Rethinking the Architecture of the Dwelling in the Digital Age

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Introduction

The House Gone Missing: The Digital Turn and the Architecture of Dwelling

Dirk van den Heuvel and Nelson Mota, editors

This issue of *Footprint* originates from a simple observation: after the digital turn, the house seemed to have gone missing from architecture debates.[1] What had happened to the notion of dwelling? When perusing the digital discourse in architecture, it is striking how its main foci almost exclusively concern new production methods, especially the 'non-standard' fabrication of building elements, and different understandings of the material dimensions of architecture that are being hypothesised under the impact of the new abstracted ways of 'drawing' as an outcome of data-processing. A case in point is the work of the architectural historian Mario Carpo, who emerged as one of the most prominent voices who helped popularise the very term 'the digital turn' in architecture.[2] The urban and territorial dimensions too, in terms of networks of social spaces and smooth, frictionless streams of goods and people, are under consistent scrutiny; Manuel Castells deserves a special mention here for the concept of the space of flows as coined in his 1989 book *The Informational City*.[3] The question of the house gone missing was furthermore triggered by the impact of the Covid-19 pandemic, when early in 2020, almost overnight, the combination of social distancing, lockdowns, and strict travel restrictions together with the widely available media technologies transformed private houses into online workspaces. This global phenomenon made visible what had already become a new but unrecognised reality: that what was once conceived as a private domain of individual or collective dwelling had become something much more complicated, layered and interconnected.[4]

We don't have to go back far to reach a time when the house occupied quite a different place in the architectural theory discourse. Mid-twentieth century, when computers were only just starting to make their way into science, military operations and governmental systems of control and redistribution, the house was considered the ultimate paradigm of the architectural discipline, a veritable epistemological ordering tool. The English-Canadian historian Peter Collins eloquently ordered the history of modern architecture according to the house paradigm in his now largely forgotten *Changing Ideals in Modern Architecture* from 1965.[5] For Collins, with the event of the Industrial Revolution and the rise of the middle classes, the individual home had become both the outcome and the register of the processes of modernisation at play.

Many historians and theorists have made similar claims. Following his mentor Rudolf Wittkower, Colin Rowe famously built his theory of architectural autonomy on the taxonomies of Palladian villas and the demonstration of principles of ordering at work in the house designs by Mies van der Rohe and Le Corbusier. Beatriz Colomina, too, identified the home as the site par excellence for the redefining of architecture, stating that 'the history of the architecture of the [twentieth] century is the history of the search for a house.'[6] In parallel, housing and dwelling have been considered key territories for architecture to reconstitute its workings and values, time and time again. However, to say it was a search is perhaps too much of an understatement; the house as architectural paradigm was to be reclaimed against all

odds, against the processes of modernisation and disruptive technologies penetrating the house. The house as the site of dwelling was never quite stable, but always in danger of collapsing under the forces of modernisation.

This was also the point of the philosopher Martin Heidegger when he reflected on the notion of dwelling, as exemplified in his seminal 1951 lecture at the *Mensch und Raum* conference in Darmstadt, 'Bauen Wohnen Denken'.[7] Despite its reactionary tendency, its propositions still resonate in all debates related to housing and dwelling. Heidegger contrasted the socio-political urgencies at stake in the field of housing with those of existential philosophy. To him, dwelling was the real question, as opposed to the quantitative provision of mass housing. The reactionary overtones of Heidegger's praise of dwelling – the *domus* – have been examined and criticised, also by voices from the field of digital theory in architecture, most notably Neil Leach.[8] Indeed, Leach deploys the connections of Heidegger's proposition with Nazi-ideologies such as the *Heimat* to reject the idea of dwelling altogether as 'ill equipped' for the digital age and its new ways of being: more fluid and flexible, more complex.

Likewise, MoMA curator Terence Riley attempted to escape the shadow of Heidegger in the exhibition 'The Un-Private House' in 1999, when he aimed to rethink the house as the central site for architectural invention.[9] Just before the massive availability and impact of the new digital media, Riley proposed – as suggested by the exhibition title – to turn the house inside out, to leave behind the notion of privacy and to start to speculate on the un-private house as he saw architects doing already, from radical transparency to the introduction of media rooms and omnipresent projection screens to the recognition of a difference between the real and the virtual. Analysing late-twentieth-century house designs in this way, Riley suggests that a new mode of *Dasein* has emerged, in which the accepted distance from events and things has dissolved:

> At the end of the twentieth century, the new kind of relationship to the world of events and things that Heidegger could not visualize, a new kind of distance in daily life with its own parameters and definitions, is clearly evident in the ascendancy of digital technologies throughout everyday life. In both theory and practice, the media's potential effect on space has become a catalyst for contemporary architectural innovation and experimentation.[10]

However, while acknowledging the penetration of the house by the new technologies and the concomitant erosion of familiar notions of domesticity, Riley maintains 'the problem of the house' could still be considered central to the discipline and its relevance through continuous reinvention. Yet today, almost a quarter century on, we may speak of a conflation of the real and the virtual, instead of a difference. The 'new kind of distance' has given way to a new kind of futurist acceleration, as propounded by the Californian libertarians who run the new media companies seeking to deliberately and consistently disrupt everyday life.

In hindsight, we might reconsider the house as a paradigm for architecture. An alternative reading of the propositions for the modern house suggests the house was always on the verge of disintegration and dissolution, and not the site of disciplinary reconstitution. Think of Sigfried Giedion's *Befreites Wohnen*, Le Corbusier's *Machine à habiter*, the many Houses of the Future: they all point to dematerialisation, abstraction, and the channelling of information flows. The digital turn in architecture then amplifies a tendency to techno-utopia, which was already there throughout the twentieth century.

If the house has gone missing, where do we see dwelling today? Around the same time Collins was claiming the house to be the ultimate paradigm for the architecture of the larger modern era, Reyner Banham speculated on the disappearance of the house. In his 1965 essay 'A Home is not a House', Banham considers the impact of new technologies, from information and communication systems to

environmental control, and how it will render the house, or even architecture, obsolete.[11] The essay is illustrated with François Dallegret's now famous diagrams of the 'environmental bubble', in which we see naked human bodies gathering around a technological 'hearth' that integrated all needs and pleasures, from food preparation to music provision. It's an iconic image of 1960s techno-utopia, which already has undertones of contemporary posthumanism in which technology, nature and culture are not separate domains, but are thought together and constitute a world of assemblages.

We see one tendency within architecture theory in relation to the question of dwelling as predominant and offering new possible readings; it concerns the reconceptualisation of architecture as ecological and relational. Even when ecology takes us back to the *oikos* or house, it must be an 'objectless' house, not a separate or distinct unit, set apart from other units, but part of a larger fabric. It might come close to a 'topology of thresholds' as theorised by Georges Teyssot, unpacking the concepts of ethnographers and psychologists, and retracing the architecture of such eminent figures as Alfred Neumann, Zvi Hecker and Aldo van Eyck, who explored new geometries and relationalities in architecture.[12] If we take up Teyssot's observations, we might paraphrase Van Eyck: that the house reappears as a city, coming together in a configuration of reciprocities. 'Built homecoming' as propounded by Van Eyck amounts to the provision of a 'bunch of places.'[13]

It must be said that the above observations occurred only during the production of this issue. Clearly, the question of dwelling and its various reconceptualisations has arisen in many places, outside of but always alongside and eventually intertwined with the digital turn proper. In our call for contributions to this issue of *Footprint,* we invited potential contributors to discuss the different ways in which the house have been reimagined and reconstituted, and to examine attempts to redefine notions of dwelling by exploring the intersections of the real and the virtual in the domestic space thrown up by the digital turn. The responses to the call held surprising takes on the intellectual and disciplinary framework we imagined for this issue of *Footprint.* Three themes generated a particular interest: the historical emergence of the digital turn, the reconceptualisation of domesticity, and questions of motivation and values. In the following sections, we'll elaborate further on each of these themes, discussing how the different contributors explore them.

Historicising the digital turn

Over the last two decades Antoine Picon has emerged as a key figure in architectural discourse, making substantial contributions to the ongoing discussions concerning the intricate interplay between architecture and technology. His seminal 2010 work *Digital Culture in Architecture* examines the profound impact of digital technology on architecture and the urban landscape.[14] His subsequent book, *Smart Cities: A Spatialized Intelligence*, serves as a compelling response to the prevailing praise for the concept of smart cities.[15] Picon delves into the deep-seated connection between the smart-city phenomenon and cultural paradigms, describing the ensuing consequences for urban space and everyday experiences. In *The Materiality of Architecture*, Picon offers a nuanced perspective on the ostensibly all-encompassing nature of remote and intangible experiences, positing that our world remains predominantly shaped by tangible, concrete, and spatial encounters, mediated through raw and transformed materials.[16]

Antoine Picon graciously accepted our invitation to contribute an opening essay to this issue of *Footprint;* entitled 'Architecture and Materiality in the Digital Age', it elucidates the enduring impacts of the Covid-19 pandemic, illustrating how the need for comfortable and functional living spaces has become increasingly pronounced. This heightened demand for comfortable and healthy dwelling experiences has been captured by the real estate

market, which capitalised on individuals' aspirations to enhance the habitability of their domestic realms, leading to a surge in the preference for single-family homes where ample space and outdoor areas could compensate for the loss of in-person social exchanges. Picon emphasises the pivotal role played by digital tools in sustaining social connections and professional relationships throughout the pandemic. Indeed, technology has facilitated remote work and virtual interactions, enabling people to remain connected despite the imposition of physical distancing measures. However, Picon observes that the experience of enduring multiple lockdowns during the pandemic has also served as a catalyst for recognising the irreplaceability of in-person interactions, thereby accentuating a clear demarcation between mental representations and tangible practices. Picon's essay underlines the indelible impact of digital culture in changing societal perceptions of the architecture of dwelling, but also reaffirms the enduring significance of physical presence in shaping human interactions.

Fredrik Torisson's article, titled 'The Digitalisation of Swedish Housing: The First Forty Years', delves into the concept of the smart home as an example of the interdependence between the virtual and the material within the realm of architecture. The article provides an overview of the evolution of the smart housing concept in Swedish social housing buildings, tracing its trajectory from its initial emergence in the 1980s to the present day. Torisson explains how the digitalisation and automation of Swedish housing have gradually shifted the focal point from the physical dwelling to the broader building structure, and ultimately to the inhabitants themselves. Torisson's analysis is focused on the proliferation of smart devices installed by homeowners and landlords within tenants' homes since the early 1980s. He charts a progression in which responsibility is transferred from landlords to technology corporations, and more recently, to utility companies. The article underscores the challenges associated with the advent of smart housing and the digitalisation of residential spaces, among which are the issues of choice, control, data collection and privacy concerns. The multifaceted nature of smart housing necessitates careful consideration of these matters, as the integration of digital technologies raises pertinent questions regarding individual autonomy, the safeguarding of personal information, and the potential implications of data aggregation.

Reconceptualising domesticity

Antoine Picon's and Fredrik Torisson's articles help us to establish a brief historical overview of dwelling in the digital age. The impact of this historical process in shaping new ways of living is explored in 'Infinite but Tiny: Towards a Hybrid Architecture of Dwelling', the article authored by Georgios Eftaxiopoulos and María Álvarez García. In their contribution, Eftaxiopoulos and Álvarez García explain how the shift in the nature of jobs, from manufacturing to information-related services, coupled with the advent of the internet and the World Wide Web, made flexible work practices and telework possible. This newfound flexibility allowed individuals to work from anywhere, at any time, thus blurring the division between private life and work, and setting the background for the emergence of a massive, immaterial labour platform: the metaverse. The authors critically examine the extent to which the metaverse can be seen as a realm of infinite possibilities, where virtual and augmented reality converge to redefine how we relate to one another and to life itself. They show how the metaverse has become a key component of a trend to mitigate the claustrophobic nature of the Tiny Homes concept promoted by IKEA among others, offering a virtually infinite space to digitally dwell somewhere else. The emphasis on the qualities of the virtual obscures the real material and tangible hindrances experienced by urbanites forced to live in sub-standard conditions.

The hybridity of the architecture of dwelling discussed by Eftaxiopoulos and Álvarez García is also explored in 'Platforms and Dwelling: Topologies

of Distributed Domesticity', by Lőrinc Vass, Roy Cloutier and Nicole Sylvia. They discuss how, under contemporary capitalism and platform urbanism, the notion of dwelling undergoes transformations and extends beyond traditional boundaries. Everyday aspects of domestic life are reimagined as services provided and exchanged within platforms such as Airbnb. Simultaneously, the home is increasingly used for economic production as work infiltrates the domestic sphere. The platformisation of dwelling reverberates throughout urban space, complicating established dichotomies between interior/exterior, private/public, and home/work. The authors discuss the dissolution of traditional boundaries associated with networked forms of dwelling that result from the interplay of physical mobility and digital connectivity. Using a topological framework, the 'manifolds of dwelling', this contribution helps us understand the materialised and articulated relations in contemporary dwelling that are reshaping human agency, democratic control, and socio-political struggles.

Motivations and values

The historical development of the digital turn in housing design and the reconceptualisation of domesticity explored in the articles discussed above, requires a critical understanding of the motivations and value systems underlying the narratives that support them, addressed in this issue from three distinct perspectives. In 'Rethinking Autonomous and Robotic Systems in Residential Architecture: Assessing the Motivations and Values of Home Automation' by Sotirios Kotsopoulos and Jason Nawyn, the authors look back on the promise of digital futurism and the potential of smart technologies, reviewing two decades of exploring digitally augmented homes at MIT's Media Lab. They reflect on the implications of digitally enhanced replacements for earlier products of industry and craft, and seek to determine which aspects of digitalisation contribute to transform human behaviour and affect residential architecture. Kotsopoulos and Nawyn suggest that a careful balance to the high-tech interventions in architecture is required, and propose that these interventions be supported by low-tech improvements in building envelopes and mechanical systems. They claim that the integration of general-purpose sensing infrastructures in the domestic space raises concerns about privacy, transparency, and the distortion of data. Instead, they argue, the focus of home automation should be on designing living environments that manage physical envelopes and systems, rather than shaping occupants' behaviour.

In her 'Housing for a Lonely Generation: Co-Living Platforms and the Real-Estate-Media Complex', Marija Marić looks into the hidden side of co-living platforms, revealing how these companies leverage storytelling techniques to construct an ideal urbanite, a networked, productive entrepreneur belonging to the global creative working class. Marić analyses the discursive techniques used by these platforms to offer a solution to the loneliness and alienation of young digital nomads, providing a housing formula for mobile professionals based on promises of community and fulfilment. According to Marić, co-living platforms are part of a real estate-media complex that commodifies housing and shapes individual and collective subjectivities. Their corporate housing model perpetuates the exploitation of precarious individuals who face the pressure to perform socially and professionally and are enticed to pay a premium to small living spaces.

The hidden side of the so-called platform economy is further discussed in 'Housing Migrant Workers: The Form of the Corporate City Along the Rotterdam-Venlo Logistics Corridor' by Renzo Sgolacchia. This article brings to the fore the role of migrant workers performing the jobs upon which the entire platform economy relies. The article examines the Rotterdam-Venlo logistics corridor in the Netherlands, a significant hub for the platform economy and migrant workers. Sgolacchia discusses how digital services are integrated into workers' housing, with corporations and public institutions utilising online platforms and applications to

manage various aspects of migrant workers' lives, including accommodation, transportation, payment, and work schedules. He argues that this digital control contributes to a hyper-rationalisation of the layout of workers' housing and amplifies employee stress. The remoteness of the housing creates a sense of alienation and nostalgia, compounded by limited mobility and reliance on technology for communication. Roma communities offer a contrasting example, with their flexible housing disrupting the agencies' coercive strategies. Sgolacchia concludes that reimagining workers' housing liberated from the surveillance and control systems to which it is currently subject could create an architecture that fosters political intermediation and action.

Unresolved questions

The contributions in this issue of *Footprint* shed light on the correlations between the architecture of dwelling and the digital age from various disciplinary perspectives. By examining the historical development of digitalisation in architecture, understanding the shifting nature of domesticity in the digital era, and critically analysing the motivations and value systems underlying these changes, the articles prompt us to reconsider the role of technology, the impact on human behaviour and social interactions. They point out the need to rebalance key notions of privacy, autonomy, and the physicality of dwellings. They also draw attention to the hidden complexities of the platform economy, migrant workers' housing, and the potential for reimagining architectural interventions that empower workers and foster political agency. The techno-utopia of the 1960s is exchanged here for a sobering view on techno-capitalism, mostly in critical terms, or as part of a larger assemblage from which dwelling might re-emerge anyway, since it is an indivisible part of human existence. There is not a call or desire for a Lefebvrean revolution, but rather a speculation on inhabitants' daily tactical negotiations to appropriate the superstructures as theorised by Michel De Certeau.

As suggested by Johan Huizinga, unresolved issues propel knowledge production. Awkwardly and worryingly, in this issue of *Footprint* the digital discourse seems worlds apart from the gender critique of the architecture of dwelling, despite Donna Haraway's groundbreaking work in, among others, her 1985 *Cyborg Manifesto*. Another related question that remains unanswered is why there is still a resistance to think of architecture, and especially the architecture of dwelling, as a piece of technology? After all, this was Le Corbusier's famous proposition: 'La maison est une machine à habiter.' Heidegger's thoughts still linger in the background of our reflections on contemporary digital dwelling. Further developing his ideas on dwelling Heidegger resorted to the poetry of Friedrich Hölderlin, especially in the essay '... Poetically Man Dwells...', which concludes with some touching thoughts on kindness, an idealist and idyllic reference to ancient Greece. The contrast with our current agitated times could hardly be starker. The piece ends with a quote from Hölderlin's last poem, 'Vista', which opens with the line 'When far the dwelling life of man into the distance goes.'[17] We want to ask again, what are we looking at? What is our view on things, and on how we inhabit the world? Has dwelling got out of reach, at the brink of disappearing here? Hölderlin suggested the perfection of nature, yet 'in that far distance'.

Notes

1. In a previous issue of *Footprint*, which centred around 'The Architecture of Logistics', the social and spatial disruptions resulting from the digital revolution were explored, but with a different focus than the redefinition of dwelling in the digital age. That particular issue delved into how logistics permeates our lives, not only influencing our living and working conditions but also enabling the very essence of existence itself. See Negar Sanaan Bensi and Francesco Marullo, 'The Architecture of Logistics: Trajectories Across the

Dismembered Body of the Metropolis', *Footprint* 12, no. 2 (2018): 1–5.
2. Mario Carpo, ed., *The Digital Turn in Architecture 1992–2012* (Chichester: Wiley, 2012); Mario Carpo, *The Second Digital Turn: Design Beyond Intelligence* (Cambridge, MA: The MIT Press, 2017).
3. Manuel Castells, *The Informational City: Economic Restructuring and Urban Development* (Oxford: Wiley-Blackwell, 1992).
4. Fiona Jenkins and Julie Smith, 'Work-from-Home during Covid-19: Accounting for the Care Economy to Build Back Better', *The Economic and Labour Relations Review* 32, no. 1 (1 March 2021): 22–38, https://doi.org/10.1177/1035304620983608.
5. Peter Collins, *Changing Ideas in Modern Architecture 1750–1950* (London: Faber & Faber, 1965), 42.
6. Beatriz Colomina, 'Couplings', *OASE: Journal for Architecture* 51 (1999): 32–33.
7. Martin Heidegger, 'Building Dwelling Thinking', in *Poetry, Language, Thought*, trans. Albert Hofstadter (New York: Harper & Row, 1971), 145–61.
8. Neil Leach, 'The Dark Side of the Domus', *The Journal of Architecture* 3, no. 1 (1998): 31–42.
9. Terence Riley, *The Un-Private House* (New York: Museum of Modern Art, 1999).
10. Ibid., 12.
11. Reyner Banham, 'A Home is not a House', *Art in America* 2 (April 1965): 70–79.
12. Georges Teyssot, *A Topology of Everyday Constellations* (Cambridge, MA: The MIT Press, 2013).
13. Aldo van Eyck, 'There Is a Garden in Her Face', *Forum* 15, no. 3 (August 1960): 107–21.
14. Antoine Picon, *Digital Culture in Architecture: An Introduction for the Design Professions* (Basel: Birkhäuser, 2010).
15. Antoine Picon, *Smart Cities: A Spatialised Intelligence* (Chichester: Wiley, 2015).
16. Antoine Picon, *The Materiality of Architecture* (Minneapolis: University of Minnesota Press, 2021).
17. Martin Heidegger, 'Poetically Man Dwells', in *Poetry, Language, Thought*, trans. Albert Hofstadter (New York: Harper & Row, 1971), 229.

Biography

Dirk van den Heuvel is associate professor at the Faculty of Architecture and the Built Environment of TU Delft, and directs the Jaap Bakema Study Centre, the research collaboration between TU Delft and the Nieuwe Instituut in Rotterdam. Notable book publications include *Habitat: Ecology Thinking in Architecture* (2020), *Jaap Bakema and the Open Society* (2018), and *Architecture and the Welfare State* (2015). Van den Heuvel has curated exhibitions, including Art on Display 1949–69 for the Calouste Gulbenkian Museum (2019) and the Dutch national pavilion at the Venice Biennale in 2014. He was an editor for *OASE* and *Footprint*, and co-edited among others the special issue of *Footprint* 'Trans-Bodies/Queering Spaces' (2017). He is an editor of *DASH: Delft Architectural Studies on Housing* and an editorial board member of *VLC Arquitectura*.

Nelson Mota is associate professor at the Faculty of Architecture and the Built Environment of TU Delft, where he leads the group Global Housing. He earned his PhD from TU Delft in 2014 with the dissertation 'An Archaeology of the Ordinary: Rethinking the Architecture of Dwelling from CIAM to Siza'. Nelson Mota is author of the book *A Arquitectura do Quotidiano* (edarq, 2010), co-editor of *Global Housing: Dwelling in Addis Ababa* (JapSam Books, 2020), and co-editor of the academic journal issues *Footprint* 17 (2015), *Joelho* 8 (2017), and *Footprint* 24 (2019). At TU Delft, Nelson is co-leader of the Global Urban Lab programme at Delft Global Initiative. He is member of the editorial board of *Footprint* and of the book series *DASH: Delft Architectural Studies on Housing*.

Dwelling in the Digital Age: Imagination, Experience, and Subjectivity

Antoine Picon

A revealing crisis

The pandemic has reinforced the importance of dwelling. Square feet have never mattered as much as during the successive lockdowns experienced by large swaths of the world population. In countries like France where small apartments are common, it has triggered a desire for single-family houses, preferably in suburban or even rural settings. Though the total number of moves out of major cities have remained limited so far – the exodus announced by the media has not happened – the imaginary of the home has somewhat shifted.[1]

The digital has proved an essential component of this heightened awareness of the importance of the home. Indeed, lockdowns would not have been manageable without the digital tools that made remote working possible and enabled family and friends to stay in touch, thus allowing the maintenance of social ties and work relations challenged by spatial separation. While making life in time of crisis easier, at least for those with jobs that didn't need physical presence, the use of these tools was accompanied by the rise of new requirements and problems. The pandemic has not only provoked a rapid evolution of the imaginary of the home; it has also transformed the understanding of what it concretely takes to make the home fully liveable. For example, lofts without partitions met with their limits when more than one person had to engage in a video call. Never have isolated rooms or corners proved more attractive than at a time when phonic isolation was becoming crucial. Simultaneously, the existing antagonism between direct sun light and the use of computer displays became more acute. After months of remote work, we understand comfort in a different way than before the pandemic.

Crises often act as revelations of evolutions that had begun years and even decades before, rather than as triggers of totally unheard-of changes. In North America for instance, the 1872 horse plague contributed to reveal the irresistible character of the mechanisation of urban transportation.[2] If Covid-19 played a part in making evident the importance of the digital in our attitudes towards dwelling, the transformation of our conceptions and practices of inhabiting had begun long before. As always with the digital, the imaginary and the real, the experimental and the widespread coexist in disconcerting ways, a consequence of its proximity both to our expectations and our everyday life. While we dream of smart homes and responsive environments, Airbnb has very concretely altered the use of apartments and houses to the point that it has become a matter of concern for municipalities like Barcelona and Paris, not to mention Amsterdam and Berlin; in all these cities, it has led to the adoption of specific regulations. Whereas Mark Zuckerberg's Metaverse is still in its infancy, a disappointing infancy so far, we already live in digitally augmented spaces with our computers, smartphones, and tablets.

How to disentangle such an intricate set of dreams and realities, mental representations, and concrete practices? How to discern in the maze of existing conditions and possible evolutions what can reasonably be expected? Dwelling in the digital age proves an especially complex question, not

only because of the specific issues raised by the digital. For the home, even more than the digital, tends to blur the distinction between the imaginary and the real. This imaginary dimension, powerfully evoked by Gaston Bachelard in books such as the *Poetics of Space,* complicates even further the very notion of dwelling.[3]

On the meaning of dwelling

Even more than to Bachelard's *Poetics of Space*, any attempt to theorise what dwelling is about must confront Martin Heidegger's seminal essay 'Building Dwelling Thinking'.[4] Few texts from the philosophical canon are as often invoked by architects, not always with a complete understanding of Heidegger's real intent. Contrary to Bachelard, the home in its architectural sense is not the real topic for the German philosopher, who probes situatedness at a much more general level, as being in the world, fully inhabiting our planet, rather than what it means to occupy a given place and live in specific premises. From Heidegger's perspective, dwelling was seriously compromised by modernity, a critique that obviously expands far beyond architectural and urban modernism.

I would like to recentre the attention on the question of architectural dwelling. What does it mean to inhabit a place and a building? From an architectural standpoint, inhabiting or dwelling connotes two things. It refers to the attachment to certain places and spaces, and to the feeling that part of us is defined by the repeated experience of these places and spaces. This feeling is inseparable from one of the most fundamental powers of architecture, namely its capacity to simultaneously regulate our relation to physical phenomena, ranging from contact with materials to the experience of light, and to suggest something about who we are. This suggestion is usually discreet. As Walter Benjamin famously remarked, architecture is usually perceived in a state of distraction.[5] Notwithstanding its discretion, such a suggestion is powerful enough to create a nagging sense of something missing when we are transplanted to places for which we feel no empathy.

There is a powerful link between architecture and the constitution of human subjectivity, a link that extends in both directions. To borrow a concept developed by science and technology studies scholar Sheila Jasanoff, one could be tempted to call this process of mutual determination a 'co-production'.[6] Tell me where and how you live, and I will tell you something about who you are. Going further, at least on the surface, Beatriz Colomina and Mark Wigley posit that 'design always presents itself as serving the human but its real ambition is to redesign the human'.[7] A seductive statement, indeed. It may be true at a very general level, considering design as encompassing all the artefacts and systems that we conceive and build, in other words as synonymous with technology and the arts as a whole. But is it so true, and so radical when applied specifically to architecture? For the latter, contributing to the constitution or the emergence of subjectivity may in fact have far more profound consequences than this alleged redesign of the human. In my book *The Materiality of Architecture*, I relate this contribution to the emergence of subjectivity to another fundamental aspect of dwelling.[8] Dwelling not only whispers in our ears and the ears of others something about who we are; it contributes to the feeling that what we think, say, and do has relevance, that it is meaningful. Never has this feeling been so necessary as in an age marked by the crisis of traditional modes of political representation. It is certainly no coincidence if this crisis corresponds to a destabilisation of traditional modes of living and inhabiting.

The meaningfulness of human thought, speech and action requires something like a frame. The built environment, architecture especially, provides this frame. The true power of architecture is analogous to that of a theatre. Even when it is empty, the theatre is organised in such a way that the words pronounced on the stage have a special resonance. Anyone who goes on stage feels this effect. Architecture stages human thoughts, words, and

above all actions. It does not necessarily need to possess in itself a significance, even if it often does, notwithstanding the advocates of the self-referentiality of architecture like Valerio Olgiati. Rather, it suggests that human thoughts and actions have a relevance, a meaning, and it nudges these thoughts and actions in some directions. This nudging is what the political character of architecture means most of the time. Indeed, architecture rarely constrains its users violently (prisons or camps fortunately remain the exception among its programmes); it orients behaviour rather than bending it forcefully, which does not mean that these orientations are necessarily benevolent. When they are not, those for whom they were designed may experience difficulty to inhabit.

To dwell strongly suggests that we can be the actors of our own lives instead of being tossed back and forth by powers beyond our control. It is good to remember in this respect that for Renaissance humanist Daniele Barbaro, one of Andrea Palladio's protectors, the role of architecture was to establish a specifically human world, partially protected from the rival powers of the gods and nature, from the transcendence of the former and the implacable immanence of the latter.[9] Both denied humans the possibility to settle in a way that suited who they are or rather who they believe they are, for to see oneself as human is always partly an imagination, a fiction. To inhabit is to be protected from the infinite and the blatantly inhuman through the creation of a built environment tailored to human measure.

Returning to Heidegger and his vehemently anti-modern stance, the philosopher was certainly right in his diagnosis of a crisis of dwelling, which was clearly a crisis of the human scale provoked by technology and its consequences for the built environment. But he tended to forget that one of the aims of modernism was to restore this human measure through a redemptive process. Modernist architecture and urbanism saw in technology a destabilising power that had introduced both exhilarating and frightening rhythms and scales that no longer had anything to do with traditional human measure and pace. With its speed, which at the time was twenty times that of the walking human, the automobile was emblematic of this shift. But modernist architects and urbanists simultaneously believed that this power could be mastered and made compatible with inhabiting. It was, for instance, the source of Le Corbusier's interest in human scale and measure.[10] His celebrated Villa Savoye, which one reached in an automobile before ascending on foot via the ramp into the interior, was meant to offer an example of such a reconciliation between the rhythms of mechanisation and the immemorial rhythm of the human gait.

Revealingly, a similar type of debate has accompanied the rise of the digital. Here again, the question of the gap between the traditional rhythms of human life and those impelled by technology has arisen. This was accompanied by a series of interrogations concerning the importance that space could keep within the new world of the instantaneous communication by means of digital networks. While the critics of digital technology lament its dramatic disruption of everyday life and its supposedly nefarious consequences on architecture, its proponents envisage it as a path towards a regained quality of life in spaces improved thanks to digital technology. In his 1995 book *City of Bits: Space, Place, and the Infobahn*, William Mitchell imagined that cities would become more peaceful and liveable with the development of online activities and the subsequent decrease in aggressive physical mobility.[11] More generally, in the eyes of its most fervent advocates, the digital seems to offer the possibility to truly dwell again, thus making it possible to overcome the disorienting effects of globalisation. Even Patrick Schumacher's 'parametricism' may be interpreted from this perspective despite its focus on the stylistic dimension and its notorious links with unbridled star-architecture hubris.[12]

Is the digital synonymous with a new age of dwelling? This question must be addressed at three levels. First, what are the changes that it brings to

the concrete experience of the built environment? The Covid-19 pandemic has contributed to reveal some of them, but the full picture is still far from clear. Secondly, how are these changes related to this different understanding of the human, which is often dubbed a transition towards a posthuman condition? Thirdly, the least easy to address: will these shifts lead to the emergence of new spatial organisations and programmes? In particular, what would the impact on housing be beyond the multiplication of screens in all sorts of rooms, from kitchen to bedrooms, and from family room to home office? This is the least easy issue to address for we are probably just at the beginning of an evolution that may prove more insidious than spectacular. Like electricity before it, the digital has begun to transform the general atmosphere of the home rather than its spatial organisation. Will it eventually, again alike electricity, translate into concrete spatial changes? Electricity gave a much greater flexibility to the design of apartments and above all allowed their stacking beyond what had been done before. It also fostered suburban development by better equipping homes, particularly individual houses, with appliances, thus making them less reliant on human labour, a process evoked by Giedion in *Mechanization Takes Command*.[13] The tall apartment building and the twentieth-century suburban house were both children of electricity. Will there be comparable changes with the digital?

A changing experience of the material world and the home

The first thing to note is that digital has not taken architecture away from the physical world, far from it. More generally, the increase in electronic stimuli and time spent online has been accompanied by a heightened sensitivity to certain aspects of the physical world. If we agree to call materiality, not a property that certain phenomena and physical objects possess in themselves independently from us, humans, but the type of relation that we maintain with the physical world, a relation characterised by the importance granted to some of these phenomena and objects by our culture, our science, and our technology, the digital corresponds to an evolution of materiality, not to a dematerialisation.

Since the beginning of the digital age, in just over twenty-five years, the use of computers, tablets and especially mobile phones has contributed to changing the way we see, hear and even touch what surrounds us. In particular, we have become much more sensitive to materials and their textures, and to certain qualities of light. Digital technology also seems to have caused a blurring of the lines between sight and touch, an effect that architecture has seized upon by means of the 'return of ornament', which has led to the multiplication of visual effects that give the impression of touching certain surfaces with both the eyes and the fingers. This impression is particularly strong, for instance, in Herzog & de Meuron's de Young Museum in San Francisco, with its skin covered with protuberances that resemble Braille characters.[14]

The blurring of the initially sharp division between atoms of matter and bits of information represents another striking evolution. Whether we surf the Internet with our computers or consult a road map on our mobile phones, we are increasingly living in a reality that can be described as augmented insofar as its physical dimension is constantly enriched by digital content. This augmentation is among the key dimensions that has enabled the rise of the smart city as a new set of urban ideals and practices.

This set of evolutions, which can be characterised as a change of materiality, has been expressed in the field of architecture by the crisis of a certain number of traditional dimensions of the discipline. Received aspects of architectural design, such as structure or tectonics, have become less important, while other aspects, such as the often ornamental treatment of envelopes, have become more so. Closer to the question of dwelling in the digital age, the notion of space central to modern architecture and urbanism is hardly applicable to the way of conceiving buildings mobilised by many

contemporary architects. In fact, it has almost disappeared from their vocabulary. In some buildings, like those produced by Zaha Hadid Architects or UN Studio, the topological complexity can at times recall modern architecture's work on space, but the resemblance remains superficial, insofar as the desired effects, starting with a certain feeling of disorientation, are quite different.

Most of the time, architectural interiority seems to unfold in relation to other factors, like texture and light, no longer envisaged as a dramatic revelation of the space, but as parameters of the 'well-tempered environment' theorised by British historian Reyner Banham in his eponymous book.[15] Speaking of such an environment, an architect like Iñaki Abalos interprets the rise of thermal performance as a key dimension of design in terms of a progressive move from mechanics to thermodynamics, a transition also staged by architect Philip Rahm in projects that pay special attention to phenomena like gradients of humidity, and above all, temperature.[16] In the new conception of materiality that underwrites much of today's experimental architecture, the physical phenomena that take place within a construction should matter at least as much as the layout of the floors, walls and ceilings.

What does it mean to feel at home in such a context? Dwelling seems subject to complex trends. To begin with, the crisis of the modernist notion of space goes hand in hand with the questioning of a conception of human subjects as radically distinct from what surrounds them. Inhabitants no longer settle within an emptiness that it is up to them to furnish. They move within a set of fields of force and networks, many of them electromagnetic and electronic, which tend to abolish any clear separation between subjective interiority and the exteriority of the environment. Borrowed from the philosophy of Gilles Deleuze and frequently mobilised by the representatives of the digital neo-avant-gardes, the notion of affect is a convenient term for this relatively unprecedented situation, to which I will return shortly.

This situation seems to reinforce the cocoon-character of a habitat perceived as inseparable from the inhabitant, except that the digital simultaneously contributes to opening it to the outside, the computer or phone screens appearing as windows on physical or electronic distant horizons. A paradox noted by historian of science and technology Paul Edwards in his seminal analysis of the control rooms of the first large-scale computer network, the Semi-Automatic Ground Environment, which was used from the late 1950s onwards to coordinate the military response to a possible Soviet air attack, is that digital age interiors, whether public or private, military or civilian, are subject to the paradoxical imperative to self-enclosure in order to be able to open up to the outside world by means of electronic systems.[17] Decades later, the digital age home is still following this pattern with a striking mix of closure and connection, like a cocoon that is impervious to certain influences while being permeated by others.

Ideally, the home of the well-off digital age inhabitant should filter physical nuisances from outside, starting with sound and excessive light, while enabling a seamless electronic connection to that same outside. However, this attempt at closure is counterbalanced by the desire to open the home to a class of phenomena, objects and beings usually categorised as 'natural'. Never has the longing for nature proved so universal. The very notion of nature is criticised by influential contemporary philosophers, anthropologists, and social scientists, from Timothy Morton to Philippe Descola and Bruno Latour, but it is at the same time endorsed uncritically by the public at large.[18] Reinforced by the pandemic, this interest has led in countries like France to a rediscovery of the advantages of living in mid-sized cities, in villages, or even in the countryside, at least for those able to work remotely. It has also translated in a multiplication of planted balconies and rooftops, a craze epitomised by projects like Italian architect Stefano Boeri's Bosco Verticale in Milan or Vincent Callebaut's utopian vision of spectacularly green cities.

The contemporary relation to the physical world is likely to not only blur the formerly sharp distinction between subjects and objects, between humans and their immediate environments. It is also likely to lead to an equally radical blurring of the traditionally clear-cut division between the natural and the artificial, a joint evolution that may be summarised as a new alliance between humans and non-humans, to use the contemporary phrasing of the humanities and social sciences. Inhabiting is supposed to erase, at least for the members of the social classes that can afford it, these disjunctions that are often accused of having contributed to the current environmental crisis.

It is necessary to relate these emerging trends to changes in the conception of subjectivity that have accompanied the rise of the digital. Again, inhabiting is related to the way subjectivity is constructed in relation to the experience of a series of physical phenomena and objects filtrated through the prism of the materiality of places, spaces, and buildings. Both the digital and architecture bear the mark of a massive ongoing transformation of the way the contemporary subject understands themselves. Both express fundamental features of this ongoing shift.

A different inhabitant

Since the Renaissance, the architectural discipline posited a subject isolated in space and able from the privileged position of the observer to experience buildings as spectacles that could generate emotion and pleasure. Modernist architecture and urbanism remained faithful to this interpretation, even if architectural space acquired affective connotations under the pen and in the practice of some of its most eminent representatives, from Le Corbusier to Mies van der Rohe. The inhabitant of the digital age seems to belong to a very different species. They appear not as a concentrated individual, like an animated statue whose sharp contours contrasts with their surroundings, but as a looser, more diffuse, or rather distributed subject, whose presence extends far beyond their body. Instead of being collected, compact, immobile or in movement but endowed with a fundamentally static character, they seem to exist only through their incessant circulation, under variable and changing subjective conditions and social identities, in physical or electronic networks.

This evolution appears as the last stage of a transformation that started in the 1960s and ’70s with the development of reflections and experiments that challenged the traditional closure of the subject. Anthropologists like Gregory Bateson had already put forward the hypothesis that it was necessary to rethink the human being as an ecology inseparable from its surroundings, rather than as an entity closed upon itself.[19] In an illuminating book, architectural historian Larry D. Busbea shows how this type of hypothesis had spread among designers in close connection with the notion of responsive environments that were to replace passive architectural objects.[20] It is certainly no coincidence that the digital promises the advent of such responsive environments, which had failed to materialise in the ’60s and ’70s, except in a few experimental projects.[21] As William Mitchell convincingly argued in one of his last books, the conception of the human subject conveyed by digital culture is surprisingly close to some of Bateson’s intuitions.[22] History does not repeat itself, but it often picks up the thread of unfinished developments.

What is probably new, despite Busbea’s claim that the most profound changes had occurred by the 1970s, at least from a design point of view, is the more and more diverse and volatile character of identity in the digital age. The stable identities of old, which seemed the basis of modern, well-managed societies, have been superseded by mobile, at times almost liquid forms of subjectivity. These diffracted and changing identities were keenly observed around the mid 2000s by the French sociologist François Asher, who saw in their multiplication a sure sign of what he called a hypermodern regime.[23] However, ‘hypermodern’

might not be the most appropriate term, insofar as it suggests a continuity between modernity and what we are currently experiencing in the digital age. Philosopher Jean-François Lyotard's characterisation of the postmodern subject as intrinsically diverse, assuming sometimes very different, even contradictory roles, is perhaps closer to today's reality, as is Bruno Latour's description of the human as a mediating figure in constant circulation.[24]

Equipped with digital tools, monitored by other digital apparatuses, treated by means of still other digital devices, the contemporary subject can be also interpreted as 'post-human' even if all their lived experiences, their knowledge and ultimately their consciousness will not yet be uploaded into giant computer networks tomorrow or the day after, with all due respect to the prophet of the singularity, Raymond Kurzweil, who has repeatedly announced this event, equivalent in his eyes to a form of immortality.[25] Away from this singularity, which would see technological development accelerate exponentially, merging humans and machines, the post-human subject has been diversely approached, from the cyborg hypothesis initially explored by Donna Haraway, who posits a seamless association between bodies and technological protheses, with a Deleuzian accent on the inner diversity of a contemporary subject that is fundamentally irreducible to the Cartesian dualism of body and mind.[26] The contemporary subject as an ecology, to use Bateson's characterisation, is also part of the post-human spectrum.

But does the post-human in all its guises contain all that there is to say about what is happening to individuals in the digital world? Their heightened sensitivity to exterior stimuli and their interest in materials and textures, with their ornamental connotations, go hand in hand with a renewed attention to the body, a body limited in space, both exalted and vulnerable, whose metabolism and performance can be quantified by the digital. The age of dividing and proliferating identities within numerical networks also sees a return to the body and the unique character of its experiences. Social networks reflect this dual character. On the one hand, its members tend to dilute themselves into their various channels, to the point that they appear like constantly transient entities. On the other hand, by posting their most recent experiences, glimpses of a physical life that they hope is unique and arresting to others, they are trying to recentre themselves, to regain a stability and a permanence challenged by their online life. Sociologist Sherry Turkle's influential analyses of the destabilisation of the self provoked by the digital age, should be counterbalanced by the recognition of the opposite tendency, to reconstruct oneself as the hero of one's life in memorialising all these 'privileged' moments, emotions and thoughts; this seems to suggest that we remain fundamentally human despite the seduction of the post-human rhetoric.[27]

Could we still be somewhat modern? Are we hypermodern, postmodern, human, or post-human? Probably all at the same time. As I have tried to show at different scales, from the return of ornament in contemporary architecture to the experience of the city being transformed by intelligent technologies, the evolution of the built environment bears the mark of our ambiguities.[28] The home is no exception. Dwelling in the digital age appears as a contested field.

New housing trends and rising incertitude

Indeed, housing reflects the contradictions of our time. On the one hand, as I observed earlier, the pandemic has made evident the need to increase the surface of dwellings; on the other hand, in many countries the tendency to reduce the square footage available to inhabitants has continued. For example, in Hong Kong, micro-flats have become an unavoidable reality.

As I said earlier, it is difficult to identify transformations of the habitat linked to digital technology that are radical enough to speak of a new era of living. Like electricity before it, information and communication technologies have no clear spatial

translation, at least for the moment. The contradictions that I have mentioned can, however, appear as the premises of future transformations. In architecture as in many other fields, contradictions represent catalysts of change. It is no coincidence that the imagination welcomes contradictions that ordinary logic would immediately reject. The evolution of the home is inseparable from a complex and contradictory imaginary.

In the digital age, the home is invested both with a desire for stability – a stability that professional life has long since lost – and with a growing concern for adaptability partly inherited from modernism, but going further. Apartments should, for instance, be able to expand and contract according to the changing needs of their occupants. A recent project developed at the Bartlett School of Architecture goes further and imagines a 'reconfigurable autonomous architecture' steered by artificial intelligence and powered by a distributed robotic material system that would allow buildings to evolve according to the requirements of their occupants.[29] As we have seen, the home of the future must protect private life while at the same time it is open to the multiple electronic networks that must help make it connected, even 'smart'. It remains to be seen to what extent these two imperatives can be reconciled. After all, the triumph of the Internet and mobile devices is accompanied by increasingly frequent dreams of partial or total disconnection. Perhaps we can imagine the home of the future as organised according to gradients of connection, just as our current apartments and houses are frequently structured according to the degree of privacy of the rooms.

Most publications on the house of the future tend to imagine gender and more generally identity as fluid spatial conditions, a miraculous conciliation between imperatives of flexibility and the desire to self-identify through inhabiting. An equally complex balance must be found in order to solve the contradiction between the multiplication of sensors sending information about the home to distant service providers and the protection of privacy. In France, for instance, the resistance to the tendency to equip the home with devices that send information to service providers is apparent in the heated debates that have accompanied the installation of 'smart' meters by the national electricity utility company.

It is also striking how the futuristic perspectives that smart technologies and the Internet of Things allow us to sketch out are accompanied by a diffuse nostalgia for the interiors of yesteryear and their soothing ambiance. The place given to natural elements is also the subject of contradictory assessments. Though everyone agrees on the need to reinforce it, balconies and planted roofs are not unanimously accepted, at least in their present form, which owes as much to the desire to create a strong impression on the viewer as it does to research into an authentic synergy between built and natural elements. These contradictions refer once again to the uncertainties surrounding the evolution of contemporary forms of subjectivity. Uncertain of their identity, today's inhabitant hesitates when about to project themselves onto the walls of their dwelling. Between disruption and nostalgia, the future on dwelling is far from settled.

The most fundamental contradiction may well refer to the increasingly individualistic character of contemporary social life and the simultaneous desire to recover forms of collective life. On the one hand, digital technology completes the process of increasing isolation of individuals by allowing them to do even more things alone and at a distance: from ordering food and goods without ever going to a store and interacting with other humans, to watching a play or a movie without going to the theatre or the cinema. On the other hand, the frustration almost inevitably generated by online exchanges that do not satisfy the need for bodies to brush against each other, for faces to meet in physical space, generates a desire to restore forms of community through habitat. The development of co-living, of 'co-dividuality' that takes co-living a step further by increasing the size and importance of shared

spaces, and of housing developments that border on utopia, like Vienna's celebrated Wohnprojekt, with its participatory character and multiple shared amenities, epitomise this desire to recreate a collective experience of dwelling.[30]

When they evoke the digitally permeated future of housing, technology-oriented writers are keen on evoking a home in which the Internet of Objects and responsive environments play diverse roles, from the possibility offered to the inhabitants to change their wallpaper at will and to control remotely and intelligently all the systems and appliances in their house or apartment, to the prospect of using programmable modulations of light and material textures to counterbalance stress and anxiety. Hollywood movies have already given striking visual expression to this potential future. Doctoral theses are now being prepared on the possible intersections between neuroscience and responsive environments. The programmable home, the smart home appears as a distinct possibility.

But will this evolution be as radical as the techno-futurists would like us to believe? Will wallpapers evoking, with a high degree of resolution, peaceful alpine meadows or tropical beaches be enough to counterbalance the lack of square feet in cramped little apartments? Again, instead of dematerialising the world we live in, the digital has actually reinforced some of its salient features. The multiplication of Zoom meetings has made us more aware of the quality and defects of the rooms in which we work remotely. As for the Metaverse, even if it eventually develops, which is far from obvious at the moment, it will probably not be able to replace the experience of this physical world in which we are born, know happy and unhappy episodes, and ultimately die.

In *City of Bits*, anticipating the development of online sociability and activities, William Mitchell urges architects to become the designers of a virtual world whose growing scope and intensity would, in his opinion, deprive the material world of some of its relevance. More than twenty years later, this advice seems to have lost some of its appeal. Even though it will be required to design responsive environments and work in ever closer contact with smart technologies, architecture remains fundamentally a matter of materiality. Its task is to make places and buildings liveable, and in so doing, to whisper to us about who we are as human beings. If atoms and bits of information are hybridising more and more every day, this does not mean that the former are disappearing in favour of the latter, nor does it imply that architecture should abandon its mission of ordering matter to organise the experience of humans in contact with it so that they can learn something about themselves and live more meaningful lives.

The growing inequality of contemporary societies constitutes another reason to distance oneself from an unbridled techno-futurism that tends to consider economic, social, and political obstacles as negligible. Not considering the one billion people on the planet who live in slums, even in developed countries access to decent housing is far from universal. Equally dramatic is the inequality in access to digital technologies despite the high penetration of smartphones in emergent markets like India. Of course, digital technology can also contribute to the reduction of such inequalities. For example, NGOs have developed digital services for slum dwellers, such as the possibility of acquiring a physical address to open a bank account, which many of them lack. [31] There are also experiments in the digital printing of low-cost houses that seem to be succeeding. In the digital age, the most urgent challenges of housing remain fundamentally physical.[32]

Dwelling differs according to the social conditions and incomes of any society at any given time. Like shelter, it corresponds to a universal need whose concrete translation depends on multiple situated factors. One of the tasks of the historian consists of suggesting where the dividing line between the universal, or rather the generic, and the specific lies. Dwelling in the digital age is no exception to this fundamental challenge of history. It may

appear limited to the sufficiently well-off to be able to be significantly exposed to its effects. However, the history of housing reveals that trends that were initially confined to the most privileged circles of the population often end up spreading to the various layers of society. For example, in countries like England and France at the end of the eighteenth century, the rise of modern ideals of intimacy transformed the homes of the aristocracy and the upper middle classes before reaching other social strata.[33] This is where the imaginary plays a role. Inhabiting is fundamentally an experience, but an experience informed by all the images of dwelling that circulate and propose alternatives to current inhabiting. The same process of proliferation will undoubtedly occur among certain trends that I have attempted to identify. Once again, dwelling engages the definition of the human and its historical evolution through a mix of concrete experience and imagination. Its transformation in the digital age is determined by many factors other than just the familiarity with computers, tablets, and smartphones. This familiarity is in fact only one of the expressions of a much more general transformation of the way human beings understand themselves in relation to their environment. Tell me where and how you live, and I will tell you something about who you are. Without always realising it, humans have become different from what they were at the time of modernism, even if part of themselves remains attached to modern ideals. To scrutinise what dwelling in the digital age might have in store for us we have to accept this evolution, even if we don't really know where it is leading us.

Among the remaining uncertainties is the nagging question about who we may have to share our homes with in the future. Since its earliest stages of development, humanity has lived with animals. The development of Artificial Intelligence may lead us to a different form of cohabitation. Algorithms and robots may very well share our domestic space in a not-so-distant future. What does it imply for dwelling? So far, Hollywood movies like *Her* and *Ex Machina* have evoked these potential housemates by lending them a ghostly presence, as if they were haunting the places occupied by humans, in a border-zone between the material and the immaterial. But are we so different from machines? One thing is certain, the fate of the human being seems to play out between animality and becoming like a machine. Part of us cannot but feel comfortable with cats, dogs, and horses, not to mention the various birds we have lived with in the past, and often continue to live with. A different part speaks to computers after having worshiped all kinds of mechanical apparatuses. Who are we? Dwelling in the digital age has not yet finished confronting humans with their inner complexity and indetermination.

Notes

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Biography

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The Digitalisation of Swedish Housing: The First Forty Years

Fredrik Torisson

The 'home of the future' has perennially been presented to the public since the era of the great exhibitions.[1] In most cases, these homes appear briefly before disappearing beyond the horizon forever. In this article I revive a few of the less glamorous exemplars, to reassemble a parade of the 'smart' housing of the future in Sweden since the 1980s. Silicon Valley narratives venerate brave pioneers from the 1960s – Cedric Price, Jay Forrester, Stewart Brand and co – lamenting that their contemporaries failed to recognise their ground-breaking work, and asserting that it is only today that the full extent of their genius can be appreciated. This miraculous rediscovery and canonisation is not entirely unproblematic, however. By focusing solely on the original dreamer, whose vision is only possible many decades later, such narratives conveniently omit the failures and setbacks that form part of a longer and far less linear development.

This article deals with smart housing, and it should be emphasised that this is fundamentally different from smart homes. I will describe the reason for this distinction, but for now it should suffice to note that smart home technology revolves around homeowners and convenience for their benefit, while smart housing technologies centre on landlords and the digitalisation of their operations rather than tenants' comfort. Ultimately, the success of any smart housing project becomes a question of getting tenants' cooperation – a notoriously difficult undertaking. Already in 1998, researchers Stefan Junestrand and Ulf Keijer noted that 'the technology itself is the smallest problem. The interesting question is whether residents are actually interested in and asking for the services provided.'[2]

The different smart housing projects mapped here together form a parade in which the same future is seemingly repeated, each time under a new moniker. Even more curious, each instance appears to deny the existence of any previous projects – or at least there is no memory of futures past. The process is usually the same: test beds are installed in a housing block to much media fanfare, a minister or a foreign head of state pays a visit to guinea pig families and brave digital pioneers, a host of publications written in an awed tone appear and then the project discreetly fades into the background and vanishes. A few years later, the process is repeated. This serial infatuation with the idea of a smart building is, as suggested above, always around the corner, here, and already gone. All at the same time.

On closer inspection however, we find variations, shifts, nuances. The protagonist – rarely the dweller – changes, from landlord to technology corporation and more recently to the utility companies, the power grid supplier. The systems employed to manage tenants grow larger, charting and memorising more about tenants. From the early 1980s until today, smart devices have been installed in tenants' walls, yet this is a history that has remained almost entirely untold, until now.

Some context

In this article I trace the digitalisation of Swedish housing from the 1980s to the present. Scholarly

attention on the emergence of the smart home has focused on domestic technologies, on the 'home' rather than the building.[3] More critical perspectives have formulated a feminist critique of how the smart home tends to put the male homeowner's leisure at the centre while habitually ignoring women's domestic labour.[4] Very little has been published in architecture or the social sciences on the history of the digitalisation of housing, as opposed to homes.[5] My focus in the following is not primarily on the technology itself, which has indeed changed radically over time. Instead, I concentrate on the way the technology transforms the tenant-landlord relationship, on the view of those whose lifeworld is interfered with, how they are expected to act, and how they have reacted to the installation of smart technologies to regulate their lives.[6]

The focus on housing rather than the home lends itself well to geographical contexts where rental housing is the norm rather than the exception. Sweden constitutes an interesting case study here. The country often adopts technology quickly, and there have been active projects to digitalise dwellings from the early 1980s onward.[7] Sweden also has powerful municipal housing corporations who themselves cultivate high-flying digitalisation ambitions.[8] To my knowledge, this article offers the first long-term historical overview of the relationship between housing and smart technology in Sweden. Previous publications addressing the digitalisation of housing have focused on individual measuring and billing, or on broadband, or they have sought to provide a snapshot of the present moment.[9] I believe that even if the specifics of each round of digitalisation here are Swedish, the larger general development will resonate in other contexts in continental Europe and potentially beyond.

Approaching smart housing from this angle places the article in relation to three overlapping topics within the discursive landscape of the architectural discipline. The first concerns the relationship between technology and architecture in the everyday use of buildings. One seminal moment in this genre is the 1948 publication *Mechanization Takes Command* by Siegfried Giedion.[10] In it, Giedion and his students set out the 'anonymous history' of how technology had continuously transformed life inside buildings. Giedion focused on technological invention and not its implementation in architecture; Reyner Banham criticised this in his 1969 book *The Architecture of the Well-tempered Environment*, which sought to explore how the technological innovations documented by Giedion were introduced in actual buildings.[11] Since Banham, this topic has resurfaced on different occasions, most recently in *Elements of Architecture,* the 2014 Venice Biennale curated by AMO and Rem Koolhaas, which traced the technological development of building elements and its impact on the built environment.[12] I draw inspiration from Banham's take on how technology affects buildings, but has a slightly different focus, specifically, on users' experience and relationship to their landlord rather than how technology is designed into buildings.

The second topic runs partially counter to the first. It concerns the problematic adjective 'smart' as employed for cities, housing, and homes.[13] This topic is conventionally considered extra-architectural; Koolhaas has noted that when technology corporations call their version of a frictionless city smart, the architect's city is, by implication, 'stupid'.[14] Since then, architectural theorists and historians have occasionally and perhaps reluctantly addressed the smart development of homes and houses, but this is generally considered beyond the scope of architecture.[15] Smart technology, then, is habitually considered as something retroactively added by developers and others, which does not affect the spatial or material composition of the building.

This view clashes with a third topic of architectural discourse: post-occupancy.[16] In the past, attention was primarily directed to the architect and their design process, but nowadays architectural history operates in a broader discursive context, and the narrative does not necessarily come to an end when the building is handed over to the client.

Smart devices put into tenants' homes by landlords are part of a control system of the house and home. Although their impact on a building's style and shape is limited (for the time being), the smart devices nevertheless affect spatial experience and how the dwelling is imagined in the digital age.

This article combines these three topics, addressing smart technological development over time in the field of housing (as constructed rather than planned) with a focus on post-occupancy and on how technology transforms tenant-landlord relations. Rather than mechanical services introduced in buildings, I look at the introduction of digital services using sensors connected to computers to regulate and log life in the flats belonging to the landlord.

Conceptual conundrums

When to begin? The question is frequently asked when researchers trace the story of the digital in architecture.[17] When exactly does housing become smart? Dreams of the automated house have oscillated between the desirable and the nightmarish – the latter is of course a favourite pop culture trope for the modern individual's powerlessness.[18] In the late 1970s and early '80s, these dreams were still highly futuristic, notably expressed in the different versions of the Xanadu houses, which combined automation with Jetson-inspired design.[19] In 1984, the US National Association of Homebuilders coined the term 'the smart home', and in 1986 it even constructed a mobile demonstration home.[20]

Around the same time, the digitalisation and automation of building management – primarily office buildings – were beginning to appear. Around this time, the concept of 'the intelligent building' emerged; a computerised building, it was supposed to automate responses that previously would have required manual responses. The customer for whom the intelligent building was conceptualised was the building's landlord or manager, whose management tasks would be optimised. The conceptual label was first applied to City Place Building in Hartford, Connecticut, designed by Skidmore, Owings and Merrill and completed in 1983. Its intelligent systems to automate building services were installed by Building Systems, a subsidiary of United Technology Corporation, itself a collaboration between companies that had previously primarily fulfilled military contracts and were now seeking civilian business opportunities.[21]

There are two narratives in the 1980s. One attends to the needs and comfort of the resident/homeowner, and the other focuses on the landlord/manager. The aim of the latter is not to increase the tenant's comfort but rather to optimise the management of the building. Soon enough, however, this logic was transferred to housing and social housing. Smart housing can be seen as 'the intersection of housing with smart technologies', as one researcher put it.[22] For clarity's sake, I want to emphasise the distinction I make here between the smart home or house and smart *housing*. Here, smart housing is concerned with questions of rental housing: provision, distribution, and tenure, and importantly for this article, the tenant-landlord relationship. I argue that there are two significant differences setting smart housing apart from both the logics of the smart home and the intelligent building. Characteristic for the smart home is the homeowner's voluntary installation and use of a smart system over which they have control. As Lynn Spigel notes: 'smart homes are an industry and as such they are targeted at the lifestyles and presumed aspirations of the consumers who can afford them'.[23] Smart housing, on the other hand, is installed by the landlord in the walls of homes where tenants have limited power to resist the installation and little or no control over the collection of data from the private home, let alone how it is used by the landlord. In the intelligent building – as conceptualised in the early 1980s – tenants and landlords were corporate entities. Smart housing is characterised by a tenant-landlord relationship that involves a different power asymmetry: particularly in social housing, the tenant is dependent on the landlord, and one cannot assume that the tenant

can simply choose another residence. Feminist critique of smart homes has highlighted that the technology intended to make life easier for the male homeowner was blind to the needs and comforts of other members of the household. Below, I will interrogate what could be called a blind spot in the rise of smart housing: the tenants, and how the 'making smart' of housing transformed the conditions under which they live their domestic lives.

The multiple stages of smart housing

What follows is a story of lives forgotten and projects discreetly abandoned, where the wiring inside the walls is the only trace of what once was the future of the digital dwelling. Different stages denote different moments in time when smart technology seemed to be the future. Each stage involves the retrofitting of a public housing block constructed within the framework of the large housing programmes of the 1960s and '70s. By no means are the projects presented an exhaustive list; there have been numerous other smart housing experiments, including private ones.[24] The projects presented here are geographically concentrated in Stockholm and Gothenburg, but nonetheless representative of development in Sweden more broadly. As vanguard projects, these experimental test beds are dead. As smart housing they were failures, and as lessons they remain unlearned. Summoning them back to life in this manner serves not only to show repetition, but also what has changed over time. All the projects aimed to apply smart technology to control tenants' energy consumption. Fundamentally, the projects concerned behavioural change, either through disciplinary technology or through attempts to discipline inhabitants to monitor their own behaviour. A common feature for all of the cases is that things did not go according to plan. Sometimes this was a result of technological failure or miscalculation, but importantly, tenants often reacted to the projects with indifference or active resistance.

Stage one: 1984–1986

With the oil crises of the 1970s, energy scarcity was painfully felt in most segments of Swedish society, and housing was no exception. Public housing constitutes a substantial part of housing in Sweden, especially after the large housing programmes of the 1960s.[25] Heat and hot water in Swedish public housing are generally paid collectively as part of the rent, with costs negotiated annually between the property owners association (Fastighetsägarna) and the Swedish Union of Tenants (Hyresgästföreningen). The sudden fluctuations in energy prices prompted research on saving energy in public housing; public housing corporations were large and powerful actors who could test solutions that, if successful, could be implemented across the housing stock. An early suggestion proposed transferring heat and hot water costs to the individual tenants; collective billing meant that individual tenants had no cost incentive for saving energy.[26]

Installing individual meters was prohibitively costly and considered unjust; flats with multiple exterior walls consume far more energy than flats sharing walls with other flats that benefit from heat leakage from all directions.[27] An alternative to charging for energy consumed is to charge for the 'comfort temperature'; that is, households pay for a specific indoor temperature, regardless of where in the building the flat is located. Comfort temperature is guided by a thermostat rather than a conventional meter. We should remember that although it is an old invention, the thermostat is the quintessential cybernetic device. Norbert Weiner famously used it as the primary example of a device that works through negative feedback in a self-balancing system.[28] However, an ordinary thermostat only measured the temperature in the flat, and did not take the tenants' habits into account. Even if tenants left their windows open through the winter, for example, their comfort temperature-determined energy bill would remain the same, and the installation would fail in its purpose to create an incentive

for tenants to save energy. The solution was found in a computer system in which sensors could react to tenants' behaviour and trigger different responses.

The earliest smart system for the digital control of tenants' indoor temperature is found in the patent application for a 'technique and device for the control of temperature in heatable spaces' submitted in 1980.[29] The invention was intended to permit individual billing for heating in multi-household residential buildings with a central boiler. A patent was granted in 1984, and the system, marketed as Termax, was presented to the public later that year.[30] [Fig. 1] Each tenant agreed with their landlord on a comfort temperature that Termax would maintain in every room of the flat. Each radiator would be equipped with a thermostat, in turn connected to an individual data-card in a central computer to which only the landlord had access, controlling the flat's radiators from a distance. Landlords would adjust the rent according to the agreed upon comfort temperature: a lower temperature equals lower rent. The patent application places special emphasis on preventing tenants from sabotaging or manipulating the equipment. All windows, internal doors, and the front door were fitted with sensors to minimise heat loss through ventilation; when a window was opened, all radiators in that room would shut off, making it impossible to waste energy (or ventilate the room and maintain the indoor temperature at the same time). If the door to another room or set of rooms was open, the radiators would shut down in those spaces as well. The system could be coordinated with the tenant's daily schedule and could be programmed to alert the emergency services if, for instance, the tenant was at home but did not use the bathroom door for more than twenty-four hours.[31]

Technology was called upon to incentivise tenants to conserve energy by enforcing certain behaviours and individualising the group of tenants who had previously constituted a collective with a common relationship to the landlord. Termax was installed in 284 flats, and the experiment ended in something of a disaster. Frustrated by the system's inflexibility, a large portion of the tenants rebelled against the system, sabotaging the equipment by cutting the wire that linked the thermostat and the radiator valve, discreetly reclaiming control of the temperature in their flats.[32] Here, the system was clearly imposed on tenants who found the system oppressive – effectively, the system punished them for seeking fresh air, and the landlord assumed a somewhat paternalistic, mistrustful role. The goal of preventing the system from being abused by individuals fits well with the general discussion about and nascent neoliberal re-modelling of the welfare state, placing responsibility with the individual rather than the collective. Technology, then, was introduced to curb abuse. The same politics of individual metering, and the same rhetoric, returns in many later projects with similar ambitions.

Here, one might emphasise the individualisation of the tenant. In the past, tenants were addressed as members of a collective. Rent negotiation, for instance, is a collective procedure. Termax produced a situation in which each tenant negotiated separately by setting a comfort temperature; the tenant-landlord relationship becomes individual; the tenant is no longer integrated in the tenant collective.[33] The act of sabotage could possibly also be read as a way of resisting this process.

Stage two: 1999–2000

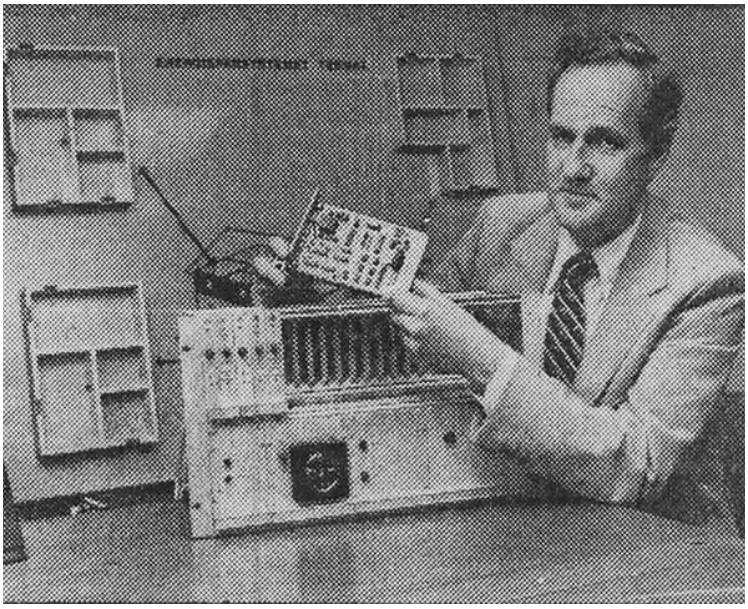
Individual metering seemed less urgent when energy prices stabilised in the 1980s. Toward the end of the decade, deregulation and privatisation became central themes in both housing policy and building services, and this development continued through a housing market crash in the early 1990s.[34] Electricity, telecommunications, media, and housing became markets rather than state-provided infrastructure, and the number of personal computers multiplied exponentially during the IT-boom. Following general trends of dismantling welfare state housing and replacing it with a more market-oriented condition, the tenant was no longer seen as a tenant, but as a customer. The assumption was

that this customer, if properly informed, would make rational decisions about, for instance, their energy consumption. Consequently, the smart housing projects of this time sought to inform customers and provide them with a wall-mounted control panel where they could follow their own energy, heat, and hot water consumption and compare it to previous usage.

The combination of these and other factors led to many smart housing renovations being initiated in the years up to the turn of the millennium in various cities and towns around Sweden, including Gävle, Skövde, Landskrona, Malmö, Uppsala, Stockholm and Gothenburg.[35] One prominent example was owned by Poseidon and located in Gothenburg (as had been the case for Termax). The IT-house (IT-huset) was part of the renovation of a run-down and stigmatised housing estate in Högsbohöjd in 1999–2000. [Fig. 2] When the estate was renovated, the public housing corporation dedicated one building containing thirty-seven flats as a testbed for technology. A central aim was to counter the stigmatisation of the estate with this flagship housing project, and as a result, to attract new tenants to the area.[36] Smart housing was presented as desirable, and the technology was – at least to an extent – designed to make tenants' lives easier, much like smart home technology. Enthusiastic tenants welcomed reporters from the local press to show off their flats.[37] While the renovation itself was not controversial, its effects were considered more problematic. The building's previous tenants were relocated to other flats in the estate, while the IT-house was populated with younger, more tech-savvy tenants who worked in the IT-industry.[38] Futurism, it seemed, should be a quality of tenants as well.

The building's smart systems included a lift that would be summoned when a tenant opened their front door, communication systems with the landlord, a noticeboard for the tenants, a digital booking system for the laundry room, the sauna, and so on, a video-doorbell that would photograph people ringing the doorbell of the flat (and save the images), and more. The new tenants in their state-of-the-art flats could also adjust the comfort temperature in different rooms using the internet, and they were charged for the comfort temperature.[39] Upon moving in, tenants were educated in how to use the system and how to save energy. The system had several unwanted side effects, for instance, heat leakage from neighbouring flats would raise energy bills, as would warmth emitted by computers, as tenants then would pay both for the electricity for running the computer and the heat it generated.[40] It wasn't until the end of the first year that the most problematic aspect emerged: when Poseidon calculated the average indoor temperature in its housing stock, it emerged that average temperature in the IT-house, with its informed consumers, was 0.8°C higher than the housing stock average.[41]

The project is interesting for several reasons. One is that the project actively sought to combine the two narratives of smart buildings: the resident-oriented and the landlord-oriented. For a short time, these two smart housing narratives became almost indistinguishable. The aim was to attract a wealthier social group to the area, following an ethos that was popular at the time: design not for the tenants you have, but for the tenants you want. The house was packed to the brim with markers of exceptionalism and services unavailable to other tenants, from live-feed cameras of the parking garage and two daily mail deliveries during which tenants could purchase stamps directly from the mail carrier. As resident-centric as it was portrayed, this customer-oriented system still permitted the public housing corporation to retain total control. Supplying volumes of data to an external corporation with whom one has entered into a contract for this specific reason – a contract that can, importantly, be terminated – is fundamentally different from one's landlord, on whom one depends for a dwelling, collecting this data; it brings the landlord into one's life in ways that have thus far not been problematised in critical discourse.



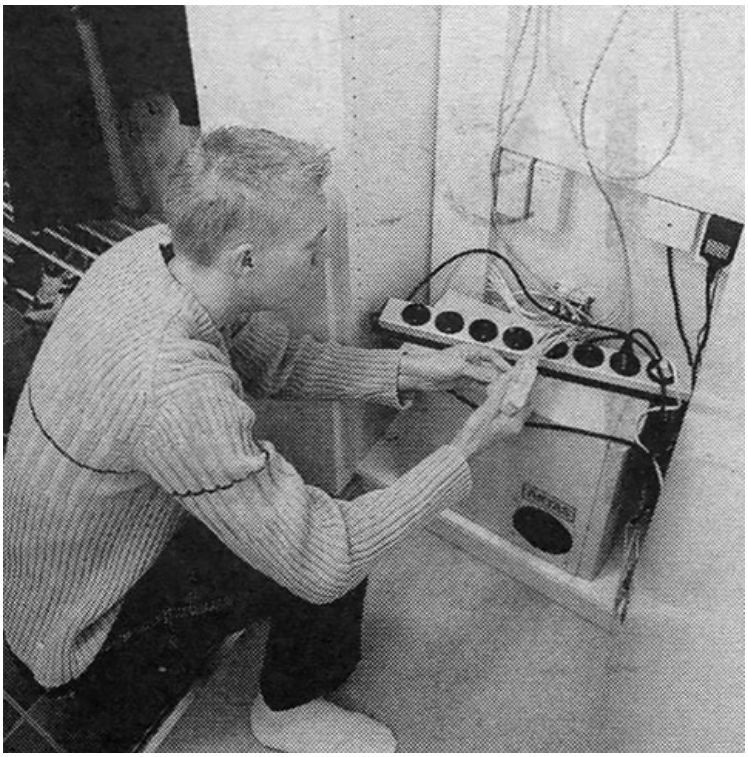


Fig. 1: Sven Hedly shows off the Termax system. Originally published in *Göteborgsposten,* 22 May 1984. Photo: Christian Tyre.

Fig. 2: A tenant shows the IT-cabinet in the IT-house in Högsbohöjd, Gothenburg. Originally published in *GT* on 16 September 2000. Photo: Tommy Holl.

Stage three: 2007–2009

In the aftermath of the IT-crash of 2000, anything labelled 'smart' was ridiculed. Public opinion had it that the era of smart was over.[42] However, only a few years passed until the next generation of smart housing was presented, if with less fanfare than before. In 2007, the Gothenburg-based company Manodo launched the Sbox, a touchscreen panel that promised to significantly lower energy consumption, to be fitted in a wall of a rented flat. [Fig. 3]

The previous generation of smart housing had overestimated how rational and sensitive to cost tenants would be when recorded information is the only motivating factor. Sbox started to introduce educational features, nudges to change tenant behaviour. Among other functions, the Sbox panel displayed electricity, heat and hot water consumption, and it assigned 'smiley' or 'frownie' icons depending on whether the tenant had remained within or exceeded their target consumption and on their consumption performance over time. [Fig. 4] Target levels were set in relation to the environmental footprint. Making the tenant a rational consumer by not only showing their consumption but also evaluating their performance was a minor modification of earlier attempts.

Like the service building of the previous generation, the new system primarily aided landlords in transferring the cost of heating and hot water to individual consumers. Like Termax, Sbox was part of an independently developed technological system marketed to landlords and housing managers rather than homeowners or tenants. Also, like Termax, the system was poised for expansion; it could, for example, be fitted with an alarm that would notify caretakers if there was no movement in an occupied flat. The built-in microphone could put the tenant in contact with the landlord or the neighbours. It also permitted local businesses to advertise products directly to local Sboxes (in tenants' homes).[43]

The Sbox was tested in eighteen flats in Vällingby and in sixteen flats in Kortedala, Gothenburg. The outcome of these tests remains unclear.[44] After a trial year, a Vällingby resident was interviewed by a technology magazine. He expressed mild curiosity about the functions but noted that he did not really need them and could not imagine paying for them, although he did think that they might potentially be of use to someone else.[45] Bostadsbolaget, the public housing corporation that owned the Gothenburg flats, purportedly planned to expand installations of the Sbox to other areas.[46] In response to a request for further information, Bostadsbolaget replied that no evaluation existed, that the Sboxes in Kortedala had been removed, and that they were unlikely to be implemented elsewhere.[47]

Sbox extended the landlord's reach into tenants' flats, with a different focus than Poseidon's customer-centred approach in Högsbohöjd. Arguably, Sbox entailed a return to management-oriented smart housing while on the surface resembling a consumer-oriented system– although it is admittedly difficult to draw any clear border.

Stage four: 2011–2013

After Sbox, smart housing projects shifted from landlords to utility companies developing smart grids designed to extend all the way from the power plant to the appliances in tenants' homes. The smart grid has two aims: to extend power production to new entities, such as buildings with photovoltaic cells, which can become small-scale power plants, and to distribute system loads evenly across the day – so-called load shifting – to smooth out peaks and valleys in the demand for electricity and avoid overcapacity in the power grid.[48] In practice, this would mean a far-reaching coordination of every link in that chain, from the powerplant via the building to the tenant's dishwasher, so that it runs when the energy load is low. The tenant's relationship to the power company is mediated via the landlord, who oversees the building's energy production and consumption. The smart grid, in other words, connects city, building, and home. In Sweden, the first smart grid experiment was a multi-stage project running from 2009–2018 dubbed the

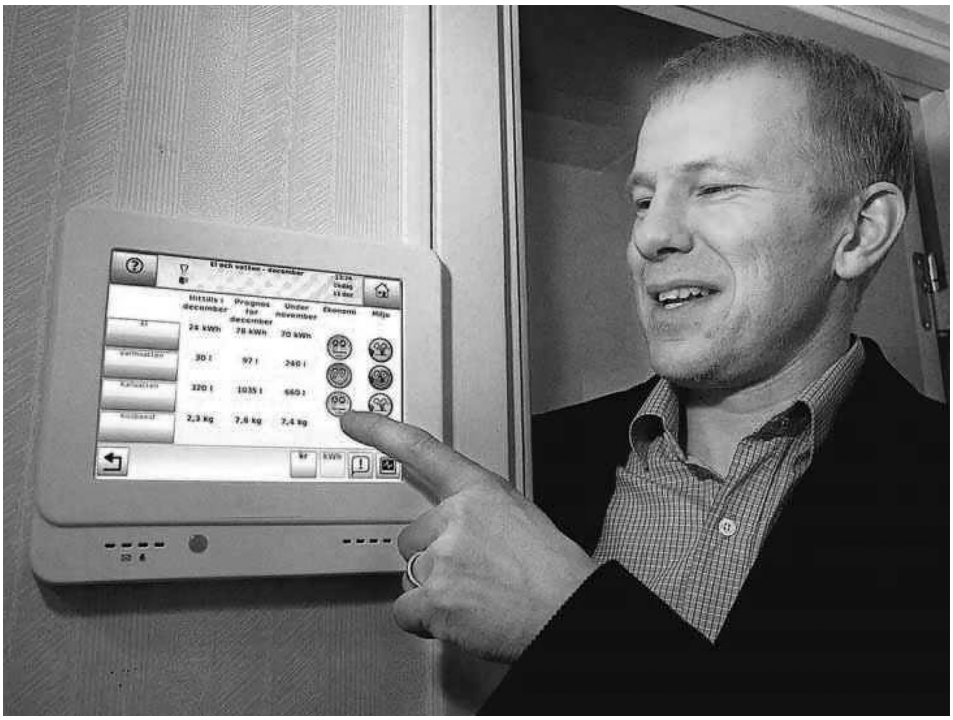


Fig. 3: Manodo deputy CEO Johan Stråkander presents the Sbox. Originally published in *Dagens Industri,* 13 December 2007. Photo: Marie Ullnert.

Fig. 4: Sbox in use in Vällingby. The smiley indicates whether the tenant has been good or bad. Originally published in *M3,* 15 December 2009.

Active House.[49] For the system to work along the entire chain, appliances in tenants' flats had to be updated to smart appliances that can compensate the system loads, and tenants would find themselves in smart homes over which they had very limited control. The technology is similar to that in the smart home, but again, it is not installed for the resident's convenience.

The smart grid concept was developed for the green flagship development Stockholm Royal Seaport.[50] The group of actors behind the project sought to test the smart solutions in one thoroughly equipped rental flat in the area, complete with appliances developed for the purpose by Electrolux. The project group advertised for volunteer families through a leaflet with a familiar call: 'Try living in the future now!' The conditions involved living in the flat for a period of two years (2013–2015) and paying partially subsidised rent for the duration of the experiment. A family of four was selected, and they embarked on their real-life experiment as pioneers with high expectations.[51] [Fig. 5] The results were underwhelming, bordering on the farcical. The project was abandoned after six months, when the family had lowered their monthly energy consumption by only 2.5 per cent and saved a total of 74 SEK, approximately €7.[52] The family reported that the house was 'active' in unexpected ways, reminiscent of the kitchen scene in *Mon Oncle*: the oven was connected to motion sensors and turned off when one left the room, so that one family member had to remain in the kitchen and in motion in order for the oven to work; the system's 'away' switch erased all settings on all electronic equipment of its own accord, and so on. Altogether, these strange malfunctions made life difficult for the inhabitants, who had to adapt their lives to appease the unexpected whims of the smart technology.

The Active House employed technologies that resembled smart home technologies, but control of data and of functions were removed from the tenant, and the technological nightmare of pop cultural portrayals were suddenly very close. Smart housing, again, seems more concerned with disciplining the tenant than with liberating them from chores and unnecessary costs. Even if this is a highly specific case, it is worth noting that the tenant here becomes increasingly dependent not only on the landlord, but also on the landlord's business partners, a relationship over which the tenant does not necessarily have direct influence if the project is implemented on a larger scale.

Stage five: 2015–2017

The Active House is enabled by digital technology and smart equipment integrated into one smart home system, used to create awareness and ultimately behavioural change for a more comfortable and sustainable way of life.[53]

A second, expanded phase of the Active House was initiated in 2015, also in Stockholm Royal Seaport. A special interface, the Tingco panel, was developed and mounted in the hallway of each flat. Via the panel, residents could monitor their electricity, hot water and heat consumption.[54] It also allowed residents to change the temperature and adjust the lighting in the flat. A promotional video for the project shows the male resident cannily lowering both lights and temperature in his flat in preparing to receive a female dining companion.[55] [Fig. 6] The panel was not only marketed primarily to male users, residents participating in the tests also perceived it as a distinctly male gadget.[56] In this sense, it reproduced the gender bias that feminist scholars have critiqued for over thirty years.[57] The project specifically targeted affluent, educated residents, and the logic was that they were likely early adopters and were savvy enough to engage with the technology. The panels were introduced in 154 households in new-build owned and rented housing for the duration of 2017.[58] Anders Nilsson, a researcher involved in the project, explains that residents were recruited for the trial by the property developer or property managers, and tenants embarked on the limited trial upon signing the contract for the flat.[59]

Fig. 5: The test family in the first phase of The Active House. Originally published in *Dagens Nyheter,* 21 March 2013. Photo: Lars Lindqvist.

Fig. 6: Still from *Smart Energy City;* the protagonist buttoning up his shirt before of the arrival of his date. The caption reads: 'Lower the temperature in your flat'. The Tingco panel is visible, out of focus, on the left.

Results were mixed. There was a mean value decrease of 10 per cent in electricity consumption, while mean value hot water consumption increased by 18 per cent compared to a control group.[60] Nilsson notes that these results would not necessarily be stable over time, as novelty value had contributed to augmented use, nor would the results be transferrable to any other setting, as the target group had been selected to have maximum impact. Some households did save energy, primarily singles and couples, whereas families' energy footprint increased. The researchers involved in the project set up two different groups: one was incentivised by reduced costs, and the other was encouraged to live more sustainably. Neither group seemed to reduce their consumption in any substantial way; however, on average, the group incentivised by lower costs saved slightly more than those motivated by ethical concerns.[61] The test was discontinued at the end of the testing period due to a lack of interest from the residents.

A second installation of Tingco panels took place around the same time in fifty-four flats in Valla torg, an existing run-down housing estate owned by a public housing corporation in southern Stockholm in 2017.[62] This was part of the EU-funded programme *Grow Smarter*, for which Stockholm was a 'lighthouse city'.[63] The flats were part of a larger refurbishment of the council estate in which some three hundred flats, mostly inhabited by middle-aged and elderly tenants, were refurbished. The refurbishment led to significant rent increases in the existing housing stock, and tenants formed a protest movement where they occupied a local building to organise their resistance to the refurbishment.[64] The Tingco panels installed here, along with other smart systems – including the weighing and documentation of each flat's household waste – were put in place despite the very loud protests of tenants. The project was ultimately discontinued due to tenants' resistance.[65] When asked, some tenants said they had thrown away the Tingco device as they saw no point to it.

In the different approaches between the flagship development and the existing public housing, a difference between smart housing and the smart home clearly emerges. When housing goes smart, it tends to reinforce social inequality. What is introduced as an interesting gadget for one social group can be understood as a means of surveillance and a tool to raise rents and motivate renoviction by another. Smart housing, in this sense, is far from equal.

Conclusions

Before moving on to my conclusions, I would like to repeat that this article is by no means an exhaustive list of smart housing projects in Sweden. For different reasons, I have omitted several projects: IT-BO (Vällingby & Landskrona, 1993–1999), Diligensen (Gävle, 2000), Vallgossen (Stockholm, 2000), Ringblomman (Stockholm, 2001), BO-IT (Skövde, 2001), Tango (Malmö, 2001), and Sverre (Uppsala, 2001), to name a few. I have also omitted projects directly aimed at digitalising assisted living, which is a field of research closely related to smart housing. In this article, I have favoured projects focused on changing the role of the landlord, and on the transformation of the relationship between tenant and landlord.

What conclusions, then, can be drawn from the projects analysed in this article? What do they tell us about the digitalisation of the dwelling? The first thing to note is that smart housing differs in kind from the smart home, even if the technologies involved are closely related. By moving choice and, to a varying degree, control from the tenant to the landlord (or power supplier), smart technology changes the relationship between tenant and landlord and transgresses the boundaries of the home. While smart home technologies, like digital assistants or smart phones, divulge one's private information to a corporation, that is the individual's choice. In smart housing, one's landlord and their tech partners acquire real-time information about one's habits in an imposed transgression of the sovereignty of the

home. The issue of privacy issue is thus fundamentally different in smart housing than in discussions of the smart home. The outcome where a landlord's power supplier can monitor an individual's activities at home seems especially dystopian in times of geopolitical upheaval where government-owned multi-national power companies function as extensions of the nation states behind them.

A second conclusion is that the digitalisation of the dwelling is a multi-faceted process with different actors starting out with different aims and motives. We are better served by approaching the digitalisation of the dwelling not as a single process, but as several digitalisations converging on the dwelling from different directions. Where the smart home serves the homeowner or tenant, smart housing concerns a range of different actors whose interests intersect in the multi-household residential building. This adds layers of complexity to the digital dwelling as it is now and will be developed in the future, introducing new alliances and new relationships between actors in the construction and management of multi-household residential buildings.

Third, the sequence of smart housing projects in renovations of 1960s housing blocks shows that smart housing remains controversial. As soon as ambitions exceed the bounds of a limited experiment, tenants have resisted the implementation of smart technology, from sabotage through cutting the wires of the Termax thermostat to the squatting of buildings by tenants to protest the upgrading of their homes in Valla torg some thirty years later. It is fair to suggest that tenants generally do not share their landlords' vision of smart housing. The digitalisation of the dwelling may be optional for the homeowner, but it is mandatory for the tenant and is often installed against their explicit wishes.

A fourth point to note is the repeated failure to generate the desired behavioural change in tenants. The emphasis on innovation in the field of anything smart, where the focus is on the future, means that there is an active failure to learn from previous attempts to approach similar problems. As Junestrand and Keijer noted some twenty-five years ago, the problem is not the technology, but that the products and solutions need to connect with the end-users, here the tenants, who often find themselves in the shadow of the technology used and unable to affect it.[66]

A fifth conclusion is that digitalisations of the dwelling differ in its application among different social groups, not only in terms of whether installation is voluntary or not, but also in that the installed equipment serves different purposes. Where the smart home is intended for the homeowner and designed to make their everyday life more efficient and leisurely, smart housing more often aims to optimise housing management and by extension, tenants' interaction with the building's infrastructure. On the rare occasion that a smart housing solution is introduced in a co-op-owned flat or an upmarket rental, the approach is softer, participation voluntary and presented as an experiment for a limited time, rather than a permanent fixture; the different ways of introducing the Tingco panels in the affluent Stockholm Royal Seaport and the run-down housing blocks around Valla torg illustrate this. In this sense, there are different digitalisations for different socio-economical groups that mean different things. Digitalisation offers the homeowner convenience and leisure, and surveillance is a hypothetical risk, while the tenant comes under direct surveillance, often by their own landlord, and is in many cases expected to live their life in specific ways. In the first case, personal data is used to sell the homeowner things, in the second, it is employed to (micro)manage the life of the tenant. This type of micromanagement echoes the control of Amazon's warehouse workers and workers in the gig-economy at large, and as a development, it is permeating more workplaces and home offices in the post-pandemic world.[67] Perhaps the future of the digital dwelling is more about learning to appease motion sensors than the vision of a homeowner of the future luxuriating in their smart home.

Notes

Every effort has been made to obtain authorisation for the use of all copyrighted material in this article. We apologise for any inadvertent omissions and would be pleased to insert the appropriate acknowledgment in the digital edition of this publication.

1. Lynn Spigel, 'Designing the Smart House: Posthuman Domesticity and Conspicuous Production', *European Journal of Cultural Studies* 8, no. 4 (2005): 403–26.
2. Stefan Junestrand and Ulf Keijer, 'Bostaden i informationssamhället: Ett arkitekturperspektiv', in *Informationsteknologi i projektering och förvaltning* (Stockholm: KTH, 1998), 13; my translation.
3. Examples include: Deborah Chambers, *Changing Media, Homes and Households: Cultures, Technologies and Meanings* (London: Routledge, 2016); Frances K. Aldrich, 'Smart Homes: Past, Present and Future', in *Inside the Smart Home*, ed. Richard Harper (London: Springer, 2003), 17–39. Others speak of the smart house, where the focus is on telecommunication capabilities; see Spigel, 'Designing the Smart House'. Even broader overviews of the social effects of digitalisation tend to focus on the private home and the public spaces of the city, omitting housing. See, for instance, Stephen Graham and Simon Marvin, *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition* (London: Routledge, 2001).
4. Anne-Jorunn Berg, 'The Smart House as a Gendered Socio-Technical Construction' (Trondheim: Centre for Technology and Society, University of Trondheim, 1992), https://www.ntnu.no/c/document_library/get_file?uuid=b77e6da1-2511-4d43-a390-33d61b378e28&groupId=10265; Anne-Jorunn Berg, 'Technological Flexibility: Bringing Gender into Technology (or Was It the Other Way Round?)', in *Bringing Technology Home: Gender and Technology in a Changing Europe*, ed. Cynthia Cockburn and Ruža Fürst-Dilić (Buckingham: Open University Press, 1994), 94–110.
5. There is a growing body of literature focused on smart housing from a perspective of platform capitalism; this literature focuses on contemporary conditions, not historical accounts. See, for instance, Sophia Maalsen, 'Smart Housing: The Political and Market Responses of the Intersections between Housing, New Sharing Economies and Smart Cities', *Cities* 84 (1 January 2019): 1–7; Sophia Maalsen, '"We're the Cheap Smart Home": The Actually Existing Smart Home as Rented and Shared', *Social and Cultural Geography* 24, no. 8 (2023): 1383–1401; Desiree Fields, 'Automated Landlord: Digital Technologies and Post-Crisis Financial Accumulation', *EPA: Economy and Space* 54, no. 1 (2019): 160–81; Desiree Fields and Dallas Rogers, 'Towards a Critical Housing Studies Research Agenda on Platform Real Estate', *Housing, Theory and Society* 38, no. 1 (2021): 72–94.
6. I build here on a study mapping Swedish housing with landlord-installed technology to manage their relations with tenants. Since this subject has not been researched widely, my study relies on a form of snowball sampling within six different archives and databases: 1) The archive of Byggforskningsrådet (The Building Research Council), a national construction-research-oriented institution that published reports on all research relating to construction until the council was disbanded in 2000. 2) The archive of reports from abroad by the Swedish science attachés at embassies around the world. These reported on developments in other countries, including early smart housing experiments in other European countries, and provide both terminology and a sense of when novel developments occurred. 3) The archive of the Institute for Futures Studies (formerly the Secretariat for Futures Studies), which conducted speculative research aiming to anticipate effects of computers on daily life in the early 1980s. 4) The archive of daily and professional press (using Media Retriever and the Royal Library's database). 5) Broader library and research catalogues (Royal Library and DiVA) to capture research that falls outside of the narrow focus of Byggforskningsrådet. 6) The database of the Swedish Intellectual Property Office for information about patents taken out for specific technological devices developed for smart housing purposes.

7. Sweden has also collaborated with other European nations, notably France, on similar programmes. See Bachir Mekibes, *Informationsteknologi i vardagslivet: Franska erfarenheter i svenskt perspektiv* (Stockholm: KTH, 1994).
8. According to public statistics, 58 per cent of dwellings in multi-household buildings are currently rented. In 257 of a total of 290 municipalities, rental housing is the dominant form of tenancy in multi-household buildings. Public housing corporations own 26 per cent of all multi-household building dwellings. SCB, 'Nästan 5,1 miljoner bostäder i landet', Statistiska Centralbyrån, 2022, http://www.scb.se/hitta-statistik/statistik-efter-amne/boende-byggande-och-bebyggelse/bostadsbyggande-och-ombyggnad/bostadsbestand/pong/statistiknyhet/bostadsbestandet-31-december-2021/.
9. There are partial mappings, notable among which are Lennart Berndtsson's mapping of individual metering of heating and hot water, and later publications by Boverket, as well as mappings by researchers like Simon Siggelsten, although these focus on individual measuring and billing rather than the use of IT in the process. A better example is perhaps Anna Hrdlicka's interviews with public housing developers engaged in smart housing projects around the year 2000. See Lennart Berndtsson, 'Individuell värmemätning i svenska flerbostadshus' (Stockholm: Statens energimyndighet, 2003); Lennart Berndtsson, 'Individuell mätning av värme och varmvatten i flerbostadshus' (Karlskrona: Boverket, 2005); Boverket, 'Individuell mätning och debitering i befintlig bebyggelse' (Karlskrona: Boverket, 2015); Simon Siggelsten and Stefan Olander, 'Individual Metering and Charging of Heat and Hot Water in Swedish Housing Cooperatives', *Energy Policy* 61 (1 October 2013): 874–80; Simon Siggelsten, *Individual Metering and Charging of Heat and Hot Water in Multi-Apartment Buildings* (Lund: Lund University, 2015); Anna Hrdlicka, *Den breda vägen: Vision – verklighet – vision: En betraktelse över bredband och bredbandstjänster i boendet i Sverige under 1990-talet* (Stockholm: Institutet för framtidsstudier, 2004).
10. Sigfried Giedion, *Mechanization Takes Command: A Contribution to Anonymous History* (Minneapolis: University of Minnesota Press, 2013).
11. Reyner Banham, *The Architecture of the Well-Tempered Environment* (London: The Architectural Press, 1969), 15–16.
12. Rem Koolhaas, James Westcott, and Stephan Petermann, eds., *Elements of Architecture* (Milan: Marsilio, 2014).
13. While there have been various uses of the term 'smart' since the 1980s, the notion of a 'smarter city' was introduced in 2011 by IBM, while the 'smart home' was introduced in 1984 by the National Homebuilder's Association. Germaine Halegoua, *Smart Cities* (MIT Press, 2020); Frances K. Aldrich, 'Smart Homes: Past, Present and Future', in *Inside the Smart Home*, ed. Richard Harper (London: Springer, 2003), 17–39.
14. Rem Koolhaas, 'The Smart Landscape: Intelligent Architecture', *Artforum* 53, no. 8 (2015): 212–17. Koolhaas extrapolates his ideas about smartness from the research in preparation for the *Elements of Architecture* exhibition a year prior.
15. The more prominent works that do engage with smartness include: Justin McGuirk, 'Honeywell, I'm Home! The Internet of Things and the New Domestic Landscape', *E-Flux*, April 2015, https://www.e-flux.com/journal/64/60855/honeywell-i-m-home-the-internet-of-things-and-the-new-domestic-landscape/; Sergio M. Figueiredo, Sukanya Krishnamurthy, and Torsten Schroeder, *Architecture and the Smart City* (Abingdon: Routledge, 2020); Antoine Picon, *Smart Cities: A Spatialised Intelligence* (Chichester: John Wiley & Sons, 2015); Orit Halpern, Robert Mitchell, and Bernard Dionysius Geoghegan, 'The Smartness Mandate: Notes toward a Critique', *Grey Room* 68 (September 2017): 106–29.
16. Rem Koolhaas and Kayoko Ota, eds., *AMO Post-Occupancy* (Milan: Domus d'Autore, 2006); Ila Bêka and Louise Lemoine, *Koolhaas Houselife* (Bêka & Lemoine, 2008).
17. The difficulty of pinpointing a starting point is apparent in the very title of one of the publications

in CCA's research programme Archaeology of the Digital: Andrew Goodhouse, ed., *When Is the Digital in Architecture?* (Montréal: CCA, 2017).

18. Examples include: the 'psychotropic house' in J.G. Ballard's story 'The Thousand Dreams of Stellavista', in Ballard, *Vermilion Sands* (New York: Berkley, 1971) and Jacques Tati, dir., *Mon Oncle* (Specta Films, 1959). Positive projections of the future home include the exhibitions of Ugo la Pietra's 'Casa Telematica', see Hans Teerds, 'La Casa Telematica Milan (IT): Ugo La Pietra', *DASH | Delft Architectural Studies on Housing* 11 (2015): 136–41, the House of the Future by Peter and Alison Smithson for the *Daily Mail* (1956); see Dirk van den Heuvel, *Alison and Peter Smithson: A Brutalist Story Involving the House, the City and the Everyday (plus a Couple of Other Things)* (Delft: TU Delft, 2013); Beatriz Colomina, 'Unbreathed Air 1956', *Grey Room* 15 (2004): 28–59. Going back even further, we find the Dymaxion House by Buckminster Fuller (1927) and Le Corbusier's L'Esprit Nouveau pavilion (1925).
19. Roy Mason, Lane Jennings and Robert Evans, *Xanadu: The Computerized Home of Tomorrow and How It Can Be Yours TODAY!* (Washington, DC: Acropolis Books, 1983).
20. Chambers, *Changing Media, Homes and Households*, 155.
21. At the time, the *New York Times* wrote: 'intelligent in this case means that each building's services will be orchestrated by a computer system and linked by a fiber-optic network – a trademarked system called a "Data Highway" – running through its core. Functions such as heating, ventilation, lighting, transportation, security, fire protection and, most important, telecommunications and electronic office services will be integrated, providing economies in construction and management.' Steven J. Marcus, 'The "Intelligent" Buildings', *The New York Times*, 1 December 1983; Ronald Fernandez, *Excess Profits: The Rise of United Technologies* (Boston: Addison-Wesley, 1983); Thomas Fisher, 'Intelligent Architecture', *Progressive Architecture* (May 1984): 167–72. The intelligent building discourse was introduced in Sweden on a broader level in the early 1990s: Anders Ewerman, *Intelligenta hus: state of the art 1992* (Stockholm : Statens råd för byggnadsforskning, 1992); Arne Rejdin, *Fastighetsförvaltning med användning av informationsteknologi* (Stockholm: Byggforskningsrådet, 1994).
22. Smart housing as a concept has different definitions. While the smart home and the intelligent building were defined by corporations or corporate interest groups with a client in mind, smart housing as a concept has no intended buyer, but is rather an analytical category used by researchers. The definition of smart housing I propose here is that smart housing is marked by the convergence of smart technology (computerised meters and sensors installed by the landlords in the flats of the tenants to help manage their relationship with the tenant) and housing. Another definition is proposed by Sophia Maalsen, who investigates the intersection of smart technologies and the housing market. Maalsen, 'Smart Housing', 1.
23. Spigel, 'Designing the Smart House', 421.
24. From the early period, these include: IT-BO (Vällingby & Landskrona, 1993–1999), Vallgossen (Stockholm, 2000), Ringblomman (Stockholm, 2001), BO-IT (Skövde, 2001), Tango (Malmö, 2001), Sverre (Uppsala, 2001), Diligensen (Gävle, 2000). After 2010, there is a sharp increase in projects of this kind as micro controllers have become more accessible and easier to programme.
25. In 1985, the public housing corporations owned approximately 37 per cent of all dwellings in multi-household buildings (excluding single family homes – *lägenheter i småhus* – from the statistics). SCB, *Statistisk Årsbok 1990: Statistical Abstract of Sweden*, Statistisk årsbok för Sverige (Stockholm: SCB, 1990), 121, https://share.scb.se/ov9993/data/historisk%20statistik//SOS%201911-/Statistisk%20%C3%A5rsbok%20(SOS)%201914-2014/Statistisk-arsbok-for-Sverige-1990.pdf.
26. Rune Buresten et al., *Datoriserade styr-, regler- och övervakningssystem utrustning för AB Göteborgshems värmeförsörjning på Hisingen i*

Göteborg (Stockholm: Statens råd för byggnadsforskning, 1981), http://hdl.handle.net/2077/46411; Värmemätningsutredningen, 'Mätning och debitering av varmvatten: Principbetänkande från värmemätningsutredningen' (Stockholm: Liber Förlag, 1983).

27. Simon Siggelsten and Bengt Hansson, 'Incentives for Individual Metering and Charging', *Journal of Facilities Management* 8, no. 4 (2010): 299–307.
28. Norbert Wiener, *Cybernetics or Control and Communication in the Animal and the Machine* (Cambridge, MA: The MIT Press, 1948), 96.
29. Sven Hedly, 'Sätt och anordning för styrning av temperaturen i uppvärmbara lokaler', Swedish Patent Database, Patent SE 8002576-0, SE 435974, PRV SE 8002576-0 (Lerum, filed 3 April 1980, and issued 29 October 1984).
30. Göteborgsposten, 'Snillrik elektronisk apparat ger varje lägenhet sin värme', *Göteborgsposten*, 22 May 1984.
31. Ibid.
32. Berndtsson, 'Individuell värmemätning', 69–70.
33. Compare with Gilles Deleuze's discussion on cybernetics in 'dividuals' and 'dividuation'. Deleuze contrasts the individual who is indivisible with the dividual, who is made separate and no longer part of a group through the use of technology that functions like a gas, filling the space between people. Gilles Deleuze, 'Postscript on the Societies of Control', *October* 59 (1992): 3–7.
34. This is an extremely brief summary of a complex chain of events. For a more detailed overview, see: Boverket, 'A History of the Swedish System of Non-Profit Municipal Housing' (Karlskrona: Boverket, 2008); Karin Grundström and Irene Molina, 'From Folkhem to Lifestyle Housing in Sweden: Segregation and Urban Form, 1930s–2010s', *International Journal of Housing Policy* 16, no. 3 (2016): 316–36.
35. In the following, I skip over one of the most-discussed examples of smart housing in Sweden, IT-Bo, conducted in Stockholm in the mid-1990s. Because the project seems to have been conducted principally as an experiment, without any clear landlord-initiated agenda, I omit it from this study. For more on this project, see: Magnus Hunhammar, *Utveckling av IT-baserad boendeservice: Ett design-teoretiskt perspektiv* (Stockholm: KTH, 1998). For an overview of smart projects from these years in public housing, see: Hrdlicka, *Den breda vägen*. Privately initiated smart new-build projects at this time have been analysed in Greger Sandström, *Smarta hem: köpmotiv och nytta* (Stockholm: KTH, 2003).
36. Hrdlicka, *Den breda vägen*, 75.
37. Håkan Boström, 'De bor i Sveriges första IT-hyreshus', *GT/Expressen*, 16 September 2000; Malin Clausson, 'Uttag överallt: utom på toa', *Göteborgsposten*, 6 September 2000; Ola Nylander, '"IT-huset": är det framtidens bostad?', *GT/Expressen*, 6 July 2000.
38. H-J Håkansson, 'Poseidon bygger för ett fåtal', *Göteborgsposten*, 11 January 2000; Lena Larsson, 'Poseidon bygger för alla', *Göteborgsposten*, 18 January 2000.
39. This system was developed by Gothenburg-based KTC.
40. Berndtsson, 'Individuell värmemätning', 71.
41. Ibid.
42. Kjell Löfberg, 'Smarta hus en rejäl flopp', *Dagens Nyheter*, 28 February 2004.
43. Gunilla Skoog, 'Ny dator kan spara vatten och elektricitet', *Göteborgsposten*, 9 November 2007.
44. This experiment was expanded in a second stage 2009, when another ninety-four flats were fitted with Sboxes, and it appears to have been included in the lifestyle concept Next Step Living, an early co-living experiment conducted by Bostadsbolaget in 2010.
45. Elina Blom, 'Sbox: En guide till ett smartare hem', *M3*, 15 December 2009, https://m3.idg.se/2.1022/1.279236/sbox--en-guide-till-ett-smartare-hem.
46. Manodo, 'Manodo SBox sköter kommunikationen i Bostadsbolagets nya boendekoncept', 10 September 2010.
47. Private email correspondence with Bostadsbolaget, 2022.
48. Fortum et al., 'Stockholm Royal Seaport, Urban Smart Grid Pre-Study (Final Report Summary)',

2011, 18; Sarah J. Darby, 'Smart Technology in the Home: Time for More Clarity', *Building Research & Information* 46, no. 1 (2018): 140–47.

49. Corporations included in the first stage of the Active House involved: Fortum, ABB and Electrolux in cooperation with developers, researchers, and the National Energy Agency. Fortum et al., 'Urban Smart Grid Pre-Study'.
50. For the background of the development project, see Jon Loit, *En stad i världsklass: Hur och för vem? En studie om Stockholms sociala stadsplanering* (Uppsala: Uppsala universitet, 2014).
51. Lisa Näs, 'Deras lägenhet är ett forskningsprojekt', *Dagens Nyheter*, 21 March 2013.
52. Helen Ahlbom, 'Smarta fiaskot för prestigebygget i Norra Djurgårdsstaden', *Ny Teknik*, 14 February 2015, https://www.nyteknik.se/nyheter/smarta-fiaskot-for-prestigebygget-i-norra-djurgardsstaden-6336033.
53. Fortum et al., 'Smart Energy City: Final Report – Stockholm Royal Seaport' (Stockholm, 2018), 19.
54. I use the word resident here as this project involved both rented and co-op-owned flats. In Stockholm Royal Seaport, the building was heated by water-based district heating, which meant heating was shown at the building level rather than at household level. Anders Nilsson et al., 'Smart Homes, Home Energy Management Systems and Real-Time Feedback: Lessons for Influencing Household Energy Consumption from a Swedish Field Study', *Energy and Buildings* 179 (15 November 2018): 17.
55. ABB Sverige, *Smart Energy City: Ett unikt forskningsprogram för energianvändning i smarta städer*, 2016, https://www.youtube.com/watch?v=LrRzf34WElY.
56. Nilsson et al., 'Smart Homes', 21.
57. See: Berg, 'The Smart House as a Gendered Socio-Technical Construction'; Berg, 'Technological Flexibility'.
58. Of these, eighty-two were co-op-owned flats and seventy-two were rented. The project was divided into two separate parts; Active House was one part and the other focused on the power grid itself. See Fortum et al., 'Smart Energy City: Final Report'.
59. Nilsson et al., 'Smart Homes', 17.
60. Ibid., 23.
61. Ibid.
62. Grow Smarter, 'D5.4 Final Report on Results of Technical and Social Validation' (European Union, 2019), https://grow-smarter.eu/fileadmin/editor-upload/Reports/GrowSmarter_Validation.pdf.
63. Grow Smarter was an EU-funded Horizon 2020 project that ran from 2015 to 2019, involving 'lighthouse cities' like Stockholm, Barcelona, and Cologne. It consisted of several projects in Stockholm and elsewhere. See European Commission, 'GrowSmarter Project: Fact Sheet H2020', CORDIS, 2020, https://cordis.europa.eu/project/id/646456.
64. Jessica Ritzén, 'Hyresprotesterna på Valla torg fortsätter', *Dagens Nyheter*, 9 November 2015.
65. Stockholmshem, 'Års- och hållbarhetsredovisning 2019' (Stockholm: Stockholmshem, 2019).
66. Junestrand and Keijer, 'Bostaden i informationssamhället', 13.
67. Workplace monitoring seems to be rapidly spreading to new arenas, and we may be facing a situation where different types of housing increasingly become the objects of surveillance. Christopher Mims, 'The Way Amazon Uses Tech to Squeeze Performance Out of Workers Deserves Its Own Name: Bezosism', *Wall Street Journal*, 11 September 2021, https://www.wsj.com/articles/the-way-amazon-uses-tech-to-squeeze-performance-out-of-workers-deserves-its-own-name-bezosism-11631332821; Danielle Abril and Drew Harwell, 'Keystroke Tracking, Screenshots, and Facial Recognition: The Boss May Be Watching Long after the Pandemic Ends', *The Washington Post*, 24 September 2021, https://www.washingtonpost.com/technology/2021/09/24/remote-work-from-home-surveillance/.

Biography:

Fredrik Torisson is a post-doctoral researcher at the Institute for Urban Research at Malmö University. His research can be placed within the fields of architectural and urban history and architectural theory. He is particularly interested in the intersections of material, financial, technological, legal, social, and ideological aspects of architectural production.

Rethinking Autonomous and Robotic Systems in Residential Architecture: Assessing the Motivations and Values of Home Automation

Sotirios Kotsopoulos and Jason Nawyn

Our story begins at the turn of the twenty-first century when enthusiasm for all things digital reached a crescendo. Within our modern Western industrialised context, a pervasive sense of optimism surrounded the development of 'smart' technologies, digitally enhanced replacements for earlier products of industry and craft. This exuberance was especially strong at the Massachusetts Institute of Technology (MIT), where we, the authors, found ourselves compelled by a vision of digital futurism that promised nothing short of liberty and prosperity for all.[1] Indeed, the digital revolution had swept through the Departments of Architecture and Media Arts and Sciences, and it would appear irresponsible not to participate in the exploration (and exploitation) of its potential.

Of course, architecture has always been subject to the winds of technological change. Every technological epoch, beginning with the stone age, has influenced how humans construct and conceive shelter; the twentieth century marked a particular acceleration of technological encroachment into architectural theory and practice. Architects like Adolf Loos and Le Corbusier dismissed ornamentation and favoured pure forms that could be perceived day or night, thanks to the invention of electric light.[2] Architectural form was abstracted and decontextualised from local culture to find its expression in the timeless, universal forms of geometry.

Industrial materials like concrete, glass, and steel, along with new universal means of production enabled radical changes in building design and construction. Large window openings supplied ample natural light, air, and view into building interiors, and the electric elevator enabled the creation of high-rise structures, radically changing the urban setting. Walter Gropius and Ludwig Mies van der Rohe enthusiastically embraced these developments. Mies van der Rohe believed that new materials and technologies could help architects to fulfil their social mission: 'We do not need less, but more technology; we do not need less science, but more intelligent science, not less but more mature economic initiatives.'[3]

Le Corbusier's aphorism that the 'home is a machine for living' characterises the modern era. It reflects a fascination with efficiency, reducing design to problem-solving, where proper analysis of function and precise metrics guarantee good results. Engineers are believed to work based on immutable physical laws, distinct and separate from the complex and nuanced reality of human experience. The mid-twentieth-century architecture was an expression of a society organised around technological progress to which everything else had to be subordinated. David Watkin notes that it gradually became essential for architecture to keep 'up to date' and even, where possible, anticipate the future. Buildings started receiving praise not for their quality or imagination but as technological achievements. The architect's role has changed from a person of education, taste and imagination responsible for 'raising our spirits' to an agent through which 'a material problem is resolved'.[4]

Unsurprisingly, this twentieth-century fascination with the mechanical evolved into a

twenty-first-century obsession with the digital. Today, we witness the proliferation of digital computing, an eruptive body of techniques, networks, and infrastructures that transform human behaviour. Nicholas Negroponte's declaration that 'computing is not about computers anymore, it is about living' has become an actuality.[5] Residential architecture could not remain unaffected. In the coming years, efforts to facilitate the digital augmentation of homes will continue alongside similar developments in other sectors, such as the automotive and consumer electronics industries.

Two decades into our journeys to this future, we now pause to reconsider some of the assumptions driving our prior work on computationally augmented homes. We will examine and contemplate the implications of this work, aiming to reach conclusions about which aspects of digitalisation are best incorporated into architectural design and which may prove out of scope. In many ways, the history of architecture parallels the history of technology. Designers of buildings and designers of technology are frequent (if unintentional) collaborators in authoring new narratives about everyday life and the future. Sometimes this collaboration is explicit, as in the production of concept homes to illustrate future lifestyles brought forth by technological innovations with impactful potential.

Early prototype houses

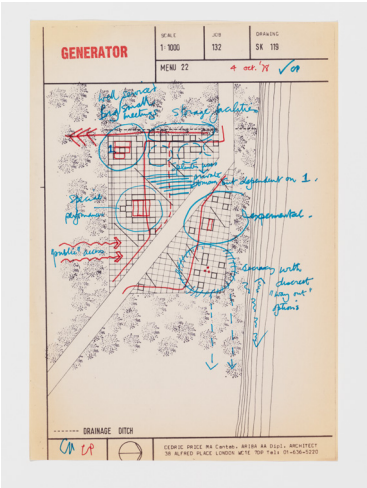
The earliest concept homes were built or sponsored by electric appliance manufacturers for advertisement purposes. While these began popping up in the early twentieth century, the most famous examples date to the 1950s. One of these, the Monsanto House of The Future was an attraction at Disneyland, California, in 1957–67.[6] The 120m^2 moulded plastic house was designed by architects Richard Hamilton and Marvin Goody and built by MIT and Monsanto Chemical Company. Monsanto wanted to demonstrate plastic's versatility as a high-quality, engineered material. The house's futuristic fibreglass components were moulded in the factory and assembled on-site. The house was an imaginative projection of what domestic life might look like in 1986. It featured a lot of electric appliances, large-screen video displays, microwaves, and dishwashers that would eventually become commonplace in homes. [Fig. 1]

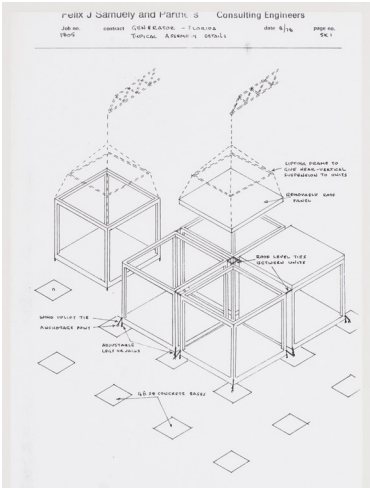
Another House of the Future was presented at the *Daily Mail Ideal Homes Exhibition* in London in 1956. It was designed by architects Alison and Peter Smithson as a full-scale mock-up projecting how a conventional suburban home might be in the year 1981.[7] Designed around an atrium that supplied natural light and private outdoor space, the house interior was enclosed, without windows to the public street. [Fig. 2] What they called 'wired acoustics' was the only way it interacted with the outside world. The line between commodity and fiction was deliberately blurred. Existing pieces of technology such as a Tellaloud loud-speaking device, kitchen appliances, a closet to dry clothes, and a washing machine were presented alongside imagined devices like after-shower body air-dryers and telephone message recorders.

Other experimental indoor spaces, such as Cedric Price's Generator Project (1976–79), were more conceptual.[8] The Generator was designed to serve as a retreat and activity centre for small groups and sought to create conditions for dynamic interactions in a reconfigurable and responsive architectural environment. [Fig. 3] Price developed a scheme of one hundred and fifty 3.6m x 3.6m mobile, combinable cubes constructed with off-the-shelf infill panels, glazing, and sliding glass doors. The parts could be moved by mobile crane on an orthogonal grid of foundation bases as desired by users to support their activities. 'The whole intention of the project was to create an architecture sufficiently responsive to the making of a change of mind constructively pleasurable', Price explained.[9] The Generator aimed to shift the roles of designers and users, questioning who and what was responsible for interactions and challenging the performance and formal expression of architecture.

Fig.1: Monsanto Plastics Home of the Future, designed by Richard Hamilton and Marvin Goody, Disneyland, 1957. Photo: Corbis, *Wired*, June 2009.

Fig. 2: House of the Future, designed by Alison and Peter Smithson, Daily Mail Ideal Home Exhibition, London, March 1956. Unknown photographer. Source: Canadian Centre for Architecture, Montréal.





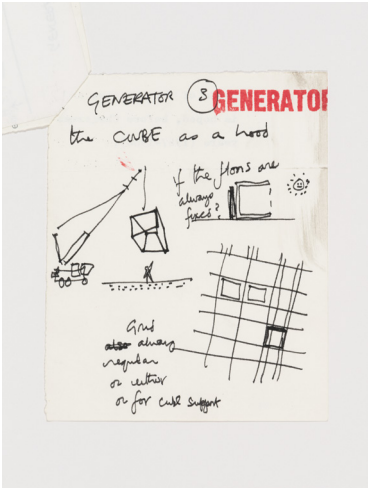


Fig. 3: The Generator, designed by Cedric Price. Site plan, axonometric of assembly principles, and sketch showing frames and grid foundation pads. Source: Cedric Price Fonds, Canadian Centre for Architecture, Montréal.

Digital prototypes

The aforementioned concept homes were largely analogue in character, reflecting the state of the art in the middle of the twentieth century. However, advancements in digital computing rapidly led to a rewriting of the future home concept, where architecture is a platform for an ever-changing array of digitally augmented experiences.

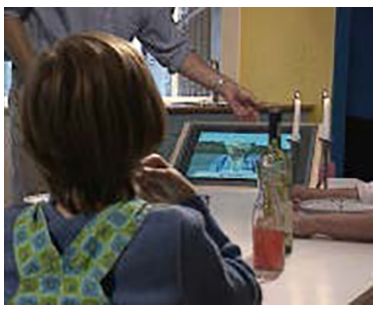
'Ubiquitous computing' is the term coined by Mark Weiser for his vision of the future, where embedded microprocessors with limited computing power populate everyday objects to make them easy to track and perform simple tasks without direct user interaction.[10] Ubiquitous computing devices are network-connected and constantly operating in the background, using processing power hidden in a network. As devices grow smaller, more connected, and integrated into the physical environment, says Weiser, the technologies will disappear and 'weave themselves into the fabric of everyday life until they are indistinguishable from it', making computing an integral, invisible part of people's lives.

Along these lines, Daniel Cook et al. define 'ambient intelligence' (AmI) as a class of ubiquitous components that are: embedded, integrated into the physical environment; context-aware, able to recognise users and their situational context; personalised, tailored to user needs; adaptive, able to change states in response to users' needs; and anticipatory, able to anticipate user needs without direct input.[11] AmI systems can involve AI agents to perform autonomously, depending on the detected needs and user input or recommendation systems interpreting the user's state and habits and initiating a response.[12]

These visions serve as the foundation for more recent home prototypes. For example, the Adaptive House, implemented by the University of Colorado, is an early neural network home experiment.[13] [Fig. 4] In this home, an autonomous control system manages basic comfort systems like air and water heating, lighting and ventilation, and by tracking the inhabitants' preferences, it learns to cater to their needs. The ComHome (1999), developed by the Interactive Institute of Sweden, was an apartment equipped with video-mediated communication, in which researchers tested modalities of home-based activity such as communication, remote work and social interaction.[14] [Fig. 5] The Aware Home, developed by the Georgia Institute of Technology, was a suburban house based on the 'living lab' and ubiquitous computing concepts.[15] [Fig. 6] The house was aware of itself and the activities of its inhabitants by maintaining continuous high-speed connectivity through cameras, microphones, and sensors. A wireless network enabled communication among devices, and a radio-locating system tracked tagged everyday objects.

The sensing infrastructures underlying these concept homes could be deployed in conjunction with robotic actuators to modify the physical space. Robotic systems are already being promoted in the building construction industry,[16] and integrating robotics in envelopes and interiors could lead to adaptable buildings that address particular needs in sustainability and occupant comfort. In this vein, a preliminary application is Agata Bonenberg's kitchen for parallel use by people with and without mobility problems featuring mobile gesture-controlled modules, enabling plumbing and kitchen adjustment.[17] Likewise, Wada Kazuyoshi et al. describe a multipurpose robotic module for people with disabilities, which can cook, store electric appliances, cooking tools, and tableware, and transform into a dining table.[18]

Each of these prototypes represents a research lineage of over two decades, yet there is no clear consensus over if, when, why, and how to integrate autonomous sensing and actuation systems into residential architecture. Some moderately advanced technologies, including robotic vacuum cleaners, smart speakers, and motion-sensing security cameras, are already gaining acceptance in homes. Their cost is not low, but homeowners embrace them. What about more advanced and expensive robotic options? What if intelligence is



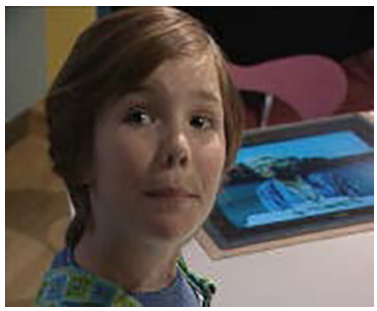


Fig. 4: The Adaptive House, circa 1999. Photo: Mike Mozer.

Fig. 5: The ComHome. A videoconferencing device, Torso, for informal everyday communication and a ComTable for video-mediated communication in a dinner situation. Photos: Stefan Junestrand and Konrad Tollmar.

more seamlessly integrated into the fabric of the home? How do concerns about the future adaptability of spatial distribution influence decisions about integrated home technologies? Moreover, who should decide what technology is brought into the home? Is it the homebuilder? The architect? The homeowner or occupant? We shall consider these questions through a review and contemplation of three ambient intelligence projects in residential architecture designed and implemented by ourselves and colleagues at MIT over the past twenty years.

Case studies

We present three case studies: a Connected Sustainable Home (CSH) aiming at adaptive sustainability, the PlaceLab, a living laboratory for studying health-related home systems, and the CityHome, a series of robotically transformable apartment prototypes. These projects were not conceived of as visions of future technologies that could or should be broadly adopted in the real world. Hence, they are not discussed in such a light now. In truth, they embody a complex network of political, technical, and design choices that, more often than not, are determined by agents beyond the researchers or the architects themselves. Nonetheless, we believe they provide a reasonable basis for discussing design criteria for autonomous systems in residential architecture.

The Connected Sustainable Home

The connected sustainability concept aspires to a vision of dynamic resource management to achieve sustainability in the spirit of the early farm communities. Various energy production, storage, and control systems operate within homes connected to a network to exchange information, manage the community's resources, and allow for dynamic energy sharing and pricing.

The CSH prototype was a testbed for connected sustainability developed by the Design Lab at MIT and the Fondazione Bruno Kessler in Trento, Italy, from 2009 to 2013. Although the project aimed to minimise home energy consumption and maximise comfort, the vision of connected sustainability was akin to broader economic, social, and cultural objectives. Local materials, companies, and building technologies were engaged in the project. The local economy, culture, and living habits were acknowledged in the design. Another goal was to provide an environmentally sensitive mode of building an original tectonic vocabulary aligned with technological innovation. Along these lines, the CSH integrated low-tech and high-tech systems to facilitate management of resources, to reduce performance uncertainty, and to provide intuitive interactions between residents and systems. [Fig. 7]

The CSH is a single-floor, free-standing suburban house with an open-plan layout, ample loft space and an open-view curtain wall facing south. Fixtures organise interior functional zones for living, sleeping, eating, and a patio area. The partitioning is adaptable; the loft can be converted into a temporary bedroom for visitors or a workspace with dividers adjusted manually.

There are four house systems: a) a high thermal mass envelope and base, b) a programmable, robotic solar wall, c) a cogeneration energy production plant, and d) a distributed control system fine-tuning the operation of all the above. Building physics governed many design decisions. A custom simulator computed the envelope's performance based on the features of the materials and the local seasonal conditions. Humidity, illuminance, temperature, thermal comfort and weather information, including statistical data and data produced by simulation, informed the design. Alternative design schemes and combinations of materials were explored through simulation and evaluation.

The plan and section of the CSH reflect energy management concerns. A high thermal mass envelope facing north is placed back-to-back with a programmable, robotic façade facing south. The high thermal mass envelope secures high thermal resistance and low conductivity to sustain heat

Fig. 6: Georgia Tech's Aware Home Research Initiative (1999). Photo: Georgia Tech.

during the winter and prevent excessive heat during the summer. The programmable façade is a matrix of robotically actuated, independently openable windows enabling precise air, visibility, sunlight and solar heat modulation in the interior as needed.

The interior of the CSH would have been unpleasant and energy-intensive without intelligent environmental management. Forcing the residents to perform this management by manually operating the house systems would have been inefficient – integrating a model-based autonomous control that constantly works in the background made human involvement optional. The control compiles data about the weather, temperature and light, the state of the envelope and the programmable façade, the occupants' activities and the energy production system to calculate a predictive plan of operation for all house systems. The plan maximises comfort at a minimum energy cost by setting the tectonic elements to perform and appear variously in response to exterior conditions, preferences, or residents' activities.

Beyond being regulatory, the programmable façade is an expressive tectonic system. Colourful house façade murals engage the eye; this is a traditional decorative practice in Trentino. The dynamic transformation of the pattern, distribution, and degree of chromatism on the robotic façade has a similar effect. Various patterns based on degrees of window chromatism applying to the façade maintain the desired level of illuminance, solar radiation, and visibility in the interior. A visual algorithm generates a façade pattern language in real time based on illuminance and symmetry and dynamically transforms how the public street perceives the house.[19]

The high thermal mass envelope – covering the north, east and west – is made from X-laminated panels, a renewable material produced in Trentino, boosting the local economy. A double layer of fibre gypsum and fibre wood panels of different densities secure thermal and acoustic insulation. The north, east and west walls are 720 mm thick, providing high heat transmission resistance. A theoretically calculated value U = 0.150 W/m^{2}K for the roof and the walls indicates that the envelope performs as a passive structure. [Fig. 8]

The south façade is a matrix of robotic windows. Each window integrates an overlay of two electrosensitive materials, an electrochromic coating regulating natural light and thermal performance and a PDLC (polymer-dispersed liquid crystal) film regulating visibility and view. Each window is driven by its low-level controller, and the house control manages the entire robotic façade.

The CSH is powered by a cogeneration heat and power plant (CHP) using solar energy and a conversion system. A custom-made solar-driven cooling and heating machine uses thermal energy stored in microporous material regenerated by solar thermal collectors. A low-level controller monitors the states of the system components under variability of load, seasonal effects, daily effects and user profiles, exchanging data with the house control and realising an adaptive energy production system.

The responsiveness of the CSH relies on control, sensing and actuation networks, aiming at comfort, sustainability, and convenience. Comfort is achieved by letting the residents set their temperature and illuminance preferences, sustainability by minimising energy consumption, and convenience by minimising the user's effort to reach the two previous goals. The three goals are realised through goal-directed planning. Predictive fine-tuning of the air conditioning, the robotic windows and the passive envelope's thermal conservation state secures the servicing of the interior atmosphere at a minimum energy cost.[20] The control operates in a stochastic domain. A probabilistic guarantee that the resident's comfort constraints will not be violated is secured by acknowledging the sources of uncertainty and planning accordingly. This is referred to as risk-sensitive planning.[21]

Schedule and comfort preferences are encoded as time-evolved goals in a chance-constrained qualitative state plan (CCQSP). Time-evolved goals are constraints placed on the system's state jointly with

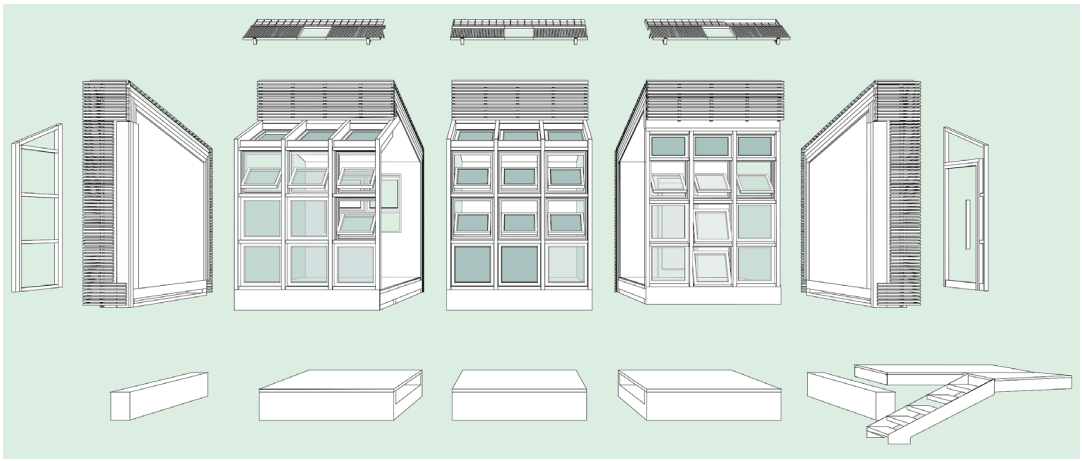


Fig. 7: The CSH prototype in Trento, Italy, 2012. Photo: MIT Design Lab.

Fig. 8: Axonometric diagram of the passive and dynamic components of the CSH envelope. Image: MIT Design Lab.

temporal information describing their timeframe, like: 'maintain a sleep temperature until it's time to wake up' or 'maintain room temperature until it's time to go to sleep'. A CCQSP is depicted as an acyclic-directed graph. [Fig. 9]

A room temperature control scenario with a twenty-four-hour planning horizon is depicted in figure 10. The resident wakes up at 08:00, leaves home at noon, returns at 17:00 and sleeps at midnight. During these times, the room temperature is set within specific ranges. The algorithm satisfies chance constraints by setting a safety margin (shadowed areas) along the boundaries.

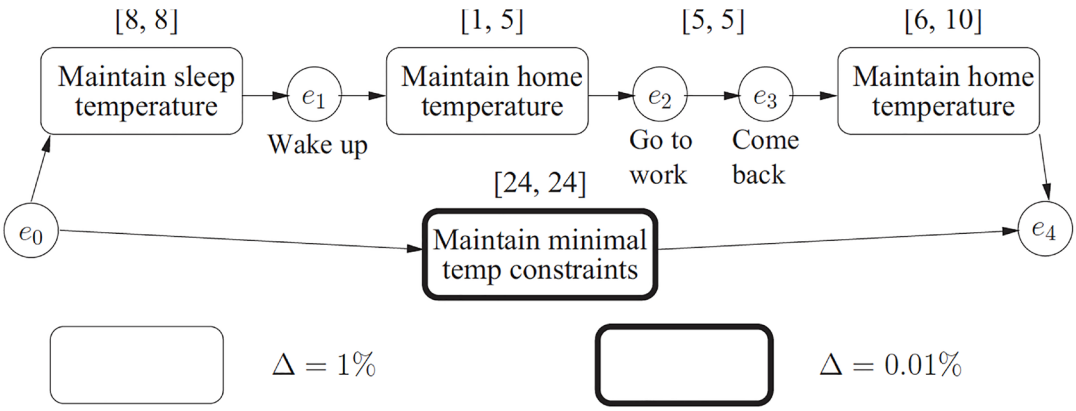
The control is integrated with the physical architecture through sensors performing real-time monitoring and actuators adjusting critical building components. An outdoor weather station performs weather measurements while indoor sensors monitor ambient parameters such as temperature and relative humidity, indicating a value inside or outside a defined wellness area. Luminescence sensors provide a lumen factor to activate the electrochromic windows. The probabilistic control algorithm proactively calculates a state plan for all house systems targeting the residents' comfort zone. It achieves significant energy savings compared to a traditional PID (proportional-integral-derivative) algorithm: 51 per cent over the PID during winter and 15 per cent, 17 per cent, and 4 per cent during spring, summer, and autumn.

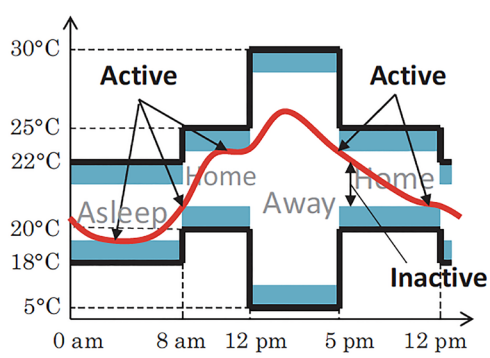
The robotic façade exploits the high thermal conservation capacity of the passive envelope. A window can be opened at precise angles so that the permeability of the façade to airflow can be adjusted. Setting the electrochromic material fully coloured – to its minimum solar transmittance value (3.5 per cent) – protects the interior from sun exposure during hot summer days. Setting the electrochromic material transparent – to its maximum solar transmittance value (62 per cent) – exposes the interior to the warm winter sun during winter days and enables solar heat storage. The PDLC film is independently controlled to supply the desired privacy and view. [Fig. 11]

These operations illustrate the necessity of trade-offs and clear objectives when automating a home for something as ambiguous as human comfort. As the CSH demonstrates, this is likely only possible through the synthesis of low-tech and high-tech systems. The performance of a high-tech, high-cost system like the robotic façade depends on the performance of the low-tech, low-cost envelope (thermal inertia, resistance, diffusivity). Different design configurations or material combinations yield different outcomes. It seems within the purview of the architect to determine a desired synthesis based on technical, aesthetic, cultural, and socio-economic criteria, though the specific interplay between low- and high-tech systems would best be determined with the assistance of physics engines plugged into computer-aided design software. Architects might then be free to explore the aesthetic impact of technological innovation on the users, residents, and the broader community. Orchestrations of dynamic visual elements such as robotic windows can be composed at design time by the architect, and experienced later by the inhabitant in response to specific physical or social conditions. As many façade configurations meet the performance requirements at any moment, the controller can choose from a library of compositions provided by the architect to evoke responses of delights and surprise from inhabitants and the public. [Fig. 12]

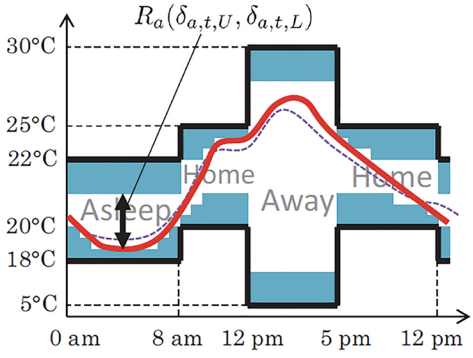
The PlaceLab

Operated from 2004 to 2008, the PlaceLab was developed as an apartment-scale shared research facility where new technologies and design concepts could be tested and evaluated in the context of everyday living.[22] It is now recognized as one of the first instrumented 'living laboratories' and was one of the most highly instrumented living environments ever built.[23] The 90m^2 one-bedroom home integrated hundreds of points of sensing, allowing researchers to study many aspects of life in the home.[24] PlaceLab experiments focused on building





(a) First iteration



(b) Second iteration

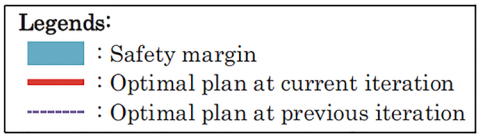


Fig. 9: A CCQSP illustrated by an acyclic directed graph depicting the resident's schedule. Image: MIT Design Lab – Autonomous Systems Lab.

Fig. 10: Overview of the iterative risk allocation algorithm. Image: MIT Design Lab – Autonomous Systems Lab.

infrastructure and energy conservation, proactive health and disease management, and user interfaces. [Fig. 13]

The PlaceLab design included a backbone system that distributed data and power to modular 'infill' cabinets customised to accommodate sensors. Each infill cabinet contained a microcontroller and network of twenty-five to thirty sensors. Environmental sensors included floor and ceiling air temperature and humidity as well as ambient light sensors. Small wired and wireless movement sensors were located on nearly every object people touch and use, including cabinet doors and drawers, controls, furniture, passage doors, windows, and kitchen containers. These sensors detect on-off, open-closed, and object movement events, allowing researchers to infer occupants' activities according to which objects were currently in use. [Fig. 14]

An audio/video capture system processed images captured by architecturally integrated cameras and microphones. The video recordings enabled the creation of detailed descriptions of activities and annotations that researchers used to generate machine-learning models for home activity recognition. The rich sensing and observational records allowed researchers using the PlaceLab to focus on interesting research questions rather than the technical challenges associated with custom sensor deployments.

The PlaceLab, though conceived as a research facility, was not intended to be experienced as one. In contrast to most other ubiquitous computing research laboratories, the PlaceLab was not located on a university campus or in an office park; it was one unit in a newly constructed residential condominium building located in a vibrant and diverse neighbourhood. All other units in the building were inhabited by owner-occupants or lessees. The PlaceLab was constructed following contemporary residential development standards but was not an architectural experiment per se. Its focus was on living. The interior design of the space was contemporary, offering all of the typical amenities one might expect in an extended-stay flat. Participants, whose stays ranged from several hours to several months, sometimes likened the PlaceLab experience to staying in a well-appointed hotel suite.

During the years of its operation, PlaceLab served many research projects and generated thousands of hours of data recordings. To illustrate the nature of these studies, three examples are offered: 1) an evaluation of a context-aware temperature control system, 2) an exploration of technologically enhanced medication reminders, and 3) a study of a 'persuasive' remote control to change television viewing patterns.

Context-aware thermostat. Using ten weeks of data from a couple living together in the PlaceLab, researchers analysed the potential for context-aware power management to reduce energy expenditures for heating and cooling. The participants were unaware that their Heating, Ventilation, and Air Conditioning (HVAC) use was being monitored for this purpose and thus were unlikely to have modified their behaviour in ways that might not be representative of typical patterns. Researchers identified opportunities to save on heating and cooling using a proposed just-in-time thermostat that uses travel distance computation from GPS-enabled mobile phones to predict arrival times at the PlaceLab. Knowing arrival times allows the system to preheat or pre-cool the space, achieving the setpoint just as the resident arrives home.

Analysing GPS travel data from eight participants (for eight to twelve weeks each) and heating and cooling characteristics from four homes, researchers found potential energy savings that could augment existing manual and programmable thermostats. Although manual and programmable thermostats can save considerable energy when appropriately used, studies have shown that over 40 per cent of US homes may not use energy-saving setbacks when unoccupied. A temperature setback is a pre-programmed time window there the heating or cooling system is set to turn off or operate less frequently when the home is expected to be empty.

Fig. 11: The dynamic façade permits the regulation of visibility, incoming sunlight, and heat. Photo: MIT Design Lab.
Fig. 12: The CSH aimed to provide novel home experiences of privacy and display. Photo: MIT Design Lab.

Unfortunately, setbacks are often not used because they are difficult to programme, or because it's hard to predict when the home will be unoccupied. However, the PlaceLab study showed that using a GPS-enabled thermostat might lead to savings of as much as 7 per cent for households that do not regularly use the setback features. Significantly, these savings could be obtained without requiring any change in occupant behaviour or comfort level, and the technology could be implemented affordably by exploiting the ubiquity of mobile phones.

In the case of the context-aware thermostat, the individual's location in the world outside of the home becomes engaged in a feedback loop with the home's heating and cooling systems. In many ways, this relationship makes sense. The structure of the building has specific properties – solar gain, insulation, thermal mass – that influence the performance of its mechanical systems and can be optimised with more information about the occupancy status of the space. Notably, the absence of context awareness results in default to baseline performance levels. In this way, the system can be described as fail-safe. Introducing additional input that improves the ability of the mechanical systems to provide comfort is just another extension of a technological throughline that started with chimney flues and moved toward increasingly sophisticated and efficient central heating systems.

Context-aware medication reminders. In 2005, PlaceLab was used to evaluate an experimental adaptive reminder system for medication and healthcare practices.[25] The system consisted of three major components: 1) a handheld interface like a smartphone for providing reminders, 2) the *PlaceLab* sensor subsystem and 3) a central server that manages medical tasks and reasons over sensor data in real-time. Operating in consort, these components optimise the timing and location of the reminders to increase effective compliance. A volunteer participant was recruited and asked to adhere to a complex regimen of simulated medical tasks. The participant was presented with both context-sensitive and scheduled reminders at fixed times during the day. The degree of adherence to the regimen, and the participant's assessment of the usefulness of each reminder (while blinded to the reminder strategy being used), were evaluated over the course of a ten-day study. Quantitative and qualitative results allowed comparison of the efficacy of context-sensitive reminders over fixed-time reminders for adherence and perceived value.

By contrast to the case of the context-aware thermostat, the feedback loop for context-aware medication reminders cannot be fully articulated, as the universe of potential contexts is much greater than the binary distinction of 'at home' and 'away'. In this study, the participant received two types of technology-delivered reminders: reminders based on both place and activity and reminders based on fixed time intervals. The results suggest that the contextual reminders were more helpful overall, but both types tended to fail in the edge cases, where the participant's behaviour (for example, sleep schedule) did not match expectations. Further work would be required to tweak the reminders' parameters to address these issues and tailor the system to the user's idiosyncrasies. It is unlikely that a fully fail-safe context-aware system could ever be defined; the nature of medication schedules is such that a fallback to time-based reminders is inevitable.

Persuasive television remote control. In a 2006 study of media consumption, researchers explored how strategies for motivating behaviour change might be embedded within usage patterns of a typical electronic device.[26] In the contemporary world, daily screen time with computers, televisions, smartphones, and entertainment systems continues to rise, with potential adverse health effects. However, ubiquitous computing technologies also create new opportunities for preventive healthcare researchers to deploy behaviour modification strategies using those same devices. To explore these ideas, the PlaceLab sensor infrastructure was combined with a handheld smartphone-style universal remote control for a

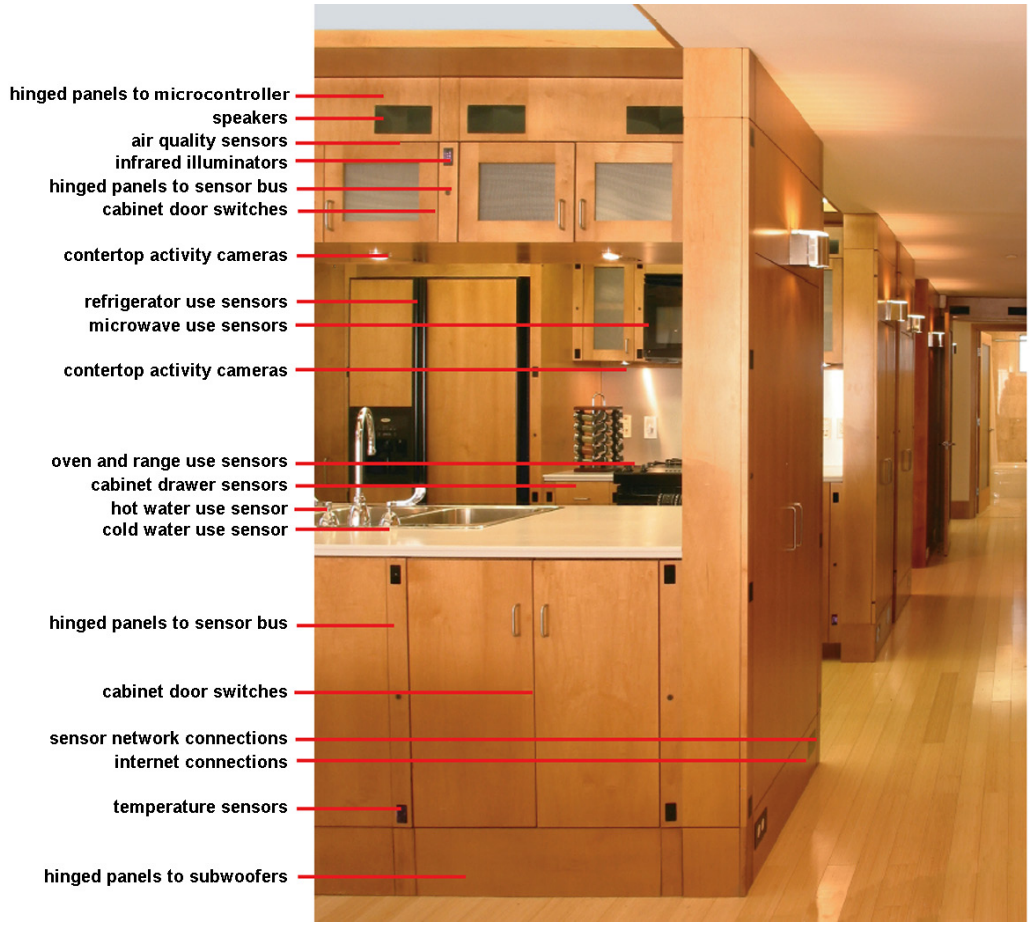


Fig. 13: The PlaceLab: a highly instrumented living laboratory to study the interaction of people and prototypical systems. Photo: Kent Larson.

Fig. 14: PlaceLab infill cabinets showing locations of sensing components. Photo: Kent Larson.

home entertainment system. However, this device's interface was designed to unobtrusively promote a reduction in the user's television viewing while encouraging an increase in the frequency and duration of non-sedentary activities. This device tracked daily activity patterns and used behaviour modification theories to persuade users non-intrusively to decrease their daily television use while increasing physical activity. Results from a fourteen-day case study evaluation revealed examples of how persuasive interface design elements might influence user outcomes without inducing a burden of annoyance.

This study provided evidence that behaviour modification strategies can fundamentally change the participant's behavioural patterns when embedded in an activity. While the study showed a reduction in time spent watching television (over seven days), the long-term impact of such an intervention is questionable. In the years since this work, there has been a trend in the reduction of television viewing overall,[27] but this has largely been offset by increases in the use of other screens, notably those of social media apps that use the very same persuasive strategies employed in this study to systematically increase engagement and screen time. These are examples of the unintended consequences that apply to the design of all systems that attempt to modify human behaviour.

CityHome

Shifting away from the live-in laboratory model of responsive architecture, we and colleagues began exploring robotic furniture to develop more dynamic urban housing that responds to changing needs of city dwellers. One concept for this, the CityHome, consists of a standardised building chassis and personalised, technology-enabled, transformable infill. It integrates new materials and systems to create urban dwellings that function as if they were much larger than their footprint suggests and strives to create rich living experiences for the occupants.

The chassis of a CityHome provides an efficiently built, open loft living space that contains all the fixed, long-life building elements with carefully located interface connections for power, data, plumbing and climate control. The construction method may vary depending on local codes and accepted design and construction processes. The infill of the CityHome consists of highly personalised, technology-enabled elements that can be rapidly configured and installed at the point of sale or lease in a matter of hours. Experimental infill prototypes include walls, tables, beds, and other furniture that translate and transform to minimise their footprint when not required by current activities. CityHome implements much of the sensing infrastructure developed for the PlaceLab to respond to the activities and needs of the occupants. Tiny wireless accelerometers, passive infrared sensors, and other data collection technologies are integrated into furniture, cabinetry, and other objects that people interact with. Activity recognition algorithms can determine basic activities of daily living, allowing the home to dynamically adjust the natural light, artificial light, audio environment, temperature, and configuration of spatial elements in response to the location and activities of people.

CityHome 200sf, the first CityHome Lab, was an 18.5m^2 prototype designed to develop, deploy, test and evaluate the mechatronics of hyper-efficient transformable infill and new home interfaces that allow easy transition between the functional states provided by the system. In this prototype, a central transformable unit encapsulated furniture for cooking, dining, sleeping, entertaining, working from home and more. A robotic wall system incorporated electric motors and pressure sensors for effortless reconfiguration, and a locking mechanism stabilised the system for seismic loads and delivered low-voltage power to electronics in the wall unit. [Fig. 15] A spatial user interface used voice and gestural control to allow customisation of the environment to current needs and preferences.[28]

CityHome 300sf (28 m^2) extended the dynamic multi-function living spaces model, emphasising vertical transformations.[29] A central living space featured a queen-sized bed, full-sized sofa, and

Fig. 15: Functional prototype of an 18.5 m² robotic apartment. Photo: Kent Larson.

Fig. 16: Functional prototype of a 28 m² robotic apartment. Photo: Kent Larson.

dining table to emphasise that comfort need not be sacrificed to live in small spaces. [Fig. 16] Underutilised space above the living area served as a docking location to store the furniture elements when they were not in use.

The concept of cleverly designed, transformable furnishings to improve the utility of small living spaces is not new. CityHome proposes better integration and, ultimately, standardisation of the components needed to realise visions of responsive homes. In some ways, this vision looks like a traditional home with easier-to-move furniture. This is perhaps the ideal representation of responsive homes, as the physical characteristics and aesthetics of the home are already well established, and the actuation enhances the flexibility of existing living patterns. However, as had become apparent in the PlaceLab case studies, challenges emerge when automation relies on predicting human behaviour, requiring ever more tweaking to handle the edge cases where the human response does not match expectations. In CityHome and related robotic design projects, significant engineering work was required to handle safety concerns encountered when humans, pets or other objects impeded the path of a robotic transformation. It was determined that human actuation is ultimately the safest mechanism and that electromechanical devices should be applied in an assistive capacity.

Discussion

Buildings often embody specialised technological innovation in response to particular conditions and problems. In some cases, this intervention is evident, determined by physical properties that provide measurable and predictable paths toward the intended outcomes. This attitude is exemplified by the CSH and Context-Aware Thermostat projects. Optimising for energy efficiency is a straightforward and largely responsive – as opposed to predictive – undertaking. Whenever prediction is used it is used in a fail-safe manner. Successful prediction accrues greater efficiency benefits than would be lost in cases where the prediction fails.

The accumulation of a high volume of precision data on the association between people and their environment may allow incremental improvements in the predictive ability of autonomous systems. However, high-tech interventions will remain less effective at increasing energy efficiency without the support of low-tech architectural improvements in the building envelope and mechanical systems. Furthermore, the practical approach is to design living environments that support adjustment of comfort and performance by managing the physical envelopes and systems, not the occupant's behaviour. In the CSH, the efficiency gains were achieved by active exploitation of the thermal properties of the passive envelope. It is critical that the intelligent control systems sense and manage the envelope and ultimately respond to changes incurred through human activity without trying to shape this activity.

There is a clear and present risk that autonomous systems are beginning to blur the distinctions between behaviour and performance. When an autonomous system is designed to achieve an outcome that incorporates human behaviour as an input, it will – no matter how 'intelligent' it may be – always resort to treating behaviour as a parameter to be optimised in achieving its target outcome. Wiegerling argues that AmI systems are reshaping the world without enabling human control over this process.[30] While in traditional system design, the performative premises of a system are determined in advance, and the evaluation of success or failure is straightforward, in complex autonomous systems involving intelligent agents the interactions between the system and the user remain open-ended. This fact leads Streitz et al. to argue for a complete reconsideration of the implications of intelligent environments.[31]

Ultimately, advancing and adopting such systems is a multifaceted issue depending on socio-demographic and personal preferences regarding privacy, security, trust, individualism, diversity, mobility, and lifestyle. For this reason, we contend that autonomous technology might best be reserved

for control systems managing building physics parameters. We have shown how building physics will likely benefit from technological intervention, and autonomous agents could be constrained to operate on measurable ambient properties. The impact of this could extend to the aesthetic experience as well. Comfortable temperature, air quality regulation, responsive lighting and visual access can significantly benefit the quality of user experience while improving energy performance.

What remains to be answered is how thoroughly and productively functionality and utility might be transformed by integrating sensing and actuation technologies in architecture. Designing and implementing intelligent systems remains challenging because it is hard to determine their evaluation criteria. More importantly, these criteria have no precedent. They cannot be extrapolated from the mechanical paradigm or general theoretical speculation. Perhaps a comprehensive narrative will be provided someday after the fact.

Individuals have widely varying needs, preferences, and dispositions in constant flux. It is inconceivable that a single back-end utility could provide a sufficient mechanism for implementation across homes, users, and living circumstances. Substantial work on ambient intelligence and wellness applications enabled by PlaceLab illustrates the primary challenge: the system must be carefully and explicitly tailored to the disposition of the individual user, or it will sometimes fail. The undesired alternative is to shape the user's behaviour to conform to the system's expectations. This entails reducing behavioural freedom of expression, a compromise at odds with most human value systems.

A further challenge to human values arises from the opacity and complexity of autonomous systems and the users' inability to comprehend how they work. Because ambient intelligence technologies operate constantly and invisibly in the background, there is no transparency about what information is being recorded and to what degree residents have control over this information. Apart from privacy implications – especially as control applications are increasingly outsourced to third-party providers – the lack of transparency over what is being transmitted or manipulated leads to a form of cognitive dissonance that cannot be resolved through architecture.

This is not to say that utility or socio-economic values cannot be addressed through automation. As smartphone technologies have progressed in sophistication, they provide countless examples of how data-driven applications offer practical benefits to billions of users worldwide. However, a smartphone is not a home; it can be turned off and put aside. A home is different. It is meant to be a place of shelter and respite from the world's complexities. We contend that collecting and using home data for behavioural applications violates this sanctity and falls outside the purview of architecture. As tempting as it may be to introduce behaviour-tracking technologies into the home's fabric, there are many good reasons to advise against this practice.

Even if we forget the concerns about privacy and transparency for a moment, there are other practical challenges to overcome. For example, there is a considerable mismatch between technological and architectural lifecycles. Whereas the timeframe of the architectural renovation cycle is in decades, the average lifecycle of a consumer smartphone is approximately two years, and the useful lifespan of a home automation system is probably not much longer.[32] There are also concerns about the right person to select which systems and applications would be deployed in the home. Is it the architect or the homeowner? In PlaceLab, this decision was deferred to the participant, who gave informed consent before participating in the research. In the real world, this decision is obscure, as residential spaces are frequently turned over to new inhabitants, and visitors to instrumented homes are immediately subjected to home system observation.

There are additional philosophical objections to integrating general-purpose sensing infrastructures in architecture. There is an increasing awareness

that the digitalisation of behaviour patterns can have significant psychological and social implications, such as the atomisation and polarisation of communities and the perpetuation of biases locked into untransparent artificial intelligence algorithms.[33] Algorithms rest on socio-political premises that remain invisible and may have obscure origins. Furthermore, the resolution of digitalisation can be poor. The nature of digitalisation is to sample phenomena and take momentary snapshots of the state of the world as it is available to the existing points of sensing.

Consequently, the machine's view of the world is profoundly reductive and lacks the nuance of human perceptivity. As Meredith Brousard explains, 'data is socially constructed', and it is dirty, too: 'Data is made by people going around and counting things or made by sensors that are made by people. In every seemingly orderly column of numbers, there is noise. There is mess. This is life.'[34] Because dirty data does not compute, technologists often have to make things up and purify the data to enable their programmes to run smoothly and thereby distort reality in favour of digital expedience. This makes reasoning possible on the average case where a clear yes/no answer can be provided but effectively eliminates edge cases that belong to the grey areas.

An alternative to integrating general-purpose behavioural sensing in architecture is embracing the standing condition. Today, the distribution of home automation and intelligent assistive devices is based on the consumer model. A device is brought into the home and configured by the end user. Users who no longer wish to engage with the device can disable or remove it from the space. As these units are self-contained, they are also fail-safe. Hence, removing devices does not create safety hazards; they only lose their prior utility. The alternative of consumer-based robotic systems was adopted in the robotic façade of the CSH and the CityHome. In both studies, the robotic components use sensing and actuation infrastructure to facilitate operation. However, they are still independently operable by the users as mechanical devices if desired or during power disruptions.

These findings are consistent with our home automation strategy tests in the CityHome, PlaceLab, and CSH experiments. We argue that residential architecture could employ AI and robotics when the parameters of sensing and actuation target measurable, tractable aspects of building physics, efficiency and ergonomics rather than less tractable aspects like social impact and user behaviour. Nonetheless, integrating these more personal technologies into our living environments remains compelling, despite the potentially negative impact on privacy, well-being and social interaction. In any case, a consumer-based distribution model is more appropriate for these applications, as it affords properties that limit the risks to home occupants.

We contend that this position is consistent with historical thinking about the role of architecture and its association with human behaviour. Rasmussen approaches architecture as an artificial environment intimately connected with daily human life, shaped around us, and configured to be used and lived in.[35] The architect intervenes as a theatrical producer who plans the setting for the actors (the ordinary users of the space) and must be aware of the natural course of human actions. The actors respond to staging and the script, but the interaction remains always one-directional. The script does not change in response to the actors' motivations, as this would result in improvisational chaos.

Architecture is, in many ways, synonymous with the stability derived from material design constraints. Buildings are big, heavy, and monolithic. However, autonomous robotic systems can quickly override these constraints unless deployed with deliberation and well-determined outcomes in mind. Designing and implementing intelligent systems that target human behaviour remains outside the realm of architecture. One reason is that such systems lack clear evaluation criteria. Their failure or success cannot be determined by means of the mechanical paradigm or historical and

theoretical speculation on the architectural effects of the machine age. Autonomous robotic systems are unprecedented. A corollary of this newness is that robotic architecture and responsive environments are currently explored in the absence of a theory adapted to the new circumstances or a vocabulary of terms for describing their effects and consequences at the architectural level. Keeping a clear mind on the role of aesthetics, functionality, and performance in architecture, rather than relinquishing it to untested and unspecified artificial bits of intelligence, is a conservative but necessary step in maintaining domestic stability.

Notes

The order of the authors of this paper, Kotsopoulos and Nawyn, was selected arbitrarily.

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Biography

Sotirios Kotsopoulos is a researcher, designer, and educator working at the interface of design and computation. As an associate professor at the National Technical University of Athens and a research associate at the School of Architecture of MIT, he contributes to the research area of computational design and shape grammars, and explores applications of networked technologies, electro-sensitive materials and artificial intelligence in architecture.

Jason Nawyn is a research scientist at MIT, where he was a member of the team that built the PlaceLab during his post-graduate studies in human-computer interaction. His current work investigates the relationship between humans and the built environment, with a focus on the ways in which digital technologies shape human experiences and decision-making.

Platforms and Dwelling: Topologies of Distributed Domesticity

Lőrinc Vass, Roy Cloutier and Nicole Sylvia

Under contemporary capitalism and platform urbanism, domesticity is distorted into new forms. The spaces and processes of dwelling become extended across digitally mediated and data-driven network technologies – 'platforms' – to realms outside the traditionally conceived domicile. Even the most mundane contents of domesticity are recast as services provided by and exchanged across platform capitalist networks – from Alexa to Airbnb and beyond. Mirroring this, the home is increasingly mobilised for economic productivity through the expansion of work into the domestic sphere. The platformisation of dwelling thus reverberates across urban space, with housing, mobility, and even human labour increasingly incorporated into various platforms like those of the so-called sharing economy, complicating and dispersing simple dichotomies of interior/exterior, private/public, and home/work.

As Tarleton Gillespie notes, platform-based organisations capitalise on the multiple, specific, yet elusive meanings of 'platform' – alternately evoking computational infrastructure, architectural condition, figurative space and political programme. These ultimately coalesce in the literal sense of a 'raised level surface' that 'suggests a progressive and egalitarian arrangement, promising to support those who stand upon it'.[1] On the contrary, as intermediaries, platform companies ultimately retain a tremendous amount of control.[2] Despite a rhetoric of sharing, the late-capitalist logic underlying platforms restricts the possibilities of collective governance and instead pushes users – and dwelling – towards an individualistic, optimised, financialised and post-political condition.[3]

Extending earlier economics-oriented theorisations of platform-based corporations, recent scholarship has begun to address the broader socio-spatial implications of platform urbanism.[4] These critiques situate platformisation in relation to the ascendant form of governmentality of our era, theorised variously as 'cybernetic', 'algorithmic', 'cognitive', 'affective' or 'surveillance' capitalism.[5] This proliferating regime is built upon fundamental shifts in the nature of control, operating on the environment of the subject rather than the subject itself and distributing control into the structures that underlie society. This transition from a disciplinary form of governance to a distributed, ecological-relational formation was notably described by Gilles Deleuze as a shift from enclosures or 'moulds' to controls or 'modulation'.[6] Erich Hörl refers to this shift as *environmentalisation*, 'the becoming-environmental of media, of power, of subjectivity, of world, of capital and of thinking'.[7] Following Michel Foucault's coinage of the term, 'environmentality' for Hörl denotes a restricted formation within a broader techno-ecological genealogy, propelled by the evolution of control technologies since the eighteenth century but especially since the post-war development of cybernetics.[8]

Operating within this regime of environmentality, platform urbanism manifests in a distinctive shape (and shaping) of space and subjectivity. Three aspects are key. First, platforms are more than companies or digital algorithms with an on-screen

interface. Rather, they are geographical agents operating in a distributed manner. Platforms coordinate and modulate urban networks through seemingly contradictory processes: decentralisation of physical form and sometimes even material ownership, but a subtle re-centralisation and redeployment of control.[9] Second, the probabilistic, pre-emptive rationality underlying platform algorithms manifests as the mining and monetisation of data towards behavioural manipulation, into which the 'hardware' of the city and the 'software' of urban life are equally incorporated.[10] Urban activity is not only the source of data extracted by digital platforms, but is itself 'a medium of capture'.[11] Third, environmental-algorithmic modulations presuppose and reproduce a new kind of subject, one reduced to the quanta of their behavioural data and conditioned to constantly engage within a telematic milieu that also manifests in spatial and temporal 'flexibility'. Individuals thus become 'dividuals', 'simultaneously hyper-subjectified, and de-subjectified'.[12]

Based on this premise, we argue that an examination of the architecture of dwelling in relation to platform urbanism necessitates contextualising both 'dwelling' and 'platform' within the aforementioned trajectory of environmentalisation, the becoming-environmental of control. This shift in condition in turn necessitates a shift in methods of analysis. The contemporary redistribution of dwelling – its simultaneous extension and integration under platform urbanism – complicates the 'flatness' of the platform metaphor. As Maroš Krivý notes, scholars across various disciplines converge in observing that platforms 'operate with a similar topology of power, one in which a core or a ground is constructed so as to enable or facilitate the production of difference.'[13] The etymology of the term – from the Middle French *plateforme,* literally 'flat form' – is indicative of this nuance: platform as an '*arrangement* of objects on a level surface'.[14] It is therefore our contention that rather than topographical and typological frameworks, the 'falsely flat' surface of platform urbanism requires a topological, systems-relational lens to map, critique, and reshape its arrangements of space, subjectivity and power.

Accordingly, in the first half of the article we prepare the ground for this discussion by outlining this topological framework in relation to the environmentalised history of dwelling. Building on an overview of topological thinking across disciplines, we establish its role in the reconceptualisation of architecture as an environmental apparatus of boundary-drawing. We then retrace the always-already topological genealogy of modern dwelling to demonstrate the ways in which manifolds of interpenetrating edifices, mediating membranes and prosthetic environments have prefigured present-day digitally mediated formations of domesticity. In the second half of the article we train this topological apparatus onto three contemporary manifolds of dwelling – condividual networks, commoning boundaries and distributed protocols – to probe the changing relations of subjectivity, space and power under platform urbanism and environmentality. We conclude by revisiting questions concerning politics and architectural agency that are brought into renewed focus by a topological lens on dwelling.

Topological thinking

As the study of continuity, boundaries and relation, topology offers an 'anexact yet rigorous' model of the (re)configurations and (de)formations of space, subjectivity and power under environmentality. As such, it supplements typological and topographical lenses in architecture, offering an alternative conceptual and analytic approach towards dwelling in its environmentalised, digitally platformised condition.

In its mathematical formulation, topology constitutes a reconceptualisation of metric models of space and time, such as Euclidean geometry and Newtonian 'container' metaphysics. These models are premised upon an extensive conception of space, with objects located in an infinite container and described through *extrinsic* properties (such as position or distance) with reference

to a transcendent coordinate system. A representative tool of such 'topographical' space is analytic geometry, in which relations between points located on two-dimensional curves or three-dimensional surfaces are expressed as relations between numbers.[15] Topology, on the contrary, is the study of *intensive* space, grounded in the intrinsic, self-referential, relational qualities of entities, such as their (dis)continuities and deformations through folding, stretching or squeezing. Its corresponding analytical tool is differential geometry, which is concerned not with Cartesian positionality but with the local rate of change (differential) in the curvature of a surface of any 'shape' and dimension, often referred to as a manifold. Topology disposes with the need for a higher-dimension 'global embedding space', insofar the complexity of a manifold is apprehended *in relation to itself*, instead of against an external frame of reference.[16] A topological lens does not oppose, but rather extends the normative topographical understanding of space.

Beyond the formal language of mathematics, 'topological thinking' has proliferated across the sciences and the humanities, from physics and developmental biology to philosophy and architecture. Following Deleuze – a topological philosopher par excellence – Manuel DeLanda describes topology as offering an '*anexact yet rigorous* style of thought', less concerned with quantity and positionality than with differential relationality and connectivity.[17] As Brent Blackwell similarly suggests, 'topology analyses the nature of the ground upon which its own self-construction lies', revealing the inherent continuity between figure and ground: 'As the study of boundaries, topology widens the scope of the definition of the object to include its context (what topology refers to as the "embedding space"). In this way, an object is not distinct from its context.'[18] Topology, then, constitutes a radically relational conceptualisation of the environment in the twofold sense of 'milieu', as simultaneously a middle and a surrounding.[19]

Boundary-drawing

Through its intensive conception of relationality and boundaries, topological thinking engenders new critical and analytical approaches to the built environment and architecture. Parallels can be found in the way topology has enjoyed a renaissance in human geography and social theory over the past two decades. The heterogeneous applications of post-mathematical topology, Lauren Martin and Anna Secor suggest, share a concern for '*relationality itself*', questioning 'how relations are formed and then endure *despite* conditions of continual change.'[20] Investigations in these fields are thus concerned with the material-discursive apparatuses that engender and reproduce particular relations. For Celia Lury, Luciana Parisi and Tiziana Terranova, the changing nature of mediating apparatuses evinces a 'becoming-topological of culture', insofar as 'topology is now emergent in the practices of ordering, modelling, networking, and mapping that co-constitute culture, technology, and science.'[21] This topologisation manifests in the way '"borders" or "frames" of mirrors, windows, screens and interfaces have become surfaces of sensation themselves by operating the opposition between inside and outside in a dynamic re-making of relations to each other.'[22]

The agential realist philosophy of Karen Barad further extends the topological understanding of boundaries through the notion of 'boundary-drawing apparatuses'. Incorporating quantum physics and post-structuralist constructivist thought, Barad advances a radically relational reconceptualisation of matter, space, causality, agency and difference, placing topological thinking at their core. Considering the nature of reality, 'the primary ontological units are not ''things'' but phenomena – dynamic topological reconfigurings/entanglements/relationalities/(re)articulations of the world.'[23] In turn, agency is not an external, interactive property of a subject or object, but an intra-active 'doing' or 'being' *within* phenomena, an ongoing redrawing of boundaries.[24] Boundary-drawing for Barad is thus

a process of 'cutting together-apart', through which the world is configured in particular ways, while other possible worlds are necessarily excluded. This ontology also demands a renewed conception of ethics, a response-ability to both entanglements and exclusions involved: 'Particular possibilities for (intra-)acting exist at every moment, and these changing possibilities entail an ethical obligation to intra-act responsibly in the world's becoming, to contest and rework what matters and what is excluded from mattering.'[25]

These observations concerning boundaries, in turn help to reorient the formal(ist) applications of topology predominant in architecture and urbanism since the 'digital turn'. As Robert A. Gorny observes, the pursuit of topological processes of form-finding and associated 'diagrammatic' vocabularies since the 1990s has transpired in the context of an increasing bifurcation between architectural history and theory. A reductive version of topology thus became associated with the 'projective' tendency in theory and practice, with a coherent elaboration of its broader implications for a (re)conceptualisation of architecture remaining wanting in critical-historical discourse.[26] Yet, a heterogeneous and growing body of post-Foucauldian and post-Deleuzo-Guattarian architectural scholarship, building on the respective notions of *dispositif* (apparatus) and *agencement* (assemblage, arrangement), supports a topological conception of the built environment.[27] Their convergence contributes to a rethinking of architecture, from an apparatus of separation and enclosure – a long-held misreading of Foucault's spatial project – to its more general, techno-ecological role in selecting, filtering and framing the material conditions of existence. In this sense, architecture can be understood as a topological machine 'determining what is related to what'.[28]

Synthesising these trajectories with Barad's rearticulation of boundary-drawing apparatuses, Gorny formulates 'the built environment … as an open system of reciprocal self-organization through its production of constitutive boundaries.'[29] As 'enabling constraints' that frame and filter relation, 'architectural arrangements thus "cut together apart" … specifically entangled social, technical, cultural, economic, and ecological systems'.[30] In other words, a topological lens foregrounds the 'relational architectural ecologies' through which, as Peg Rawes articulates, 'modern subjectivity, and our habits, habitats and modes of inhabitations, are co-constituted.'[31]

Manifolds of dwelling

To begin to apply a topological lens to dwelling, one must recontextualise the present-day digital distribution of domesticity as the latest manifestation of an environmentalised, always-already topological trajectory of modern dwelling. This, in turn, allows the identification of specific topological patterns – manifolds – that can act as critical-analytical lenses.

The aforementioned historical trajectory is strikingly articulated by Georges Teyssot via the notion of a 'topology of everyday constellations'. Teyssot examines the dynamic reconfiguration of technical apparatuses, social collectives and more-than-human milieus, tracing a techno-ecological genealogy of modern dwelling from nineteenth-century Parisian interiors to our contemporary digitally mediated condition. He characterises the project as an inquiry into 'the nature of spaces, public or private, at the moment they become part of the innumerable series of devices and technical equipment that control the movements of people and things.'[32] Informed by Foucault's theorisation of material apparatuses – as evinced by the specific use of the term 'equipment' – the investigation thus situates dwelling within the history of environmentalisation.[33] Instead of emerging as causal responses to societal needs, collective equipments produce their own production, generate new needs, and partake in regimes of social normalisation.[34] Accordingly, Teyssot underlines the reciprocity between 'habit(us)' and 'habitat', with the former comprising the collective equipments that condition repetitive acts of inhabiting, including 'the

house itself, conceived as a receptacle of practices, routines, and customs'.[35]

Building on Teyssot's work, we propose three historical manifolds as conceptual lenses to analyse present-day permutations of digitally platformised domesticity: interpenetrating edifices, mediating membranes, and prosthetic environments. These manifolds exemplify the modern reconfiguration of the demarcation between interior and exterior, organism and environment, domestic and public, and the redistribution of dwelling across these boundaries.

The first manifold, interpenetrating edifices, is characterised by the dissolution of spheres previously understood as separate. This condition is beautifully described in Walter Benjamin's *Arcades Project*. Benjamin observes the emergence of a modern topology and contrasts it with its antecedent: 'The twentieth century, with its porosity and transparency, its tendency towards the well-lit and airy, has put an end to dwelling in the old sense.'[36] Richly furnished domiciles and expansive arcades are equally symptomatic of the interpenetration of formerly distinct spheres of public and private, interior and exterior, whereby a sense of permanence gives way to transience and instability. Domestic interiors are progressively exteriorised through environmental technologies such as electric illumination, their outwardness also exhibited in popular 'cutaway' illustrations: 'like a reversible surface, the interior opens out into an exterior.'[37] In parallel, the arcades, railway stations, winter gardens and other public edifices inaugurate 'vast "interiors" for the collective, so huge that they do not have exteriors as such.'[38]

In Hilde Heynen's reading, Benjamin oscillates between a nostalgia for the sense of belonging offered by 'the notion of dwelling as leaving traces behind', and an enthusiasm for the perceived emancipatory potential of the transitory 'habituation' that followed it.[39] This latter, 'new, nomadic way of living' is well illustrated by Hannes Meyer's 1926 manifesto for a radical, anti-bourgeois lifestyle in Co-op Interieur, conveyed through a single photograph of a sparsely furnished yet idiosyncratic room.[40] Through its implied nomadic subject linked to a collective, this proposal equally resonates with an ethos of cooperation and solidarity, and aligns with the modernist development of 'minimum dwelling' *(Existenzminimum)*.[41] It similarly prefigures contemporary digitally platformised nomadism, in both its convivial and precarious permutations. [Fig. 1]

The second manifold, mediating membranes, concerns the nature of the boundaries defining the surfaces that host relations. This tendency emerges through the more fundamental topological reconceptualisation of life itself that was propelled by mid-century developments in cybernetics and biology. Henceforth, life (and dwelling) is seen as an entanglement between organism (or system) and its environment, occurring 'at the limit, on the borders'.[42] Following Gilbert Simondon, relations are primary: the individual and its environment emerge together from the process of individuation, 'which literally coproduces the individual and its associated milieu together. As such, the individual must be defined as an encounter, a result, but also as the milieu of individuation, through a succession of configuring phases', as a result of which 'the individual invokes neither unity nor identity … there are only multiple processes of individuation.'[43] The membrane that folds back on itself is not only a zone of contact between inside and outside, but the very source of their dynamic, chrono-topological becoming.[44]

The crystal and the egg, representative morphogenetic figures of individuation, became key motifs of architectural speculation during the 1960s: 'Blobs and bowels, bubbles and balloons, shells and membranes, capsules and cells, warped surfaces, crystals and nappes, cables and webs, labyrinths and topological surfaces'.[45] In these examples, 'the primary elements of architecture (basement and attic, wall and partition, floor and ceiling, passage and disruption, ground and roof)' come to 'metamorphose and transmute into topological surfaces of contact.'[46] However, these experiments often

verged on the formally iconic and the reductively geometric rather than being relational or truly topological, and have in turn been succeeded by the ongoing computational (ab)uses of topology characteristic of 'architectural Deleuzism'.[47]

The third manifold, prosthetic environments, rethinks dwelling as a technological milieu of iterative reconfiguration. Drawing on Donna Haraway's seminal conceptualisation of the posthuman subject as a cyborg and Jean-Luc Nancy's notion of ecotechnics, Teyssot asserts that 'it is not so much a case of devising new dwellings for cyborgs. Those semihuman, semisynthesized, constantly mutating entities are already environments, milieus, surfaces where relationships between self and world come into play.'[48] In this sense, dwelling can be understood as a co-production: always-already cyborgian bodies interacting (and intra-acting) with prosthetic technologies, with the lines between the two perpetually blurred.

The prosthetic entanglement of humans with their milieu is also central to Peter Sloterdijk's immunotopological spherology. Refuting a 'romanticism of openness', Sloterdijk contends that as 'ecstatic beings' humans are 'forever held outside in the open; … but they can only be outside to the degree that they are stabilized from within from something that gives them firm support. … Buildings are thus systems to compensate for ecstasy.'[49] Conversely, Teyssot articulates the inverse, redefining the interior of the dwelling

> as the movement of the body towards the exterior, in a state of *ekstasis*, through the various filters – thresholds, frontiers, wireless networks – that delimit our surroundings. … Like a Klein bottle – or an ordinary sock – the interior will conceivably be able to turn itself logically, and topologically, into an exterior. Architecture is thus transformed into a device that participates in this staging of an 'ecstasy'.[50]

These historical manifolds of dwelling thus prefigure our unprecedented contemporary interconnectivity. Interpenetrating edifices describe the longer trajectory of the dissolution of the boundaries between interior and exterior and between public and private spheres. Likewise, mediating membranes formulate dwelling as the dynamic modulation of relation that in turn defines living entities. Finally, prosthetic environments recast dwelling as a co-production with(in) a technical milieu – whether 'smart' or inert, enveloping or handheld. From these historical insights we can discern the outlines of a topological lens on contemporary dwelling, which incorporates but is not limited to its current digitally inflected permutations.

Contemporary manifolds

Topological thinking allows one to see patterns of relation – what we call manifolds – that are otherwise challenging to discern. These topological manifolds allow designers to push beyond established analytical approaches such as typology, which are challenged by contemporary socio-spatial shifts.

The limits of typological analysis are apparent in a recent study on the relationship between dwelling design and the dominant mode of economic production under industrial versus cognitive capitalism, by Francesco Spanedda and Matteo Fusaro. Compared to previous eras, the effects of the cognitive (or digital) economy on housing are more varied and difficult to discern via spatial taxonomy.[51] The authors highlight four transformations: the reintegration of work into the domicile, occasionally through dedicated home office spaces; the revalorisation of housing as a means to attract knowledge workers to specific locales; the commodification of housing driven by digital platforms such as Airbnb; and the decoupling of private-public and interior-exterior correlations via the integration of the home into various digital networks.[52] [Fig. 1] Observing the overlay of 'completely new ways of working and living, like home working, guest hosting, and media production' onto 'spaces that were designed with separation, privacy, and different functions in mind', the study questions the veracity of typology for describing the contemporary condition of dwelling.[53]

Fig. 1: Home ’14: Pavilion based on Hannes Meyer’s Co-Op Room, exhibited in *AirBnB Pavilion*, Venice, 2014, organised by åyr collective (Fabrizio Ballabio, Alessandro Bava, Luis Ortega Govela and Octave Perrault). Rendering courtesy of åyr.

Instead, the environmental genealogy of dwelling and its digitally platformised permutations calls for analysis attuned to what Eyal Weizman describes as 'a more dynamic, elastic, topological, and force-field-oriented understanding of space, as well as an understanding of the immanent power of constant interaction between force and form.'[54] Whereas Weizman's pioneering analysis has primarily focused on territories in states of exception and misuses of power, we second Adrian Blackwell's call to also train this topological lens onto the 'more banal territory' of (platform) capitalist property relations, insofar 'it is precisely through the lens of architecture that the spatiality of power can be analyzed most effectively.'[55]

Accordingly, in the remainder of the article we draw out three contemporary manifolds of dwelling through a topological (re)reading of representative urban conditions and theoretical positions. While not intended as an all-encompassing series, the three manifolds – comprising condividual networks, commoning boundaries and distributed protocols – respectively foreground the changing shapes of subjectivity, space and power under platform urbanism, and environmentality.

Condividual networks

The first contemporary manifold concerns the nature of relations engendered by networked forms of dwelling that result from the interplay of physical mobility and digital connectivity. It revolves around the dispersion of domesticity across urban networks and the subsumption of the domicile within commodified platforms. Central to this manifold is the ambivalent notion of the dividual, which encapsulates the aporia of networked subjectivity as a topology of belonging and dispossession.

The networked form of urban nomadism evoked by Meyer's Co-op Interieur and other architectural speculations have since the 1980s found their consumerist counterpart (and counterpoint) in the megacities of Tokyo and Seoul, where the combination of high urban densities and extensive public transportation networks have precipitated the dispersion of certain domestic activities – such as singing, net-surfing, movie-watching, comic-reading, bathing, or sex – into commercialised spaces. Jorge Almazán and Sanki Choe theorise this phenomenon of monetised access to personal spaces on a short-term basis as 'dividual space', complicating the predominantly negative reading of the concept in Deleuze's original formulation.[56] Rather than being mere desubjectification, dividual space is seen to enact a liminal form of domesticity spread across the urban realm: it 'compensates, reproduces or replaces spaces and qualities associated with home' and 'serves as a kind of buffer zone for disparate and fragmented lifestyles produced by rapid demographic and cultural shifts in East Asia' (and beyond).[57] It also offers alternative forms of association beyond normative domestic arrangements such as the nuclear family. Through these temporary, non-committal forms of socialisation, domesticity is recast as 'a social condition that expands the possibilities of city dwelling.'[58]

Yoshikazu Nango similarly notes that networks of 'intermediate' spaces and services in Tokyo represent an extension of home into the entire city.[59] Often characterised by solitary occupation in physical proximity with others, such spaces are entangled with the global increase in single-person households and individualised lifestyles, and the condition of non-stop digital connectivity. Nango stresses that amid this intensification of connection and disconnection across online and physical networks, it is important to distinguish between quantitative and qualitative forms of solitude – isolation and loneliness, respectively – that can greatly differ in degree and tenor depending on the context. Although such (in)dividualised forms of dwelling might be deeply conditioned by platformised patterns of consumption, they also harbour potential for new modes of sociability.

The problematic of dividual connectivity in the digital age is explored in two recent exhibitions of Japanese experimental housing: *House Vision 2*,

subtitled *Co-Dividual: Split and Connect/Separate and Come Together*, and *What is Co-Dividuality?*[60] The projects included in these exhibitions speculate (with mixed success) on novel forms of collectivity under the pretext of post-individualism, social media and the digital or sharing economy.[61] [Fig. 2–3] More importantly, the interpretation of co-dividuality as 'reconnecting individuals' appears to gloss over the ambivalence inherent in Deleuze's dividual subject, and risks reproducing the problematic status quo of contemporary co-living discourse, often permeated with an extractive platform logic. As Gorny summarises, 'novel forms of shared living are not simply an extension of reformist/socialist debates on *Existenzminimum* spaces and collective forms of living', but instead 'must be approached through the (neoliberal) political economies (and ecologies) in which their capsular spaces facilitate a newly capturing form of relationality, which may well be at the verge of turning into a new kind of captivity.'[62] A similar issue is latent in Sloterdijk's aforementioned immuno-topological model of 'co-isolation', epitomised by the cellular modern apartment and its 'autogamous' inhabitant, who aggregate with others in 'foams' and interact within a digital 'tele-socialism'.[63]

Addressing this contradiction through the etymology of the term 'dividual, Gerald Raunig proposes a more nuanced topology of networked subjectivity as 'condividuality'. Raunig contrasts the individual, characterised by dissimilarity, to the dividual, marked by similarity as con-formity: a partial, non-total relationality comprising a singularity in relation with others.[64] He distinguishes two restrictive modes and one generative mode of dividuation: partition, 'a procedure of counting and measuring, producing equivalence and quantifiability' and inhibiting the concatenation of parts; participation, an organic partaking towards a totalising whole, in which the singularity of parts is erased; and conversely, division, a 're-singularization … that engenders singular unambiguity in multiplicity.'[65] Corresponding to the third modality, condividuality synthesises 'the component of the singular, an affirmative mode of separation, and the component of composition, of concatenation, of the *con*-.'[66] In turn, Gorny builds on this notion of condividuality to theorise apartments as a topology that 'transgresses the fine conceptual line between forms of separation (addressed in terms of living "alone together") and modes of relationality (as living "together apart").'[67] This (re)conceptualisation of apartments can also be extended to a broader consideration of networked subjectivity and forms of dwelling, involving not only spatial arrangement but a topology of mental belonging and material (dis) possession.

This topology finds resonance in a series of conceptual speculations by Cristina Díaz Moreno and Efrén García Grinda of the architecture practice amid.cero9, collected under the title 'A Civilization without Homes' (2000–2019), alluding to social historian Arthur W. Calhoun's observation a century ago, with reference to the then-proliferating residential hotel lifestyle in the United States, that 'our current capitalism is willing to try the experiment of a civilization without homes.'[68] This proposition is reworked in relation to the contemporary era. The first in the series, 'hOH: Houses by the Hour' comprises flexibly programmed domestic spaces as 'incubators for anomalous forms of inhabiting' in dense urban centres that opportunistically build on the decentred aspect of dividual space.[69] Conversely, the fictional city of Nocturnalia addresses the darker side of digital capitalism, drawing on Jonathan Crary's notion of '24/7', the non-stop temporality of global capital that has eroded even the boundary between wakefulness and sleep.[70] There are no conventional domiciles in Nocturnalia, and sleep – a profoundly useless and intrinsically passive activity – is practised collectively in a monumental edifice as a form of resistance 'to a life exposed to the machinic process of the exploitation of our awakened existence.'[71] Chapel of Collective Sleep and Peckham House represent variations on this idea, with the latter taking inspiration from a type

Fig. 2: House with Refrigerator Access from Outside by Yamato Holdings and Fumie Shibata, *House Vision 2 Tokyo Exhibition*, 2016. Photo: authors.

Fig. 3: Rental Space Tower by Daito Trust Construction and Sou Fujimoto Architects, *House Vision 2 Tokyo Exhibition*, 2016. Photo: authors.

of 'dividual space', the *jimjilbang* – a large public bathhouse equipped with shared sleeping areas, common in South Korea. [Fig. 4–5] The proposal comprises a dwelling prototype where 'collective rest and dispossession are practiced as a way of life.'[72]

Taken together, these manifolds of condividual networks exemplify both the (platform) capitalist erasure of distinction between the will of the economy and the life of the subject through the modes of dividual partition and participation, and their convivial potentials as condivision. By reducing or relinquishing domesticity in the conventional sense, such experiments gesture towards radical forms of inhabiting and (dis)possession.

Commoning boundaries

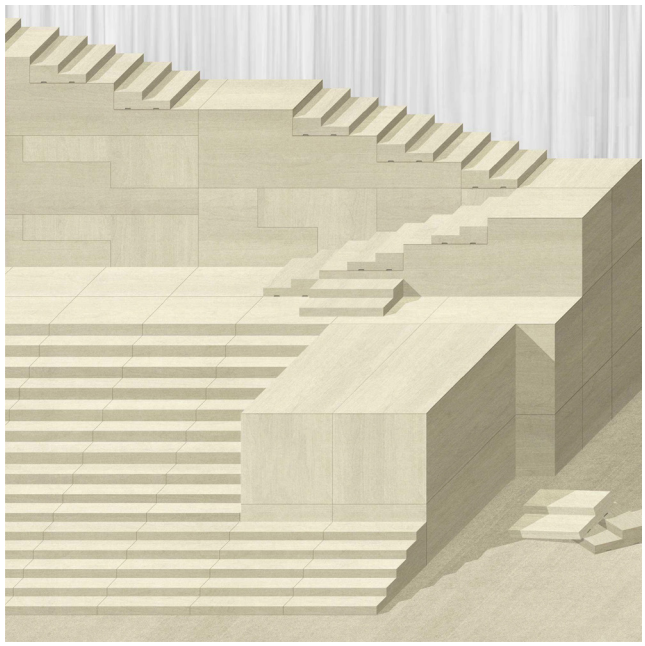
The second contemporary manifold is a study in paradoxes. It consists of numerous instances in which contemporary architects, faced with the destabilising, boundary-eroding, atomising and desubjectifying forces of contemporary capitalism, seek to turn their attention back to the definition and composition of boundaries within systems. Despite it often being criticised as anti-systems or anti-relational rhetoric, commoning is in fact a deeply topological practice – one often based in a rejection of connection and reconstitution of boundaries. At the same time, apprehending these configurations topologically foregrounds their broader concern with the politicisation of boundaries, and the aforementioned (re)conceptualisation of architecture as a process of boundary-drawing. This pattern has recently reappeared in force in reaction to the rise of platform urbanism, seeking to resist or repurpose it through manifolds of collective assembly.

At one end of the spectrum, boundaries are conceived as limits that define both material form and political capacity. This position is well-illustrated in the research project *Platforms: Architecture and the Use of the Ground* by Pier Vittorio Aureli and Martino Tattara of Dogma.[73] [Fig. 6–7] As a counterpoint to the discourse of platform urbanism, the project centres on the platform archetype as a material-ordering apparatus. Platforms are defined, in their physical, political and digital manifestation, as 'spaces that at once facilitate and condition use. The platform therefore embodies the quintessential meaning of institutional power since, like institutions, such structures are apparatuses of social order, their functions based on the stability of recurring patterns of behaviour.'[74] Dogma's architectural genealogy of the platform as a raised level surface spans from its prehistoric role in the beginnings of sedentary lifestyles to subsequent manifestations as 'means for both communal gatherings and social asymmetry.'[75] Through this emphasis on framing and delineating functions, the research aligns with Dogma's broader stance that architectural form serves to define and delimit space, thereby constituting a common ground from which to resist the commodifying flows of global capitalist urbanisation, including platform urbanism.[76] For instance, in an earlier text Aureli links the concept of the 'common' in architecture to that of 'type', interpreting the latter (via Aldo Rossi) as a structuring principle tied to a particular historical, social and political condition. Actualised in tangible urban artefacts, types constitute a common, inexhaustible, ideal realm of potentiality for giving form to the city.[77] In 'Platforms' Aureli and Tattara draw on formally austere examples such as Adolphe Appia's scenographic designs and Aldo van Eyck's playgrounds to espouse their 'defined and yet-unbound', utopian character that opens them to alternative uses 'beyond possession and control.'[78]

Architectural form alone, however, is insufficient to realise spatial justice, as Dogma themselves admit. Underlining this limitation, Tim Gough asks: 'is not the reduction of architecture and its possibilities of resistance to questions of architectural form precisely that – a *reduction* to a limited area of concern which disturbs neoliberalism not one bit.'[79] Similarly, fixation on the autonomy of formal archetypes risks overlooking the politics inherent in the more fluid boundary-topologies crisscrossing

Fig. 4: Charcoal Bang. Drawing courtesy of amid.cero9. A Civilization Without Homes research project (2018–19) on Korean jimjilbangs presented in the SBAU 2019.

Fig 5: Sleeping Room Bang, detail. Image courtesy of amid.cero9. A Civilization Without Homes research project (2018–19) on Korean jimjilbangs presented in the SBAU 2019.



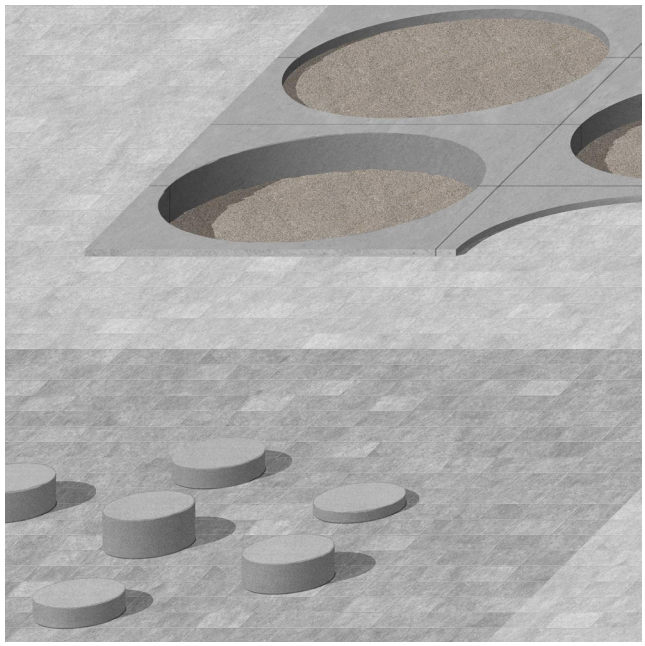


Fig. 6: Scenography for Christoph Gluck's Orpheus und Eurydike designed by Adolphe Appia, Festaal, Hellerau, 1909. From *Platforms: Architecture and the Use of the Ground,* 2019. Drawing courtesy of DOGMA.

Fig. 7: Sumatraplantsoen, Aldo van Eyck, Amsterdam, 1950–60. From *Platforms: Architecture and the Use of the Ground,* 2019. Drawing courtesy of DOGMA.

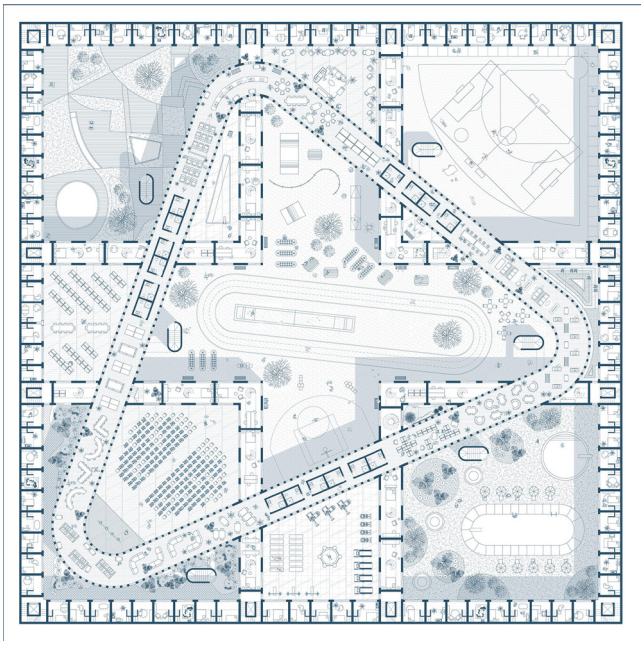


Fig. 8: ‘Fields’, from Commune Prototypes, 2021. Drawing courtesy of The Open Workshop.

Fig. 9: ‘Figures’, from Commune Prototypes, 2021. Drawing courtesy of The Open Workshop.

the contemporary city, including those of digital platforms. As Douglas Spencer reminds us,

> The production and articulation of networks, the channelling of subjects according to preferred patterns of movement and association, in fact the very act of dismantling limits and boundaries is … a political practice. It is the politics of this practice … that needs to be contested, rather than discounted *tout court* as a manifestation of the unlimited.[80]

Another, more processual approach considers the ways material assemblies interface with less formally determinate systems. This move parallels the shift from the relatively static notion of commons to that of dynamic 'commoning', as outlined in 'Commoning Domestic Space' by Neeraj Bhatia of The Open Workshop. Incorporating case-study research and speculative design, the project explores 'the dialectic of individual distinction and collective equality' through which 'the public realm becomes the arena for political negotiation.'[81] It takes a critical stance on the proliferation of private micro-apartments and the individualistic lifestyles they promote, which are in turn enabled and complemented by services offered across digital platforms, from food delivery to remote storage. Conversely, the research surveys realised and unbuilt examples of co-housing, analysing the configuration of three components: 'hardware' (spatial arrangements and public-private interfaces), 'software' (social profiles of inhabitants, including family structure and practices of sharing) and 'orgware' (structures of governance and the distribution of labour, resources and power).[82] In turn, five 'Commune Prototypes' derived from the study – titled 'Grids', 'Rooms', 'Figures', 'Fields' and 'Surface' – 'examine differing relationships between the private and public realm – from highly defined and delineated to fluid and malleable. In each case, a technique of form informs the typological arrangement.'[83] [Fig. 8–9] The focus on the interface between spatial, social and organisational arrangements provides a critical lens onto the commodified permutations of co-living under platform-urbanism, which are often collective in name only. Yet despite the interest in relationality across hard/soft/orgware, the preoccupation with formal or geometrical distinctions in these prototypes hinders a more generative, topological understanding of the modulation of boundaries.

A thoroughly processual topology of boundaries is articulated through the notion of the threshold by Stavros Stavrides. As he argues, 'Thresholds may appear to be mere boundaries that separate an inside from an outside, as in a door's threshold, but this act of separation is always and simultaneously an act of connection.'[84] Against the 'archipelago' model of urbanism that informs a positive conception of limits (such as in Aureli's work), Stavrides conceives commoning as an ongoing process characterised by threshold spatiality and temporality. Common space is thus a liminal experience, 'not an accomplished state of things, a concrete materiality, but a process … [that] keeps on producing those who produce it. The production and uses of common space cannot be separated.'[85] It follows that a radically relational notion of collective assembly exceeds spatial taxonomies based on legal, political or economic criteria as well as the binaries of public versus private and collective versus individual: common space 'keeps on destroying the boundaries between public and private not by absorbing one into the other … but by transforming their historically shaped antithesis into a myriad of new syntheses.'[86] The threshold-characteristic of commoning, then, resonates with the broad assortment of boundary apparatuses elaborated in Teyssot's techno-ecological topology:

> Un*fold*ing their 'duplicity,' walls and fences, doors and windows – today, the various screens that organize the face (surface) and the interface of our mediating with the world – can lead to inversions and displacements. The door that closes is precisely that which may be opened, as the river is what makes a crossing possible.[87]

Seen topologically, a common thread running through these manifolds is the way in which dwelling is enacted through the always-politicised process of articulating boundaries – whether amid a physical urban platform, across architectural thresholds or via electronic interfaces, or most likely, involving all of the above.

Distributed protocols

The third contemporary manifold takes the form of zooming out from the game pieces to the rules of the game, rethinking the topological protocols that underlie architecture and dwelling. It focuses attention on the relational substrate of environmentality – its modulatory, 'protocological' mode of control – and seeks to alter and subvert it through counter-protocols. Responding to the shift from disciplinary to control societies, Alexander Galloway appropriates the notion of the computer protocol – the rules that define and govern the operation of digital networks – using it to describe the underlying distributed logic of technological control of our environmentalitarian epoch. Insofar as 'shared protocols are what defines the landscape of the network – who is connected to whom', Galloway contends that resistance to the protocological forces of contemporary digital capitalism needs to take place '*through* protocol … not against it', by unfurling its restrictive topologies into more empowering ones.[88]

These provocations find a clear architectural analogue in the work of Keller Easterling, whose conceptualisation of 'infrastructure space' and 'medium design' is inflected by topological thinking. For Easterling, space constitutes a medium in the sense of a milieu. Far from a backdrop to the objects of architecture, it is an information-rich substrate, 'a soupy matrix of details and repeatable formulas that generate most of the space in the world', from communication networks and global production chains to highway design specifications and suburban subdivisions.[89] Easterling argues that the architectural discipline, for the most part, is preoccupied with making 'unique objects – like stones in the water – whereas a constant flow of repeatable spatial formulas constructs a sea of urban space'.[90] In order to extend their reach and relevance, Easterling suggests that architects become proficient in the language of this 'infrastructure space' and learn to rework the logics underlying its relational arrangements. She refers to these logics as 'disposition', 'the agency or potential immanent in an arrangement – a property or propensity within a context or relationship'.[91] Topology is often used by Easterling in the specific sense of the 'wiring' of networks, but underlies her work in its broader sense of intensive relationships. It forms a part of the repertoire of redesigning disposition through spatial software or '*protocols of interplay* – not things but parameters for how things interact with each other.'[92] Importantly, these protocols are not premised or based on digital networks or 'smart' devices; rather, digitality is recast as one among the many mediums of infrastructure space.

To illustrate this approach in the context of dwelling, Easterling's 'Subtraction Protocols' explores various unfolding scenarios in which the demolition of housing becomes an opportunity for more convivial spatial arrangements. [Fig. 10–12] For instance, the 'Forest/Jungle Protocol' proposes to manage suburban sprawl and deforestation in Kenya through housing densification by leveraging a reduction in road infrastructure with burgeoning broadband connectivity.[93] Similarly, her 'McMansion Protocol' considers the North American single-family home through its capacities in addition to being a financial asset, such as material assembly, energy production, biodiversity, carbon storage and resilience to natural disasters. The protocol compounds these interdependencies to facilitate urban densification through strategic demolition.[94]

In a recent co-authored article on relational infrastructures, Easterling and activist Kenneth Bailey explore public kitchens as an example of 'relational platforms'.[95] Bailey and Easterling argue that, conceived as 'essential infrastructure', public, accessible kitchens have the potential to rewire

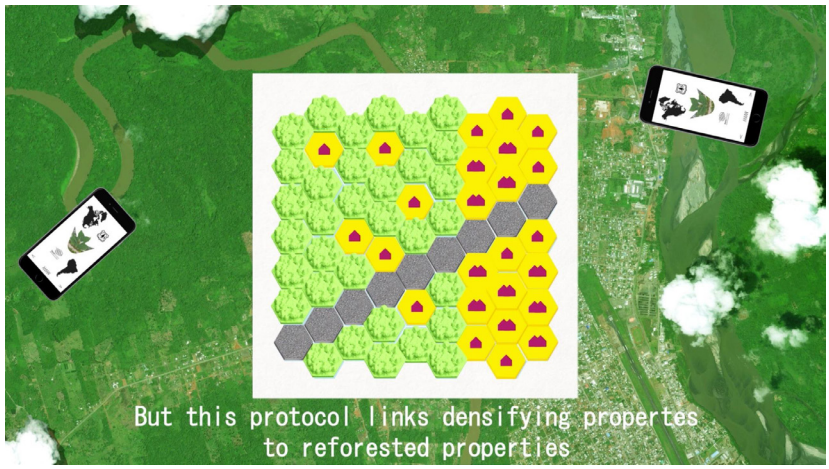


Fig. 10: Subtraction Protocol Forest/Jungle, 2014. Drawing courtesy of Keller Easterling.

Fig. 11: Subtraction Protocol Forest, 2019, video still courtesy of Keller Easterling.

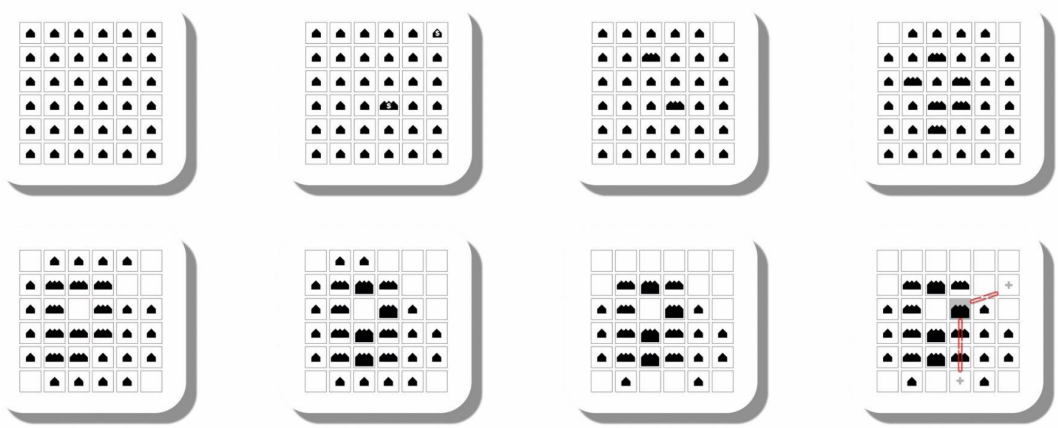


Fig. 12: Subtraction Protocol 1 McMansion, 2011. Drawing courtesy of Keller Easterling.

relationships in the city and 'model completely new arrangements of communities'.[96] They further suggest that

> the real power of relational infrastructures like transportation switches or alternative land holding organs and public kitchens is the way that they can make something from almost nothing in a way that benefits many. They do not always require steel or concrete. Even a modest investment can generate new physical arrangements in space and create compounding decommodified values in a community economy.[97]

Involving both 'heavy' spatial variables and reconfigured material, economic and social relationships, these protocols exemplify a topological rethinking of (platform) urbanism and domesticity beyond the limited sense of digitally mediated interactions. In a sense, architects and designers already tacitly engage systems in this manner; however, this approach can be made more explicit, extended, and refracted into theory. In this way, the examples from the previous two sections may also be productively read through this counter-protocological approach, recasting them as protocols of condividuality and commoning.

Conclusion

In all of the aforementioned examples, the key shift is toward a topological understanding of architecture and space, using its relational character to critically reflect on the way designs relate to systems of power and control. This shift positions architects to respond to the increasingly relational, systemic, protocol-shaped, and digitally mediated nature of both governance and dwelling. A topological approach creates potential by allowing new modes of mapping, critiquing, resisting and subverting the unequally distributed agency and power underlying the circuits of platform urbanism, and environmentality more generally.

Topology provides resources to analyse and critique these restricted manifolds, and also engenders a broader, radically relational reconceptualization of dwelling across spatial, technical and social ecologies. For instance, the examples under 'condividual networks' engage the reality of digitally mediated, networked living and speculate on its potentials beyond extractive models such as platform-managed co-living or the encroachment of Big Tech on housing. Crucial in these proposals is the particular topology of condividuality – the delicate interplay of belonging and dispossession – which determines where they land on the spectrum of conviviality and alienation. Conversely, experiments in 'commoning boundaries' generally begin from an opposition to the often depoliticising force of distributed networks and rally around forms and practices of collectivity. Seen through a topological lens, the efficacy of these approaches hinges on the extent to which they conceive commoning not as ground-making but boundary-drawing – selectively filtering, framing and connecting entities across material, technical and social realms. Finally, 'distributed protocols' take aim at the environmentalised, modulatory logics underlying platform urbanism, simultaneously unmasking its restricted topologies of decentralised power, and pursuing alternative entanglements. This last trajectory remains largely to be explored by architects, and thus harbours the greatest potential.

Topological modes of thinking help us apprehend the boundary-drawing processes through which relations are materialised and articulated – 'cut together-apart', as Barad puts it.[98] Contemporary manifolds of dwelling involve both entangled material arrangements and digital networks. They are not static enclosures or flat surfaces; instead, they are dynamically (re)configured and, in turn, they reconfigure us. The topologies embodied in these interactions shape varying degrees of agency, democratic control and possible forms of association. Architects and designers have recently employed topological modes of analysis to treat these as key arenas of investigation and sites of spatio-political struggle. For these designers,

thinking the architecture of dwelling topologically brings questions of ethics and politics into sharper focus.

Notes

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Biography

Roy Cloutier, Nicole Sylvia, and Lőrinc Vass are the founding members of Contingent, a multi-disciplinary research and design collective established in 2017 in Vancouver. Contingent's work seeks out new material and social arrangements and forms of coexistence attuned to contemporary social and ecological challenges. Recent drawn and written speculations examine agency, control and indeterminacy in design, specifically focusing on spatialisations of collectivity, decentralised domesticity, emergent nature-cultures, and drawing as a commoning practice. These have been published in numerous books, journals, and conferences – most recently in *Footprint*, *Bracket Journal*, and the book *Design Commons: Practices, Processes, and Crossovers* (Springer). In 2022, Contingent's design and research project *Lots in Common* received first prize in the Urbanarium Mixing Middle Competition. Roy Cloutier and Nicole Sylvia are adjunct professors at the School of Architecture + Landscape Architecture at the University of British Columbia, and architectural designers at Patkau Architects in Vancouver. Lőrinc Vass has taught at UBC SALA as a sessional lecturer and is an architectural designer at Pechet Studio in Vancouver. Web: www.contingent.site

Infinite but Tiny: Towards a Hybrid Architecture of Dwelling

Georgios Eftaxiopoulos and María Álvarez García

Ten years after the turn of the millennium a new movement started to take shape in the United States, which believed in the possibility of living with fewer things, even asking, 'Is it possible to own nothing?' The pioneer of this way of life – the Cult of Less – was Michael Kelly Sutton, an American software engineer born in 1987. He started the movement by selling almost all his belongings until he managed to live out of only 'two suitcases and two smallish boxes'.[1] According to Sutton, all of his music was already '100 per cent' digital, so he did not have any CDs ('I just have an iTunes library'), nor did he own any DVDs ('I just rent movies on occasion from iTunes or stream them using Netflix'); even his books could be contained within a Kindle, 'so now I can just read whatever book I want on the device'.[2] Sutton argued that much stress and anxiety could be reduced by taking stock of possessions and bluntly asking oneself 'What do you really need?' Soon other people followed, who took the movement further by deciding to live on the road. Chris Yurista, a DJ from Washington DC, and Joshua Klein, a New York City-based technology innovation consultant, digitised as much as they could of what they owned and started living out on the streets. They no longer needed to worry about the state of their belongings, about cleaning or organising them, since their new digital goods 'can continue to live on indefinitely with little maintenance'.[3] For Yurista, 'the internet has replaced my need for an address'.[4]

This new way of living was only possible thanks to the rise, over the last quarter of the twentieth century, of the so-called service economy. By the end of the 1970s, 'the share of service industries ha[d] risen from 40 to over 60 per cent', reducing the dependency on muscle power and replacing it with intellectual and clerical skills.[5] Against static manufacturing, the service-based economy had caused 'more than 50 per cent of all US jobs [to be] centred in information-related activities'.[6] The changes in the nature of jobs and the advent of the World Wide Web finally made the mainstreaming of flexible work practices and telework possible, bringing along a new type of subject: the contemporary worker, who could work anywhere, at any time. This new flexible mentality did not only canonise connectivity but permitted the outflux of work beyond the traditional space of the office and diffused it across the city. Using in-between spaces such as coffee shops, libraries and co-working areas, the division between life and work became blurred. It was this hybrid mode of living and working which, coupled with cloud computing technologies and non-stop connectivity, constructed a continuous space of production for an increasingly mobile, dynamic and allegedly collaborative workforce. They were the 'catalyst' able to 'radically change the structure of American society in much the same way that the automobile acted as a catalyst on our way of life during the first half of [the twentieth] century.'[7] By the 2020s, the any time, anywhere work ethic had been successfully assimilated.

In this sense, the new digital vagabonds that emerged after Sutton had very little to do with earlier radically minimal ways of living, such as the hermits in fourth-century Europe who withdrew from

the world not only as the result of the institutionalisation of the church, but also as an escape from 'the oppressive conditions of urban life'.[8] The hermit who chose to live a life of solitude, separated from both family and community, was renouncing a mundane life. Sutton's idea of dispossession could not be further away from the famous Franciscan vow to live without property – *vivire sine propio* – when establishing 'use' as a radical alternative to ownership. The understanding of use proposed by Saint Francis, *usus pauper*, presented an alternative way of life. Yet, the philosophy established by the Cult of Less and its followers was not one based on renouncement, but on substitution. As Sutton had predicted, 'cutting down on physical commodities in general' meant 'cutting down on physical commodities that can be replaced by digital counterparts'.[9] The Cult of Less did not propose the renouncement of material things only in order to optimise space, but to have access to a digital world of infinite possibilities. Thus, the promoted 'digital minimalism' could rather be understood as 'digital maximalism'. Why have just twenty – or two hundred – records when you can have access to all sorts of music for just a few dollars' subscription? In this sense, the sphere of consumerism was not transformed, but shifted from the real to the virtual realm. This new life is no less dependent on superfluous things; on the contrary, it relies excessively on digital storage. However, although the Cult of Less had little impact on our form of life, dominated as it is by a capitalist ethos, it did have a huge impact on our form of dwelling: in the twenty-first century, living between the material and the virtual realms of commodities became truly possible.

A new kind of space

What started as those new 'digital counterparts' that could be stored in the cloud – music, photos, videos, books and the like – were soon followed by digital social relationships, triggered by the widespread use of social media.[10] The latest step in this process would be the digitalisation of one's spatial surroundings and, potentially, one's subjectivity. It took place on 28 October 2021, when Mark Zuckerberg, CEO of Meta, announced the company's vision for a 'beyond universe' with constant connection and where someone could feel present irrespective of distance: 'Imagine you put on your glasses … and you are instantly in your home space. It has parts of your physical home, … it has things that are only possible virtually and it has an incredibly inspiring view'.[11] The metaverse, as Zuckerberg explained, could be described as the three-dimensionalisation of the internet, occupied 'with people from all over the world, online avatars, and commerce platforms'.[12] [Fig. 1] In this sense, through the use of both virtual and augmented reality, the metaverse will not only create a realm of infinite possibilities, but it also aspires to redefine the way in which we relate with one another and, ultimately, to redefine life itself.

Originally, the term 'metaverse' was coined by Neal Stephenson in his 1992 science fiction novel *Snow Crash*.[13] Similar to the way Zuckerberg would describe it almost three decades later, Stephenson imagined a three-dimensional virtual realm where 'physical, augmented, and virtual reality' converged in 'a shared online space.'[14] In the story, the metaverse emerged in response to a collapsed global economy in the form of an urban environment developed around a single wide street. It was conceived as a terrain of real estate supported by equidistant service points and different transportation modes, and it stretched across the entire circumference of a fictional planet. The space, accessed through personal and public terminals and experienced in a first-person perspective, allowed the development of a group of people who chose to be continuously connected. As Ken Friedman explained in 1998, Stephenson's metaverse 'could be considered a glorified chat room with total-body surround made possible by a sophisticated system of earphones and goggles that allowed individuals to live and act.'[15]

Fig. 1: One of the spaces presented during Mark Zuckerberg's introduction to the metaverse. Screenshot from Meta, 'The Metaverse and How We'll Build It Together: Connect 2021', *YouTube*, 28 October 2021.

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In fact, Stephenson conceived the metaverse parallel to the rise of online gaming environments and the emergence of virtual worlds. In the early 1970s, the first developments in the video-game industry such as those from Atari, dwelled on the construction of digital built environments from scratch, and from the early 1990s, the mimetic realism of the new massively multiplayer online role-playing games (MMORPG) took the lead in the reproduction of real-world environments into virtual worlds.[16] However, it would be the next generation of platforms in the early 2000s, such as *The Sims Online* (2002) and *Second Life* (2003) that, unlike traditional video games designed to be finished products – both copyrighted and goal-oriented – came closer to what the author of *Snow Crash* had originally envisioned. These have become the true 'harbinger[s] of a 3D environment', able to provide 'a richer, more expressive interactive environment than today's internet.'[17] By erasing obligatory levels to complete as the fundamental part of the game, they provided an experience that has no finality. The absence of goals is taken over by a 'platform which provides a real-world quality that is lacking in other modes of computer mediated communication.'[18] As a result, a new spatial communicative paradigm emerged that escapes from the inefficiencies found in computer-mediated communication such as emails, instant messaging and chat rooms. Within this virtual space one can establish a new virtual community, and explore it by immersing oneself in it.

The immersiveness of perception, which has been an intrinsic characteristic of some MMORPG and the dawn of the metaverse, has an earlier precedent in the multiscreen and multimedia techniques of information presentation. Spaces like those of war situation rooms, TV control rooms or even traffic control rooms, in which a wall, filled with screens, embraces its viewers and presents them with multiple perspectives of different scenes to provide a comprehensive understanding of a complex environment. As Beatriz Colomina has argued, 'designers, architects, and artists were involved from the beginning' and played 'a crucial role in the evolution' of these modes of presenting information.[19] Perhaps one of the earliest and clearest examples is the 1959 American exhibition in Moscow, for which Charles and Ray Eames imagined 'a new kind of space'. [Fig. 2] It consisted of seven twenty-by-thirty-foot (six by nine metres) screens suspended within the 250 foot-diameter (seventy-six metres) golden geodesic dome designed by Buckminster Fuller. The screens projected *Glimpses of USA*, a movie by the Eames composed of thousands of images from many different sources, showcasing the American lifestyle to the people of the USSR. The effect of the exhibition's immersive experience 'was so convincing that apparently some people even smelled things when no smells were introduced, only a suggestion in an image or a sound'.[20] Yet, as Colomina explains, 'the Eameses' innovative technique did not simply present the audience with a new way of seeing things. Rather, it gave form to a new mode of perception that was already in everybody's mind' and 'manifest[ed] in television, space programs, and military operations.'[21] It was a mode of perception that altered linear discourse, so conflicting interests and different viewpoints could be explored at once.[22]

With the metaverse, a complete immersive virtual experience is closer than ever. Rather than merely viewing content through small glowing screens, users, immersed in this created environment, experience what they could not have experienced on a simple 2D app or web page. In the so-called next chapter of the internet, 'people will hang out, you'll be able to really feel like you're present with other people, you'll be able to do all kinds of different work, there'll be new jobs, new forms of entertainment.'[23] In fact, this will be what the company has described as their 'big transformative idea'. [24] The metaverse would be the emergence of 'the internet from being lonely and empty to being a place that always has other live people in it'.[25] In this sense, Zuckerberg's announcement came right on time after a year and

a half of strict government-imposed lockdowns and quarantines that had created a context of deserted cities, empty offices, closed shops, and most importantly, no physical interaction. The Covid-19 pandemic had forced tens of millions of people to self-isolate. Online meetings on Zoom, Teams, and Skype replaced physical contact. Grids of names and faces took over and became the environment in which to relax, meet with friends and escape the four walls of our homes.

But the metaverse 'already feels almost more real, and more like you have a sense of space, than a Zoom call.'[26] This sense of space would be developed further by the ambition that, in the metaverse, all different systems and platforms would be knit together. Movement within the space will not be restricted to the company that owns the specific platform. Instead, instantaneously, people will have the possibility to switch between spaces or withdraw into a separate place. According to Matthew Ball, an established venture capitalist and expert on the emergence of the metaverse, the metaverse will be characterised by 'unprecedented interoperability'.[27] Within it, from virtual identities to digital goods, from avatars to new creations, all would have the possibility to move across platforms. This unrestricted vision, against today's barely interoperable and siloed platforms, fosters the possibility for a seamless use and transition in the metaverse. It is precisely this free movement in space that makes the growth of a myriad of experiences possible in live mode. As an infinite and real-time space, the metaverse 'will be persistent – which is to say, it never "resets" or "pauses" or "ends", it just continues indefinitely.'[28] It will be a space that will always be on, facilitating the possibility to live synchronous experiences.

This synchronicity is clearly communicated in Meta's advertisement, 'The Tiger and the Buffalo'. The advert is set in a museum, where four teenagers come together to realise that, on a painting, the tiger's eyes are moving. After a moment, the tiger looks at them and says: 'this is the dimension of imagination'.[29] Music starts to play and all the animals in the painting start to move their heads to the rhythm. Soon the teenagers, mesmerised by the image, join in, suggesting that what happens in the metaverse, happens in sync with reality. [Fig. 3] Contrary to previous lifeless virtual spaces, where interaction was reduced to a repetition of predescribed mechanical responses, the metaverse is presented as a space full of life. People's actions in the metaverse would be coming directly from the real world. They would be 'spontaneous', 'instilling in the virtual world a real-world sensibility.'[30] The presence of such real-world features, amounting to multimodal communication, would facilitate a great fluidity and regularity across multiple levels. Whether this is between the participants' real selves and their avatars or among participants, this interactively enhanced virtual world would be further supported by users' possibility to explore a variety of activities but also create and amend the virtual landscape themselves. As Meta's advertisement concludes: 'this is going to be fun.'[31]

The next labour platform

Yet, as Ball points out, the metaverse should not be perceived as a game or a mere virtual theme park. Instead, 'in its full vision, the metaverse becomes the gateway to most digital experiences, a key component of all physical ones, and the next great labour platform.'[32] It presents an ideal workspace of new capabilities that expands Meta's Infinite Office, a personal virtual office space.[33] Built upon studies that indicate the effectiveness of someone when working on multiple and related things at once, this future will enable the possibility to 'pull up your perfect workstation … anywhere you go, … all set up, … all preconfigured to the way you had it', all 'with basically a snap of your fingers'.[34] It allows the development of an economy of virtual labourers able to work remotely. Unbound to geographical locations, via the metaverse companies could potentially overcome local labour shortages, and workers could live beyond commuting distances.

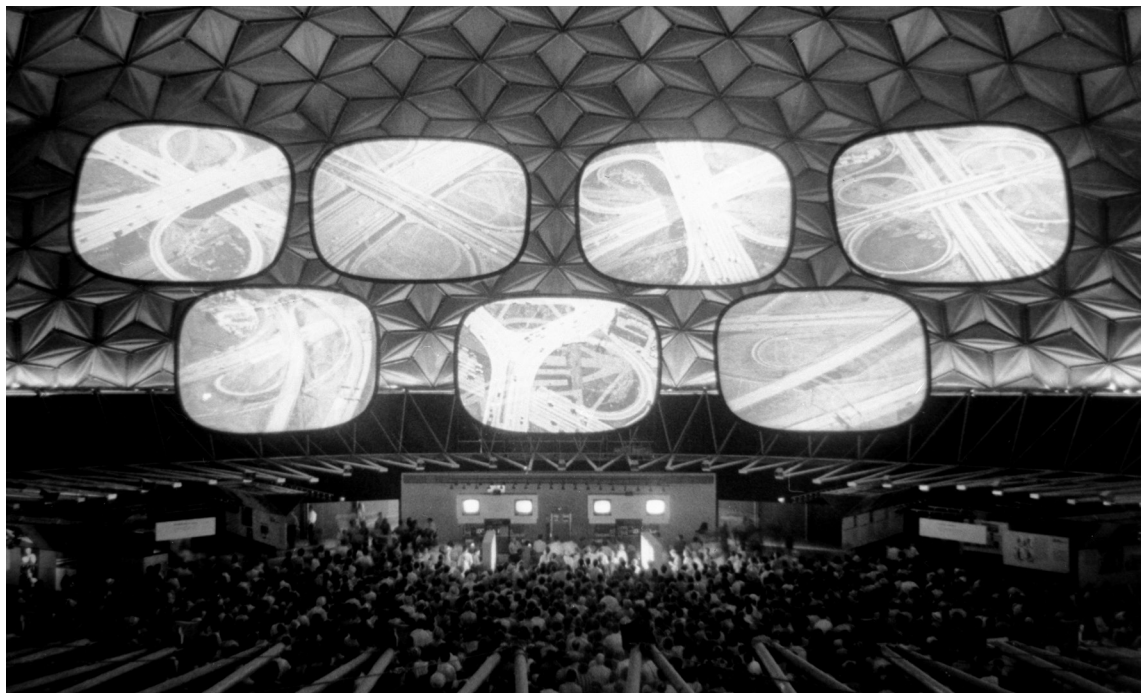

Fig. 2: Multi-screen presentation by Charles and Ray Eames, ‘Glimpses of the USA’, shown to an audience in the geodesic dome theatre by Buckminster Fuller at the American National Exhibition in Moscow, 28 August 1959.

Fig. 3: Screenshot from Meta, ‘The Tiger & The Buffalo’, *YouTube,* 4 November 2021.

Changes to employees' working and living routines caused by the pandemic are thus materialised, consolidating a model of remote work.

Certainly, the idea of remote work is not new. In the 1970s, Jack Nilles, director of interdisciplinary research at the University of Southern California, delinked work from the central-business-district location and proposed a diffused work society organised into subunits or 'new centres'. He described a modified mode of working and living that cut down on US automobile dependency that ultimately relied on finite oil reserves. Thanks to emerging telecommunications and computer technologies, he envisioned a complete transformation in the geography of work, with the role of the central office replaced by a flexible model where information industry workers could 'perform their work … at locations much closer to their homes', or else 'telecommute'.[35] [Fig. 4] In a sense, Nilles did not read the 'problem' as one of transportation, but as one of communication. In a similar way, in 1979 Frank Schiff, vice president of the Committee for Economic Development, concluded his *Washington Post* article 'Working at Home Can Save Gasoline' by asking 'Why not give it a try?' Surprised to notice that no extensive attention had been paid to the scenario of remote work, especially when working tools like distant access to stored data and portable terminals had started to emerge, Schiff endorsed an 'Industrial Revolution in reverse'. According to him, it was about the growth of 'new types of "cottage" industries', similar to those that had proliferated during the pre-industrial period before they were taken over by the 'rigid disciplines of the factory process'.[36] [Fig. 5] The repatriation of work to its 'home' was about to take place.

However, the response to Schiff's question was more complex than originally imagined. According to Nilles, this change was not only a matter of the advent and widespread diffusion of mobile and affordable technologies across the market, such as personal computers, teleconferencing software and fibre-optic systems. Beyond the potential proliferation of relatively inexpensive technological products, interventions at a higher level and broader scale became imperative. Whether at the level of federal regulations or state legislation, the development of policy changes played a key role in influencing the decision of an organisation towards decentralisation.[37] And yet, irrespective of the period's technological advancements and the progressive shift towards a different legislative framework, companies were hesitant to permit their employees to work remotely. On the one hand, the change required spending on training and the employees' adjustment to the new environment, and on the other, it mandated that companies 'keep a more careful eye on [their] employees' and secured the possibility for distant supervision.[38] Precisely such difficulties rendered this shift unrealizable at the time.

Nonetheless, in nowadays post-industrial post-pandemic context, everything is ready for this change. Flexible and mobile, today's globalised and digitalised culture and workforce could shift to an extreme stage of diffusion instantly, and at a significantly reduced cost to the employers. Almost fifty years after the conception of remote work, the global health crisis of Covid-19 became the force for decentralisation that had not been available before. It was the tipping point that, by capitalising on a highly compatible terrain, managed to alter things and convert remote work from home into the norm. With hardly any objection, the 'giant experiment', nurtured for half a century, swiftly increased the portion of the workforce working from home from 3 to 42 per cent.[39] The pandemic eroded the last remaining barriers between life and work. According to Daniel Pinto, J.P. Morgan's co-president and COO, there is 'zero chance' of going back to a pre-pandemic mode of work.[40] Earlier fears over employees' productivity levels are now allayed by data to the contrary. Online retailers like Amazon, financial service providers like American Express, sharing platform enterprises like Dropbox, and social media networks like Meta, all progressively

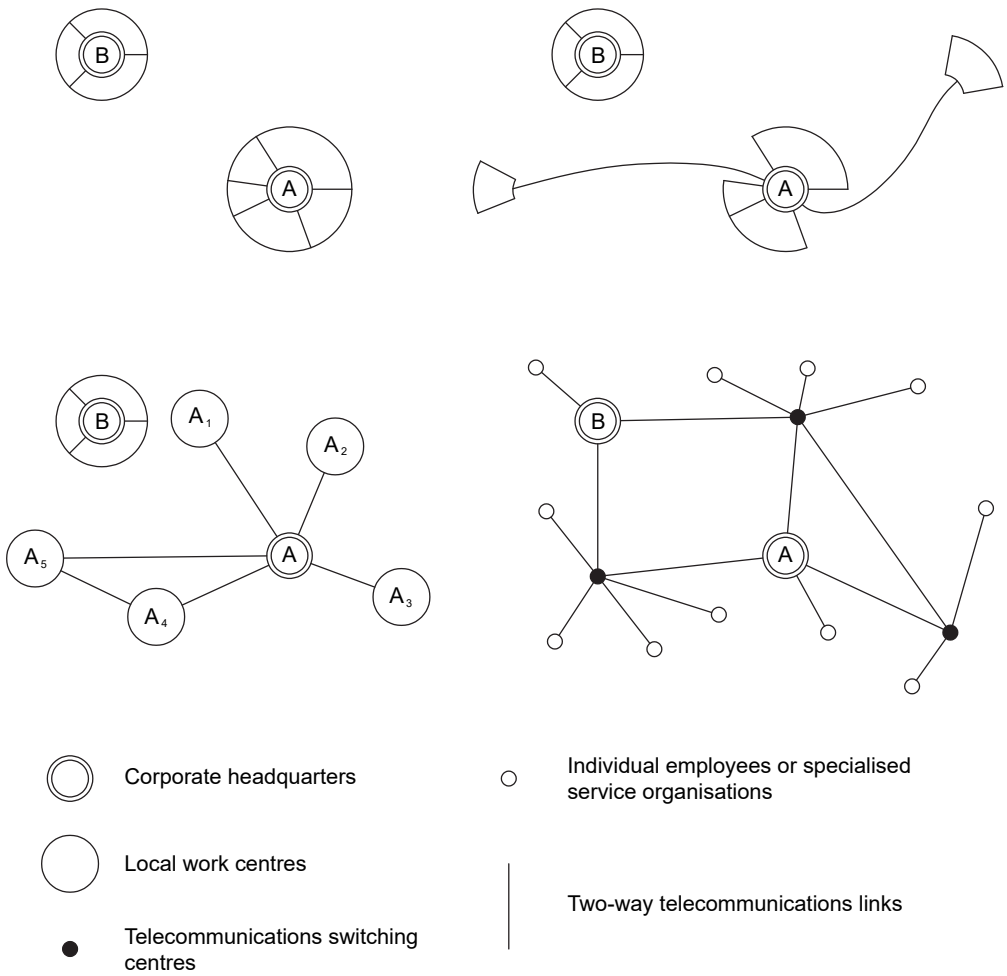

Fig. 4: Organisational evolution for two cases, Corporation A and B: (a) centralization; (b) fragmentation; (c) dispersion; (d) diffusion. Diagram: Jack M. Nilles, *The Telecommunications-Transportation Tradeoff*, redrawn by the authors.

substituted temporary work-from-home arrangements with long-term schemes.[41] Whether these are remote-first models of work or hybrid models with different ratios of remote and face-to-face work, telework is today the new status quo.

If Nilles or Schiff's visions did not succeed during the last quarter of the twentieth century, the new 'telecommuting' facilitated by the metaverse provides the possibility to advance telework further. Today, following the pandemic, the 'dream' model of remote work is here to stay. The service workers' incredibly fast reflexes, legislative frameworks and supervision technologies are well established, while the possibility provided by the metaverse to not only telework but potentially teleport, would elevate such a premise. As Zuckerberg claimed, 'a realised metaverse could be the next best thing to a working teleportation device.'[42] In this sense, by utilising the latest technologies – from virtual reality and augmented reality equipment, to tablets and smartphones – the metaverse re-constructs a process of naturalisation. In Zuckerberg's words, 'I don't think that this is primarily about being engaged with the internet more. I think it's about being engaged more naturally.'[43] Different from navigating through a grid of apps, the metaverse employs elements such as a sense of space and presence, towards the development of a more 'natural' experience: an experience that ultimately argues to become more comfortable, more familiar and more homely. In the metaverse, interactions 'will be a lot richer, they'll feel real.'[44] It promises to provide the capacity to not only deal with, but literally face any problem and be there for any situation or discussion.

Unrestricted by caps on concurrent users, or the number and size of screens, in the metaverse, someone may not only share as much content as they want during a meeting, but can also 'customise their office space, and have it feel like … a digital continuation' of their physical working place.[45] It is precisely through such an approach that, beyond replicating the work patterns of a contemporary office, the metaverse will prepare the ground for new types of work and life that aspire to span among the physical and virtual worlds. It intends to create a new inhabitable space in the interoperable digital realm which appears to be no different from the accessible physical reality.[46] It will be a brand-new, infinite built environment that relies on the same real-world experiential principles, ultimately, becoming 'an extension of the real world that includes not just a physical appearance, but also cultural and social interaction, aesthetic appreciation, and philosophical engagement.'[47] In this way, the metaverse seeks to become the ultimate model not only for a new hybrid mode of working, but for a new way of dwelling – between the virtual and the real world – that will eventually reshape the very architecture of the home.

Happy homes

Less than a month after Zuckerberg's presentation, Ikea, the Swedish furniture giant, launched its latest project Tiny Homes. Located in Tokyo's Shinjuku district, the ten-square-metre apartment condenses the kitchen, bathroom, living and sleeping areas into a single volume designed and laid out with Ikea furniture: an extremely small, cheap, and optimised apartment containing all the necessary services for living. [Fig. 6] Ikea's project did not signify the company's expansion into the real estate business, but intended to prove that Ikea's solutions could fit the ever-shrinking apartments offered on the Tokyo real estate market.[48] In fact, the project emerged as an advertising campaign carried out by the Tokyo branch of the Wieden+Kennedy advertising agency. The idea was quite simple: they would rent one of the city's micro-apartments, furnish it with Ikea solutions, and advertise it via the traditional real estate agencies at an extremely low rate, only ninety-nine yen per month (seventy euro cents). The low price would inevitably draw attention to the apartment, and consequently, to Ikea's products. As Max Pilwat, the creative director, stated in an interview, 'by truly solving a tiny living space with

Fig. 5: Cottage industry. William Hincks, *Twelve Engravings Illustrating the Manufacture of Linen in Ireland* (London: Wm. Hincks, 1783), Plate 4.

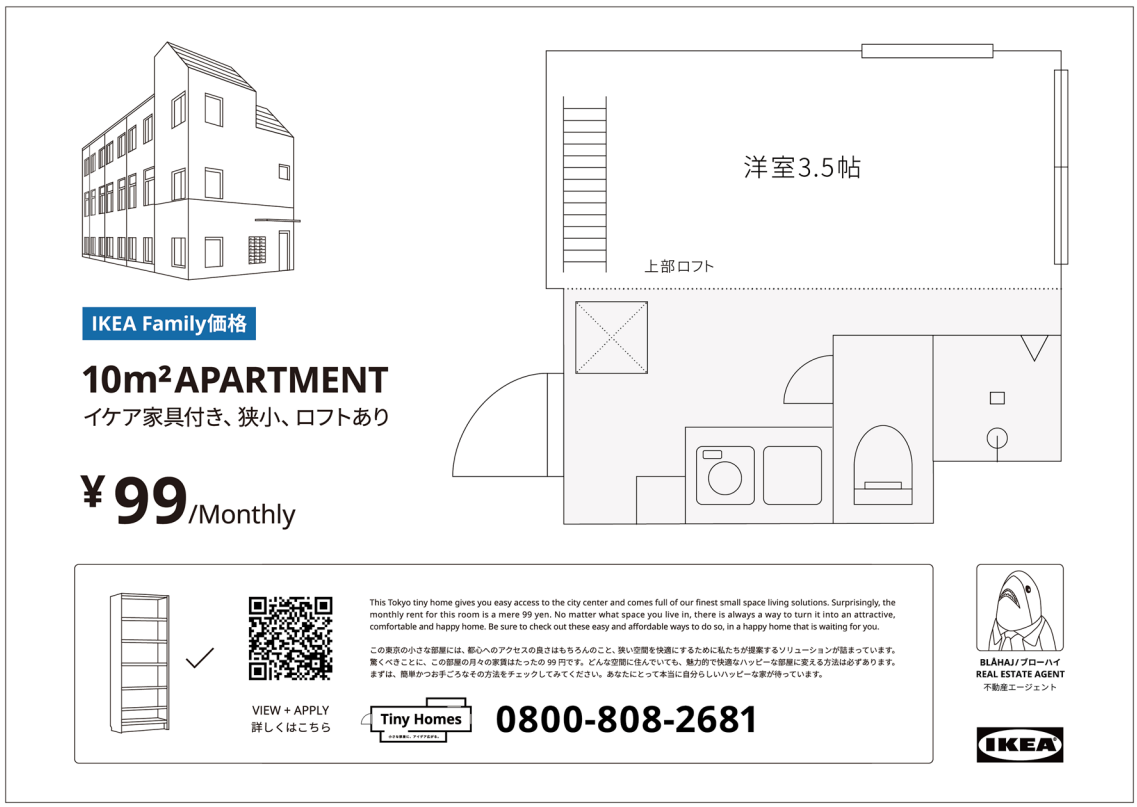

Fig. 6: Floor plan of the apartment just big enough to accommodate a single person. Image: Ikea Japan.

Fig. 7a, 7b: The before/after transformation of the Tiny Homes apartment in Tokyo. Image: Ikea Japan.

Ikea, we directly debunked the myth that Ikea furniture isn't made for Japan's small spaces.'[49]

The campaign was thoroughly curated. On the one hand, the chosen space needed to be carefully selected to convey 'a stark contrast' as part of a before-and-after transformation. [Fig. 7a,7b] As a result, the selection did not include any of Tokyo's micro-apartments, but one with an appealing volume. That way, beyond the few square metres of its floor plan, its height could be used to show the infinite possibilities of a three-dimensional space that, despite its smallness, could provide its inhabitant with a tiny double-height living room. Within it, anything is possible, from work to rest to, even, a party.[50] On the other hand, the campaign targeted a specific demographic: the young contemporary workers born as part of a service economy that promotes 'sharing' rather than 'owning'. In this sense, Blåhaj, a shark cartoon that '[came] out of the vast ocean' in Sweden 'to expand the possibilities of what you can do with small rooms' in Tokyo, became instrumental in communicating with an audience familiar with TikTok filters and animated avatars.[51] [Fig. 8] It played the role of an Ikea real estate agent that teamed up with an Ikea interior design team to transform the tiny flat into the 'happy … aspirational home that people would want to live in'.[52] The story, similar to a Netflix series, was delivered in different episodes and soon went viral not only in Japan, but also in other countries such as Russia and China.

The Ikea Tiny Homes campaign was a response to the new phenomenon of condensed dwellings that had started to populate the urban landscapes of global cities like Tokyo, Hong Kong, London, and San Francisco. Despite their lack of square metres – usually these units can only accommodate a bed, a cooking appliance, a small toilet, and some storage – micro-apartments appear to suit the needs of a generation who seems unconcerned with physical space. In fact, some political figures, like former New York mayor Michael Bloomberg, proposed the micro-apartment as a way to tackle the housing crisis by capitalising on this demographic change. In 2012, Bloomberg's office launched a competition for the construction of 'micro-flats'; they were to be an 'experiment', given that 'New York City's housing codes have not kept up with its changing population, and currently do not allow an entire building of micro-units.'[53] Thus, the mayor would commit to waive certain zoning regulations for the competition's site in Manhattan's Kips Bay neighbourhood, since the brief called for innovative ways of living together, even if within the ca. twenty-seven square metres 'these efficient, self-contained units [had to] include kitchens and bathrooms.'[54] The winning project by nARCHITECTS, completed in 2016, would become the first micro-apartment building in the US, with rental prices reaching as high as 2 800 euros per month.[55]

Unlike historical versions of the minimum living unit, such as rooms in boarding and communal houses, the kitchenless apartments of residential hotels, or even Japanese capsule hotels, which externalised most domestic activities, the contemporary micro-apartment condenses everything into the space of the home, reassuring its inhabitants with a certain sense of autonomy. These two opposing visions of the minimum dwelling were shaped by discussions on the housing shortage and degrading living conditions of the late 1920s. The idea of 'the minimum dwelling as a unit-sized reduction of the typical, bourgeois, single-family house' dominated most architects' proposals at the second CIAM congress held in Frankfurt in 1929, which was entirely dedicated to the question of the minimum dwelling.[56] In opposition to them, Karel Teige, a Czechoslovakian artist and critic, described an alternative way of living in his 1932 book *Nejmenší Byt* (published in English as *The Minimum Dwelling*). Instead of a condensed apartment, the minimum dwelling unit is defined as a 'minimal but adequate, independent, habitable room' supported by shared domestic services.[57] Meanwhile Teige's approach incorporated a collective ethos, the relation to the exterior that the architects of the *existenzminimum*

Fig. 8: Blåhaj, the shark mascot. Image: Ikea Japan.

envisaged is substituted by the promise of an alleged autonomy.

Yet, despite this autonomy, those minimum conditions provided within each dwelling would be highly reliant on the city's infrastructure. It was a process that started in the nineteenth century, when different districts were reorganised to be connected to different networks, and continued in the twentieth century, with the rise of domestic equipment that was able to shape a new living culture. As the architect Aristide Antonas explains, it would be precisely the possibility to freely plug in to this infrastructure that became, on the one hand, 'the first step in a culture of distinct shared systems', and on the other, a significant contribution 'to the decline of the community.'[58] The dominance of the city's infrastructure over its built fabric, over a common reading of life and dwelling, would form the foundation upon which the city would transform into a system of minimum cells devoid of any collective or shared functions.

The emergence of another network of infrastructure over the past decades, the internet, signified another key step forward in this transformation. After the 2008 economic crisis, in the 2020 Covid-19 pandemic those people lucky enough to remain in possession of their properties saw themselves forced to stay at home. Instead of enjoying what the city had to offer, the internet, via its platforms and the possibility to connect and play online video games, could act as a consolation. In fact, during both crises, sales of game hardware and software dramatically increased in North America.[59] As Nick Dyer-Witheford and Greig de Peuter point out, 'a maturing audience of stay-at-home gamers would cocoon around the Wii, Xbox 360, or PS3 or migrate to *World of Warcraft* or *Second Life* to enjoy a diversion from economic disaster.'[60] Thus, the constrained domestic space of the home, hit by the crisis and reduced even further towards the very minimum of a traditional flat, would expand into the virtual realm in order to provide an alternative to city life. The space of the minimum dwelling would extend beyond reality to virtuality through the infrastructural support of the internet, setting forth an array of possibilities as well as a place to escape from the burdensome circumstances of reality. This constitutes a new condition in which digital technology may have become as important as the need for shelter.

It would be precisely this canonised condition of infrastructural dependency that Ikea's Tiny Homes relies upon. Connected not only to the traditional city infrastructure but to the infinite network provided by the internet, Ikea's 'aspirational home' celebrates the micro-apartment that has become more autonomous than ever. By incorporating all the necessary domestic services – kitchen, toilet, laundry – within the unit, it answers the question of the minimum dwelling by continuing CIAM's predicaments of 1929. However, while in the 1920s, dwelling in a minimal space was expected to inspire in its inhabitants a certain material abstinence in search of defining 'real' human needs, today the direct behavioural consequence of residing in a space that has been reduced to the bare minimum translates into a new ethos of digital consumerism. Even if there is not a single digital device present in Ikea's Tiny Homes advertising campaign, their presence can be felt everywhere. As architect Nicholas Negroponte has remarked, 'like air and drinking water, being digital will be noticed only by its absence, not its presence.'[61] In fact, screens have already managed to colonise every ambience of the contemporary domestic space and soon, with the advent of the metaverse, all sorts of AR and VR equipment will become the indispensable mediator towards a virtually infinite productive terrain, in which every social and working relationship is relegated to the virtual. Understood as the architectural typology *par excellence* for today's global city, Tiny Homes celebrates the micro-apartment as the housing paradigm for a new service working class that has mastered a new mode of dwelling between the real and the virtual realm.

Towards a hybrid architecture of dwelling

In our current precarious context, the micro-apartment is becoming less a choice, as it was for the tech-savvy workers who embraced the Cult of Less, and more a last resort for many city dwellers across the globe. Yet, with the launch of the metaverse and its promise of a seamless connection of multiple realities, the condition of precarity, as defined by Paolo Virno and others, seems to take on a new shape, as is apparent in Ikea's Tiny Homes project. Both events – Meta's announcement of the metaverse and Ikea's Tiny Homes – appear to come together to naturalise this condition as a frictionless and comfortable state, free of worries about too many possessions and the burden of a fixed permanent house that requires care and maintenance. Such an 'absent' existence, disguised by the new 'freedoms' acquired via constant mobility and flexibility, is characterised by an utter uprootedness. Nearly a quarter of a century after Negroponte's 1998 article 'Beyond Digital', we are entering a period where digital and nondigital life are almost indistinguishable. The interplay 'between digital, biological, cultural, and spiritual systems, between cyberspace and real space, between embodied media and mixed reality in social and physical communication, between visual, haptic, auditory, and kinaesthetic media experiences, between virtual and augmented reality' has become more than a mere duplication of dwelling.[62] It has established a new relationship in which the boundary between the real and the virtual worlds is blurred. This unification of domains projects a hybrid future where people and communities simultaneously inhabit both realms. Even if only a few years ago this coexistence was thought to be 'certainly not for everybody', the advent of the metaverse promises to effortlessly colonise every aspect of human life.[63] Cyberspace will no longer be just the 'the habitat of the imagination', occupied by a liquid architecture unbound to earth: clearly a different realm from the real world, that constructs an alternative reality.[64] On the contrary, in the metaverse, the virtual is disguised as a new, infinite extension of reality for working, studying, playing, or socialising, in which there is a natural transition from the physical to the digital. It is a transmutation of already-known actions, but now, to be performed in a controlled, safe, and surveilled environment that presents itself as just another office, another classroom or another coffee shop, completely 'naturalised'.[65]

However, as Ball explained, 'the metaverse requires everyone to be able to create and contribute "content" and "experiences," not just well-staffed corporations and technically skilled individuals trying to make games or movies.'[66] It needs to be '"populated", rather than just "populable", and this population must then fill in this digital world with things to do and content to consume.'[67] It will be created by people, but not from scratch, since the metaverse should not be perceived as an empty space. As Zuckerberg points out, a number of apps and tools have already been specifically designed and set in place to 'help build the skillsets of the people who build these experiences'.[68] But at the same time, there is also a need to ensure that 'creators are ready to share their creativity and capitalise on this emerging opportunity from day one.'[69] This way, the genuine interest in facilitating and liberating users' creativity becomes the framework to place these users in a frantic mode of production that takes place every time they leave the real world and inhabit the virtual one.[70] It generates a subtle change in the form – rather than level – of engagement that signifies a pioneering form of accumulation. Extending the perpetual process of extraction, this novel type of accumulation increases its reach even more as it builds further on what Paolo Virno described as the 'general intellect'.[71] It shapes a context of continuous creation where today's diffused factory gets the possibility to be spread further. Entering the new platforms of the metaverse is more than just a new way of working or socialising; it manifests a transition into a new world where the individual's soul continues to be exploited. Driven by real-time connectivity and

market pressures that prevent any sense of collective construction of such worlds, the metaverse resembles a sophisticated construct where the 'digital virtualities amplify and reinforce imperial actualities'.[72]

Hence, diversity and inclusion emerge as an opportunity for profit in pursuit of the ultimate globalising project.[73] The one billion users that are predicted to populate the metaverse within the next decade will transform it into a gigantic immaterial labour platform where everyone, irrespective of place, becomes a creator. In fact, the necessary hardware and connectivity infrastructures are already widespread and will become even more so.[74] Enabling a global community with more tools and connections, rather than the great empowerment of individuals, will inevitably facilitate a radical expansion of the labour market. It emerges as a new economic opportunity, in which the metaverse transforms from just a new product into 'an ecosystem'. In Zuckerberg's words, 'together, we can unlock a massively bigger creative economy.'[75] For this reason, 'the metaverse has become the newest macro-goal for many of the world's tech giants.'[76] Unlike the arrival and rise of the World Wide Web, which relied on public research and government funds, with private corporations only realising its commercial potential at a later stage, these premises are altered in the case of the metaverse.[77] As the owners of the skills and resources, 'the major tech companies don't just want to lead the metaverse, they want to own and define it.'[78] From corporations like Microsoft, Google and Meta to the creators of *Second Life*, Linden Lab, all are competing to build and commercialise the metaverse's infrastructure. Like the internet's mine of raw data, the metaverse too can be understood as an untapped quarry of raw materials which these private organisations would extract and control. Their software will soon be ubiquitous and move more and more into the background, becoming invisible; it will have more power over our lives than ever before.

In this sense, the upscaling of the digital dwelling and the parallel downsizing of the physical one echoes the interests of contemporary global capitalism. 'The inexorable dematerialization of physical space, distance, and objects constructs a resilient environment that responds to today's context of instability and uncertainty by confronting the static architectures of the real world with its transformable, dynamic and easy to reconfigure virtuality.'[79] It forms a flexible, fluid, ever-changing space that evades permanency and may be read as an ongoing process: negotiated and subject to constant reappraisal. Thus, the possibility of a hybrid architecture of dwelling translates into a domain resistant to economic disasters and health crises, granting the plutocracy an unprecedented, and much demanded, degree of security. In fact, crises such as the Covid-19 pandemic which, beyond threatening individual safety, have a huge impact on the economy, make the continuous shrinkage of the physical space and the maximisation of the digital an utmost priority.[80] Although the virtual will not be able to eliminate the city altogether, its disproportionate increase has the capacity to facilitate the construction of a threefold goal: a highly healthy world, devoid of real contact between people; a highly secure world, where everything is monitored, surveilled and controlled, leaving no space for an uprising; and, finally, a highly productive world, where existence becomes work itself.

This way, the division between the domestic space and the work space introduced by modern housing, which conveyed a perception of the house as a haven detached from the world of production and disguised all forms of reproductive and domestic labour, would get inverted and return in its pre-industrial form. Similar to the mediaeval house, where domestic and work spaces were combined within the same building, today we face a return to such an interiorisation. Yet, rather than facilitating a degree of self-governance, this inversion brings a series of conditions with it. While enclosing all the traditional functions of the home, Tiny Homes

appears to be more sustainable and affordable, easier to maintain, and, most importantly, virtually infinite. If this space becomes claustrophobic, there is always the possibility to digitally dwell somewhere else. It is precisely how the metaverse means to reshape the prospects for a new immersive virtual dwelling. Yet, within this framework, dwelling transforms into the ultimate form of production. What appeared as an opportunity to withdraw and resist the dominant order, is in fact about to become a new moment of dispossession. Consequently, this illusionary exodus does not construct an alternative but reconstructs the survival of the status quo. Disguised behind the idyllic image of a huge and infinite space where everything is possible and devoid of any spatial, economic and technical limitations, the metaverse emerges as the new essential infrastructure to be plugged into.

Devoid of any sense of belonging and community, any sense of care, and any possibility for a *bios* – the 'qualified life' that Giorgio Agamben opposes to *zoe*, the bare life – dwelling withholds the possibility of 'being' in Martin Heidegger's sense, and is surpassed by a mere productive existence. In the infinite but tiny space of this new type of hybrid architecture and urbanisation, dwelling becomes almost impossible. The home and its material tradition are uprooted, while, in parallel, 'virtual reality is creating a "deep-seated virtualization of human beings".'[81] It signifies an existence within a vicious cycle of constant production and monetisation that disguises a need for consumption and steers us towards the possibility of becoming 'machines, enslaving ourselves in our own virtualized reality'.[82] Within such a fully economised condition, subjects and avatars are 'not just … workers (as labour power) but also… consumers (the "mind share" targeted by marketers), … learners (university degrees as vocational preparation), and even… a source of raw materials (the bio- value extracted for genetic engineering)', thus upending the very condition of dwelling.[83]

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Biography

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Housing for a Lonely Generation: Co-Living Platforms and the Real-Estate-Media Complex

Marija Marić

The new way of living is inhabiting time, space and place that stirs inspiration inside of us.
Join the global living movement.
Find your people.
Join us.

Imagine a place where you enter as an 'I' but leave as a 'we'.
Connect in spaces designed to bring incredible people together.
Meet neighbours and make new friends.
Be more together.

We are:
Allergic to the unoriginal.
Unbound by convention.
Opposed to the 9 to 5.
Inspired by independence.
Open to adventure.
And firm believers that we're only as good as the people with whom we surround ourselves.

Network with freelancers.
Brainstorm with entrepreneurs.
Share skills and find solutions.
Our community might just contain your next friend, lover, or mentor.
#wecommunity.

Grab a coffee fix to kickstart your day.
Perfect your presentation in the co-working space.
Now book the boardroom and nail that pitch.
Live it up.
Stress less.

Gather. Stretch. Steam.
Caffeinate. Co-work. Present.
Meet. Mingle. Collaborate.
Watch. Learn. Create.
Chop. Chat. Unwind.

It feels like home. Maybe even better.
This is home.
It's your home, your workplace, and your playground.
A home to share with friends, teachers, chefs, engineers, artists, and yourself.
Stay or live.

Take a break and connect with those around you over lunch.
Join the wine society in the restaurant for a tasting, then prepare a feast with friends in one of the shared kitchens.
Living with passionate, inspiring, positive people who are excited and open to discovering the world.
Game-changing convenience in one all-inclusive bill.

Hello. We are co-living.
We're the world's largest co-living provider.
Yes, that's big.
Building real-estate of the future.
Property and software under one roof.
The Good Life.[1]

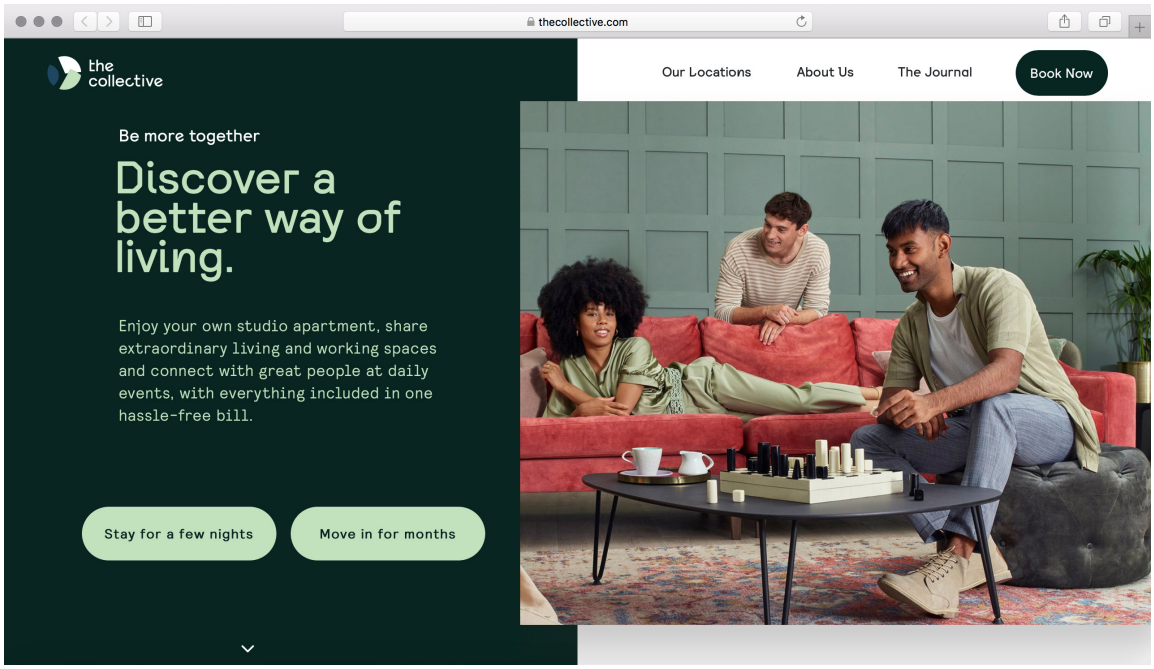

Fig. 1: The Collective (project's website), screenshot, 18 November 2020.

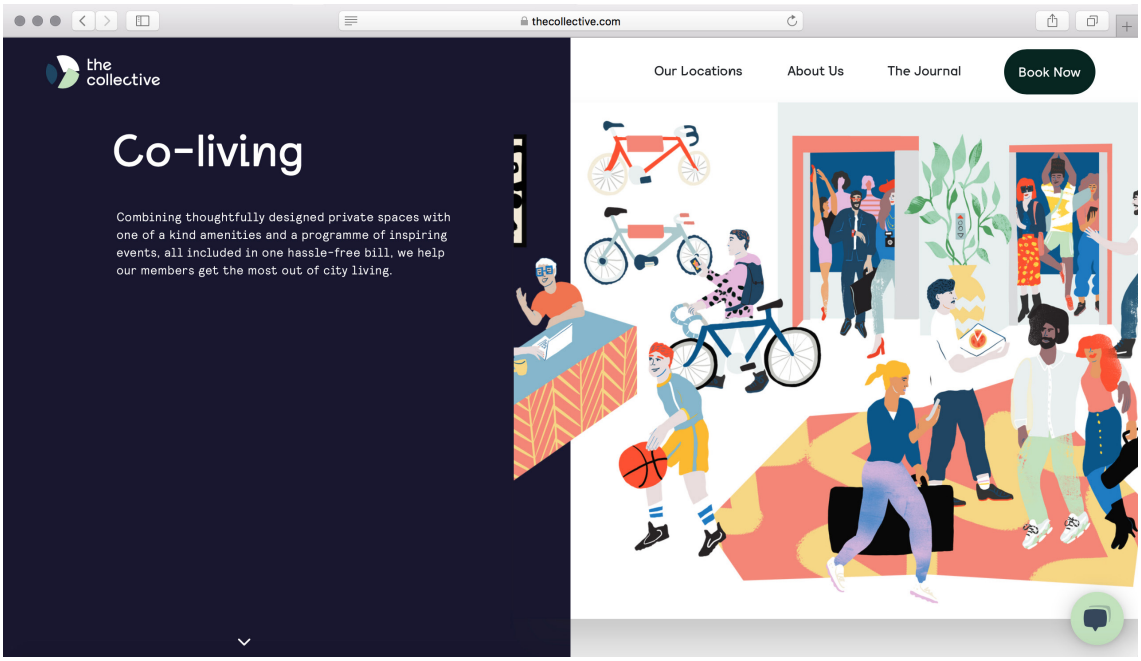

Fig. 2: The Collective (project's website), screenshot, 18 November 2020.

Organised around the advertising language for three co-living platforms – WeLive, Quarters (now Habyt), and The Collective – this essay frames the corporate housing model as inseparable from the digital media infrastructures transmit its messages. The media-specificity of co-living real estate advertisements, as ephemeral, anonymous texts, written in English and distributed online, points to the very condition of the 'spatial products' they are selling – fast circulation, far-reaching dispersion, and universalist tendencies. As such, co-living projects could be seen as a genuine product and manifestation of what could be described as a real-estate-media complex, referring to the close entanglements of speculative property markets, media infrastructures and digital technologies in the commodification of housing. Understanding the digital as 'materially grounded in everyday life and inseparable from the power relations therein', this essay outlines corporate co-living platforms, as both real estate and media projects, which serve as a powerful tool for the shaping of our individual and collective subjectivities.[2]

This essay builds upon the 'feminist real estate theory', framed by Hélène Frichot and Helen Runting as a theoretical framework grounded in feminist critique, used for unpacking the ways in which capitalist real estate markets produce not only housing inequalities, but also vulnerable subjectivities.[3] Following the 'critique (of) the innovative and community conscious approaches to real estate … marketed under the banner of "co-living"', which, in the words of Frichot and Runting, 'relies on a disavowal of dependencies, vulnerabilities, and intimacies, of bodies, and of politics' – one could ask: could the performative language of co-living real estate projects be seen as a site where this disavowal takes place?[4]

Narrating corporate housing 'utopias'

In his book *City Branding: The Ghostly Politics of Representation in Globalising Cities,* Alberto Vanolo observes how branding industries recognised the crisis of the industrial city during the 1970s as potential setting for transforming entire urban imaginaries into marketable products. As he points out, the representations of industrial cities as 'icons of modernity, prosperity, and progress' have shifted to 'being explicitly stigmatised and associated with ghosts of crisis, structural decline, and physical decay.'[5] With the rise of the technopoles during the 1980s, the model of 'techno-urbanism', referring to techno-parks and science campuses combined with free economic zones, appeared as one such 'urban product' and a formula to be replicated and applied to cities around the world. After the techno-city imaginaries waned during the 1990s, as Vanolo further notes, 'many city managers tried to get something more from branding', creating a context in which new designations to brand urban spaces into marketable products such as the 'creative city', 'sustainable city', 'resilient city', and recently also the 'smart city', started populating urban discourse.[6] What all of these urban narratives had in common, however, was their reliance on the language of crisis. Thus, for instance, if the idea of the 'creative city' capitalised on the precarity of the emerging global creative working class, the 'sustainable city' appeared commonly as a label for the real estate market's response to the collective fear of environmental collapse.

Although still lacking its '-city' trope, corporate co-living platforms have emerged during the last decade as a real estate response to the housing crisis of young digital nomads, usually members of the so-called Generations Y and Z, often described as 'the loneliest generations'.[7] Appearing in the aftermath of the 2008 financial crisis, reaching a peak and finally a decline during (and after) the Covid-crisis – co-living platforms were born in the broader technological and media turn the property markets experienced at the time. On the one hand, the period saw technological innovation organised around managing post-crisis traumas and uncertainties, such is the automation of rent collecting and the emergence of large property rental platforms like AirBnB.[8] As Desiree Fields observes,

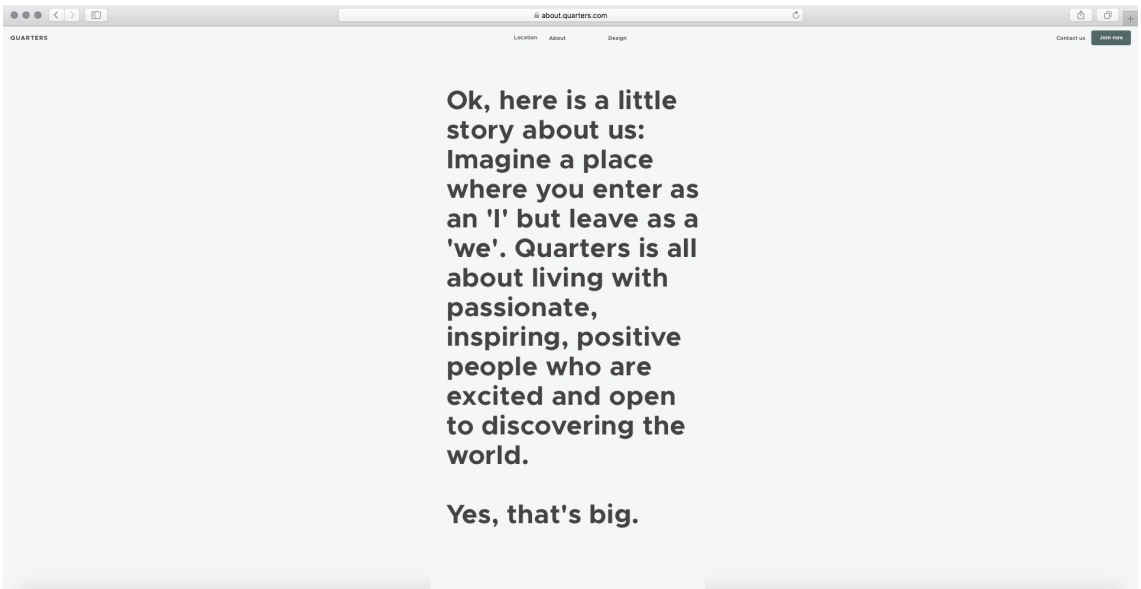

Fig. 3: Quarters (project’s website), screenshot, 18 November 2020.

post-crisis digital technologies appeared as a way to 'reshape the operation of power within housing markets, modify relationships among real estate stakeholders, and bear upon the political economy of housing.'[9]

Simultaneously, this period also saw a change in the mediation and advertising techniques used to launch real estate products to the market, which has largely lost credibility and social trust. The turn towards storytelling – essentially a turn from (architectural) objects to subjects as central protagonists of the real estate advertising discourse – positioned language, narrative, and media representation at the very forefront of the entire property industry.[10] With housing becoming increasingly unaffordable, and with 'human attention (becoming) a scarce and hence valuable commodity', co-living projects appeared as a 'different solution' – a housing 'formula' consisting of cell-like apartments for (often involuntarily) mobile, young professionals, digital nomads who require a good Internet connection for their community needs.[11] The frantic need to differentiate co-living platforms from the rest of the property markets' repertoire, however, has created an internal paradox, as they all started to seem different in the same way.

It is striking, for instance, how all three of the platforms I analysed consistently position themselves as initiators of a 'new movement', precisely framing their own project of co-living as a radical rupture from the existing housing system. Ambitiously promising a 'new way of living' that will 'transform the rigid and isolating housing model of yesterday', co-living platforms claim the capacity to change 'the way people live together and share their lives around the globe', enabling them 'to lead more fulfilling lives.'[12] Carefully targeting its prospective users, co-living real estate language employs various storytelling techniques to construct the ideal co-inhabitant: a networked, economically and socially productive entrepreneur, member of a global creative working class. In 'creating a home for our generation' and 'a new living experience that connects you with people on similar journey across the planet', these narratives make it clear: 'whether you're a modern-day nomad who is just stopping by or dipping your toes in the city before taking the big leap … all you have to do is show up with your suitcase.'[13]

Generous promises of belonging, home-making, new friendships and communal life go hand-in-hand with a less generous offer of actual square metres of individual rooms or apartments in the co-living housing projects.[14] In their unpacking of the co-living 'cell', Hélène Frichot and Helen Runting ask about the conditions of confinement:

> What kind of production and reproduction do these spaces make possible? … What about sex or private discussion, relations that one wishes to limit to a given circle, relations one cannot, or simply does not wish to, extend to all members of the co-living community? The cell provides privacy to a prone body glued to a laptop or asleep, but it cannot physically accommodate more than one body, the infrastructure as a whole cannot support intimacy.[15]

To complement the spatial bare minimum, the real work of construction is contained in the advertising of the shared spaces. One could thus note the overlapping of narrative elements with physical spaces in the common use of the terms like the 'neighbourhood', 'street', or 'city' to describe the room clusters, hallways and buildings of co-living projects. Similarly, the branding of shared spaces such is The Collective's *The Exchange* (lobby) or *The Secret Garden* (work station decorated with pot plants) could be seen as an attempt to create added value to the project and justify the cost of the sub-minimal dwellings.[16] The '"unbundling" of the elements of a home, such that one could pay only for the amenities they really need', as Claire Flurin, the co-founder of one such platform based in New York explains, goes hand in hand with the (re)construction of spaces through narratives that exceed their physical scale.[17]

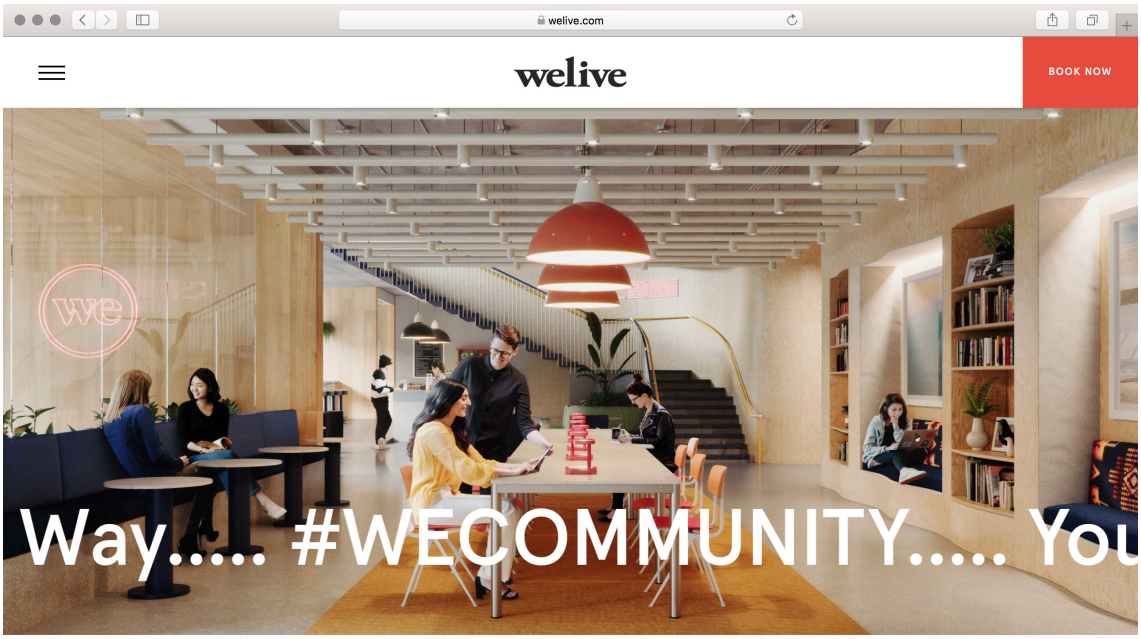

Fig. 4: WeLive (project's website), screenshot, 18 November 2020.

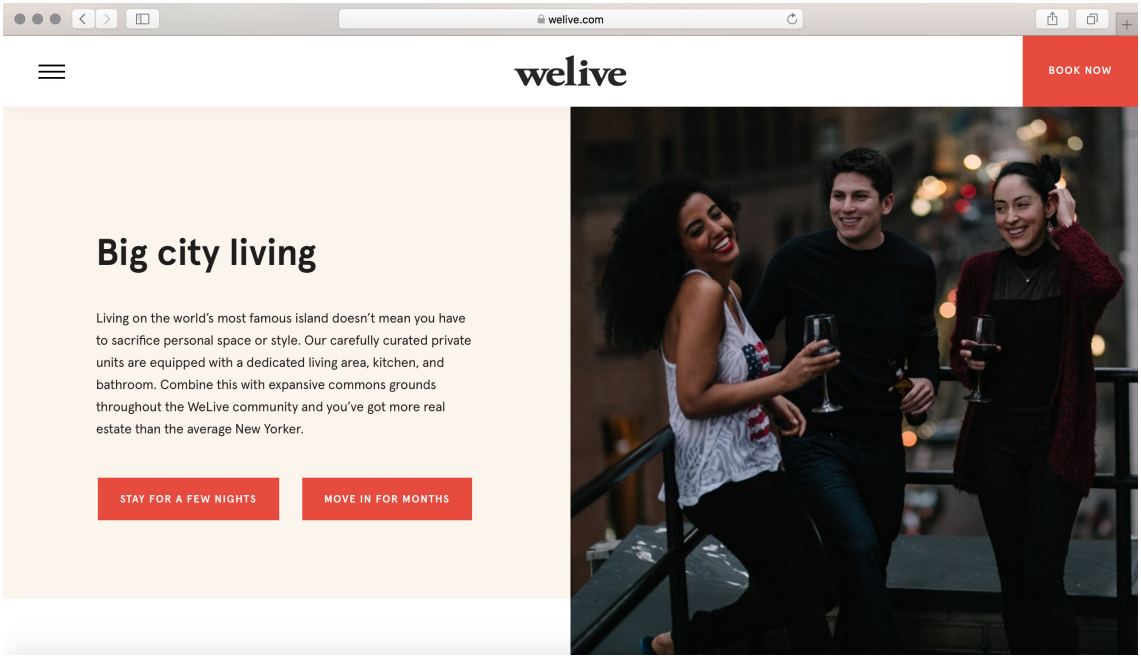

Fig. 5: WeLive (project's website), screenshot, 18 November 2020.

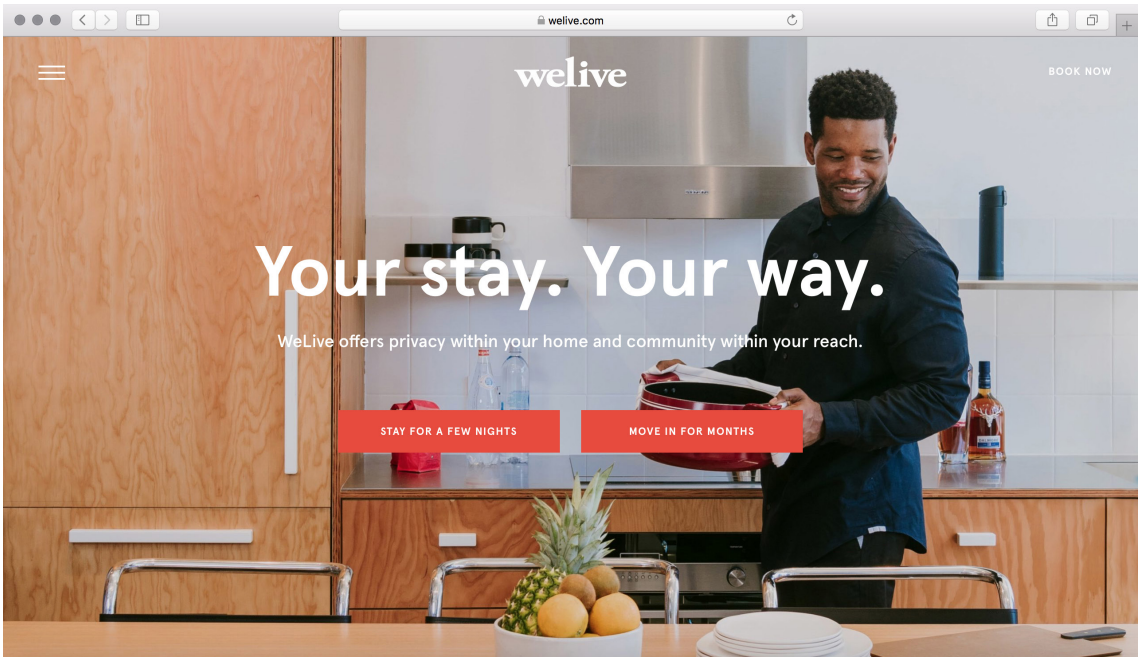

Fig. 6: WeLive (project's website), screenshot, 18 November 2020.

Evgeny Morozov and Francesca Bria analysed the financial performativity of the 'smartness' narrative in the construction of smart cities, arguing that real estate developers charge 'a smartness premium' in order to obtain even higher profits. Similarly, the 'community' narrative also operates as an intangible asset in the co-living property markets.[18] These close entanglements of real estate fiction with square metres could be seen in light of what Anna Tsing describes as 'the economy of appearances', referring to the 'self-conscious making of a spectacle' operating as a 'necessary aid to gathering investment funds.'[19] A common practice of start-up companies and venture capitalists, the construction of this 'magical vision', as Tsing further reminds us, points to 'those historical moments when capital seeks creativity rather than stable reproduction.'[20] From the companies' names – 'WeLive', 'The Collective', 'Common' – to the appropriation of the notion of community in creating corporate media products like the hashtag #wecommunity of 'WeCompany', advertising language and digital media could be seen as the actual sites of production of the co-living projects.

With 'privacy within your home and community within your reach', social life becomes part of the convenience package, facilitated by new types of professionals such as a 'community host' or even a 'community curator'.[21] That co-living projects construct their value on the promises of community, also becomes visible in the amenities they offer: In the Quarters co-living project, high-speed Internet and free laundry are advertised hand-in-hand with a promise of 'open-minded people and regular community events.'[22] However, on a second reading of this advertisement, it becomes clear that, after all, community does not come fully free-of-charge. Rather, the users of the co-living platforms – themselves the building blocks of the elusive concept of a community – are required to perform and socialise, thus in fact taking upon the role of (unpaid) workers in producing the added property value. Directed at 'anyone who is ready to embrace a more connected way of living', the platforms 'empower members to co-create their experiences', to 'meet the neighbours and make new friends', 'let loose' and to 'live it up'.[23] Urging its inhabitants to 'be more together', the biopolitical power of the company over its users and the pressure it imposes to perform – whether professionally, socially, emotionally – underlines all aspects of the co-living life. As such, co-living platforms appear as corporate housing 'utopias' (or rather, dystopias, depending which side of the rental contract one stands on) in which life and work blur seamlessly, distinctions between citizens and tourists are negated, and community appears as a hashtag and an amenity one can occasionally consume.

The shape of housing unaffordability

In his essay 'Planning as Persuasive Storytelling in the Context of "the Network Society"', James Throgmorton points out that planning should be seen as a form of storytelling.[24] Thinking of planners, as Throgmorton suggests, 'as authors who write texts that may be read in diverse and often conflicting ways', leads to the understanding that 'planners-authors have to build conflict, crisis, and resolution into their narratives, such that key antagonists are somehow changed or moved significantly'.[25] Following from here, it becomes clear not only that planning could be seen as a form of storytelling, but also the other way around: that storytelling could be seen as a form of planning; design by the means of narrative and (real estate) fiction. With communication preceding rather than succeeding architectural and urban design in the era of the global circulation of capital, goods, information and people, the boundaries between built landscapes and their 'mediascapes', homes and screens, start to blur.[26] Co-living projects could be seen as a housing typology existing in this blurry field. In the context in which 'the network is the new electricity', and the living environment becomes 'the house-shaped manifestation of the internet of things', as Justin McGuirk writes to describe the

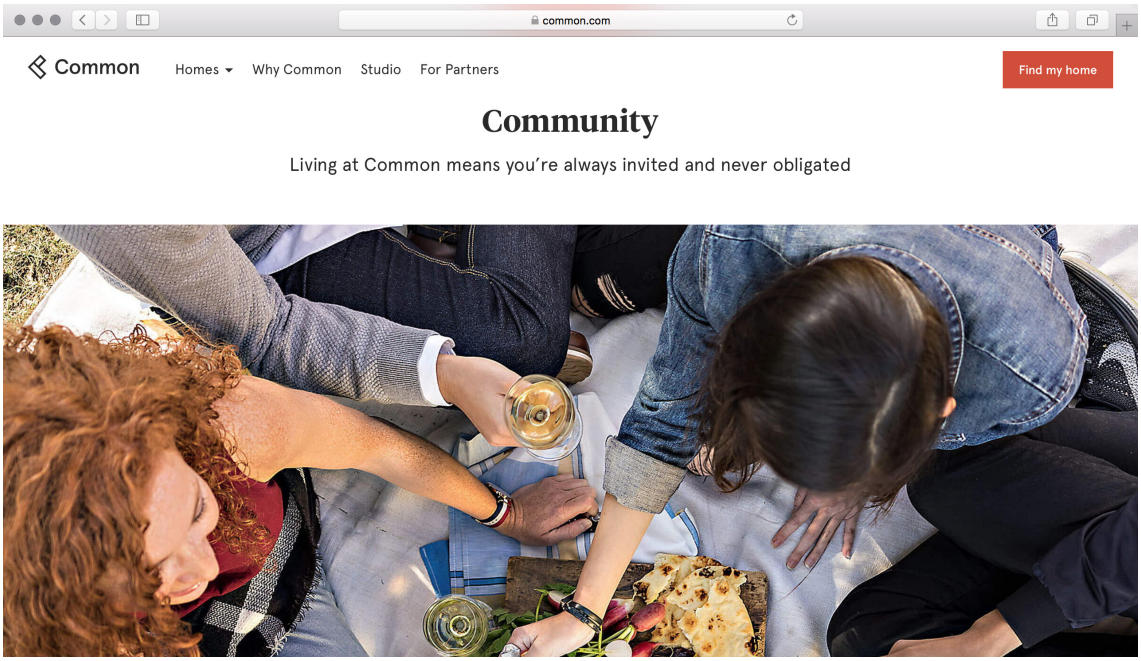

Fig. 7: Common (project's website), screenshot, 18 November 2020.

new domestic landscape of the digital era, we might ask: What are the corporate co-living platforms manifestations of?[27]

Although grounded in the logic of digital media, corporate co-living platforms essentially represent an all-too-familiar formula of rentier capitalism, a predatory real estate project aimed at detecting and extracting from those who are economically, socially and politically vulnerable. The production and circulation of co-living projects, thus point to the current state of the speculative housing market, whose growth has heavily depended on the constant repackaging of the already existing. In this process, the language plays a key role. The question then becomes: How do we study hybrid housing-media typologies like these corporate co-living platforms: by analysing their architectures and spatial arrangements, or by reading their real estate fictions?

Notes

1. 'Housing for a Lonely Generation' is a 'real estate poem' composed solely of phrases taken from the websites and online brochures of the three analysed co-living platforms: WeLive, Quarters, and The Collective (accessed on 14 August 2019). Real Estate Poetry is a long-term publishing project in which I consider the language of real estate advertising as a source of fiction and poetry.
2. Desiree Fields, 'Automated Landlord: Digital Technologies and Post-Crisis Financial Accumulation', *Environment and Planning A: Economy and Space* 54, no. 1 (2022): 160–81, 176.
3. Hélène Frichot and Helen Runting, 'The Promise of a Lack: Responding to (Her) Real Estate Career', *The Avery Review* no. 8 (May 2015), http://averyreview.com/issues/2/the-promise-of-alack.
4. Hélène Frichot and Helen Runting, 'In Captivity: The Real Estate of Co-Living', in *Architecture and Feminisms: Ecologies, Economies, Technologies*, ed. Hélène Frichot, Catharina Gabrielsson, and Helen Runting (London and New York: Routledge, 2018), 140–49, 140.
5. Alberto Vanolo, *City Branding: The Ghostly Politics of Representation in Globalising Cities* (London and New York: Routledge, 2017), 17.
6. Ibid., 119.
7. Jamie Ballard, 'Millennials Are the Loneliest Generation', YouGov, 30 July 2019, https://today.yougov.com/topics/lifestyle/articles-reports/2019/07/30/loneliness-friendship-new-friends-poll-survey.
8. To name just a few: Fields, 'Automated Landlord'; Joe Shaw, 'Platform Real Estate: Theory and Practice of New Urban Real Estate Markets', *Urban Geography* 41, no. 8 (2018): 1–27; Nick Srnicek, *Platform Capitalism* (Cambridge: Polity Press, 2017).
9. Desiree Fields and Dallas Rogers, 'Towards a Critical Housing Studies Research Agenda on Platform Real Estate', *Housing, Theory and Society* 38, no. 1 (2019) :72–94, https://doi.org/10.1080/14036096.2019.1670724.
10. Marija Marić, 'Real Estate Fiction: Branding Industries and the Construction of Global Urban Imaginaries' (doctoral diss., ETH Zurich, 2020).
11. On the attention economy, see Claudio Celis Bueno, *The Attention Economy: Labour, Time and Power in Cognitive Capitalism* (Lanham, MD: Rowman & Littlefield, 2017).
12. 'WeLive', real estate advertisement, WeLive website, https://www.welive.com/; 'Quarters', real estate advertisement, Quarters website, https://quarters.com/; 'The Collective', real estate advertisement, The Collective website, https://www.thecollective.com/; all accessed 25 September 2020.
13. Ibid.
14. The room and apartment sizes are rarely included in the advertisement descriptions of co-living products.
15. Frichot and Runting, 'In Captivity', 145.
16. 'The Collective Old Oak' real estate advertisement, The Collective website, https://www.thecollective.com/locations/old-oak.
17. Giovanna Borasi, 'Attention to New Sites for Architecture', in *A Section of Now: Social Norms and Rituals as Sites for Architectural Intervention*, ed. Giovanna Borasi (Montreal: Canadian Centre for Architecture, 2021), 7–36, 27.

18. Evgeny Morozov and Francesca Bria, *Rethinking the Smart City: Democratizing Urban Technology* (New York: Rosa Luxemburg Stiftung, 2018).
19. Anna Tsing, *Friction: An Ethnography of Global Connection* (Princeton: Princeton University Press, 2005), 57.
20. Ibid., 57.
21. 'WeLive', real estate advertisement.
22. 'Quarters', real estate advertisement.
23. Ibid. and 'WeLive', Real Estate Advertisement.
24. James A. Throgmorton, 'Planning as Persuasive Storytelling in the Context of "the Network Society"', *Planning Theory* 2, no. 2 (July 2003): 125–51, 2.
25. Ibid, 2.
26. On mediascapes see Arjun Appadurai, 'Disjuncture and Difference in the Global Cultural Economy', *Public Culture* 2, no. 2 (1990): 1–24.
27. Justin McGuirk, 'Honeywell, I'm Home! The Internet of Things and the New Domestic Landscape', in *Housing After the Neoliberal Turn*, ed. Stefan Aue et al. (Berlin and Leipzig: Spector Books, 2015), 47–52, 48.

Biography

Marija Marić is an architect, researcher and curator based in Luxembourg. She works as a postdoctoral research associate at the Master in Architecture programme, University of Luxembourg, where she also teaches. In 2023 Marić co-curated the Luxembourg Pavilion at the Venice Architecture Biennale with a project that critically unpacks the question of space mining through the perspective of resources. She obtained her doctoral degree in 2020 from the Institute for the History and Theory of Architecture (gta), ETH Zurich, with research examining the role of media strategists in the communication, design and globalisation of urban projects. Marija's work has been presented and published internationally. Her research is organised around the questions of real estate, media, and the production of the built environment and its imaginaries in the context of global capitalism and the global flow of information.

Housing Migrant Workers: The Form of the Corporate City Along the Rotterdam-Venlo Logistics Corridor

Renzo Sgolacchia

Containerised and flexible housing

In April 1966, a container ship of the company Sea-Land sailed from the United States to the port of Rotterdam for the first transatlantic voyage.[1] A year later, in the article 'Flatscape with Containers', Reyner Banham stated that architecture is the 'victim' of containerisation, describing ports and other intermodal terminals as expanses of concrete and asphalt surfaces without buildings on which countless containers smoothly move in perpendicular trajectories.[2] He argues that the containers offer protection from weather, similar to the function served by warehouses before they became obsolete.

The container is the established volumetric module, the 20-foot equivalent unit (abbreviated TEU)[3] that revolutionised and standardised the shipping industry, using multiple modes of transport, minimising the time and cost of loading and unloading goods, and channelling enormous quantities of commodities.[4] Echoing its military origin, the container has disciplined the labour force, which historically interfered in the continuous flow of goods, extending and stretching the factory's assembly line to the territorial scale of logistics corridors.[5] Over the years, journalists and researchers have made many incognito visits and written reports to describe the arduous working conditions within distribution centres.[6] Examples include the repetitive actions carried out in a standing position for many consecutive hours, the daily distance covered along trajectories generated by an algorithm, the strict control of bodies through GPS and body scanners, and the routine of inspections to prevent corporate theft.[7]

Since the start of its commercial use, the shipping box has been adapted to container homes for residential purposes. The short article titled 'Containerscape with Flats' – a play on words – placed alongside Banham's piece shows the alternative functional use of containers, illustrating the prototypical study called a 'home-tainer'.[8] It is a living unit consisting of two assembled 20-foot containers that can be shipped and moved like any typical goods container. Predicting the potential of a large-scale supply of these boxes, the article's author claimed that the 'home-tainer' might fulfil the needs of 'the growing horde of migrant workers.'

Since then, containerised housing has acquired an extensive meaning and widespread use. Other modular boxes, such as foldable containers, mobile and trailer homes, prefabricated and preassembled units, and even houses packaged in cardboard boxes, have been introduced to fulfil housing needs. Capable of accommodating a large number of people in a short time, the construction of flexible boxes rapidly increased. Displaced people looking for a new home after natural disasters, refugees and asylum seekers looking for a new life in a different country, and migrant workers looking for a better wage working in remote extraction and construction sites or distribution centres have all been housed in structures of this type.

The topic of contemporary workers' housing is largely unobserved by architecture discipline. Because it is supposedly designed 'for a market with

low aesthetic standards' and as they are 'similar all around the world,' this mass-produced and low-cost containerised housing is only read as 'useful' to the world economy, therefore not interesting to consider from an architectural perspective.[9] In this article I would like to suggest a broader view of the phenomenon, and to investigate workers' housing with the concept of 'analytic borderlands' in mind. Coined by Saskia Sassen, this concept understands the 'spaces of intersection' as overlapping global and local strategies where operations of power and a logic of domination take place.[10]

The so-called platform economy offers digital shoppers 24/7 access to the infinite space of online consumption. Gigantic distribution centres represent the physical dimension of the flow of goods in which invisible algorithms efficiently process orders, coding, sorting and shipping commodities.[11] Real and digital, that is, visible and invisible aspects of the platform economy, constantly merge, generating hybrid logistical infrastructures. This article investigates workers' housing as a concrete aspect and direct result of the platform economy, and as characterised by a structural integration of digital services. Governing data on accommodation, transportation, payment and the management of shifts and work activities through digital applications, among other things, are essentially embedded into the complex structure of contemporary workers' housing.

I focus here on the corporate city where migrant workers reside, which in fact consists of a multiplicity of residential zones spread throughout the Netherlands, and constitutes the materialisation of different forces, domains, and modes of production. Due to its size, development, and the presence of more than six hundred employment agencies, the Rotterdam-Venlo logistics corridor can be considered an emblematic case to study the nature of this housing sector. Particularly affected by the 450 million tons of transhipped goods per year in the port of Rotterdam,[12] the Netherlands became the leading logistics platform serving the entire European continent, providing 146 million square metres of distribution centres, comprising 12 per cent of the entire and existing built-up surface in the country.[13]

Due to corporations' lack of transparency and reluctance to share information, for this study my approach is based on field research, interviewing dozens of migrant workers in the Rotterdam-Venlo corridor. I asked them about their living and working conditions, about their nationality, age, the task at work, their employer and employment agency, and their perception of dormitories. Since November 2020, I have also conducted semi-structured interviews with experts on labour migration to the Netherlands, with representatives of non-profit organisations (FairWork, Barka Foundation), the secretary of Stichting Normering Flexwonen (SNF), members of the trade union FNV and employers' organisation ABU, developers, politicians, inspectors, residents of neighbourhoods near dormitories, employees and former employees of agencies.

Although the predominant narrative in architecture critique seems to focus on the boxing in of the landscape and the growing spatial footprint of distribution centres, this phenomenon is also a matter of people. The Dutch economy relies on a substratum of migrant workers from the European Union, a vast labour force of around 750 000 people arriving in the Netherlands from Central, Eastern and Southern Europe.[14] Recruited directly and individually from abroad and through online platforms, this workforce seems to live in a parallel society. Migrant workers mainly reside in remote, segregated sites such as specifically-designed labour hotels and campsites, or former holiday parks and military bases, primarily located behind distribution parks and greenhouses, within forests, and next to highways. Journalistically stigmatised as *Polenhotels* (hotels for Poles), the workers' housing and recruitment are neither temporary nor spontaneous solutions, nor are they the result of uncoordinated strategies. Rather, they are precisely and logistically structured by a network of companies external to production, the international employment agencies. These corporations

Fig. 1: Landscape: infrastructure, in between production, control. Photos: author.

expect an increase of 50 000 migrant workers per year, to reaching 1.2 million foreign labourers within a decade, almost double the current 750 000 workers.[15]

Due to the general lack of suitable housing, the government has the ambition to stimulate the construction of 15 000 *flexwoningen* (flexible housing), 15 per cent of the massive development of 100 000 new units per year, with the aim of achieving 900 000 by 2030.[16] The *flexwoningen* are a new emerging segment in the housing market. They are defined as living units that can be 'moved, stacked, connected, or split', and only if 'one of the following aspects has a temporary character: the house itself, the occupation through temporary lease, or the location'.[17] Mentioning only the mobility and temporary character of the *flexwoningen* implicitly excludes users' customisations of single units. Focusing exclusively on standard units, agencies provide both *flexwoningen* and flexible workers according to a complex logistical supply chain.

A set of digitalised operations conducted on online platforms and software installed on workers' personal devices enables these corporations to efficiently organise hiring procedures, schedule work activities, control work performance, and even enable workers to digitally open and close the living units' doors with smartphones. In addition to corporations, public institutions too, in joint ventures with technology developers and agencies, test and launch digital applications for migrant workers. For instance, municipalities that develop these platforms aim to provide information about regulations on living and working in the Netherlands, to answer the specific questions of workers registered on the apps, and thus, to subtly extract data from them. The applications can also offer 'extra information layers' to affiliated agencies that can then customise their specific digital service.[18] Data mining and analysis are the extractive processes that help agencies to identify patterns, which supports the solution of problems, the removal obstacles, making more informed business decisions, and the prediction of future trends within the labour and workers' housing markets. Although the objective is to achieve a seamless workflow beyond the factory, these pervasive forms of control hyper-rationalise the layout of workers' housing and increase the employees' stress.

Workers' housing in motion

Global logistics corridors have a dual nature – they form infrastructural connections, and they enact operational processes. For example, a corridor facilitates the negotiation of customs practices across several national borders, moving goods and workers, but it also contributes to the formation of new borders along the transportation trajectories of global flows.[19]

Workers' housing is dispersed, clustered and confined within frontier zones along corridors. The typical 'dormitory labour regime' is characterised by the spatial proximity of the dwellings and the workplace.[20] These factories-cum-dormitories enable employers to strictly control a sizeable migrant workforce, adapting it to flexible just-in-time production, stimulating the mobility of single workers according to the corporate's needs, and reducing their collective bargaining power.[21]

The Rotterdam-Venlo corridor can be considered unique, in that the workers' housing does not adjoin distribution centres; the distance can be a hundred kilometres in extreme cases. The centralised control practised by agencies organises the dispersed activities and locations along the corridor. Analogous to the companies that ship and deliver goods worldwide, these logistical actors optimise the use of existing infrastructures and vacant sites to distribute people, calibrated according to distance and time.[22] So, for instance, shifts are scheduled to avoid rush hour traffic, and dormitories are placed on empty plots near highways.

Echoing the Taylorist character of factories organised through the scientific management of workflows, minimising cost and efficiently using time, the agencies enact material and digital forms

Fig. 2: Architecture: flexibility, modularity, containerisation. Photos: author.

of labour exploitation. These corporations orchestrate the daily lives of workers, regulating the workers' behaviour through inspections and warnings and organising shifts and transport with the use of algorithms, revealing the coercive nature of workers' housing. The twenty-seven-year-old Polish Natalia works as a picker at XPO Logistics in Tilburg and lives thirty-five kilometres away in a forest in the North Brabant region. Describing the atmosphere of the holiday park transformed into a 'labour camp', she commented that despite the rather claustrophobic scale of the rooms of the 'bungalows', living in the forest is 'nice'.[23] For her, sharing the quiet of the terrain's shared park enables the inhabitants to discuss experiences and information about their life at work. 'Sometimes you really feel [like you are] on holiday,' she said. Suddenly, a private guard of the security service interrupted our conversation. Equipped with a chest-mounted body camera, he paternalistically reminded Natalia that it is prohibited to receive visitors; he then noted the data from her identity card on his mobile phone and informed her that he was forwarding a notification of this – second – warning to the employment agency. Natalia expressed her deep frustration over this 'domestic incident', saying: 'sometimes this place seems like a prison.'

The mixed feelings about the dormitories as places of both freedom and control are common among workers living within the corridor. The disorienting character of workers' housing seems unaffected by the bucolic surroundings. I interviewed residents of various sites – such as a renovated resort in Hellevoetsluis, old holiday parks near Oss, Oisterwijk, Oosterhout and Kaatsheuvel, purpose-built labour hotels within the logistics sites in Waalwijk and Greenport, the new parks for mobile homes in Venray and Maasbree, and the former military base in Weeze, Germany – and they alternately considered living there either liberating or oppressive.

In an analysis of the architecture of Familistère Guise, a labourers' housing complex, consisting of three four-storey blocks with large courtyards, Michel Foucault claims that although the building 'manifested the power of ordinary workers to participate in the exercise of their trade,' its panoptic qualities could also 'have allowed it to be used as a prison.'[24] He further explains that 'no one could enter or leave the place without being seen by everyone.'[25] Considering that architectures are based on many appropriations rather than having an univocal meaning, Foucault suggests to focus on the 'convergence' between the intentions of the architect and the effective practice of freedom.[26]

In this light, the Dutch workers' dormitories only seem innocent; their nature is, in fact, panoptical. Isolated in suburban areas far from local Dutch communities, one could read the residential sites as places outside the established juridical order, where exceptional practices become the rule. According to Giorgio Agamben, the camp consists in the materialisation of what he calls the 'state of exception' in which law is suspended, and in the subsequent formation of a 'space of exception' in which 'bare life and juridical rule enter into a threshold of indistinction.' Although Agamben's well-known concept of the camp does not explicitly focus on the topics of migration and labour, he states that 'we find ourselves virtually in the presence of a camp every time such a structure is created, independent of the kinds of crime that are committed there and whatever its denomination and specific topography'.[27]

Subjecting the inhabitants to the condition of 'bare life', workers' housing seems instrumental in developing a disciplinary code to educate the workforce and can be considered to exist within an exceptional regulatory condition, a lawless space outside the jurisdiction of the state. Reusing existing holiday parks and hotels or designing dormitories as simulacra of vacation accommodations enables agencies to reinforce their pervasive presence and constant surveillance.

Regardless of the building type, workers' housing invariably reiterates a set of functions: a living room, a shared kitchen, a collective laundry

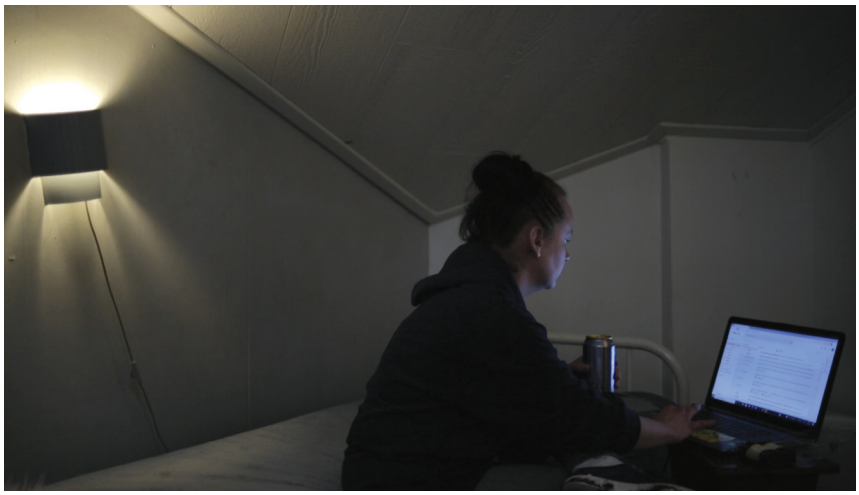

Fig. 3: Interior: minimum liveability, social media, leisure. Photos: author.

room, a fitness room, in some cases a grocery store, outdoor recreational areas with barbecues, a reception desk to control access to the location, and a parking lot where agency cars and buses constantly arrive and depart from and to the workplaces. The rhythm of the factory directly influences life in the dormitories. Each day is divided into the three consecutive factory shifts: the morning from 6:00 to 14:00, the afternoon from 14:00 to 22:00, and the night from 22:00 to 6:00. When they are not working, the workers' main activities are to rest, exercise, do laundry and shop. Most of them do not own cars, and therefore spend the majority of their time in the camp or in the near vicinity. Their distance from the active life of urban centres adds to a feeling nostalgia for their country of origin. The remoteness of the housing produces alienation and loneliness that are only partially mitigated by mobile phones, tablets and laptops, used to communicate with friends and relatives and to help with orientation in the new environment. Through phone calls, electronic messages and posts on social media platforms, workers share information mainly about their leisure time and pleasant aspects about life in the Netherlands, reporting only positive facts about the work experience abroad with their real and virtual communities. Exposure to social media tends to inhibit the workers' freedom of expression, making them careful not to publish information about or images of the precarious housing and working conditions. By contrast, workers share their repressed opinions on Google Maps, publicly but mostly anonymously. Dozens of negative reviews reveal geographical sites that accommodate workers and divulge workers' impressions on the quality of housing. The workers post photos of the actual condition of dwellings, openly criticise the management of residential sites, comment on their alienation from the corporations' digital applications, and award scores to various locations; most are given the lowest rating. 'Poor conditions. And I made a friend called João, a mouse,' Nivaldo writes ironically, giving two out of five stars. 'Looks like Birkenau,' Viktor comments about the rigid grid of a mobile home park in Venray, with one star. 'When I got there I thought I was in a refugee camp. The agency's coordinators are beyond rude. They put me in a trailer home with three twenty-year-old boys whom I never met before and I am a thirty-seven-year-old female. Ninety-five euros per week plus you pay for laundry. There should be some standards for renting,' Stip Stip describes in detail, giving one star. 'One of my problems was not knowing how to lock the door via the app and I had to leave the house open even when at work,' Sorin posts, with two stars. By contrast, the enthusiastic, or perhaps sarcastic, Lucy in Space says: 'I am giving four stars only because I had to share my accommodation, everything else is good. I wouldn't suggest it to people who don't feel good surrounded by peaceful nature. I love it!' According to most of the interviewed workers, the reviews on Google Maps are an essential and reliable source of information, directly explaining tangible aspects of their lives without the filter and eye of 'lying' agencies. The messages on this platform can be seen as an explicit return of the repressed, through which workers intend to make the entire community of migrant workers aware of the agencies' modus operandi.

Single and double bedrooms are the most typical options within housing units. Most workers move to the Netherlands as individuals or couples, while families and groups of friends travel in the summer for working holiday periods. Workers' children, who are not allowed in agency dormitories, live with grandparents in their country of origin. Agency coordinators usually group new arrivals according to their nationality and workplace, trying to keep couples and families in the same living unit and separating groups of friends. The single bedroom is the favourite option because of the privacy it affords, allowing residents to relax after an intense working day without the interference of people with different lifestyles and schedules. According to most of the interviewed workers who occupy double rooms, having to share a room of just a few square metres

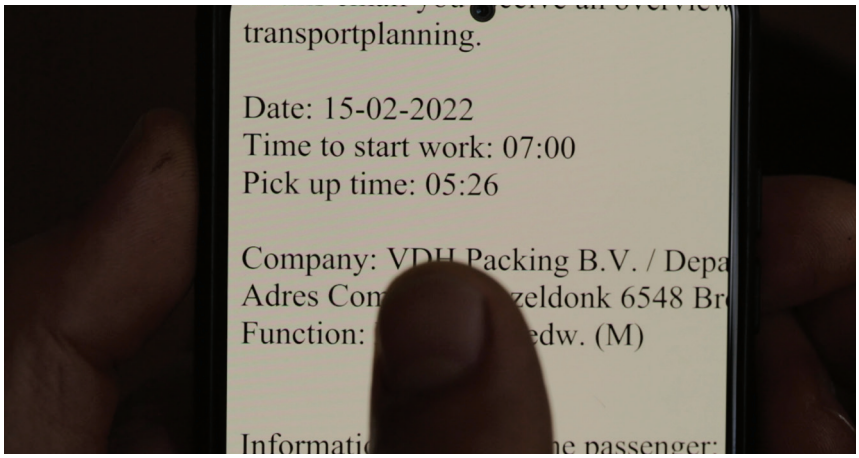

Fig. 4: Working: night shift, algorithm, homelessness. Photos: author.

with an unknown person is the worst part of the stay.

The rental cost makes the parasitic nature of agencies conspicuous. Regardless of the agency, location, building type, or room size, a single bed costs around a hundred euros per week, amounting to four hundred euros a month per person. Rather than recruitment, real estate activity is in fact employment agencies' primary source of profit.[28] Workers are doubly exploited by both employers and agencies. Employers extract the Marxian surplus value, the difference between the sale of a product and the labour cost to manufacture it, by extending the work shift or intensifying productivity. At the same time, employment agencies focus on extracting profit by extending the stay of its tenants. For instance, during low production seasons, the zero-hour contract enables agencies to employ workers for only a few hours a week, letting them earn barely enough to survive. This contrasts with the workers' aim, which is to work hard and return to their country of origin as soon as they have saved enough.

Workers incur additional costs – apart from rent – that are related to their conduct. Stela, a thirty-year-old Slovak, lives near Tilburg and works in the Den Bosch distribution centre of the Jumbo supermarket chain.[29] For her, living in a 'labour camp' follows a predictable and standard pattern and 'abnormal behaviour' immediately stands out. The employment agencies have a strict code of conduct in the dwellings. Smoking cigarettes at home is prohibited; visitors are only allowed with the approval of the camp authorities, and the bedroom and kitchen must be kept clean. Although inspections are weekly scheduled, agency coordinators can also enter the rooms unannounced when employees are not at home, and can order the eviction of dwellers that violate rules. A warning can result in a fine of fifty euros. Anomalous conduct can also be reported by workers themselves, who can thus actively participate to the monitoring of the dormitory. 'There is no privacy and I don't trust anybody here. This is modern slavery, really!' as Stela lamented.

Apart from control and privacy, workers' leading concern is healthcare. Agencies deduct monthly insurance fees from the salary. Although the worker is enrolled at the municipality, insured, and entitled to the care of a general practitioner, finding available doctors for the thousands of unexpected new clients in small towns has become difficult. The only dedicated health care facilities were installed to vaccinate the entire population of workers during the Covid-19 emergency. Workplace accidents are most common in the logistics sector, almost 3 per cent of employees have accidents.[30] Health problems can also appear once the worker has returned home. Wojciech, a thirty-two-year-old Pole employed at XPO Logistics, managed to find a doctor five kilometres away from his dormitory. However, when he broke his knee, the agency did not accept the medical advice, exerting pressure on Wojciech to quit his job and granting sixty days of sick leave only after a few weeks, when surgery would have been necessary to save the limb. Generally, the workers' mobility and flexibility keep them from accessing health protection.

Workers' housing in the corridor is extremely unstable. Very rarely does a worker reside in a dormitory for a full year. The agency often moves migrants from one dormitory to another, regulating the flows of people and following the demands of production. At the same time, the worker constantly tries to find better working and living conditions, and as a consequence, frequently changes agency and dormitory. For each migrant worker, housing is the outcome of a hectic, itinerant and multidirectional trajectory linking various dormitories in the corridor.

Self-regulated box

Dutch governmental institutions focus exclusively on the essentials of living units, rather than the management of housing for migrant workers. In 2012, various parties including the Ministry of the Interior, trade unions and employment agencies' associations launched *Stichting Normering Flexwonen* (SNF, the foundation for flex living

Fig. 5: Roma community: extended unit, extended family, leisure. Photos: author.

norms). Based on self-regulation, this foundation establishes standards of flexible housing for migrant workers, enables agencies to self-register accommodations and self-monitor the adherence to standards, and annually schedules inspections in agreement with agencies to check if the registered locations meet the requirements.[31] Agencies can display the 'mark of quality', and an information sheet downloadable from the SNF website, on every registered living unit.[32] Currently, 15 000 locations for migrant workers are registered, almost 75 per cent have already been inspected, and two hundred workers' complaints have been forwarded to the foundation, which is processing them.[33]

During our interview, Jolet Woorders, secretary of SNF, gestured with her mouth and index finger, implying that much of their work was guesswork (referring to the Dutch proverb *natte vingerwerk*, literally wet finger work). She alluded to the foundation's estimate of the minimum area of a migrant worker's single room, is 3.5 m^2. The SNF defines the standards on the 'minimum liveability' of workers' housing, defining, for instance, the minimum amount of square meters per person, the minimum volume of cupboards, and the minimum dimensions of beds.[34] The well-known report *Geen tweederangsburgers* (No second class citizens) mildly criticises the SNF approach. Its suggestions include higher requirements for the SNF quality mark, such as a minimum area bedroom of 5.5 m^2 square metres per single room, unannounced inspections of buildings, the separation of work and rental contracts, and certification for housing providers and not only for buildings.[35]

The non-restrictive standards on minimum liveability by both of these authorities seem adapted to potentially register as many locations as possible, perhaps to provide an overview of this phenomenon and bring it under the institutional radar, or to validate the agencies' strategy. The defined minimum area for single bedrooms, 3.5 and 5.5 m^2, respectively, corresponds to the size of single bedrooms of old and new mobile homes, the standard living units of 'labour camps'. A prefabricated mobile home, which workers usually call a 'bungalow' or 'chalet,' consists of three bedrooms, a bathroom and a living room with an open kitchen, and can host three or four people.

The *Geen tweederangsburgers* report also states that mobile homes can be occupied only for the harvesting season, from the 1 April to 1 October, but also this recommendation is not commonly followed. Ciprian, a twentynine-year-old Romanian employed in a pharmaceutical distribution centre in Venlo, lives in a mobile home park nearby Arcen; his room is 3.9 m^2. Especially in the old type of mobile home, the thermal insulation is unsuitable for an extended stay. 'During the summer the chalet is very hot, in autumn and winter it is full of condensation. Everything gets wet, including the walls, floors, windows, clothes, and mattresses. It's horrible!'[36]

Migrant workers occupy a vulnerable position. Playing the dual role of landlord and recruiter, agencies evict workers when their work contract expires and then, when the rent exceeds the wages earned from a few-hours-a-week job, converts them into debtors.[37] The morality of debt turns the debtor into the guilty party.[38] With no savings, most evicted workers avoid returning to their country of origin, preferring to live on the street. There were approximately a thousand homeless people living in Rotterdam during the first six months of 2022; 75 per cent were EU migrants, and were current or former employees of logistics companies in the Netherlands.[39] Homelessness can be the end of the worker's migration trajectory or the beginning of a new life cycle within the productive machine of the corridor.

Out of the box

Before the digital age and the opening of the Dutch labour market in 2007, when the passport of 15 European countries allowed access without a work-permit requirement, seasonal workers, notably from Poland, came to the Netherlands mostly without the intermediation of recruiters, counting on the

support of their community of origin.[40] Relying on word-of-mouth advertising, relatives, friends and fellow villagers embarked on the same journey as the pioneer workers.[41]

Currently, migrant workers live an individual life. The agencies bring single workers from abroad, following standard procedures of recruitment and housing, arranging job applications on global online recruitment platforms, either on websites or social media, and offering weekly payments, a wide range of digital services, and suitable accommodations without specifying or showing locations.

One campsite in North Brabant, close to the Belgian border, seems an exceptional case of self-tailored mobility. Marius and Lavi, two 'Gypsies' from Bistrița-Năsăud county in Romania, came to the Netherlands in 2020 during the Covid-19 emergency.[42] After their first work experiences under the agencies' yoke, they emancipated themselves, finding another place to reside without the recruiter's intermediation and living with their children, who are not allowed in agencies' dormitories. Reaching an agreement with the Witte Plas campsite owner and settling there with their families, they invited, essentially through digital communication, relatives and fellow villagers living in different European regions. Currently, the Romani community comprises almost three hundred people living at the campsite of which nearly a hundred primarily work as pickers at Bol.com, a well-known Dutch webshop, in the distribution centre in Waalwijk. They act as a sort of trade union that can directly negotiate with the factory management about specific requests and benefits, such as days off on Saturdays, Sundays and religious holidays, a forty-hour working week with a fixed schedule during afternoon shifts, fair remuneration for the cost of transport to the workplace, and the training of newcomers to the community in Romanian.

The exceptional bargaining power and mutual aid at work reflect their living situation, emancipated from the agencies' control, including the use of apps. The Witte Plas became a collective form of housing with specific rituals such as going to church on Sundays, sharing outdoor areas for everyday activities and available rooms to house newcomers. The notion of flexibility tout court is back.[43] The single units, which are mobile homes bought or rented at the campsite, are genuinely flexible, and are adapted, customised, rearranged, refurbished and extended to meet the needs of single.

By excluding agencies and the control they exercise, this Roma community organizes the living place according to their own needs and beyond 'bare life', disrupting the dormitory labour regimes and imagining housing in terms of class struggle.

Conclusion

In the digital age, our society cannot function without migrant workers, and the entire platform economy is dependent upon them. Although the figures show how wide-spread a phenomenon this is, in Dutch specialised and mainstream media the representation of workers' housing is limited and stigmatised. This housing is based on a logistical regime, moving workers according to the fluctuating demands of production, connecting remote residential sites and workplaces through the reuse of existing infrastructures, and managing the everyday deployment of workers by governing and mining data. Agency housing entirely subsumes workers into corporate operations through specifically-designed digital technologies and standardised living units. The direct results of the cost-efficient and self-regulatory practices reflect on the hyper-rationalisation and minimum liveability of housing, inhibiting and limiting workers' conduct and behaviour. The agencies with their pervasive surveillance control workers' real and digital lives, increasing their alienation, estrangement, stress and debts. Rather than facilitating their lives, the digital service package offered by agencies is essentially indifferent to workers' needs and preferences. It dictates orders, representing a barrier between corporations and workers.

By contrast, the community of Roma people can be considered an exception. Their truly flexible

housing is the product of the disruption of the coercive agencies' strategies. Perhaps workers' housing could be reimagined, beyond its spatial and digital panoptic qualities, as a new architecture where political intermediation and action can take place.

Notes

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13. College van Rijksadviseurs, *(X)XL-verdozing: minder, compacter, geconcentreerder, multifunctioneler* ((X)XL-boxes: less, more compact, more concentrated, more multifunctional) (The Hague, College van Rijksadviseurs, 2019), 28–31. https://www.collegevanrijksadviseurs.nl/binaries/college-van-rijksadviseurs/documenten/publicatie/2019/10/29/xxl-verdozing/%28X%29XL+verdozing+-Minder%2C+compacter%2C+geconcentreerder%2C+multifunctioneler.pdf.
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18. For instance, see the municipality of Waalwijk; many migrants reside and work in its logistics hotspot. In partnership with OTTO Work Force and Covebo Uitzendgroep (two employment agencies) it tested for two years and recently launched MYinfoNL, a digital application available in five languages and designed by BookThat Group, a company specialised in digital platform development. Association of Dutch Municipalities (VNG), 'Gemeente Waalwijk helpt arbeidsmigranten op weg met app', (Municipality of Waalwijk helps migrant workers on their way with app), *VNG.nl,* 9 June 2022, https://vng.nl/nieuws/gemeente-waalwijk-helpt-arbeidsmigranten-op-weg-met-app.
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24. The architect Jean-Baptiste André Godin designed the Familistère Guise in the French city of Guise in 1859. Michel Foucault, 'Space Knowledge and Power', interview by Paul Rabinow, trans. Christian Hubert, *Skyline,* 1 March 1982, https://foucault.info/documents/foucault.spaceKnowledgePower/.
25. Ibid.
26. Ibid.
27. Giorgio Agamben, *Homo Sacer: Sovereign Power and Bare Life,* trans. Daniel Heller-Roazen (Redwood City: Stanford University Press, 1998), 21, 169–170. Agamben focuses on the Ancient Greeks' dual meaning of life: *bios,* the biological aspect of life, and *zoē,* the form in which life is lived, while contemporary languages have lost this distinction. 'Bare life' indicates the predominance of biological dimension rather than the quality of life.
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31. Stichting Normering Flexwonen (SNF), 'Information for residents', https://www.normeringflexwonen.nl/information-for-residents.
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Biography

Renzo Sgolacchia is an architect and filmmaker based in Rotterdam and PhD fellow at IUAV, University of Venice. His research focuses on the relation between housing, labour, and contemporary forms of urbanisation. Supported by the Creative Industries Fund NL, he is currently completing a documentary about the lives of migrant workers in the Netherlands. He is the founder of *Cinema Architecture,* a project combining research and film screenings, and a member of the international research group The Surroundings Lab. In 2020 his proposal, *Learning from Films,* was selected by the Future Architecture Programme. He collaborated with KCAP, Atelier Kempe Thill and Studio Marco Vermeulen. He contributed to *Footprint* 23, *The Architecture of Logistics* (2018), with the co-authored article *Twenty-four Hours at Work.*

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Footprint is grateful to our peer reviewers, who generously offered their time and expertise. In this issue, the following papers were peer-reviewed: 'The Digitalisation of Swedish Housing: The First Forty Years', 'Rethinking Autonomous and Robotic Systems in Residential Architecture: Assessing the Motivations and Values of Home Automation', 'Platforms and Dwelling: Topologies of Distributed Domesticity', 'Infinite but Tiny: Towards a Hybrid Architecture of Dwelling'

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