Horizons 2034
Executive Report

RIBA

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Looking to the future is difficult but pressing

Muyiwa Oki
RIBA President 2023–2025

It is difficult to get the headspace to consider what is ahead of us when our current concerns and energies are all focused on surviving in the present: obtaining and retaining work during an economic downturn and operating amid complex regulatory changes.

However, it is pressing that we do pay attention to what is coming down the tracks at us, so that we can be prepared. Whether it is for environmental challenges, fractured global economic conditions (impacted by climate crisis and geo-political rifts), population changes or technological innovation.

It is not, however, just a matter of being ready. If architects are to reassert their position in the design and construction industry and wider society, we need to assume agency and lead from the front. This is why a priority for me this year is Architecture Without Boundaries. As architects, we are educated to have a complex skillset that should enable us to punch above our weight. When working in practice, those skills and competencies are fully tested.

We have an important contribution to make to communities and wider society, not just as designers of individual buildings but as problem-solvers and thought-leaders.

An important piece of work that sits alongside horizon scanning is the 2024 RIBA Artificial Intelligence Report. Delivering the findings of the recent AI member survey, it reflects on the current and near-term realities of the application of AI in architecture. In the report, I call for a "critical yet optimistic mindset" to what is emerging as one of the most "disruptive tools of our time". When scanning the horizon for 2034 and looking at wider emerging trends, I also urge you to have a similar outlook, paying attention to both risks and opportunities.

Access to the horizons scans on **Architecture.com** is an exclusive member benefit for all chartered and student members; the scans will only become open access four months after publication.

The initiative represents the opportunity for you to engage with big-picture emerging trends and expert voices from across the world. Whether you are on the starting blocks of your career or an experienced professional, I urge you to invest a little bit of time reading the scans, carving out that essential thinking time to engage with the near future.

RIBA Horizons 2034: foresight and action

Adrian Malleson
Head of Economic Research and Analysis, RIBA

RIBA's foresight programme, Horizons 2034, looks ahead to the next decade and invites response.

It employs the established forecasting method of horizon scanning, in which subject matter experts develop 'scans' to identify and analyse emerging social, economic, environmental, and technical shifts, to ascertain what the future might look like.

So, in 16 scans, the programme uncovers the mega-trends shaping our society, the built environment, and the architectural profession, aiming to equip decision-makers with valuable foresight to make informed choices in a rapidly changing world.

The Environmental Challenge

The climate crisis demands radical change. This theme explores how the built environment, responsible for almost half of all global emissions, must recognise its accountability and become an agent of change.

How can architects address this urgent, generation-defining challenge?

The Economics of the Built Environment

Global economic systems and forces drive development. How money is spent directly affects social equality and individual life chances. The built environment is increasingly becoming the embodiment of buildings as financial mechanisms.

How are financial dynamics shaping our surroundings and how can architects respond?

Population Change

Demographic patterns vary widely worldwide. Some regions experience rapid growth, while others face ageing populations and contraction.

How can design professionals respond to urban-scale changes while fostering social cohesion for ethnically diverse and intergenerational communities?

Technological Innovation

The technological tools available to the profession are rapidly increasing in sophistication, scope, and ability. With the rise of AI, the prospect of autonomous tools is becoming real.

How will the role of the architect respond to rapid technological innovation?

View of the horizon west of Georgetown, Guyana. Agricultural housing lines irrigation and drainage canals, dividing plots of land into peculiarly narrow strips – as a wide as a house. Photo: Johnny Miller / Unequal Scenes, 2023

These themes are explored by a range of leading experts in the pages that follow.

To be clear, though, what follows is not the future predicted, nor is it a statement of RIBA policy. Instead, it is an initial exploration of those trends set to shape our future world. But, more than an exploration, the programme is also a call to action. By understanding these trends, we can actively shape our future world.

Already we can see huge changes coming, changes that will radically alter our lives and the environment in which we live them. Not all these changes are benign. While we still have time to act, the collective failure to address carbon emissions is set to be humanity's most expensive mistake at best, and an existential threat at worst.

But there are also huge opportunities: greater social cohesion, reduced inequality, successful urbanisation, increased global prosperity, and a safer, more efficient, construction industry, better meeting society's needs, transformed through technological innovation.

Indeed, there are few, if any, roles or professions in the construction sector better placed to effect change than architects. Following an intense and extensive education and qualification process and ongoing professional development, architecture straddles aesthetics, art, history, society, law, and technology. This breadth and depth of knowledge puts architects in a uniquely strong position to understand and respond to future challenges.

So, architects are not mere bystanders on history's field of play, awaiting the change to come. Instead, they can be, are, and increasingly will be, premier agents of change, literally shaping the built environment to meet the needs of communities, delivering a sustainable future, and securing the profession's place.

While we still have time to act, the collective failure to address carbon emissions is set to be humanity's most expensive mistake at best, and an existential threat at worst.

Reflections on the Themes

Michèle Woodger
Architecture journalist

Michèle Woodger reports on some concluding reflections on RIBA Horizons 2034. Key programme contributors discussed the intersection between the programme themes in a global context - with an eye to future opportunities for architects.

In the words of RIBA Past President Sunand Prasad, the RIBA Horizons 2034 program has yielded "an amazingly rich set of reflections, information and analysis". And yet, as the final instalment of this foresight-gathering exercise demonstrated, many questions remain unanswered, including: "What does it all mean for the built environment and specifically for the practice of architecture?"

The session brought together theme editors Alice Moncaster, Astrid Haas and Phil Bernstein, RIBA Past President Sunand Prasad, plus RIBA's Head of Economic Research Adrian Malleson and David Light of Autodesk to round off the four themes of environment, economics, technology and population. And, as Prasad commented, "the intersection of these themes is where the exciting conversations and opportunities are".

This animated concluding session explored this interconnectedness, highlighting, in Malleson's words, "where we can position ourselves for future success, and how we can shape the future".

Global discrepancy

A point reiterated throughout the discussion was the discrepancy between global north and south. In the north, population growth is predicted to remain almost static to 2050. Across the south, however, populations are increasing rapidly, with that of Africa set to double in that time. The world already reached the 8 billion mark in 2022, but, said Haas, "the poorest 50% of the world owns only 1% of it".

There is also an enormous difference in carbon emissions, with Africa responsible for "a fraction" of Europe's. Importantly, said Moncaster, "across Europe we already have pretty much all the buildings we need, but energy use per capita is very high". To lower these emissions, we should be "radically reducing our embodied carbon by minimising new build…and reducing operational carbon in our existing buildings through appropriate retrofits" she summarised. "If I were setting up a practice in the global north right now I would be focusing on renovation and restoration" agreed Bernstein.

Conversely, in the global south, new build is drastically needed. "Cities, particularly in emerging economies, are going to have to accommodate nearly one billion more people" said Haas, "and that built environment is not yet there – it needs to be constructed – so there is a major opportunity".

Fundamentally, this construction must respect local context for the population to thrive, as Moncaster elaborated: "Africa already suffers from little resilience, poverty and exposure to harsh climates… understanding regional differences [via the lived experiences of communities] is essential for ensuring a just transition."

Growth and cities

"Across history and across the globe, people have been moving to cities in search of opportunity" said Haas. When they function well, cities are able to mitigate the downsides of density and unleash the benefits of productivity and innovation. "But we are not getting it right", she said. Real estate is "financialised", remote ownership facilitated, the poor neglected, and the world left facing a housing crisis.

Bernstein elaborated on the role of the architect in this economic picture. "What we do as architects is convert big piles of money into buildings," he said. "We are at the front end of a very complex chain of global financial structures that are super interested in built assets right now. And we are going to continue to do it … until there is some top-line, policy-level change that affects the flow of capital markets." Moncaster shares this view: "Without a much stronger control or regulation… there won't be anything to push us towards making the right choices".

What's needed is a paradigm shift. Is there space for such a thing? asked Prasad. Could we even begin to measure growth spiritually rather than economically, such as through 'Gross National Happiness'? "GDP growth is not a sufficient condition" agreed Haas. "We may be moving the numbers one way but that that doesn't mean we are distributing the outcomes, in fact we are going further and further away from that". But such shifts take generations, beyond the scope of the ten-year horizon. "How we can distribute the outcomes of GDP growth to benefit the majority…that's where the conversation should go."

But is there nothing we can do to improve the state of our cities meanwhile? In terms of biodiversity, for instance, while increased urbanism is damaging ecosystems via different mechanisms, blue green infrastructure and other urban greening strategies help mitigate loss and build climate resistance. "We need green solutions to be incorporated into building projects as standard [and] avoiding green gentrification", Moncaster said. Indeed, she argued, climate change may well "force a paradigm shift" upon us very soon.

Technology, employment and education

And what of technology? "There is the tendency to think that technological tools are magic and will solve our problems", Bernstein argued. But the future lies not in 'cool new gadgets' but in strategically harnessing technologies, mindful of ethics, equity and risk.

Perhaps the biggest disruptor is AI, which has the potential to revolutionise efficiency, but at devastating environmental cost. Tech generally also risks supplanting jobs, including jeopardising the manual labour that emerging economies currently rely on.

Bernstein, Light and Haas approached this debate from different perspectives. "Roles shift significantly as technology opens up, creating new services and propositions", said Light. "It will need a significant mindset shift, but I do believe [architects] should see these technological solutions as an opportunity".

Haas, on the other hand, reiterated the importance of construction labour for sub-Saharan economies. "The professions that are emerging [from technological change] require a high skill set," she argued. "What I am speaking about is a billion people in 25 years moving to cities looking for jobs …[these new roles] are not going to satisfy … this vast number of people".

But AI may help break down the siloes contributing to our current problems. In the future, speculated Prasad, we will see that "where interdisciplinarity became the dominant theme in how we work, AI was there to help us navigate it with extraordinary processing power and capacity to integrate vastly different fields of knowledge". Collaboration will be key to delivering an equitable future built environment. "Maybe we can't design out poverty," said Moncaster, "[But perhaps we can] use technology to do the grunt work to give us time to think".

"I really believe in the power of education," she continued. "Not just teaching facts that people can regurgitate [but in the] opportunity to come together and discuss things with very different people, and to develop our understanding of what the problems are from a much wider perspective than our own."

Sharing knowledge can indeed help rebalance opportunities. "The number of built environment professionals per capita in sub-Saharan Africa is low, we are having to import our design thinking," Haas said. "Being able to upskill professionals whose lived experience is in the environment they are trying to change, is a first critical step".

Design in perspective

So, "What is the capacity of design?" Prasad asked the panellists to conclude.

"I am split" admits Moncaster. "Architecture as a profession has a certain arrogant sense of itself, that design can provide the solution to problems. However, there is something about an architecture education that … does push people to think more widely and encourage people to look from different perspectives." This outlook surely places architects in a unique position.

"In emerging economies, it is estimated that two thirds of the built environment is yet to be built…In this two thirds there is the need to be creative," said Haas. "Seek to work with communities and individuals from radically different backgrounds. Ask 'Do I value this voice? Do I value this opinion? Why is this opinion different from mine?'" In so doing, opportunities will be unleashed.

"We are coming to a moment now where there are huge collaborative opportunities" urged Bernstein. "Experiment in a collaborative way and see if this thesis about the free-flow of information really has legs".

The Future of Design and Make

Nicolas Mangon
Vice President, AEC Industry Strategy, Autodesk

Through Horizons 2034, RIBA set out to collaborate with experts from across the industry to understand significant global themes on how we build and live in the future.

We see strong synergies with our own path here at Autodesk. We recently released the 2024 edition of our annual State of Design & Make report after interviewing 5,399 industry leaders, futurists, and experts. The report identifies the most pressing issues shaping today's businesses to help leaders make informed, strategic decisions about how to prioritise and invest in the future.

Key themes that emerged were business resilience, the upskilling of talent and sustainability. While cost control has come up as a new challenge, confidence is growing and leaders feel their companies are more resilient. The data also show increased trust and optimism in AI and digital transformation, especially as the industries that create buildings and infrastructure are aiming to become more efficient and cost-effective.

In fact, the next 25 years will see a breathtaking pace of technological change. According to the report, firms are preparing by adopting digital solutions at a faster pace than ever before. For example, 27% of those surveyed increased their investment in technology to deliver improved project outcomes over the past three years.

But limiting factors remain. 35% of respondents stated that cost was a barrier to digital transformation and felt that the time needed to invest in new tools and ways of working was holding them back.

The industry needs a better way of working that simplifies adoption and workflows, saving time and money. While Building Information Modelling revolutionised AECO (architecture, engineering, construction and operations) practices by allowing organisations to centre their workflows with a model-based approach, BIM technologies have historically been limited in their ability to enable trusted collaboration and connectivity across project phases and stakeholders. In large part this is because data have been locked in proprietary files, hindering transparency, data-sharing, and interoperability in ways that create additional value.

Today's BIM environment is hampered by fragmented technological processes, with the average AECO professional toggling between at least four design software applications daily. These technologies are often complex, overburdening users with details and offering little in the way of automation or decision support. They are also frequently incompatible, forcing AECO organisations to rely on document-based collaboration. Rather than working from a shared data repository, engineers, designers, and other stakeholders resort to emailing documents back and forth, limiting the ability of teams to merge their best ideas and work together in real time.

The shift towards open, integrated cloud platforms and the adoption of granular data for efficient and precise information exchange represent fundamental changes in the industry's operational model, facilitating the advanced utilization of AI and enhancing collaboration, productivity, and sustainability in the AECO industry. Photo: Zoonar GmbH / Alamy Stock Photo

To overcome these limitations, the industry's technology providers are **embracing interoperability** through open, integrated cloud platforms. The **Autodesk Construction Cloud** also supports open standards and APIs, which are an important path to a future where a fluent exchange of information brings about the next generation of BIM.

But that future also depends on how that information is structured. Exchanging big files isn't the best way: the goal is to break these exchanges into more precise elements. An IFC file contains tens of thousands, if not hundreds of thousands, of components. The currency is shifting from these large discrete files to more granular data. If an architect sends an 850 MB file to an engineer, it often contains superfluous information that isn't relevant to the engineer's scope of work. Sharing granular data means contributors can send a set of curated information or make updates to specific parts of a design.

Software technology called data models enable common data environments to parse granular data. For example, Autodesk Construction Cloud's common data environment, **Autodesk Docs**, uses an AEC data model to differentiate between design elements without the need for additional parsing of metadata.

What can granular data do? The possibilities are almost endless. Granular data on a platform enables simplified workflows. It will enable frictionless connectivity; secure access at any time, from anywhere; real-time and on-demand project insights; better, informed decision-making; and effortless collaboration. It's already enabling a vibrant third-party ecosystem of apps and services, as well as powerful generative co-creation using AI.

Productivity gains are a promising effect of AI, and business leaders are pushing their teams to pilot use cases in hopes of converting opportunities early. One benefit of this urgency is improved sustainability. AI has risen to the top spot of technologies that leaders are using to make their businesses better equipped to meet the challenges posed by climate change, population growth and economics.

Combining human intuition and expertise with AI's computational capabilities allows us to expand the realm of possibilities and can bring us closer to better informed and more creative solutions. For example, AI-platforms such as Autodesk Forma enable architects today to integrate AI capabilities in their design process, simplifying everything from exploration of design concepts to evaluating environmental qualities surrounding a building site. And this is just the beginning.

It is clear that the AECO industry is ready for a better, faster, more decisive way of working, one that harnesses the power of AI to automate repetitive tasks, augment human design, and analyse data to uncover critical insights to make businesses and the built environment more resilient for the future. As the RIBA Horizons 2034 programme looks ten years into the future, it's clear that we face a great deal of change and uncertainty. The world needs human ingenuity more than ever – and it needs the data to do it.

At Autodesk, we believe that technology will always be one of society's most powerful catalysts for progress, and that progress requires collaboration and partnership. So, let's change how the world gets designed and made, together.

The Environmental Challenge

Introduction

Alice Moncaster is Professor of Sustainable Construction at the University of the West of England, following academic posts at the Open University and the University of Cambridge, and degrees from Cambridge (BA and MA), Bristol (MSc) and UEA (PhD).

She seeks through her research and writing to challenge the status quo in the construction sector, thereby achieving a radical transition towards environmental sustainability and resilience to climate change.

She works with national and international partners across disciplines and retains a close link with practitioners and industry.

The only possible answer to the climate crisis is to recognise our global responsibility, even as the political mood swings towards nationalisation.

Radical change is needed to meet the urgency of the climate crisis. The scans in this theme will explore how the built environment is accountable for almost half of all global emissions and how the design and construction industry has a pressing need to recognise its responsibility.

The environmental challenge facing us is both vast and urgent. Use of energy and materials is increasing globally, greenhouse gas emissions are going up rather than down, the devastating impacts of climate change are already being suffered from sub-Saharan Africa to the poles, and the crisis in global biodiversity is unprecedented.

Vested interests, lack of understanding, and inertia are compounding the problems. As Latour asks in Down to Earth: “How can we not feel inwardly undone by the anxiety of not knowing how to respond?” **[1]**

Architects and built environment professionals have a particular responsibility. As highlighted in the International Energy Agency and United Nations Environment Programme Global Status Report 2022, greenhouse gas emissions arising from heating, cooling and lighting our buildings are responsible for 27% of global emissions. **[2]** Constructing and maintaining those buildings emits an additional 10%, with construction of infrastructure responsible for another 10%. Our built environment, then, is responsible for almost half of all global emissions – and, by implication, so are its architects.

At the same time, urbanisation, more extreme weather, growing populations and increasing migration are exerting an ever-greater pressure on our cities. The need for resilient buildings to shelter us all in comfort and security from the heat and storms to come is only going to grow.

The only possible answer to the climate crisis is to recognise our global responsibility, even as the political mood swings towards nationalisation. How should architects respond professionally to both this responsibility and this demand, in the next ten years and beyond?

The current system of education and skills, manufacturers and supply chains, procurement and finance, and developers and design firms, is so unwieldy that it is no surprise that the construction industry is seen as one of the slowest to change. And yet change is happening. An understanding of the importance of improving energy efficiency is now widespread and enshrined in regulations across much of the world. The measurement and gradual reduction of embodied carbon in building materials is finally starting to catch up, with national regulations just introduced in the Scandinavian countries and spreading.

But professional training and practices still tend to reflect old siloes based on rigid divisions of knowledge and labour. They still respond to a conceptual framework which sees buildings and infrastructure as technologies made up of individual parts, rather than integrated socio-technical systems. This has too often produced battles rather than consensus: arguments over whether operational or embodied carbon is the most important, over heavy-weight versus lightweight structures, over demolition versus retention, and over densification versus low-rise.

Radical change – indeed revolution – is needed, and this is what RIBA Horizons 2034 is challenging us to achieve.

The four Horizons 2034 topics are overlapping and inter-connected. Degradation of the environment is unfairly experienced at both global and local scales, with economic systems increasingly protecting the rich at the expense of the poor and vulnerable. Population growth and migration add additional pressures. Technological innovation is often held out as the holy grail, and yet repeatedly fails to reduce carbon emissions, often instead producing unintended negative consequences.

Within The Environmental Challenge theme we considered four topics. **'Adaptation'**, is reproduced in this Executive Report. The other three - mitigation, biodiversity and the role of engagement and activism - are reproduced in the full version of this report.

Climate change mitigation is the most advanced area, focusing on the reduction of carbon emissions and driving the net zero transition. Climate change is already here and its effects are increasing, and so architects also need to simultaneously adapt the existing built environment to help society to cope with heat waves, storms, flooding and drought. Biodiversity and protecting the variety of life on Earth in all its forms is also crucial in ameliorating the impact of global warming on ecosystems and preventing local environmental degradation. However, driving change at a policy and an individual level requires engagement and activism in a cycle of continuous debate and lobbying. These areas are intrinsically linked.

So, this is how architects must respond. They must rethink the boundaries of their responsibilities and start a revolution. Revolution is needed all along the supply chain, to produce near-to-zero carbon products and buildings.

But revolution is also needed at the point at which projects are first imagined, at the point at which planning is approved or denied, throughout the design professions and the construction industry and within regional and national governments.

Building professionals must reconsider their role, not as great designers of new objects to be admired and consumed, but as servants of global communities who need more from their built environment than ever before.

And rather than working in siloes, they need to learn about and practice maths, art, humanity and understanding – and above all humility.

Change is needed in the ways that decisions are made, in the arguments that are openly had, those that are hidden, and those that are never discussed.

Every step of our approach to the built environment must be deconstructed, in order to reassemble it as one that is fit for the future, that minimises our impact as a species on the climate and on Earth's ecosystems, and that provides us with a built environment capable of sustaining our future on the planet.

References

[1] Bruno Latour (2018). Down to Earth: Politics in the New Climatic Regime (Catherine Porter, Trans.). Polity Press

[2] Global Alliance for Buildings and Construction (9 November 2022). 2022 Global Status Report for Buildings and Construction. United Nations Environment Programme https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction

Aerial view of flooded houses in Halych, Ukraine. Photo: iStock|Bilanol

Climate adaptation: how can design science help the transition?

Ronita Bardhan is Associate Professor, Director of Research, Deputy Head, and has chaired the EDI committee of Department of Architecture at University of Cambridge. She holds a visiting position at Cambridge Public Health, and Department of Computer Science and Technology.

She leads the Cambridge Sustainable Design Group and works on built environment intervention-led health and energy inequalities in the warming climate, harnessing data-driven design for precision prevention.

She was awarded the prestigious EPSRC Women Ambassador in Engineering award (2023), the Exceptional Woman of Excellence accolade by the Women Economic Forum (2019), and a notable felicitation by the Ministry of Health, Government of India (2022).

Ronita Bardhan looks at the next 10 years, when sustainable design will no longer be just about carbon emissions reduction and shifting to net zero. The onset of climate change will require adaptation of the existing built environment to ensure it is resilient to increasingly adverse weather conditions.

Climate change is currently under way. We will increasingly feel its effects over the next 10 years as extremes of weather affect our buildings and infrastructure.

There's a growing concern that, without immediate and deep efforts to slow climate change, global temperatures will surpass the critical 1.5°C threshold above pre-industrial levels by 2027. **[1]**

Simultaneously, the world is becoming more urbanised, with major urban areas becoming extremely vulnerable to the hazards of climate change. This situation has intensified the need to depart from traditional business-as-usual strategies in urban areas in favour of more sustainable development.

In general, actions to address climate change broadly adopt a two-pronged approach: mitigation and adaptation. As Abimbola Windapo and Alice Moncaster show in their horizon scan, mitigation strategies slow climate change by reducing carbon emissions. Adaptation strategies, on the other hand, accept that climate change is already under way and respond by bolstering our capacity to cope. Adaptations, in their most basic definition, permit "adjusting to the actual or anticipated climate and its effects." **[2]**

An approach centred on people, places, and practices is founded on the tenet that species adapt to changing environments. This allows them to minimise or avoid harm while evolving under stress. According to the Intergovernmental Panel on Climate Change (IPCC), it will be difficult to avert the effects of climate change even with "the most stringent mitigation efforts". **[3]** Consequently, climate adaptation becomes indispensable and unavoidable.

Climate adaptation in the field of building science and design is not new. The earliest builders improved their buildings in response to varying extremes of the local climate to maintain a stable indoor environment. Over time, they integrated technological advances and adjusted design parameters to, for example, enhance airtightness, weather resistance and insulation. New materials like cement and concrete were incorporated to make more enduring shelters to accommodate the expanding human population.

Had it not been for the challenge of carbon emission reduction, the building design industry would have persisted along the same trajectory of innovation in materials and technologies.

Partly because of these first-generation building design innovations (such as introducing materials like cement and concrete), the construction sector contributes approximately 40% of worldwide greenhouse gas emissions.

Apart from buildings' increased carbon emissions, studies also suggest that they fail to foster good health. According to recent estimations, current building design practices contribute to approximately one-fifth of chronic diseases. **[4]** While buildings need to mitigate their greenhouse gas impact, they also need to adapt not just to inevitable changes in the climate but also for the health of their occupants.

Designer's dilemma – challenges in climate adaptation?

Adapting to climate change is a complex challenge that necessitates preparing for multi-dimensional severe weather phenomena, including intense fluctuations in temperature and precipitation, rising sea levels, flooding, prolonged droughts, and intense winds.

Since climate scientists assert with "very high confidence" that the planet is facing a 1.5°C rise in temperature, even the most optimistic will likely agree that we need robust adaptive measures to counter its negative effects. [3] Such a rise in temperature will present unique challenges to humanity, infrastructure, economies, and natural systems, all of which will deviate from what is currently considered normal.

Nonetheless, there is still uncertainty about the rate of climate change, and how soon its negative effects will kick in. This uncertainty is a dilemma for building design scientists. Presently, the practice of architectural design is advancing to meet the demands of a changing climate, which includes departing from traditional building materials and construction practices to embrace climate resilience. Yet, without precise predictions of when these changes will occur, achieving the Goldilocks design that ensures effective adaptation is a formidable task.

Also, while climate change affects the entire planet, its impacts are unevenly felt, with the people of the Global South experiencing more severe consequences due to widespread poverty. Adaptive building technologies such as mechanical cooling systems are often not designed for local climatic differences and may not be universally applicable.

Most design norms are derived from empirical studies conducted mainly in the Western context, leading to adaptive design parameters that cater to those specific environmental and societal contexts. Yet, despite facing more acute climate vulnerabilities, the developing world often adopts these same design standards without modifying them to suit their own unique environments. **[5]**

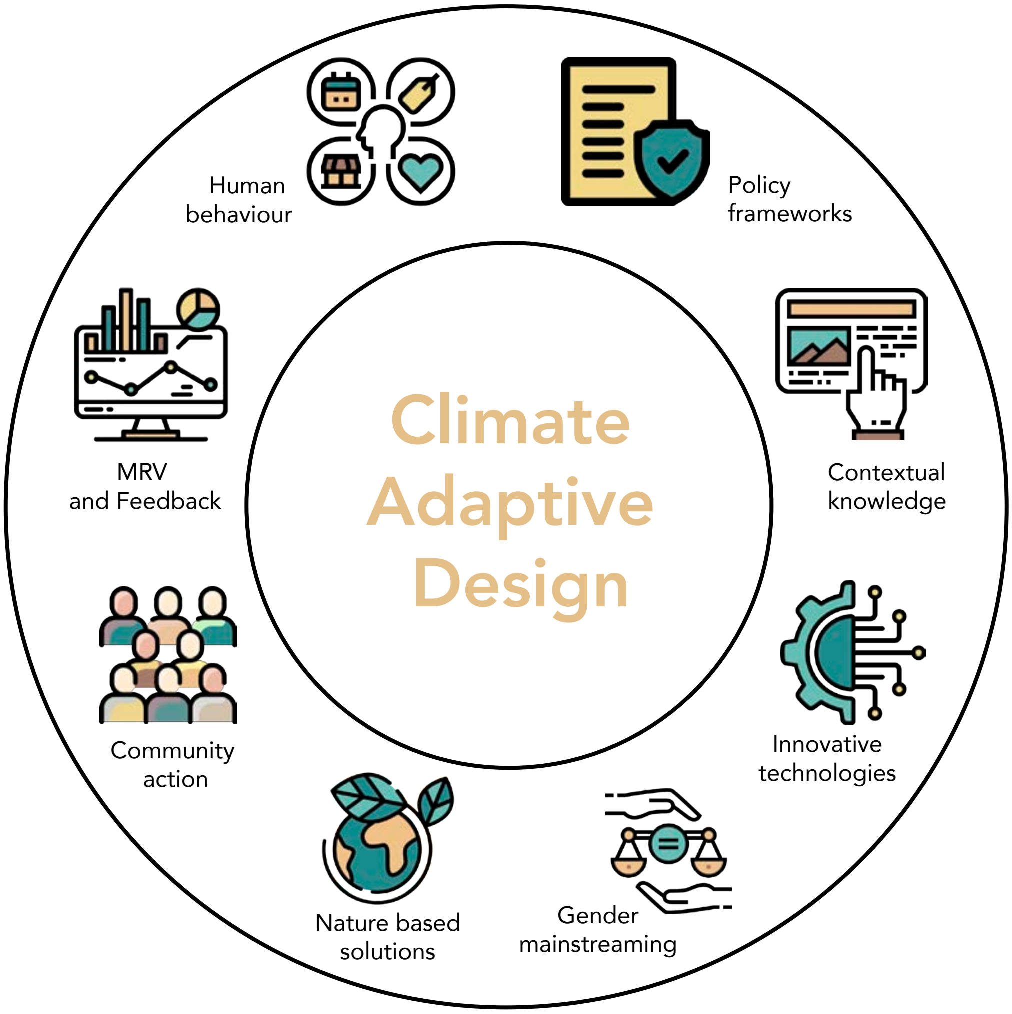
The challenges in moving beyond these misunderstandings are multifold. They include a dearth of comprehensive information. For example, there is a significant lack of data on human adaptive thresholds that consider historical climate exposure, social behaviours and cultural norms. This gap means that current standards may not effectively meet the needs of diverse populations facing varied climate impacts.

There is a pressing need to gather more inclusive data and develop accessible adaptable design parameters that recognise and address the specific vulnerabilities of different regions, especially those most affected by climate change.

Foundations for climate adaptation through design

Architectural design science is grounded in the principle of constructing environments that foster a sense of physical and mental well-being while ensuring sustainability. Due to climate change, buildings now have the dual function of reducing carbon emissions while simultaneously enhancing the health, well-being, and productivity of occupants by protecting them from the extremities of future climate by maintaining a 'good' indoor environment. Realising the health potential of adaptive design strategies is still at an early stage, yet there is empirical evidence that they can improve indoor air quality and the thermal environment, which can affect human behaviour and impact health outcomes.

Approaches to climate adaptive designs can be defined as fitting within eight foundation principles, which between them delineate specific and practicable ways to enhance the resilience of the built environment to climate change.



Foundational principles of Climate Adaptive Design.
Credit: Original drawing by Ronita Bardhan. Redrawn by Marie Doinne, RIBA

Contextual knowledge

One of the daunting challenges for the science of designing for climate adaptation concerns how to include local knowledge. The only way to ensure that buildings are resilient to specific local weather patterns and cultural practices is if their design harnesses accurate contextual knowledge.

This is about understanding unique region-specific data on historical climate exposure, stress-coping mechanisms, thermal history and socio-cultural dynamics to design and construct buildings that not only respond to the local climate's idiosyncrasies but also resonate with the community's way of life.

By incorporating indigenous materials and traditional construction techniques alongside modern technology, designs built with contextual knowledge ensure sustainability and comfort. At the same time, they foster a harmonious relationship between the built environment and the natural ecosystem.

Tailored approaches like these enhance resilience, diminish environmental impact, and uphold the local community's cultural traditions.

We can capture contextual knowledge by using methods from the social sciences and humanities, including narrative surveys, focus-group discussions, and key informant interviews. These methods inform designs by using grounded data that reduce uncertainty about climate change risks. **[6]**

Innovative technologies

Innovative technologies harness data-driven methods, smart materials, and bioclimatic principles to create built environments that respond dynamically to changing environmental conditions. Utilising advancements such as weather-responsive facades, green and energy-efficient methods, and AI-driven climate control systems, innovative technologies help designers to optimise comfort, reduce energy consumption and adapt to the current and future impacts of climate change.

However, the implementation of this technology is often hindered by uneven access, limitations in widespread application, and asymmetry in communities' preparedness to integrate new technologies, particularly in resource-constrained settings. As a result, useful technologies may not be suitable for adoption, especially if they are very sophisticated.

Transformative gender mainstreaming

Climate change has an uneven impact on different genders, often exacerbating existing gender inequalities. Women are disproportionately impacted by climate change. For example, pregnant or elderly women are more prone to dehydration and can suffer more from extreme heatwave days. This leads to – and from – their continued marginalisation and underrepresentation in accessing and co-designing effective adaptive strategies.

The disparity in how women are affected by climate change is frequently determined by their designated roles and unequal power dynamics arising from customs and societal norms, all influenced by historical, cultural, and social factors. This results in maladaptation. **[7]**

Incorporating climate-resilient designs that take into account gender-specific roles within a community can help to break the link between poverty and the dual pressures of health and energy costs.

This is particularly relevant in low-income areas where women's decisions to use active cooling solutions indoors are often influenced more by social norms and the cultural expectation to be the family's stabilising force, rather than by a direct need to manage thermal comfort. Unfortunately, these ingrained behavioural patterns, deeply rooted in social customs, are frequently overlooked when developing strategies for climate-adaptive designs.

Data on the gendered differences in climate change impacts and processes of adaptation are currently scarce but crucial for successful climate adaptation.

Unlike rigid, engineered solutions, NBS can grow, self-repair, and adjust to changing conditions, which makes them more resilient to climate change.

Nature-based solutions

Nature-based solutions (NBS) in architecture promise to reduce the whole life carbon of buildings while also offering various multi-scalar ecological regeneration benefits.

For example, using green roofs can lower the temperature of buildings and their surroundings, a useful adaptive strategy in areas where extremes of heat are rising. (Green roofs also reduce operational carbon by lessening the need for air conditioning and mitigating the urban heat island effects.)

Another advantage of NBS is that they present the opportunity to utilise local knowledge, which allows ethical factors to influence climate adaptive designs.

NBS can encompass design approaches that imitate natural processes, such as biophilic design, ecosystem-based arbortecture, **[8]** and design for disassembly, frequently using natural materials such as timber, clay, and bamboo.

NBS systems are inherently adaptive. Unlike rigid, engineered solutions, NBS can grow, self-repair, and adjust to changing conditions, which makes them more resilient to climate change. Also, they are easily accessible to people and disrupt daily lives minimally, allowing them to gain community acceptance naturally. Being natural ecosystems, NBS remain effective over the long term, and their acceptance by local communities ensures their continued care, protection, and longevity. In short, they are long-lasting sustainable systems. (Coincidentally, some NBS also allow buildings to work as material banks and carbon sinks, **[9]** which are both useful mitigation strategies.)

Although there is currently a move towards using multiple NBS, a significant constraint is that they require extensive interdisciplinary knowledge and comprehension of natural materials and ecosystems. Effectively utilising NBS in this way will necessitate expansive collaboration between people in the fields of natural sciences, engineering, and design.

Monitoring, reporting, verification and feedback

Reliable data on the effectiveness of designs' adaptive potential is crucial for their successful implementation. We can only know how successful they are with extensive monitoring, reporting and validation through post-occupancy evaluations and other forms of research.

The feedback can be used to inform and improve models and simulations and develop data-driven design heuristics to ensure design consistency, which will help designers to verify that their designs will be effective.

To evaluate the tangible advantages of adaptive designs, it will be necessary to develop new metrics and tools that can accurately assess the economic, social, and environmental benefits and reliably correlate them with particular climate adaptive design strategies.

Influencing human behaviour

Design interventions can have an impact on human behaviour. To influence behaviour reliably to support the effectiveness of adaptive measures, we must comprehend the behavioural dynamics of inhabitation and resource utilisation that could hinder climate adaptation strategies.

The literature on how designs interact with their occupants to enhance good climate adaptive behaviours is scarce. Although still evolving, the fields of salutogenic design potentially hold useful insights.

Community action

Community action (through climate action groups, for example) is probably the most effective way for individuals and communities to have their voices heard. Listening to them can help to identify viable strategies for adapting to climate change, and by engaging with relevant groups, designers are more likely to devise successful strategies.

To ensure that the community's perceptions, sentiments, and needs are properly represented, design processes should incorporate co-creation and participatory design approaches. Groups within the local community with relevant information thus have the opportunity to become catalysts for positive change. In short, the approach ensures that people are central to both the design process and the resulting products.

Emerging methods like computational social science have the potential to capture and process the community information required, especially in early design stages. **[10]**

When designers recommend adaptive design measures, they encounter barriers from local approval bodies.

Policy frameworks

Policy support is necessary for climate adaptive designs to work. Presently, many building design regulations and policy guidance (and the codes they refer to) fail to account adequately for the upcoming effects of climate change. When designers recommend adaptive design measures, they encounter barriers from local approval bodies.

Effective adaptation requires an in-depth understanding of possible risks in the context of evolving community needs. As a public good, developing and monitoring this regionally specific understanding is a government responsibility. It can be used to inform policy frameworks to either nudge or, if the risks are serious enough and public interest strong enough, regulate building design practice towards outcomes that are properly resilient to local climate change risks.

Adaptation for a better future

Design science offers a multifaceted toolkit for climate adaptation, crucial for the reconfiguration of our built environments to better withstand impending climate change.

The essence of sustainable development lies in a dual approach: reducing emissions through innovative design while bolstering our built environment's resilience to potentially damaging climate change.

Eight foundational principles underpin architectural design that harmonises with environmental exigencies, integrates community knowledge, leverages technology, and aligns with gender and policy frameworks. This holistic approach aims to protect our built environment and the people most at risk from climate change.

Overcoming entrenched conventions, bridging data gaps, and democratising access to these solutions remain significant challenges. Yet, the promise of climate adaptive design – rooted in rigorous data, inclusivity, and community engagement – paves the way towards sustainable living and a climate-resilient built environment.

As we navigate the unpredictability of climate effects and consider the practice of architecture over the next 10 years, it's critical to embrace and champion design breakthroughs that embody climate resilience. Although the risks posed by climate change can appear catastrophic, such change can also bring opportunities. Adopting climate adaptive design strategies is one such opportunity, with the power to propel humanity forward.

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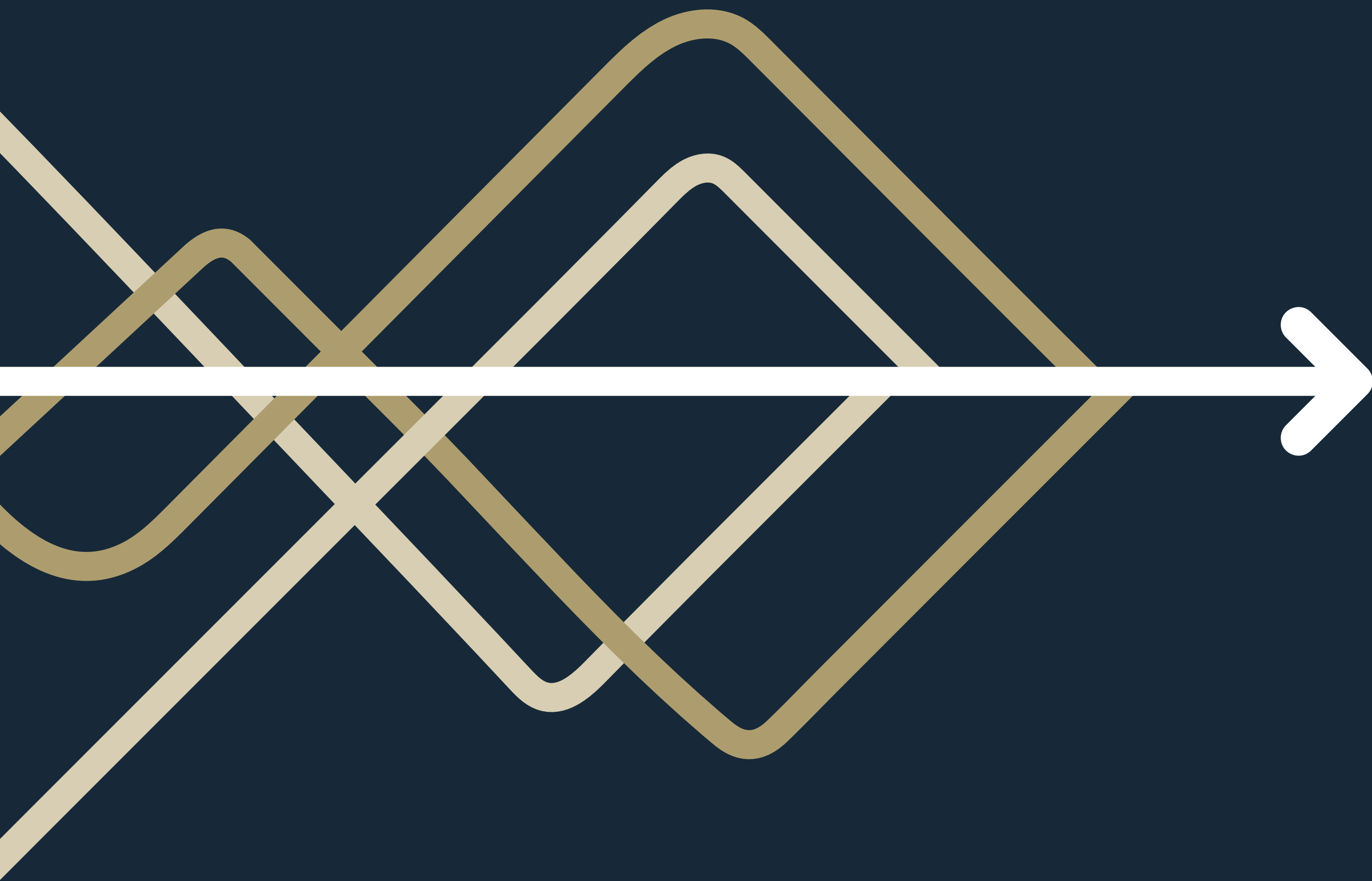
Economics of the Built Environment



Introduction

Astrid R.N. Haas is an independent urban economist working across research and practice, supporting cities in Africa, the Middle East and Asia with questions of strategy related to financing and funding. She also has appointments as Adjunct Professor at the School of Cities, University of Toronto, Research Associate at both ODI and the African Centre for Cities at the University of Cape Town, and Extraordinary Lecturer at the African Tax Institute at the University of Pretoria. Her previous engagements include working as an urban economist with the African Development Bank and as Policy Director at the International Growth Centre. She holds an MSc in Public Financial Management from SOAS, University of London and an MA in International Economics and International Development from Johns Hopkins University.

In the 1990s, through policy transfer, governments globally jumped on the political and economic privatisation bandwagon.

What are the global economic systems and forces that will continue to drive the development of the built environment? How will the way money is spent on new and existing buildings by the public and private sector impact on social equality and the life chances of individuals?

In the day-to-day practice of architecture, thinking about economics is most often restricted to the financing of projects: are the economic conditions right for clients to get the funding they need for well-designed projects?

The second theme in RIBA Horizons 2034 programme, 'The Economics of the Built Environment', invites a deeper consideration of the global economic system and architects' part in it.

How is wealth created, owned, distributed and spent, and by whom? Who has the wealth now, and how did they get it? What are they using it for? What effects does the way that money is spent have on those with very little of it? Who gets to commission buildings, and for what purpose? Is the urban form, and the buildings within it, as much an expression of economic forces as it is an expression of design and client choice?

Looking deeper still, are economic forces themselves a manifestation of ideology? During the 1980s, Ronald Reagan and Margaret Thatcher turned the tide on the public sector spending of the postwar years with a zealous enthusiasm for privatisation and new public management, which took a private sector approach to delivering public services. In the 1990s, through policy transfer, governments globally jumped on the political and economic privatisation bandwagon. This has had a profound and lasting impact on the way that governments worldwide delivered many policies – including, for example, housing policy.

So, might client requirements and their resolution in design be helpfully understood not only as expressions of aesthetics and creativity but also as the results of economic and ideological imperatives, sometimes unseen and unacknowledged? And can these considerations inform architects' future choice of how to practice, including what buildings to design, for whom, and where?

The Economics of the Built Environment theme broke down into four topics. The **'financialisation of the built environment'** is reproduced in this Executive Report. Scans covering interconnected and specialisation, emerging economies and inequality as in the full report.

Powerful economic drivers

Since the establishment of ancient civilisations, cities have been synonymous with economic, cultural and human prosperity. Whether cities in the future are to remain productive, liveable and sustainable will ultimately be determined, in large part, by the shape of the built environment.

To date, across history and around the world, there is abundant evidence that urbanisation is one of the most powerful driving forces to shift entire generations from poverty to prosperity. **[1]** The power of cities lies in their density and in a built environment that drives interconnectedness and specialisation. For the private sector, this means that firms are closer to a wide and diverse pool of labour, critical for productivity. It also ensures that firms are well networked, allowing them to specialise because they can rely on other firms around them for other specialised inputs into production. Cities also ensure that firms are close to markets – locally, nationally, regionally, and globally – by developing infrastructure that provides avenues for trade. The same density that drives productivity in the private sector also brings people closer together, so spurring new ideas and innovation.

These drivers of economic growth are the same ones that Adam Smith described in his seminal work, 'The Wealth of Nations', first published in 1776. This is why economists emphasise that cities can become key engines for growth. This should be encouraging for many emerging economies, which are currently some of the most rapidly urbanising places in the world. For example, due to high population growth, the number of people living in African cities is set to triple between 2024 and 2050. This has huge implications for the built environment in these places: based on current projections, the urban footprint of Africa is set to expand by more than three times in the same period. **[2]**

As much of East Asia's urbanisation trajectory has shown, the expansion of the built environment needs to be carefully managed. Where this does not happen, urbanisation results in sprawling, disconnected urban spaces characterised by unmanageable density in the form of congestion, insecurity of tenure and the proliferation of informal settlements. Cities that do not invest enough in infrastructure fail to attract businesses and the rapidly growing youth population – i.e., those under 35 years – struggle to find employment, ultimately driving the growth of informal work. Even China's built environment, which has experienced one of the highest rates of expansion in the world, is experiencing an economic slowdown as its population ages and urbanisation slows, leaving broader questions about how to make urbanisation-led growth sustainable.

UN Sustainable Development Goal 11 codifies the global aspiration to "make cities and human settlements inclusive, safe, resilient and sustainable". **[3]** Its first target is to "ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums by 2030". Distressingly, it is one of the few targets that has gone backwards. **[4]** Across the world, the urban environment is failing its inhabitants. UN-Habitat and the Office of the High Commissioner for Human Rights define adequate housing by seven criteria: security of tenure; availability of services, materials, facilities, and infrastructure; affordability; habitability; accessibility; location; and cultural adequacy. **[5]** Ensuring a sufficient supply of affordable housing, a key determinant of liveability and productivity, has become a central challenge for built environment professionals.

How housing is produced and where it is located is a substantial driver of inequality. **[6]** In high-income housing markets, developers are highly incentivised to respond to the demand from their clients to ensure that housing is of good quality and well-located. However, poorer, more vulnerable communities are more tied to what they can afford, often having to forgo most of the other measures of adequacy. For example, many social housing projects are being built further and further from city centres, and thus are far from economic opportunities.

Inequality has been exacerbated by the financialisation of urban land and housing markets since the 1980s. Pioneered in the UK and the US and created by the globalisation and the associated liberalisation of capital markets **[7]**, financialisation is resulting in the current global affordable housing crisis, as experienced in Europe, the UK, the US, and many other parts of the world. Accelerated by technological innovations, banks and other large lending institutions have not only entered but now dominate finance in the built environment – including in housing. **[8]** Land and housing have both substantially appreciated in value over the past decades, becoming the preferred form of collateral. As a result, housing no longer functions just as a home but also as an asset that provides a store of value. As finance-stimulated demand rapidly increases, so too does price, particularly for well-located properties.

A future-focused, intersectoral response

Continuing business as usual is not an option. Not only will it fail to serve our communities, especially the poor and most vulnerable, but it will also fail to address the climate crisis. Currently, cities are responsible for over 70% of emissions globally, and with so many needing to be built to meet projected population growth, continuing at this rate is unsustainable.

The built environment professions must innovate urgently to match the dynamism and pace of change in cities. The approaches adopted must be tailored to their context. What works in regions with ageing populations, such as Europe, are likely to be different compared to what works in regions with a much younger workforce, such as in Africa and Asia. Other changes will also need to be accounted for. In the US, for example, built environment professionals must acknowledge the impact of working from home. **[9]**

Importantly, none of this innovation can be done in isolation. We need an intersectoral response by architects and planners, working closely with economists, engineers, sociologists, and others, to come up with solutions that unlock the potential of the built environment globally. Doing so successfully will have positive repercussions not only for current populations but for many generations to come.

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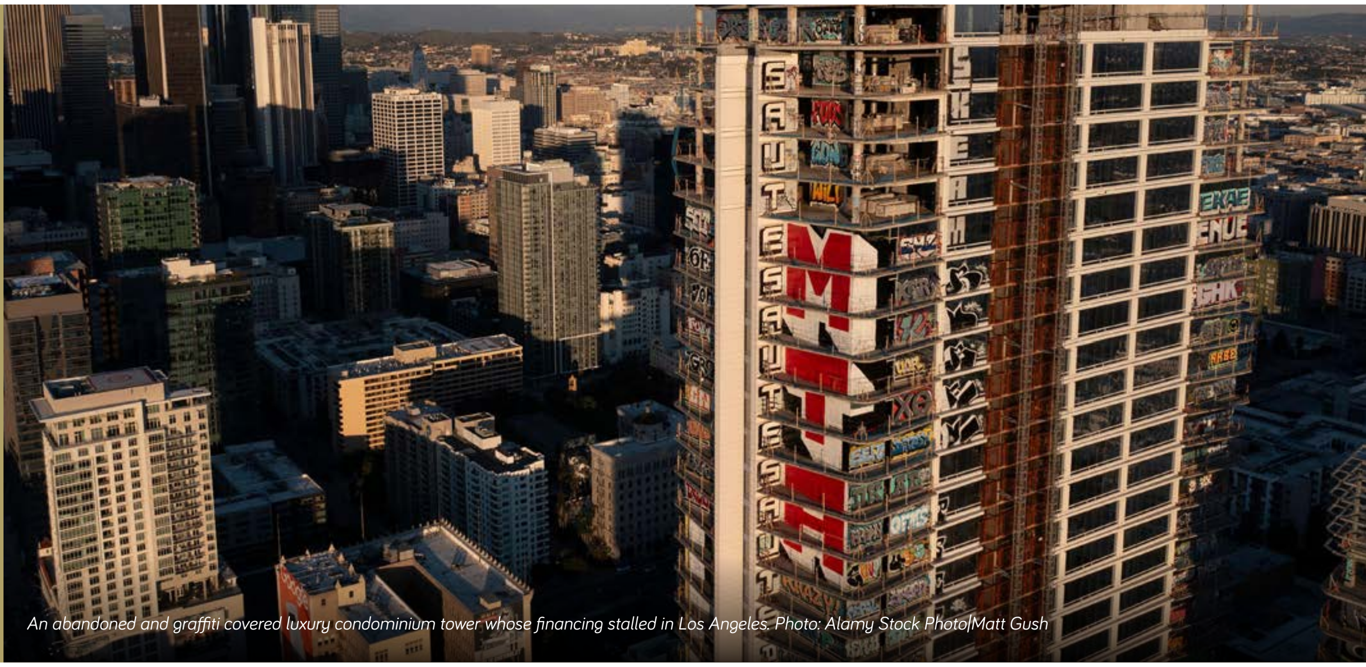
An abandoned and graffiti covered luxury condominium tower whose financing stalled in Los Angeles. Photo: Alamy Stock Photo/Matt Gush

Financialisation: buildings and architecture at the centre of global financial systems

Matthew Soules is Associate Professor of Architecture at the University of British Columbia's School of Architecture and Landscape Architecture, and founder of Matthew Soules Architecture. He has been visiting faculty at the Southern California Institute of Architecture and visiting associate professor at the Harvard University Graduate School of Design. His most recent book is 'Icebergs, Zombies and the Ultra-Thin: Architecture and Capitalism in the Twenty-First Century' (Princeton Architectural Press, 2021). He is co-founder of Architects Against Housing Alienation (AAHA), an activist collective that represented Canada at the 2023 Venice Biennale of Architecture.

Matthew Soules explains how built property now sits at the very heart of complex, global financial systems. This situation will only be compounded in the decade to come with the expanding scope and scale of property technology and the housing crisis. How might a sharper awareness among design and construction professionals of buildings' role in financialisation deliver a more just and beautiful built environment?

A defining challenge for the architectural profession in the 21st century is how to position itself in relation to financialisation. While buildings have always been to some degree 'financial' – physical embodiments of wealth necessarily connected to economic systems – it is a relatively recent transformation that has embedded them squarely at the centre of vast and complex financial systems. It is not a stretch to say that buildings are now not only dialectically informed by and informative of finance, but an integral and primary medium of finance itself.

In the forthcoming decade to 2034, emerging trajectories of financialisation, such as the expanding scope and scale of property technology and the entrenchment of the spatial politics of crisis, will pose significant implications for buildings. A sharper awareness of buildings' role in relation to financialisation has the potential to empower architects, professional membership institutes, and the wider public. Understanding how financialisation works reveals opportunities and constraints for how to create a more just and beautiful built environment.

The FIRE economy

While finance is integral to capitalism, its prominence has risen and fallen over time. At the time of writing, 2024, it is very prominent. Indeed, there is near-consensus of an unprecedented rise in finance's scope and scale since approximately 1980.

American sociologist Greta R. Krippner defines financialisation as "a pattern of accumulation in which profits accrue primarily through financial channels rather than through trade and commodity production. 'Financial' here refers to activities relating to the provision (or transfers) of liquid capital in expectation of future interest, dividends, or capital gains." **[1]** Real estate occupies a central position in financialisation. The extent of its symbiotic integration has even spawned its own term: 'FIRE economy', where FIRE stands for 'finance, insurance, and real estate'.

The extent of this economic ecology can be measured in a myriad of ways. In most euro area countries, bank mortgage loan portfolios exceed 200% of the core capital of banks. **[2]** Americans have over $12 trillion USD in mortgages, accounting for 70% of consumer debt. **[3]** US commercial banks alone hold approximately 5.5 trillion USD in real estate loans, a 22-fold increase in constant dollars since 1980. **[4]** Multinational insurance companies are among the world's largest real estate investors. Buildings and their subdivided increments are integrated into a vast and interconnected financial network like never before.

The giant pool of money and asset architecture and urbanism

An important driver of financialisation is the 'giant pool of money', i.e. the aggregated and growing amount of worldwide capital savings that are held in a variety of forms such as pension funds, mutual funds, or insurance funds. In a process that David Harvey describes as the "perpetual need to find profitable terrains for capital-surplus production and absorption", the built environment has provided a primary site of the giant pool's absorption. In so doing, it has changed to suit the logic of financialisation. **[5]**

The resulting finance capitalist architecture and urbanism is inherently unstable and creates spaces in perpetual crisis. This is seen in the increasing unaffordability of housing in most major cities and the large swings between various forms of growth and decay that pulsate across cities, regions, and continents. Buildings increasingly function as physical sites to store wealth speculatively. From mega-basements in Aspen to hyper-tall and thin condominium towers in Dubai, buildings are mutating, literally changing shape and scale to soak up capital.

Perhaps most significantly, financialisation challenges real estate's position as the quintessential illiquid asset. The slow friction wrapped up in the saying "all real estate is local" has been ground away. Today, real estate is a smooth, radically expanded market of maximum liquidity where large amounts of self-similar architectural assets are exchanged with relative ease.

Transforming buildings and their subdivided increments into more liquid assets necessitated shifts in finance, law, business, technology, and physical form. Inherently more liquid financial instruments were invented and tethered to built space, including mortgage-backed securities (MBS) and shares in Real Estate Investment Trusts (REITs). Condominium laws that emerged in the 1960s and gained widespread popularity in the 1990s, facilitated for the very first time in many jurisdictions the direct ownership of housing units separated from the ground. Owning a condominium unit high in the sky literally removed it from the messy unpredictability of the public ground plane. International real estate brokerage firms that first emerged in the mid-1970s, and radically expanded in scope and scale in the 21st century, helped individuals and entities to purchase real estate in far-flung locations. All of this was supercharged with the rise of so-called proptech (property technology), a subset of financial technology devoted to real estate, that started in the 2000s and continues to gain momentum.

Buildings increasingly function as physical sites to store wealth speculatively. From mega-basements in Aspen to hyper-tall and thin condominium towers in Dubai, buildings are mutating, literally changing shape and scale to soak up capital.

View featuring high-end apartments along the High Line towards the towers of Hudson Yards, New York. Photo: Getty Images| Alexander Spatar

The forms of finance

At the beginning of the 21st century, architect Rem Koolhaas wrote: "In the free market, architecture = real estate." **[6]** While buildings have acquired heightened liquidity through new financial instruments, laws, and business practices, their physical form and function are also at play. There are four primary design strategies for making built assets more liquid: 1) simplifying space, 2) maximising the number of assets, 3) facilitating remote ownership, and 4) adding superficial complexity to compensate for the negative consequences of the first three strategies.

Common tactics to simplify spaces include deploying design characteristics that minimise the possibility of meaningful social interaction. The unpredictable and unique nature of the human life that unfolds in and around buildings is time-consuming to account for as an investor, and so makes buildings less liquid. Reducing the chances of social interaction standardises space and converts it into something more abstract and easily exchangeable. Maximising the number of assets means repeating standardised units in large numbers. Facilitating remote ownership centres on adjusting the siting, massing and organisation of buildings to reduce maintenance demands and security concerns and thus the need to be on hand to deal with problems as they arise.

Units that comprise the entire floor of ultra-thin towers; vast horizontal expanses of tightly spaced and almost identical single-family homes; residential towers severed from the public realm because they sit atop private podium landscapes: these are all avatars of architectural assets optimised for liquidity.

Paradoxically, while applying the first three strategies heightens built assets' liquidity, it also damages their appeal. The diminishing 'real' in 'real estate' threatens to undermine its very capacity as a unique asset class. To resolve this inherent tension and compensate for what has been lost, designers invent conditions that merely seem complex. The obsession with views, recreational leisure space, complex surface geometries, and manufactured natures in the guise of sustainability are all manifestations of this compensatory complexity.

The strategies apply to many different segments and geographies of financialisation: they are as prevalent for middle-class housing in ex-urban Spain as they are for luxury flats in central Beijing.

Variegated, localised, and global [7]

Even though the forms and logic of financialisation are global, they differ from neighbourhood to neighbourhood, city to city, and country to country. Financial instruments such as REIT and MBS may not have a direct presence in low-income countries, but the buildings produced in these contexts can often be equally financialised.

For example, housing micro-finance has dramatically expanded in the Global South where it is now deeply enmeshed with informal architecture and urbanism. **[8]** In Latin America, it is common for large construction material companies to provide self-builders with consumer loans, allowing transnational finance to flow through low-income spaces. **[9]** Proptech in the form of new mobile apps is expanding the micro-financing of housing across Africa. **[10]** And sometimes financialisation connects the architecture of high-income and low-income countries in surprisingly direct and perverse fashions. Take, for example, Bjarke Ingels Group's Vancouver condominium tower that included the world's first "one-for-one" home gifting program, in which each condominium purchase funded the creation of a housing unit in a "slum" in Phnom Penh. **[11]**

Ongoing financialisation, instability, and emerging implications

In the aftermath of the 2007 to 2008 global financial crisis, which started in real estate, there were numerous policy changes meant to mitigate the risks of a repeat. However, financialisation itself has continued apace, and during the pandemic, it accelerated.

All manner of risk remains. What was once the world's largest real estate company, Evergrande, was ordered to liquidate in early 2024 amid the ongoing real estate crisis in China. At the same time, regional banks in the US were experiencing real estate-related losses, fueling worries of a new financial crisis.

It's anyone's guess what will happen, but financialisation's continued march and associated instabilities are certain. Two likely trajectories that pose significant implications for architecture are, first, the expanding scope and scale of proptech and second, the entrenchment of the spatial politics of crisis.

Expanding scope and scale of proptech

The expanding scope and scale of proptech is likely to accelerate financialisation in the coming years. Digital twins of built space, which are designed to facilitate smart buildings and city planning, operations, and maintenance, is also being used to streamline real estate transactions.

During the pandemic, virtual home tours became commonplace, and this practice will likely become widespread and more varied. Virtual home staging is already touted as a way for sellers to save money and time, and generative AI is poised to become fully synthesised with the effort. At the same time, crowdfunding real estate platforms (such as Fundrise) that allow real estate investment for as little as 10 US dollars are gaining momentum.

While it will be full of fits and starts, dead ends, and failed ventures, the convergence of digital twinning, generative AI, and digital real estate investment platforms will almost certainly expand the limits and character of financialisation in the built environment.

The spatial politics of crisis

The prevalent opinion in public discourse around the world is that housing is in a state of crisis marked by widespread unaffordability, too little space per person, precarity, and homelessness. While almost everyone agrees that housing is not faring well, the reasons for the crisis are hotly contested. To what degree is it a result of financialisation? To what degree is it the result of an undersupply?

The scope and scale of this highly politicised crisis have no easy answers or quick remedies. However, it seems certain that financialisation is involved to an important degree, and that built environment professionals will be operating within the crisis for the foreseeable future. The implications for architectural practice are significant.

Implication 1: digital twin feedback

When the use of digital twins becomes widespread in the buying and selling of housing, a peculiar phenomenon occurs: digital twin feedback.

This is how it works. Certain spatial characteristics are easier than others to represent in a digital twin that is navigated on a mobile or desktop application. And indeed, certain characteristics become paramount to the liquidity of the architectural asset within this medium. Because these virtual characteristics are easier to represent, they become ubiquitous, with the result that they begin to infect the real world.

Kate Wagner, architecture critic for 'The Nation' and creator of the 'McMansion Hell' blog, has written about the omnipresence of the colour 'greige' – gray-beige – in actual residential interiors. She brilliantly describes this as a byproduct of the "reorganisation of the real estate industry away from traditional vectors – television and magazines – toward the Internet" and the way that "neutral gray colors are integral to [the] new post-digital kind of unreality' of virtual staging. **[12]** The point here is that greige is so important in the housing market's digital marketplace that it entrenches the colour in physical, built space. It might even be possible to say that greige is the colour of financialisation.

Online real estate platforms and all manner of mortgage lenders now use Automated Valuation Models (AVMs) for the valuation of real estate. In fact, AVMs are one of the most widespread existing uses of artificial intelligence, and their use is spreading globally. **[13]** As a 2023 report from the Brookings Institute states, AVMs "are among the most established, ubiquitous, complex, and impactful algorithmic systems in the United States." **[14]** With providers like CoreLogic UK and Hometrack/Zoopla, the UK appears to be the most active European country using AVMs.

As these systems become more central to the valuation of buildings, a major challenge for architects is the limitation in what AVMs can 'see'. The systems are most accurate when working with generic architectural space. They don't possess the means to value design elements beyond basic real estate metrics of things like proximity to schools, size, and number of bathrooms.

In the near future, it is likely that these systems will be able to assess digital twins, allowing them to 'see' more aspects of architectural design and thereby factor them into valuations. There is a tremendous possibility that this will result in greater simplification and standardisation of buildings in the service of greater liquidity. Proportions, spatial relationships, circulation, window placement, will all be algorithmically maximised to perform optimally for machine vision algorithms.
The omnipresence of greige is only the beginning of this digital twin feedback loop.

Implication 2: alternative forms of practice, from activism to the developer-architect

As financialisation continues, the potential for meaningful and spatially just architecture within the dominant economic paradigm will be further constrained. This is likely to result in more architects searching for alternative modes of practice, ones that extend beyond the most common and well-understood bounds of the profession.

The intensity of the spatial politics of crisis, which is driven at least in part by financialisation, may see more architects involved directly in activism, operating overtly to challenge the political economy of the built environment. Witness the rise of The Architecture Lobby as a case in point.

At the same time, project delivery models that operate outside the common strictures of the private market are already flourishing and may see increased growth on the horizon. A renewed interest in such things as housing co-ops, co-housing, co-living, and community land trusts all open avenues for architecture that is resilient to the limitations imposed by financialisation.

Architects may increasingly become actively involved in the financial context of their projects, designing creative and critical forms of finance that operate synthetically with physical form. John Portman, perhaps the most renowned developer–architect, said back in 1976 (just as financialisation was taking shape) that he had learned "to think of real estate architecturally." **[15]** German Baugruppen, Catalan housing co-ops, and developer–architects like Melbourne's Nightingale Housing can all be understood as contemporary and relevant manifestations of thinking about real estate architecturally.

Implication 3: affordability versus design

Housing crises and the intensity of the political discourse around them is generating a patchwork of new policies at all levels of government (local, regional and national) that will continue to evolve into the foreseeable future. This results in a dynamic and diverse terrain for architects to navigate.

Perhaps somewhat paradoxically, some of the new measures aimed at addressing affordability will accelerate financialisation and housing alienation. This all stems from the widespread argument that today's housing crises are primarily the result of low supply.

A harbinger of what may be in store occurred in late 2023 when the Canadian government announced plans to introduce a catalogue of government-sanctioned and "pre-approved" housing plans to "unclog the housing pipeline." **[16]** Shortly after its announcement, Allan Teramura, past president of the Royal Architectural Institute of Canada, called it out as a misconception. He wrote: "The … concerning implication of this initiative is that somehow the time spent on the design of housing is a major impediment to lowering its cost. This is a fallacy … The housing industry is already based on a model of the absolute minimum of time spent on design." **[17]**

Fighting the negative impacts of financialisation: activist architects and critical finance

For the foreseeable future up to and beyond 2034, financialisation will be central to the built environment sector. It will continue to inform everything from the design of floor plans to the political environment within which architects operate.

Practitioners, professional institutes, and non-governmental organisations can respond with activism to blunt its impact, or by promoting new modes of practice that involve adaptive collaboration with critical and creative financial consultants. Either way, they will be well-served to self-consciously position themselves in relation to its ongoing constraint of architectural potential and its de-socialising consequences.

The intensity of the spatial politics of crisis, which is driven at least in part by financialisation, may see more architects involved directly in activism, operating overtly to challenge the political economy of the built environment.

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Population Change

Introduction

Jane Falkingham is Professor of Demography and International Social Policy at the University of Southampton. She is Director of the ESRC Centre for Population Change whose remit is to better understand the drivers and consequences of demographic changes.

A wide variation of demographic patterns is emerging internationally, with rapid growth continuing in some regions, ageing and contraction elsewhere, coupled with wide-scale movement. How can design professionals simultaneously respond to the level of change at the urban scale, while supporting social cohesion for diverse and intergenerational communities?

According to the United Nations, on 15 November 2022 the world's eight billionth citizen was born in the Dominican Republic. [1] The UN described it as "a milestone in human history" – the culmination of an era where dramatic improvements in diet, sanitation, education and income have led to better health, resulting in an acceleration in the size of the global population.

It took all of human history for the world to reach its first billion at the dawn of the 19th century. The pace of change then quickened as the Industrial Revolution spurred on economic growth and social change, with the landmark of the second billion reached in 1930. Since then, the time between successive billions has shortened, with the result that, within the lifetime of someone born in the early 1970s, the world's population has doubled from four billon to today's eight billion.

It is widely accepted that the global population cannot continue to grow at such a pace. Most demographers believe that the world's population will stabilise at around 10.4 billion at the start of the next century, ending three centuries of population growth. **[2]**

So where might we be in 10 years' time in 2034? Population growth is already slowing as families adjust their behaviours, with parents choosing to have fewer children. Fewer births mean that the world's population is changing in shape, moving from the classic 'population pyramid' – with lots of children at the bottom and few older people at the top – to a 'population rectangle' where there will be similar numbers of people at each age. In short, this means that we have an ageing population.

Population growth is already slowing as families adjust their behaviours, with parents choosing to have fewer children.

The Population Change theme for RIBA Horizons 2034 considers four challenges.

The first is how architects should respond to changing demographics. How do we design for tomorrow's population, with more single person households, smaller families and more generations alive simultaneously? How do we ensure that our (smart) homes can age with us, enabling us to continue to age in place and remain living in the community? And how can cities be designed to support an ageing society?

Not all parts of the globe have gone through this demographic transition at the same time or pace, meaning that the spatial distribution of the global population has changed and will continue to do so. Europe and North America are projected to reach their peak population this decade, and indeed some countries within these regions are already experiencing population decline. In contrast, the population of sub-Saharan Africa is still growing and is expected to almost double by 2050, surpassing two billion inhabitants.

Urbanisation is the second population challenge, and is reproduced in this Executive Report. The diversity in population growth, allied with stark differences in economic and social life chances between countries and areas within countries, means that more people than ever are on the move.

Today, four and a half billion of the world's eight billion citizens live in urban areas and this is likely to increase by a further two and a half billion by 2050. **[3]** Rural to urban migration has seen the emergence of megacities – that is, cities with over 10 million inhabitants – in China, India, Latin America and parts of sub-Saharan Africa, with all the challenges this creates for the built environment and the supply of services.

As well as moving from rural to urban settings, more people than ever are moving across international borders and so migration and displacement is our third population challenge.

According to the UN, the number of persons living outside their country of birth or citizenship reached 281 million in 2020. **[4]** Today, international migration helps to maintain the population size and labour force in countries where the birth rate is low, adding to the cultural diversity of villages, towns and cities across Europe.

However, skilled economic migrants are just part of the picture. The past decade has witnessed a marked rise in the number of people displaced because of armed conflict and famine, with mass movements of refugees and asylum seekers. How should architects respond to these movements?

The final population challenge – the increasingly diverse population – brings together aspects from all three previous challenges. The built environment professions need to respond to the increasingly diverse makeup of our communities, creating places that meet the needs of different age groups and communities while promoting social cohesion.

Looking forwards

Population change over the next decade will provide exciting opportunities for designers, while presenting some resourcing challenges, meeting a skills gap.

With cities in the Global South expanding rapidly, often in unplanned ways, the need for design professionals to drive equitable and sustainable development has never been higher. In many low- and middle-income countries, developing collaborative ways to advance, retain and enlarge the pool of those much-needed professionals is a priority.

Moreover, the UN population projections used here assume that the IPCC target to limit average global warming to 1.5°C above pre-industrial levels will be met by the end of this century, which may be optimistic. Should we fail to adequately address the climate challenge, global displacement and forced migration because of rising sea levels, desertification and the increased risk of natural disasters will be on a much bigger scale than anticipated.

Going forward, built environment professionals need to be aware of the complex nexus between environmental and population change, taking care to minimise their impact upon the environment while addressing the need for housing and public infrastructure for our changing population.

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The Dharavi slum with apartment complexes behind, Mumbai. Photo: Johnny Miller / Unequal Scenes

Urbanisation: the coming decade will be make or break for cities and the planet

Peter Oborn RIBA RIAS HonMRAIC HonMRTPI HonFIStructE HonRAIA currently serves as President of the Commonwealth Association of Architects and is a member of the UN-Habitat Stakeholder Advisory Group Enterprise (SAGE). Following a successful career in private practice, Peter has spent the past decade addressing the challenges of sustainable development at city scale, working with national governments, local governments, and fellow built environment professionals around the world.

Peter Oborn looks at the challenges of urbanisation in the Global North and South against the backdrop of climate change, highlighting the need for design professionals, planners and engineers to work collaboratively and sustainably.

The United Nations' (UN) Sustainable Development Goal 11 recognises the importance of cities as contributors to sustainable development, which seeks to "make cities and human settlements inclusive, safe, resilient and sustainable". [1]

Indeed, UN-Habitat estimates that 65% of the 169 targets underpinning the 17 Sustainable Development Goals are attributable to urban and territorial development. **[2]** Little wonder then that urbanisation is now recognised as one of the five global megatrends **[3]** or that, in a speech delivered before the Rio Earth Summit in 2012, the then UN Secretary-General, Ban Ki Moon, said that "our struggle for global sustainability will be won or lost in cities". **[4]**

Today, just over half the world's population are urban dwellers. By 2050, UN-Habitat predicts that two out of every three people will be living in cities. **[5]** That's an increase of 2.5 billion more urban dwellers, 95% of whom will be in Asia and Africa, where 95% of the cities most at risk from the impact of climate change are to be found. **[6]**

Nearly half of the growth in the number of people living in cities is predicted to be in Commonwealth countries. This doubles the Commonwealth's urban population, from 1 billion to 2 billion urban dwellers in less than 30 years.

The foundations for tomorrow's cities are being laid today and, as we look forward to 2034, architects and their professional bodies, such as the Royal Institute of British Architects (RIBA), clearly have a critical role to play. So, how well-equipped are we to deal with the challenges ahead and what are the main issues to be faced?

A tale of two city types

In its World Cities Report 2022, published by UN-Habitat in the shadow of the global pandemic, the authors recognised that responding to climate change vulnerability and rising levels of inequality are global concerns. Even so, the key priorities confronting developed countries in the Global North are different to those facing developing countries in the Global South. **[7]**

Historically, cities in Europe and North America developed over time as a result of agglomeration. This is where the clustering of firms in a variety of sectors brought advantages that led to the development of large, diverse cities.

The advantages included abundant employment prospects that attracted a skilled labour force. In turn, this facilitated economies of scale which resulted in greater productivity, higher wages and a better quality of life due to increased levels of social and cultural engagement.

Such has been the success of urbanisation, particularly in industrialised countries, that today more than 80% of global gross domestic production is generated in cities. **[8]** Indeed, many of the world's wealthiest cities, such as New York and Tokyo, now qualify as megacities, with populations of over 10 million residents.

But urbanisation is not without its challenges, not least the fact that today's cities consume over 70% of the world's energy and produce more than 60% of global greenhouse gas emissions. **[9]** So, while no country has prospered economically without first urbanising, equally, no city has grown without also significantly increasing its carbon footprint.

The imperatives for cities in the Global North are therefore to rapidly decarbonise by plotting a course towards a net zero future. This means upgrading and modernising ageing infrastructure and revitalising urban centres while meeting the needs of an ageing population.

The pattern of urbanisation over the past few decades in many parts of Africa and Asia has been distinctly different. They have experienced significant levels of rural-to-urban migration aggravated by increasing numbers of people affected by forced displacement due to conflicts and natural disasters.

This has led to rapid urbanisation that has overwhelmed many city authorities' capacity to respond, resulting in large numbers of informal settlements, which in turn has led to inequality and vulnerability. **[10]**

Such unplanned growth is characterised by low density development, which has frequently resulted in uncontrolled urban sprawl. The area of the city has expanded out of all proportion to population growth, with damaging consequences. Not only has it led to the loss of productive agricultural land and damage to precious ecosystems, but it has also meant that basic utilities and social infrastructure have not been able to keep up.

There is typically a lack of basic services (for the provision of energy, waste treatment, and water) together with a lack of access to facilities such as education, healthcare and public transport. Needless to say, these all have correspondingly negative impacts on social, economic and environmental wellbeing.

Therefore, the imperatives for cities in rapidly urbanising countries are to address rising levels of poverty and the challenge of slums, and to provide basic services together with adequate affordable housing.

In many countries, such challenges are compounded by high levels of youth unemployment and the difficulty of accessing finance. Consider that the median age in the UK, which has a population of 67 million, is around 40 while the median age in Uganda, with a population of 45 million, is just 16.

Revealing the capacity gap

As we entered the Decade of Action **[11]** to deliver the Sustainable Development Goals in 2020, the Commonwealth Association of Architects (CAA), along with its planning, engineering, and surveying counterparts, published a survey of the built environment professions in the Commonwealth. Their objective was to establish how well-prepared the professions were to deal with the challenges ahead. There were three key findings. **[12]**

1. Lack of professional capacity

First, they found a critical lack of capacity among built environment professionals in several Commonwealth countries, many of which are urbanising rapidly and are among the most vulnerable to climate change impacts.

The capacity gap was most acute in the public sector and in secondary and intermediate cities, which are urbanising just as fast as their larger counterparts. For example, while the UK has approximately 40,000 registered architects in a country urbanising at less than 0.5% per annum, Uganda has barely 300 architects in a country urbanising at over 5% per annum. The situation is even more acute in the case of town planning.

2. Lack of educational capacity

Second, they found a corresponding lack of educational and institutional capacity to grow the profession fast enough to make up the shortfall in these same countries. This situation was often aggravated by a shortage of experienced teaching faculty, an outdated curriculum and a lack of the mandatory continuing professional development necessary to maintain competency among both faculty and practitioners. The UK, for example, has 61 schools of architecture whereas Uganda has just four.

3. Poor governance

Third, they found that these countries' built environment policies, including their planning policies and building codes, were weak in terms of standards, implementation and enforcement.

The size of the risk associated with this finding is thrown into sharp relief by research from the International Energy Agency. It anticipates that around 90 billion square metres of additional floorspace will be built in Africa in the next 40 years, **[13]** yet there are barely a handful of countries on the entire continent that currently operate mandatory building energy codes. **[14]**

The informal settlement of Kya Sands next to the middle-class suburb of Bloubosrand, Johannesburg. Photo: Johnny Miller / Unequal Scenes

Rising to the challenge

Such is the nature, scale and complexity of the challenges ahead that the coming decade will be make or break for cities and the planet. Together with their professional institutes, architects have a pivotal role to play – especially in the areas of advocacy, capacity building and climate action.

Advocacy

Central to this effort is the need for built environment professionals to work much more collaboratively and at scale, not only across built environment disciplines but also with economists, researchers and others to advocate for the value of sustainable development.

A critical objective is to help policymakers in both central and local government to make better evidence-informed decisions on built environment issues. The Declaration on Sustainable Urbanisation, which was adopted by 56 heads of government at the Commonwealth Heads of Government Meeting in 2022, is a good example of what is needed. **[15]**

It recognised the Call to Action published by the Commonwealth Sustainable Cities Initiative, of which the CAA was a founding member. **[16]** The message is increasingly getting through. For example, the 2023 G7 Urban Development Ministers Meeting in Japan illustrates that governments understand the issues. **[17]**

Unfortunately, these examples are the exception rather than the rule. The voice of built environment professionals is missing from many critically important policymaking forums. The sector needs to work harder and smarter to make themselves heard, helping to bridge the gap between policy and practice by bringing their experience, creativity and design thinking to bear.

Building capacity

Capacity-building and knowledge-sharing are vital if the critical issues identified in the Survey of the Built Environment Professions in the Commonwealth are to be addressed. The UK Built Environment Advisory Group (UKBEAG), a collaboration between RIBA, the Royal Town Planning Institute, the Institution of Structural Engineers and the Landscape Institute, demonstrates how uniquely well-placed professional institutes are to work with national governments and development partners around the world.

For example, UKBEAG worked with UN-Habitat on the UK's Foreign, Commonwealth and Development Office's (FCDO) Global Future Cities Programme to support 19 cities in 10 low- and middle-income countries on 30 projects in the areas of resilience, transportation and urban planning. **[18]**

RIBA is also a member of the CAA Knowledge Sharing Partnership, bringing together 16 member organisations from around the five regions of the Commonwealth to work together on shared challenges.

Climate action

Effective climate action is by far the most important and pressing aspect of the work ahead, in terms of mitigation, adaptation and climate justice. Analysis by the CAA has revealed that half of carbon emissions from Commonwealth countries is attributable to just 10% of their combined population and that these people live mainly in the industrialised countries in the Global North.

The other half of total Commonwealth carbon emissions is attributable to the remaining 90% of the population, who mostly reside in the countries that are urbanising most rapidly.

This highlights the imperative to address the issues in both urbanised and urbanising countries simultaneously. Built environment professionals need to bring their collective knowledge and expertise to bear across a broad front – including policymakers, practitioners, and the public – to ensure a just transition while leaving no one and no place behind.

The architectural community is responding to these challenges in a myriad of different ways.

At the University of East London, for example, researchers are making good progress with the development of a bio-based building material called 'Sugarcrete'. **[19]** It uses the waste from sugar cane (the world's largest crop by volume) together with non-cementitious binders to manufacture a range of products including insulating panels and load-bearing blocks. Countries in the Caribbean, Asia and the Pacific have already shown considerable interest in the material, and the project has recently been shortlisted for the Earthshot Prize.

The Architects Climate Action Network is a network of individuals within architecture and related built environment professions taking action to address the twin crises of climate and ecological breakdown. It is working together with RIBA and the Standing Conference on Schools of Architecture to develop teaching materials for both practitioners and teaching faculty to accelerate climate literacy and sustainable practice throughout the profession.

Other organisations are contributing. For example, the Feilden Foundation, the charitable arm of Feilden Clegg Bradley Studios, not only helps to deliver community facilities across East Africa but recently secured funding from ENABEL, the Belgian government's development agency, to develop a training programme for passive design strategies called the Manifesto for Climate Responsive Design. **[20]**

Other roles

There are plenty of other roles for built environment professionals, not least in connection with their technical know-how. For example, the CAA is leveraging its network to support the rollout of the IFC Edge Designing for Greater Efficiency training programme among teaching faculty throughout Sub-Saharan Africa. **[21]**

CAA has also been working with the Ordnance Survey to use artificial intelligence to produce digital base maps, the object being to provide local governments with a starting point for better planning. The pilot programme, which focused on Lusaka in Zambia – a city of 3.5 million people, 65% of whom live in informal settlements – enabled its base map to be completed in less than a tenth of the time it would have taken by traditional means. **[22]** Importantly, the technology is scalable and replicable.

Leadership for a better future

The key findings from FCDO's Global Future Cities Programme identified five common areas of weakness in many of its subject cities. These were:

- a lack of integrated and inclusive planning
- a weakness in governance and collaboration
- the ineffective use of data and lack of evidence-based policymaking
- poor business case preparation and weak procurement practices, combined with poor monitoring and evaluation, implementation and enforcement

The overarching lesson from the programme was the critical importance of effective leadership. As we face the nature and scale of the challenges ahead, we must all be leaders now.

The Architects Climate Action Network is a network of individuals within architecture and related built environment professions taking action to address the twin crises of climate and ecological breakdown.

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Technological Innovation

Introduction

Phil Bernstein is Deputy Dean and Professor Adjunct at the Yale School of Architecture, where he has taught since 1988. He is a former vice president at Autodesk, where he was responsible for the company's Building Information Modeling strategy that included the development of the Revit platform. Prior to Autodesk Phil was an associate principal at Cesar Pelli & Associates where he managed many of the firm's most complex commissions including projects for the Mayo Clinic, Washington National Airport, and Goldman Sachs. He writes and lectures extensively about issues of architectural practice, project delivery, and technology. He is the author of Machine Learning: Architecture in the age of Artificial Intelligence, RIBA Publishing.

Machine learning has recalibrated the human relationship with technology. Moving beyond the existential threat of replacement, which artificial intelligence can pose, this theme explores the emergent technological tools and how architects can best take advantage of their innovative use.

When Nicolas Negroponte speculated about architects empowered by the new-found agency of computers in his 1970 book The Architecture Machine, [1] he envisioned powerful tools that could depict, analyse, and help construct a design. And while his contemporaries were experimenting with the rudimentary precedents of what had recently been deemed 'artificial intelligence,' he could not possibly have anticipated a world where computation, digital information, and connectivity were both extraordinarily powerful and ubiquitous. The digital tools of yesterday – CAD, BIM, even the internet – will soon give way to autonomous AI agents that may drive our architectural processes from project conception to industrialised construction in ways far beyond that book's wildest speculations.

2034: the automated future of AI

While the tools of today extend the architect's human agency, those of 2034 are likely to be less instrumental and more autonomous, shifting the role of the architect even further from singular author to orchestrator of both human and algorithmic processes. The anticipated shifts are numerous: from supervising drawing production to prompt engineering; from exploring three-dimensional implications from perspectival rendering to using immersive environments partially authored by AI agents; and from generating construction details from assembly diagrams to transferring assembly instructions to manufacturing platforms.

The two-decade transition to BIM occurred within the bounds of architectural practice, undergirded by advances in computer speed and graphic resolution. Ironically, the graphic processing units (GPUs) that made BIM possible are powering the move to AI, suggesting the pace of change is accelerating and making 2034 feel as if it is far in the future. But best to begin preparing now.

Four scans, four perspectives

The four perspectives offered by the horizon scans in the Technological Innovation theme anticipate this future while prescribing an interconnected series of recommendations that are a template for a proactive practice strategy.

Innovation Strategy counsels that the inflection point offered by the digital turn is not to be missed by an industry sorely in need of less friction and higher value. It suggests that the entire ecosystem of delivery – designers, builders, and asset owners – collaborate by capturing data and connecting it through new systems and infrastructure like digital twins.

The Digitalisation of Design suggests that the novelty of AI will give way to pipelines of information and autonomous agents that will smooth – and in some cases, replace – traditional modes of service and delivery.

Automation in Construction envisions the construction site of 2034, not bristling with robots and drones, but refactored by principles of information-enabled industrialised construction, where certain assemblies are created by designers and manufacturers offsite, and the resulting building is optimised by sensor controls.

Finally, **Architecture in the Age of AI** - which is reproduced in this Executive Report - asks four important questions about professional knowledge, the meaning of professional judgement, business efficacy, and professional responsibility and risk as measures of the potential for AI to transform the building industry.

Through a purely technological lens, the contributors each frame the implications of a design and construction industry that is inevitably digitised and where liquified information flows freely between the various participants in the supply chain. Collective efforts will be required – to define data standards and workflows, to set new automated process protocols, and to design new mechanisms of risk and reward – that the technology makes possible, but does not guarantee. If the original vision of BIM as frictionless digital collaboration was never realised, is it likely that AI-enabled, high-resolution, data-driven, computationally intensive processes will reach that goal?

Retaining professional responsibility

Here lies the critical logic behind framing this section as 'Technology Innovation' rather than 'The Future of More Cool Technology in AEC.' The title itself implies an obligation of the architectural profession and the collaborators on which they depend to not just demand and episodically deploy every new instrument that the emergent world of AI-powered technology is sure to provide, but rather to thoroughly examine everything about how the built world is created and where the resulting processes can be embraced, rejected, or refactored. That effort, at the heart of an industry-wide innovation strategy, must broadly consider an array of questions involving issues as disparate as design ethics, digital assets, education, risk and reward balance, new models of delivery, and social equity, just to begin the lengthy list.

The demand for industry innovation catalysed by – but not solely reliant upon – technology is nowhere more apparent than in the tragedy at Grenfell Tower that occurred 17 years before 2034, these scans' cut-off date. The fire resulted from an epistemic failure of modern design, construction, technical standards, product testing, regulatory oversight and asset operation, where critical decisions were disassociated from a coherent understanding of their implications and, even worse, an enforceable model of responsibility. From the most charitable perspective, data about the circumstance might have been available, but not in a way that the danger could be detected. The systems to connect, evaluate, and predict behaviour of the deadly assembly were impossible, made inoperable by the means and methods of modern project delivery. Everyone on the Grenfell team had access to plenty of technology, but with no chance of using it to prevent disaster.

2034 might see multi-modal process automation tools where this data will cohere in digital twins and predictive technologies will evaluate performance prior to assembly on automated platforms. But, as the AI scan contemplates, all will turn on an industry consensus about the meaning and implications of professional responsibility in a world where the line between computation and human work is increasingly blurred.

Other components of the RIBA 2034 Horizons project examine architecture's role and responsibilities for externalities that will also shape the profession – climate, economics, and population. Each sets out a fundamental challenge that architects can address with its skills. Our ability to translate those skills will turn, however, on whether we can convert the enormous opportunities of newer technologies into tangible, relevant, and critically needed results. A fascination with the instrumental possibilities of technology is not enough to achieve this end. It demands an innovative and collaborative stance that can challenge and dramatically improve the way the industry works. Dame Judith Hackitt's recommended Golden Thread, from the independent review of building regulations and fire safety, **[2]** is not just an information theory, but rather an innovation strategy to be applied across the entire delivery spectrum. Perhaps technology-driven innovation can help.

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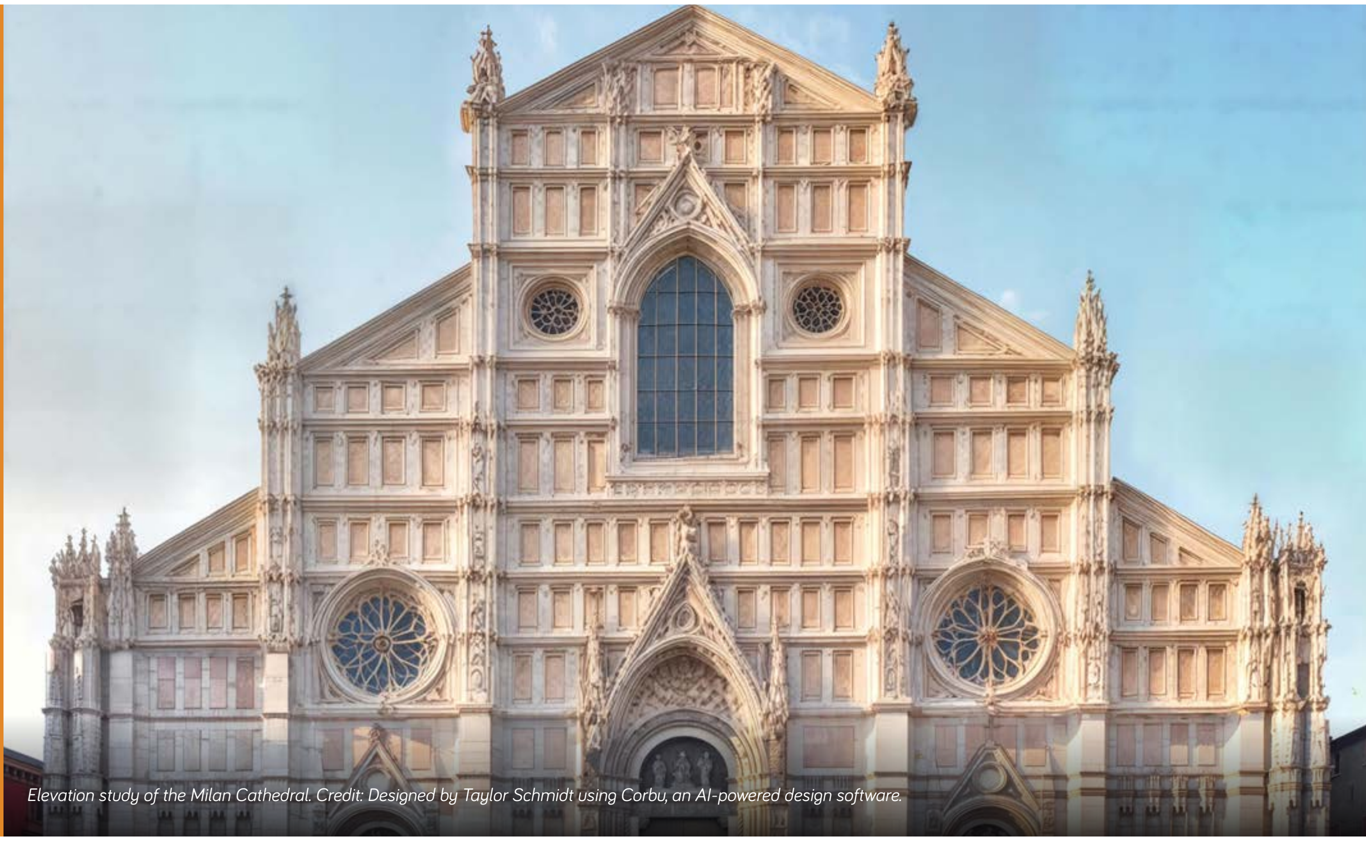


Elevation study of the Milan Cathedral. Credit: Designed by Taylor Schmidt using Corbu, an AI-powered design software.

Architecture in the age of AI: four signposts to watch

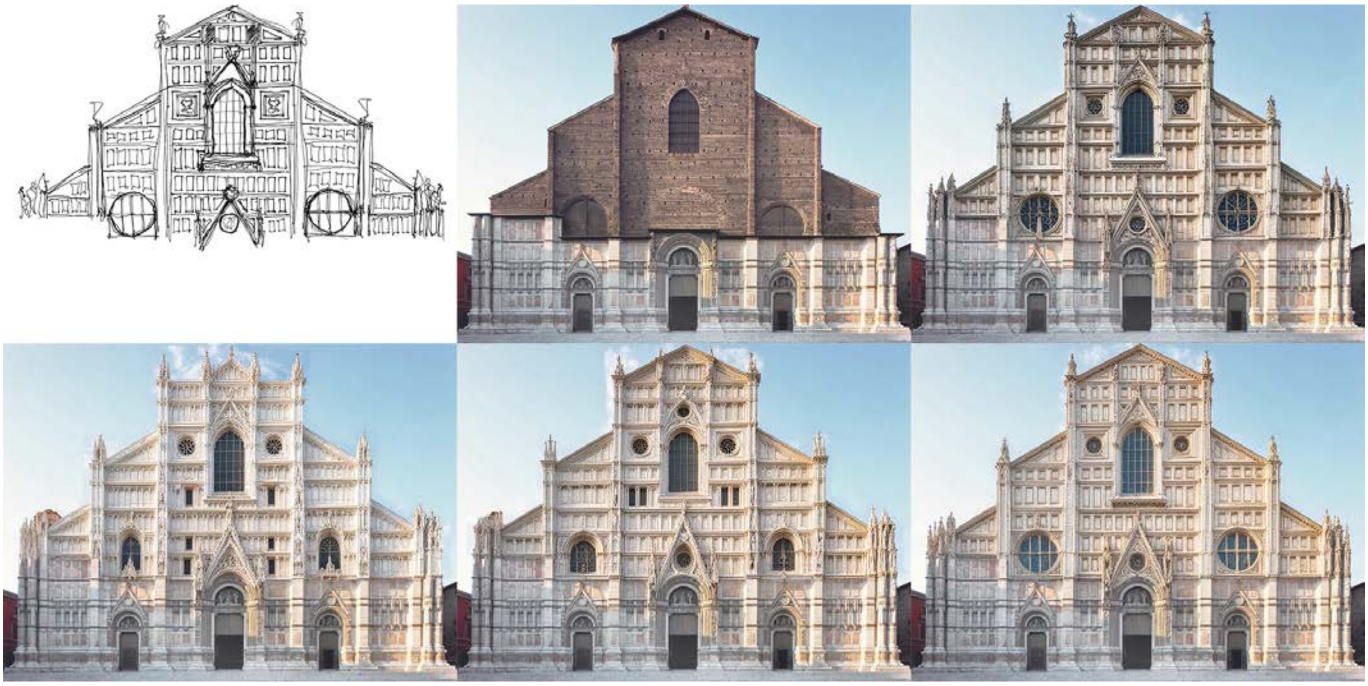
Mark Greaves is currently Executive Director of the AI and Advanced Computing Institute at Schmidt Sciences. Prior to that, he was a senior leader in AI and data analytics within the National Security Directorate at Pacific Northwest National Laboratory, where he created and managed large research programs in AI on behalf of the US government. Before then, he was Director of Knowledge Systems at Vulcan Inc., Director of DARPA's Joint Logistics Technology Office, and Program Manager in DARPA's Information Exploitation Office. He has published two books and over 40 papers, holds two patents, and has a PhD from Stanford University.

How will we know over the next decade that AI is delivering beneficial outcomes for the practice of architecture? AI thought-leader and computer scientist Mark Greaves highlights four key signposts for its development: acquisition of professional knowledge, achievement of human-like judgement, integration into business and clarification of professional responsibility.

Let's perform a thought experiment. Imagine that it is 2034, and AI has turned out to be an enormously beneficial force in the practice of architecture.

Recently completed projects are noticeably safer, more harmonious and more sustainably constructed. The use of AI throughout architectural firms has enabled an explosion of design creativity, coupled with a more collegial relationship with engineers and builders. Even the smallest and most routine structures bear the touches of thoughtful design.

Clients are delighted, professional employment is stable, and fees exhibit steady growth commensurate with the greater overall value that the profession brings.



While AI-based image generators often have a mind of their own, they can be persuaded to create provocative alternatives.
Credit: Designed by Taylor Schmidt using Corbu, an AI-powered design software.

Architects and their staff routinely work collaboratively with a suite of AI-enabled software that allows them to access an immense bank of empirical and theoretical knowledge concerning the ways that the built environment can support human practices and aspirations. They routinely leverage AI-based capabilities to fluidly support all phases of interaction with clients and builders in the delivery of a building.

This vision is the 'Ideal Outcome' for AI and architecture in 2034. To have reached this goal, what issues must have been solved along the way? What signs would indicate that progress was being made?

To answer these questions requires a basic understanding of the way that modern AI works.

How AI works

AI has historically been concerned with giving computers sufficient knowledge of relevant aspects of the world so that they can perform tasks that require some degree of intelligence.

Until the early 2000s, the dominant AI method was to use complex and obscure mathematical tools to manually author thousands of distinct statements about the world, download these statements into computers, and then employ specialised AI software to process and combine these statements to support intelligent behavior. This method was laborious and difficult to scale, had severe challenges encoding uncertain or imprecise knowledge, and typically resulted in systems with narrow and often very brittle capabilities.

The great revolution in AI over the past 20 years has been the development of machine learning algorithms. These take advantage of immense amounts of computational power to process internet-scale quantities of text and imagery, automatically derive knowledge of the world from correlations in this data set, and encode this knowledge into enormous and opaque numerical structures.

These algorithms have been astonishingly effective. **[1]** Using these techniques, computers have quickly become remarkably fluent in language and reasoning and have been able to acquire subtle information about human experience from deep patterns in human communication.

Current AI systems – those trained using machine learning – leverage these patterns in ways that are not fully understood. They enable computers to exhibit human-like conversational behavior, demonstrate superhuman skills across many tasks, acquire new capabilities, create novel artefacts, and make new scientific discoveries.

Four signposts

Given this capability, how will the worlds of architecture and AI intersect in 2034, and what early signs of change will indicate progress towards the Ideal Outcome?

Scientists have observed that machine learning systems appear to follow 'scaling laws' that quantify how capability might increase in AI systems as they learn from more and more data. **[2]** These scaling laws allow AI companies to predict how much capital and computing power they need for a particular level of desired capability.

For our purposes, these scaling laws undergird a set of four fundamental signposts that allows us to monitor progress towards AI capabilities that would enable the Ideal Outcome.

Acquiring professional knowledge

The first of these signposts involves the acquisition by AI systems of characteristically architectural data and epistemology.

In 'The Future of the Professions,' Richard and Daniel Susskind argue that "knowledge asymmetry" between professionals and their clients and the hoarding of "practical knowledge" are fundamental to professionals maintaining their status as experts. They also argue that computation and the internet have the potential to redress the imbalance between the providers of professional judgement and their consumers. **[3]**

Modern AI has this potential. The AI scaling laws show that increasing AI capability depends strongly on its ability to train on increasing quantities of relevant text, imagery and other data. In their ceaseless quest for data on which to train their AI systems, AI companies have already mined huge swaths of text, images, and video from the internet, and have leveraged the contents of the world's great libraries and information repositories. AI systems will soon have absorbed most of the world's publicly accessible essays, textbooks, curricula, blog posts, and media concerning architecture and related topics, and will have derived an immense amount of knowledge of what works and what doesn't.

This has given rise to ferocious battles about the degree to which the use of this information for AI training falls under the doctrine of fair use and fair dealing. AI's dependence on vast amounts of training data certainly risks transferring resources from those who create to companies who use their creations to train models that supplement or replace the creators. The legal status of training AI systems from copyrighted architectural designs or buildings is not currently settled. **[4]**

However, in the field of architecture, much of the Susskinds' "practical knowledge" is locked away in firms' private repositories of artefacts such as contracts, sketches, correspondence, standards, floor plans, building sections, and 3D representations (e.g., digital models, renderings, and analytical and physical models). Furthermore, these artefacts are based on a specialised epistemology and set of abstractions, in which junior architects gain fluency through the human process of architectural education and workplace mentoring.

For AI systems to acquire this critical practical knowledge of the profession, and thereby gain capability in the processes needed to operate in a firm, this private knowledge must be made available for AI systems to train on.

In domains like medicine and law, we are already starting to see commercial AI systems that claim to safely combine the power of general-purpose AI models with an individual business's proprietary data. An important signpost for this capability would be seeing powerful AI systems being marketed to architectural practices which can incorporate firm-specific proprietary data and artefacts.

Achieving human-like judgement

A second signpost for progress towards the Ideal Outcome involves AI systems achieving the capability to interact in a professional way and to form professional judgements from uncertain information.

Architects rely daily on a refined intuition to guide subtle decisions about imprecise tradeoffs and engineering constraints, and to account for ill-defined ethical, cultural, and perceptional interpretations. Not only do they need the skill to make design decisions, but they must also persuasively defend their decisions to a client who will choose, experience, and pay for it.

Today's AI systems have rudimentary capabilities in these areas, but they are not yet close to acquiring the insight and awareness of the human context that is characteristic of an experienced human architect. Still, AI systems are on a trajectory to develop a level of proficiency in areas like these. AI-enabled assistants for scientists, lawyers, and other professionals are starting to emerge commercially, as are early (and somewhat creepy) AI-based social and romantic partners that exhibit early signs of emotional intelligence.

More fundamentally, many of the largest AI companies are actively working on how to modify the behavior of their systems to match enumerated human values so that their systems exhibit behavior consistent with standards of fairness, cooperation, truthfulness, and the like. This type of work is referred to in the AI industry as "alignment." **[5]** Progress here would be a clear indicator that the Ideal Outcome is becoming more possible.

AI image generators lack spatial understanding but are beginning to show partial spatial awareness, as these images of a living space, into which the designer was asked to insert mirrors, suggest. Credit: Designed by Taylor Schmidt using Corbu, an AI-powered design software. Original image by interior designer: Noz Nozawa. Photo: Colin Price Photography.

Integrating into business

A third signpost for progress towards the Ideal Outcome involves agreement on how to best integrate AI systems in business contexts.

AI systems can greatly speed up tasks and allow humans to be more efficient. Creating initial good drafts of essays and documents, generating images and video renderings, answering questions, following chains of reasoning, checking artefacts for compliance and other properties, summarising large amounts of material, and exploring the implications of specific design choices are examples of professional tasks that AI can perform in seconds with an impressive degree of quality.

As AI-based computation displaces the human intellectual effort to perform architecturally relevant tasks, the cost of providing architectural services could be substantially reduced, possibly leading to a corresponding reduction in firm staffing and the fees architects can charge. Significant advances in automation technologies have often dramatically displaced workers (the Luddite era is a well-known example), especially during the transition period.

But some argue that this is too facile. The scholar Kathryn Lofton, for example, has cautioned against the "delusion of efficiency," and reminds us that the introduction of powerful new technologies often results mostly in a rebalancing of job requirements and stimulates the introduction of new jobs that are required to take maximum advantage of the new technology.

In short, it is currently unclear how the integration of AI into architectural practice will impact staffing and fees. AI is just starting to have real involvement in different sectors of the economy, and there is very little data that would allow us to confidently predict how the rhythms of architectural work will evolve in the face of powerful new AI systems. One signpost to watch, though, is the rate of introduction of new AI-specific jobs, especially in architecture. The advent of AI systems has already produced several new job categories (e.g., 'prompt engineer' and 'AI auditor') as businesses experiment with ways to integrate AI systems. This suggests that using AI in the context of an architectural firm will bring with it a reordering of jobs instead of simply displacing architects.

Clarifying professional responsibility

A fourth signpost for progress towards the Ideal Outcome involves clarifying the relationship between professional responsibility and intelligent machines.

A fundamental characteristic of professionalism is personal, human responsibility – being on the hook. Critical concepts of obligation, culpability, duty, and trust are currently rooted in a social contract where the morally accountable actors are humans acting in specific roles. AI systems can exhibit superhuman knowledge and abilities, but they are currently treated exclusively as helpers to humans, and humans still have ultimate accountability for actions.

However, the Susskinds foresee a "post-professional society" where knowledge and expertise reside not just in people, but also in machines. **[6]** In such a society, it is vital to be explicit about where responsibility lies. The Grenfell disaster in London was attributed to the dissolution of professional responsibility in the complex web of decisions, material choices, and failures of the building delivery chain, simultaneously making everyone and no one responsible.

A signpost for progress towards the Ideal Outcome is therefore a more careful delineation of responsibility between humans and highly capable AI software. If we see examples of actual delegation of legal accountability to a piece of software (instead of always to a person who serves as a professional guarantor of its outputs), this would be an indicator for the Ideal Outcome.

AI, architecture, and society

The dramatic development of AI over the last decade suggests that a transformational impact on architectural practice is on the horizon. However, the signposts we propose demand that architects consider issues beyond raw AI capability on the way to achieving the Ideal Outcome.

The pace of AI development currently exceeds the ability of wider society to absorb and come to consensus on those developments. Although the computational capability needed to achieve these signposts might be available by 2034, each of the signposts also involves deep collective tradeoffs, which will be resolved in different ways and at different speeds in different societies.

Furthermore, the impact of AI on architectural practice will not develop in a vacuum – it will have a tremendous impact on the overall ways that we live and work, and this will inevitably shift our goals for the built environment. How will the design of physical spaces need to change to reflect this changing nature of human work and leisure? **[7]** How will possibilities for these spaces evolve as it becomes feasible to embed AI and robotics into the building itself?

The ways we create, build, use, and experience space in an AI-enabled world, as well as the ways in which the purpose of the built environment will itself transform, are difficult to anticipate. They will play out over decades as the dividing line between physical and digital experience continues to blur in the information age.

AI capabilities will be enormously advanced by 2034. Their impact will drive changes in architectural practice and coordinating these changes will be the joint work of all the players in the architectural ecosystem. Working to realise the Ideal Outcome will become increasingly critical as the architectural profession strives to tackle the larger challenges addressed in the RIBA Horizons 2034 programme, including creating a built environment fit for a changing population amid a climate emergency. The signposts proposed here will help the profession to monitor and evaluate the growing impact of AI over the next 10 years.

The ways we create, build, use, and experience space in an AI-enabled world, as well as the ways in which the purpose of the built environment will itself transform, are difficult to anticipate.

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