projects, which include Beijing Daxing Airport, the Battersea Power Station redevelopment in London, and the Morpheus Hotel in Macau. He has driven the development and application of design technology at Buro Happold over the past decade, with a focus on interdisciplinary work, the integration of analytics into design modelling, and the transparency of the design process. He also leads the firm's work in industrializing the construction process. Throughout his career, Wolf has been active as an educator, notably at the Architectural Association in London and most recently at the University of Applied Arts in Vienna, where he was appointed professor of Structural Design in October 2021. Wolf has published widely and been a lecturer and speaker at universities and conferences worldwide.

DOMINIQUE MAKOWSKI

was trained as a clinical neuropsychologist and cognitive-behavioural therapist in France and is currently working as a researcher at Nanyang Technological University (NTU) in Singapore. He studies the factors influencing the perception of reality. He earned his PhD in psychology from the Université de Paris on the neurocognitive underpinnings of emotion regulation through fictional reappraisal.

PANAGIOTIS (PANOS) MAVROS

is a senior researcher at the Future Cities Laboratory of the Singapore ETH Centre. He obtained his PhD at UCL CASA (UK) studying pedestrians' emotions during unconstrained navigation in cities. He also holds an MSc by Research in Digital Media and Culture at the University of Edinburgh (UK) and a Dip Ing in Architecture from NTUA (Greece). His current research in Singapore is focused on high-density cities, in which he integrates multiple methodologies from architecture and behavioural science, such as spatial analysis and psychophysiological measures, to study pedestrian navigation and subjective experience.

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is an assistant professor of urban design in sustainable communities and Infrastructure at the University of Houston Gerald D. Hines College of Architecture and Design. She has a decade of professional experience in architecture and urbanism, focusing on adaptive strategies and resiliency methods. She leverages experience in urban systems design, environmental planning, and architecture to work with local communities across scales toward resilient cities and urban environments. Munenzon's work on resilience is focused on coastal adaptation and long-term strategic planning while leading the efforts of One Architecture & Urbanism on many high-profile, award-winning projects. Among these are the Climate Ready Boston Downtown, East Boston, and Island End River Resilience study. She hopes to carry forward her knowledge and experience to promote healthy, inclusive, and resilient cities in the 21st century. Dalia received a Master in Architectural Studies from MIT (SMarchs Architecture + Urbanism program), where she worked as a researcher at the Center for Advanced Urbanism. She is a registered architect in Israel with a Bachelor in Architecture and Town Planning from the Technion, Israeli Institute of Technology.

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FILIPA PAJEVIĆ

is a course instructor in the Master of Urban Innovation Program and a Postdoctoral Research Fellow at the Institute for Management and Innovation (IMI) at the University of Toronto Mississauga. Filipa's research interests revolve around changes in ways of working and their spatiality. She is interested in the impact of digitization, mobility, and flexibility on work and workspaces. Her doctoral research explored the spatial behaviour of knowledge workers in Kitchener-Cambridge-Waterloo, Ontario, to reveal a circular relationship between new ways of working and rising real estate costs. Her postdoctoral research will explore how planning and policy efforts at the city level are changing in response to the COVID-19 pandemic. It will focus on downtown recovery plans in Toronto and beyond. Filipa holds a PhD in Urban Planning, Policy and Design from the School of Urban Planning, McGill University, Canada, a Master of Science in Urban Management and Development from Erasmus University Rotterdam, The Netherlands, and a Bachelor of Arts in International Relations and Economics from Franklin University, Switzerland. In addition to publishing in academic journals, she has written for The Guardian and co-authored op-eds for CityLab (Bloomberg) and CityMetric (The New Statesman).

ELISABETTA PIETROSTEFANI

is an urban geographer and geographic data scientist interested in applying data and technologies to improve the understanding of urban development and inequalities. She has analysed the effects of density policies and urban development, assessed well-being and inequalities in contexts of mass displacement, and most recently investigated informal labour markets to evaluate livelihood strategies. She holds a PhD in Planning Policy and Urban Economics from the London School of Economics and is also currently an Honorary Senior Research Fellow at University College London.

EIVOR OBORN

is a Professor of Healthcare Management in the area of Innovation and Organisational Change at Warwick Business School, UK. She earned her PhD at Cambridge Judge Business School, the University of Cambridge in 2006 and is currently an honorary Fellow at Cambridge Judge Business School and Fellow at the Cambridge Digital Innovation Centre (CDI). Eivor is Senior Editor at MISQ and has published work in leading journals, including the Academy of Management Journal, Organization Science, Information Systems Research, and MISQ. Her scholarship has won numerous awards including best published paper from American Medical Informatics Association (AMIA) and Academy of Management (AOM). Her research interests span the fields of healthcare, online communities, digital innovation and ICTs, and entrepreneurship in ecosystem contexts. She teaches in the area of Change Management, Strategic Health Leadership, and Corporate Entrepreneurship.

AGNIESZKA OLSZEWSKA-GUIZZO

has a PhD in landscape architecture and urban ecology with a neurosciences approach. Her research interests inform the design of cities for mental health. To this end, she utilizes neuropsychophysiological tools to evaluate the relationship between the design of the everyday environment and the mental health and well-being of urban residents and people suffering from mental disorders. She has introduced and operationalized the concept of contemplative landscapes and has proposed a tool for designers called the Contemplative Landscape Model. This is a quantitative expert-based scale for assessing and classifying landscape views based on their potential to generate mental health benefits in green space users through just a passive exposure. She has been a research fellow in two research projects at the National University of Singapore: the Biophilic Town Framework and the Effects of Landscapes on the Brain. She is the President and a cofounder of NeuroLandscape, a research NGO registered in her home country, Poland. In her work, she strives to implement scientific research into practical actions to promote mental health in cities.

NIRIT PUTIEVSKY PILOSOF

is an architect and researcher exploring the intersection of Healthcare, Technology, and Architecture. Nirit is the Head of Research in Innovation and Transformation at Sheba Medical Centre in Israel. She is a Faculty Member at the Coller School of Management at Tel Aviv University and an Associate of Cambridge Judge Business School (CJBS) at the University of Cambridge in the UK. Nirit also works as a consultant for international healthcare organizations and serves as the executive member of Israel at the UIA Public Health Group. She holds a PhD from the Technion – Israel Institute of Technology, a Post-Professional M.Arch from McGill University, and an EDAC from the Center for Health Design in the USA. Nirit has practiced healthcare architecture as a design project manager at leading architecture firms in Israel and Canada and has won international awards, including the prestigious AIA Academy of Architects for Health award, the American Hospital Association (AHA) graduate fellowship, the McGill University major fellowship, and the Azrieli Foundation fellowship.

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is partner and head of innovation at the Copenhagen based design consultancy GXN. GXN was spun out of Danish architecture studio 3XN, and Kåre works with strategic design research across 3XN and GXN projects. Taking the approach that multidisciplinary research is key to solving the most pressing challenges that the built environment faces today, GXN seeks to innovate architecture to create buildings that work better for both people, and the planet. Kåre's work bridges strategic consultancy and research with a specific focus on decarbonization, the circular economy, and human well-being. He holds a DPhil in Anthropology from the University of Oxford, where he researched the impact of digital technologies on human cognition and creativity. He also holds an MSc in Digital Anthropology from University College London and an MSc and BA in International Development Studies and History from Roskilde University.

TAMARA STREEFLAND

most recently has taken the position of Head of Networks at Built by Nature, where she enables systemic action to accelerate toward a built environment working in unison with nature. Throughout Tamara's work experience, projects, and education, her focus has been on driving transformative impact in sectors that are fundamental to our ability to live in urban centers in a world that is increasingly susceptible to disruptive extreme natural and social events. Her projects take a systemic approach and combine creativity and solid science with a hands-on approach. She spent the previous five years at Metabolic, a systems thinking agency focused on transforming the global economy to a fundamentally sustainable state. During her time at Metabolic, she played many diverse roles, including Urban Systems Lead, Consultant, and most recently, Consulting Director. She has extensive experience advising NGOs, industry, and government on building the livable cities of the future and tackling complex sustainability challenges. Tamara has worked on over 30 projects in various global cities and regions, engaging with municipalities, developers, and other urban stakeholders. Tamara holds a Master of Science in Design and Urban Ecologies from Parsons The New School for Design in New York. Tamara's background in earth sciences positions her well to integrate knowledge on ecological impacts with creative solutions that deploy innovative technologies and are sensitive to social issues. Tamara also enjoys mentoring students about complex contemporary urban challenges.

JOLIJN VALK

is co-founder and architect-director of Amsterdam-based architecture and design studio Urban Echoes. She graduated from the Amsterdam Academy of Architecture in 2010 on a 'living bridge' and has worked for such offices as SeARCH and studioninedots. In 2013, she founded Urban Echoes. The studio engages with a wide spectrum of complex challenges, constantly searching for the next level in architecture, art, and urban design and how these spatial interventions echo in its context. They emphasize the context of a place as inspiration for its future and are constantly searching for hidden layers through rethinking and researching. In 2020, the office started a study about the influence of pandemics on the cities and how to restore the balance between human and natural settlement, with focus on the 'in between space' and on living materials in urban design. Next to this, Jolijn is an architect member of aesthetics and quality commissions for Dutch municipalities, participates in several architecture juries, and is a guest lecturer, examiner, and mentor at Dutch architecture schools and academies. Since 2021, she has been chair of the Royal Institute of Dutch Architects, BNA.

PABLO VAN DER LUGT

is an architectural engineer who obtained his PhD at Delft University of Technology in 2008 for his research about the environmental impact of engineered biobased materials. Since then, he has been active in the building industry as senior consultant on sustainability, circularity, and biobased building ever maintaining a connection with the academia through TU Delft and the AMS Institute. He is the author of several books on biobased building, including Tomorrow's Timber (2020) and Booming Bamboo (2017), and regularly publishes his research findings in popular magazines, scientific journals, and conference proceedings.

IRIS VAN DER WAL

is a designer and researcher. Her broad interest in architecture, emerging technologies and its implications, social interaction, and sustainability has led her to develop interdisciplinary, collaborative projects in both the academic field and in her design practice. She works on experimental architectural and exhibition designs and occasionally teaches at Delft University of Technology. There, she has also been involved in the University's campus development. Iris has worked with architecture and design firms including Kossmanndejong, Zaha Hadid Architects, and Studio Roosegaarde, and she has led the art, science and technology programme 'Crossing Parallels', a collaboration between Delft University of Technology and TodaysArt. Iris studied Architecture in Delft and graduated in 2017 on redesigning contested heritage.

CHRISTIAN VEDDELER
is an architect and has recently joined 3XN/GXN Architects in Copenhagen. He has a portfolio of 60+ renowned projects in Europe, the US, and Asia. Christian has a focus on design excellence, innovation, sustainability, and entrepreneurship. He is former director at UNStudio, and HPP partner. Christian's involvement in academia includes numerous teaching positions and visiting professorships, including at ETH Zürich, Harvard University, Delft University of Technology, AA Visiting School, and Städelschule Frankfurt. Christian graduated from Delft University of Technology with a Master of Science with Honours degree in architecture. He also holds an MBA degree from University of Cambridge, with a final thesis on the value of design.

ANN-BRITT VEJLGAARD
is a sustainability engineer at 3XN Architect's independent innovation unit GXN. She is engaged in applying and developing tools and workflows that can inform building design in a more environmentally aware direction. With her technical background and innovative approach to digital workflows, she works towards informing the design strategy by integrating analytical tools such as life cycle assessment, daylighting simulations, and indoor and outdoor comfort simulations. Her focus at GXN is on documenting sustainability, using analysis and simulation tools to quantify environmental impacts and help substantiate the value of integrating green solutions and circular building practices in the built environment.

ELS VERBAKEL
is a founding partner of Derman Verbakel Architecture and serves as the Head of the School of Architecture at Bezalel, Jerusalem and the UNESCO Chair in Urban Design and Conservation Studies. In 2003, she was a J. Clawson Mills Research Fellow at the Architectural League of New York for the exhibition 'Urban Life. Housing in the Contemporary City'. Els's research and design work has been published internationally in journals such as Harvard Design Magazine, AD Magazine (UK), Lotus (IT), Oase (NL), Archis (NL), and Block (IS). Els is a recipient of the Belgian American Educational Foundation Fellowship (2001), The Israeli Design Award (Ot Ha'Itsuv, 2012 and 2013), The Culture Award of the Flemish Ministry of Culture, Belgium (2008). and The Award for Excellence in Teaching at the Technion (2008). She has co-edited the books In Search of the Public. Notes on the Contemporary American City (2013), Cities of Dispersal (2008) and Constellations: Constructing Urban Design Practices (2007). She holds a PhD from Princeton University, an MSc in Urban Design from Columbia University, and a Master's in Civil Engineering – Architecture from KULeuven, Belgium. Els has taught architecture and urbanism at the Technion, Columbia University, Pratt Institute, Princeton, and KULeuven.

AUREL VON RICHTHOFEN
is an architect and urban planner. He is an Associate at Arup and leads the Cities team in Berlin. His focus is on data-driven digital methods to tackle complex urban topics at the intersection of sustainability and digital solutions. Aurel earned his degrees in architecture at ETH Zürich and Princeton University. He holds a doctorate degree in engineering from TU Braunschweig and is a registered architect with the Berlin Chamber of Architects. He was assistant professor at Ohio State University and the German University of Technology in Oman, lecturer at the National University of Singapore, course director for the Urban Redevelopment Authority in Singapore, and leader of the Singapore-ETH Centre's Asia Month. He secured funding for large interdisciplinary research projects at the Future Cities Laboratory of ETH Zürich in Singapore on foundational technologies for digital twins, smart cities, circularity, and sustainable urbanization.

SAMSURIN WELCH
has almost two decades of experience in research, teaching, advisory and entrepreneurship in the intersection of technological disruption, sustainability and the circular economy. He is a Research Associate with the University of Cambridge Circular Economy Center and Co-Founder and Chief Research Officer for Hyve Forum, a Cambridge, UK-based think tank. Samsurin is a strong advocate for the 'green disruption', where companies need to embrace strategic transformation towards more sustainable and circular business models to stay relevant in the emerging business environment. His research interests lie in how digital technologies such as artificial intelligence, blockchain, and Internet of Things can drive the sustainability and circular economy agenda. Samsurin spent much of his career in the energy sector. He was previously Head of Digital Strategy and Innovation in PETRONAS, the national oil and gas corporation of Malaysia. He has also advised organizations across the energy, retail, and real estate sectors on their digital transformation and sustainability journeys. Samsurin holds a PhD and MPhil in Management Studies from the University of Cambridge, an MSc in Management Information Systems from the London School of Economics and Political Science, and a BA in Computing and Information Systems from Northwestern University.

HANNAH-POLLY WILLIAMS
is a senior sustainability and Environmental, Social and Governance consultant with close to 15 years' experience advising and working for blue-chip businesses, foundations and international non-governmental organisations. She is currently a Senior Director at FTI consulting, based in Paris and working globally. She advises clients on the design and deployment of their ESG and sustainability programs, guiding them in the implementation of tailored, sector-leading strategies that allow them to seize ESG-related opportunities. Hannah-Polly also advises clients on the implementation of appropriate corporate governance structures. Before joining FTI Consulting, Hannah-Polly worked for the International Rescue Committee where she was the Global Director of Board Strategy and Engagement, based in New York. Hannah-Polly started her career in London developing private sector partnerships at Oxfam, the Overseas Development Institute, and the Allegra Foundation, where she led UK Coffee Week and ProjectWaterfall. Hannah-Polly has a BSc in Economics and Government from the London School of Economics, an MSc in Global Governance and Ethics from University College London, and an MBA focused on sustainability from Judge Business School at the University of Cambridge.

SHARON YAVO-AYALON
is an architect, artist, curator, and researcher. She currently serves as an adjunct assistant professor at Columbia GSAPP and as a postdoctoral associate at Cornell ´a digital twin for Roosevelt Island with a focus on equity and social justice. Her PhD explored the linkage between urbanism and art and how local identity, spatial injustice, and social exclusion and inclusion are forged or deconstructed by artistic activity in cities. This research was awarded the President of Israel's Grant for Scientific Excellence and Innovation. Her work has been published in leading international peer-reviewed journals such as CITIES, The Journal of Urban Management, The Journal of Urban Design, City and Community, The Journal of Urban Affairs, and Cultural Sociology. She received her PhD from the School of Architecture and Town Planning, Technion Israel, where she graduated summa cum laude BArch and MSc. Ayalon served as the PeKA Gallery and the Gitai Architecture Museum chief curator.

ADRIANA ZURERA GÓMEZ
is an architect. She has worked at Acme since 2017, when she joined the practice's London office, before transferring to the Berlin branch in 2019. During her time at Acme, she has worked on a variety of projects at very different scales, ranging from a small pavilion in Stratford to masterplans in the UK and abroad. Most notably, she was involved in the development of the Dublin Central masterplan in Ireland and the One Euston masterplan in London. Before joining Acme, she worked in two other London practices: at CRAB Studio with Sir Peter Cook and at Barnaby Gunning Architects, and she did an internship at TORAFU Architects in Tokyo. Adriana graduated with an MArch from the Polytechnic University of Madrid, having added a year to her studies at Università di Roma La Sapienza and another year as a research student at the University of Tokyo. She also took part in the Vastu Shilpa Foundation Habitat Design Workshop in Ahmedabad, India in 2012. While completing her studies, she worked as an editor for Kokoro Editorial, a children's books publisher, of which she was a co-founder.

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This book is not about the prediction of the future. Instead, it aims to define the conditions that future cities would need to meet and to envisage a range of scenarios for possible, and possibly desirable, city futures. To gain a better understanding of the challenges and opportunities of future cities, the book presents a multiplicity of research trajectories that go far beyond the core concerns of urbanism. The transitional conditions between and interdependencies of inhabitant and habitat, society and environment, and physical and virtual domain allow speculation about inclusion, diversity, initiative, participation, and quality of life.

The aim of this book is to collect and contrast a unique and open-ended array of individual perspectives, insights, observations, ideas, research, strategies, inventions, and solutions that are all critically engaged with several dimensions of future cities and city futures.

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