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Umwelt as the foundation of an ethics of smart environments

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Due to the increasing embeddedness of pervasive and immersive technologies in the built environment, a new type of spaces known as smart environments emerges. With them arise many ethical issues related to freedom, agency, consciousness, and the governance of human-machine interactions. In this paper, I use Jakob von Uexküll's Umwelt theory to devise principles for an applied ethics of umwelt, as part of a broader ethics of smart environments. Umwelt ethics is one of human beings' surrounding world in the context of environmental capitalism. As umwelt becomes a resource to be exploited by economic agents with de facto or de jure rights to control space, defining ethical principles pertaining to the digitalization of space in the built environment is more important than ever.

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Introduction

Among the myriad of upheavals stemming from the ever-deepening embeddedness of digital technologies in human lives, there is one which is so primordial that it might be easily overlooked: the way we relate to the outside world, or more precisely the way we experience reality around us. Human beings' relationship to their environments, or their *umwelt* as defined by German Baltic ethology pioneer Jakob von Uexküll in the early 20th century (2010), is the product of millions of years of evolution.

In the context of the built environment, changes to human umwelt are closely related to the emergence of smart environments, meaning physical spaces invaded by a plethora of non-conscious cognitive devices in what amounts to a tectonic shift for humanity (Hayles, 2014). By merging physical space and digital space, smart environments embody a new type of space known as smart space (Lecomte, 2019). Several technologies including the Internet-of-Things, 5G, big data, Augmented Reality, Artificial Intelligence converge to give rise to these new spaces imbued with ambient intelligence.

In smart space, people's interactions with their surroundings are invisibly and silently mediated by technology according to the principles of ubiquitous computing (Weiser, 1991) while the customisation of the building occupants' experiences owing to the collection, storage and management of an unprecedented quantity of data allows for user centricity. Smart space is proactively engaged in a bi-directional dialogue with its users, defining a new phenomenological way for occupants to experience the built environment.

Paramount to this phenomenology is a space user's digital surrounding world called umwelt after Heidegger's phenomenology (Lecomte, 2020). Whomever controls smart space has the ability to shape building occupants' umwelten without the latter being aware of any active interferences (Lecomte; 2021, 2023). Power imbalances exist among all parties, most notably due to abyssal knowledge gaps between those in control of the technologies and the space users as well as because of the latter's potential technical alienation. This raises serious ethical considerations respecting agency and governance relationships in smart real estate[1]. All spaces enclosing human lives are concerned: from the intimate space of domesticity in smart homes to the productive spaces of work and consumption in smart commercial buildings.

So, what is umwelt? How is a concept initially designed in ethology relevant to the analysis of human experiences in technology-powered environments? What is the connection between umwelt, agency, and governmentality in smart space? Is there a need for ethical guidance with respect to umwelt in smart environments? If so, what could be the principles for such *umwelt ethics* as part of a broader digital ethics of smart environments?

The article addresses these questions in four sections. The first section introduces the umwelt theory and analyses the interplay between umwelt and the cybernetisation of the built environment. The second section studies the impact of changes to umwelt on human agency and governmentality in smart environments. It then explores how umwelt customisation has ushered capitalism into environmental capitalism. In this new form of capitalism, human beings' relationship to their environment is a resource that can be appropriated and harvested for profit. The third section proposes guidelines, principles, and instruments for an ethics of umwelt in smart environments. The fourth section concludes.

Umwelt and smart environments

Definition of umwelt. In the foreword to his seminal text *A foray into the worlds of animals and humans*, Jaköb von Uexküll (2010) states that he does not aim to introduce a new science. However, this is precisely what he did when his umwelt theory was first presented in 1909. In German, Um-Welt means the world around. Brentari (2015) notes that in philosophy, umwelt refers to the environment-world, that is 'the world in which the subject is placed in immediately and without reflection'.

For Uexküll, '[Animals'] essential activities consist in perception and production of effects … for everything a subject perceives belongs to its perception world, and everything it produces, to its effect world. These two worlds, of perception and production of effects, form one closed unit, the environment.' Umwelt is like an invisible soap bubble surrounding each subject, be it a tick, a bird, or a human being. 'The bubble represents an animal's environment and contains all the features accessible to the subject.' (Uexküll, 2010). It is a lived world that subjects build based on their needs and available tools akin to a spider spinning out 'its relation to certain qualities of things and [weaving] them into a solid web, which carries its existence' (Uexküll, 2010). Umwelt encompasses an organism's lifeworld and the built, artefactual environment defined as quasi-umwelt. While the lifeworld relates to direct, experiential sensemaking, quasi-umwelt is mediated and, in the case of personalized media environments, depends on pre-designed intended affordances (Andersson Schwarz, 2019).

Uexküll (2010) posits that all animals live in three environment spaces:

- The effect space, or 'the free space of our movements [which] serves as the basis for all spatial determinations';
- The tactile space;
- The visual space which, unlike the other two spaces, is constrained by the horizon. Visual space is species dependent and represents an important aspect of umwelt (Berthoz, 2009). For instance, research shows that visual perception of the world influences behaviour in primates (Cheney and Seyfarth, 1990).

Umwelt is inherently subjective so that there is 'no space independent of subjects' (Uexküll, 2010). As constituent of this subjectivity, a subject's mood plays a key role in their perception of umwelt, by impacting the tone taken by the environment. With a different environmental tone, an object's significance might change from one umwelt to another. Mood and tone are therefore central in differentiating umwelt among subjects, even from the same species.

Umwelt's subjectivity also stems from its semiotic nature. As pointed out by Uexküll (2010), umwelt is made up of 'subjective perceptive signs'. The bubbles within which each species lives, represent systems of signs to be interpreted (Sharov, 2001). By establishing relationships between signs, animals build their own space according to their unique model of environment spaces, thereby giving rise to their 'meaningful world' (Deeley, 2001). However, subjectivity does not prevent world making. All subjective individual umwelten interconnect 'as part of the overall harmony of nature' (Schroer, 2021).

Human beings' condition as 'semiotic animals' (Deeley, 2001) sets their umwelt apart from other organisms'. Among human umwelt's distinctive characteristics are (Tønnessen, 2003):

- Humans' ability to perceive their own actions;
- Human umwelten's high levels of individuality so that 'one human Umwelt can differ substantially from another';
- The link between the number of actions available to humans and the number of objects in their environments;
- The importance for participating in 'common-Umwelten (cultures, subcultures)' to the individual umwelt experience.

Bringing 'all personal Umwelt spaces under a common denomination … has become indispensable for civilized human beings.' (Uexküll, 2001).

- The role played by 'a conceptual world', inclusive of language. Human umwelt is conceptualised insofar as 'the perceptual objects of humans are under most circumstances colored, imprinted and structured by various concepts.' (Tønnessen, 2003)

To make sense of this 'conceptualized Umwelt experience', Tønnessen (2015) proposes a model of human umwelt according to three components: a) Core umwelt linked to 'face to face encounters', i.e., direct and immediate interactions; b) Mediated umwelt embodied in indirect encounters through 'memory, fantasy, anticipation, modern media, etc.' Mediated umwelt encompasses perceptual and mental acts which are wilful, i.e., not automated but interpretation-based; c) Conceptual umwelt which relies on 'predicative reasoning or human language'.

Of the three components of human umwelt, mediated umwelt is undoubtedly at the heart of the ethical questions discussed in this article. In particular, how does technology-powered mediation impact the three components of human umwelt and their interplay in shaping human experiences in smart environments? As mediated umwelt positions itself at the center of human activities in smart space, what role is left to core and conceptual umwelten? In that respect, do immersive technologies such as augmented reality lead to the disappearance of core umwelt stricto sensu? More generally, do technologies turn mediated umwelt's supposedly wilful acts into automated acts, i.e., code-based acts, at the expenses of space users' freedom and projectuality[2]?

Human umwelt and the cybernetisation of the built environment. Uexküll's umwelt theory finds a new relevance in the context of smart environments as a result of the massive transformation of human-world relationships triggered by pervasive and calm technologies (Lecomte, 2019, 2020). With its atmospheric technical mediation of sensation, ubiquitous computing radically alters the human environment (Bohn et al. 2004). 'Ubiquitous computing was, from the outset, a proposal not for how technology should be but instead how it should be experienced. […] New technologies inherently cause people to reencounter space' note Dourish and Bell (2011).

Umwelt which used to be 'the intertwining of vital relations with other living beings' (Brentari, 2015) becomes the realm of mediated communications whose features have shifted from recording, storing and assembling to serving as 'a platform for immediate, action-facilitating interconnection with and feedback from the environment' (Hansen, 2011). Hörl and Parisi (2013) refer to 'a new digital matrix of algorithmic environments' (*algorithmischer umwelten*) to describe computational environments populated with a myriad of algorithmic objects.

According to Hayles (2021), the cybersymbiosis achieved between humans and machines enmeshes the former in cognitive assemblages where distributed agency makes the concept of human free will practically irrelevant. She writes: "as machines communicate more with each other than with us, the intervals and pervasiveness of machine autonomy increase- areas where machines make decisions that affect not only other machines but also humans enmeshed in cognitive assemblages with them". Smart buildings are interactive, autonomous, and adaptable (Dakheel et al. 2020). Through AI-initiated processes, they can learn (Alanne and Sierla, 2022). In that respect, smart buildings enmeshed in cognitive assemblages with their occupants qualify as moral agents according to Floridi and Sanders (2004)'s guidelines for agenthood.

In smart environments' 'cybernetically constituted realities' (Andersson Schwarz, 2019), every experience and every sensation are systemically permeated by technologies, so much so that the 'technical mediation of [human] environmental sensibility' becomes a concern (Hansen, 2012). Calm technologies bring to the fore 'the absolute prioritization of mediation' (Hörl, 2013). Consequences are wide-ranging. According to Andersson Schwarz (2019), a technologically mediated umwelt 'becomes a question of not only cybernetics (control), but of human ecology (interaction with the built environment) as well as questions of ontology (being), epistemology (knowledge), and axiology (values).' Fundamentally, 'the mediated environment prompts human self-understanding to take on mental categorizations that are isomorphic to this environment.'

All environment spaces theorized by Uexküll (i.e., effect, tactile and visual spaces) are affected by mutations in human sensory perception which correspond to fundamental 'changes in the material, cognitive and affective capacities of a body to feel' (Parisi, 2009). Lecomte (2019) writes: 'As a phenomenon, smart space is lived, not perceived'. Since affordances in smart environments are unperceived, there is 'a fundamental shift in address to experience' (Hansen, 2012). Technologies eschew subjectivity, i.e.'perceptual consciousness', to target the 'non-subjective subjectivity at issue in a wordly microsensibility'.

Therefore, given the overbearing mediation of pervasive technologies as the mandatory 'in-between' between humans and the world, is there any human umwelt left in smart environments at all? The view that human umwelt morphs, or even vanishes, in smart environments has been mentioned in many studies since Weiser's (1991) seminal paper introduced a new computing paradigm 'for the 21st century'.

Araya (1995) underscores how in an ubicomp world, the merging of human beings with their environment would lead to the disappearance of their surrounding world. He explains: '[In a ubicomp world], the environment, that which immediately surrounds us, becomes intimately tuned to us by not only making possible our engagement in activities leading to satisfaction of needs, but by actively engaging itself in those activities. … Significant parts of the environment lose important aspects of their otherness … In this sense, the surrounding world has almost disappeared.' The obliteration of the world's otherness is so advanced that people are no longer aware of it. As anticipated by Heidegger in *The Age of the World Picture* (1938), the world imbued with pervasive technologies discloses itself to human beings who inhabit it as a pre-formed image, and no longer as an 'other' that they can understand, let alone control (Araya, 1995). Their world picture, i.e., their 'fundamental, intuitive and immediate understanding of the world which projects its significance in every part of our life' (Hui, 2010), is coded and dependent on their personalised, albeit pre-determined, interactions in smart space.

For Floridi (2007), the mutation of human umwelt is concomitant with the emergence of the 'infosphere' under Web 6.0 characterised by ubicomp, ambient intelligence, and Internet of Things, that is an environment which includes 'offline and online spaces of information'. He writes: '[As] the infosphere is progressively absorbing any other space, … we are witnessing an epochal, unprecedented migration of humanity from its umwelt to the infosphere'. Consequently, the 'threshold between here (analog, carbon-based, offline) and there (digital, silicon-based, online) is fast becoming blurred'.

As a result of pervasive technologies' ingression into their living and working spaces, people are turning into 'inforgs' for whom there is 'no ontological difference between infosphere and umwelt' (Floridi, 2007). Whilst the infosphere becomes synonymous with being, people's ordinary environment is reontologised in

informational terms as part of a synchronised (time), delocalised (space), and correlated (interactions) infosphere. Thus, technologies powering Umwelt's migration into the infosphere are in effect 'modifying the context and the practices through which we shape ourselves'. As 'the most powerful technologies of the self to which we have ever been exposed', they should be handled with care (Floridi, 2014).

To make sense of these changes in the context of smart real estate, Lecomte (2021) applies the umwelt model in the realm of economics, by focusing on the production of space in smart environments. The corresponding model of space user in smart real estate, designed after Heidegger's phenomenology and known as cyber-dasein, positions umwelt at the heart of the analysis of smart environments.

Umwelt is a space user's highly personalized digital surrounding world. It unfolds in time as more data are collected each time cyber-dasein interacts in smart space. It is therefore fluid and mutable. The digital surrounding world is the world-space of the 'being-there' in smart environments, as opposed to the 'being-in' in physical real estate.

Due to pervasive technologies' hypermnesia and ability to reach beyond the boundaries of the physical spaces they are operating in (e.g., through cyber-physical linkages of different spaces), smart environments imprint on human umwelt a compression of both time and space. To account for these new temporality and spatiality, human umwelt can be broken down into three components according to the resources necessary to produce the smart space where umwelt takes shape (Lecomte, 2023): i) immediate umwelt, i.e., the environment constructed from a space user's immediate interactions in smart space; ii) umwelt in time, which is the digital environment materializing over time as more data are collected and stored; and iii) linked umwelt, i.e., the digital environment that derives from linkages of different spaces which might be smart and/or digital[3]. Hence, human umwelt in smart real estate is not so much dissolved in cyberspace as projected, both spatially and temporarily, far beyond the boundaries of Uexküll's three environment spaces as illustrated in Fig. 1, which represents cyber-dasein's being-there in smart environments according to Uexküll's classic bubble metaphor.

By materializing the in-betweenness of ubiquitous computing, umwelt defines the ontology of smart space. Because of this unique position, 'the concept of umwelt epitomizes the new set of social and ethical responsibilities facing the real estate sector with pervasive computing and embedded technologies' (Lecomte, 2021).

Umwelt and human freedom in smart environments

Customised umwelt and human agency. Smart environments' highly personalised experiences, powered by ubiquitous computing, raise numerous questions with respect to their occupants' agency. The issue of agency in smart environments is multifold. First, ubiquitous computing changes the nature of space. Hansen (2012) describes a space animated by its own agency. People are left with no control and hardly any awareness of the computational agents they interact with. Secondly, experiential customisation, based on algorithms and advanced profiling techniques, challenges space users' ability to make their own decisions and overall freedom of action. One way to decipher what happens to space users' agency in smart real estate is to think in terms of umwelt.

Umwelt in smart environments is created and reshaped by interactions which are proposed to space users or, rather, imposed on them, by the technological apparatus that mediate them. Through personalised experiences, smart environments become the stage of customized human umwelten. The main reason for technologies embedded in the built environment to have such drastic impact on human agency is their pervasiveness, which enables the seamless integration of physical and digital spaces in a new totality, the customised umwelt of Fig. 1 with its time-space compression.

Space users calmly dwell with computers. They become engaged in ambient user-centric experiences while forming cognitive assemblages with non-conscious cognitive devices in smart space (Lecomte, 2019). In a world enveloped by an ICT-friendly infosphere, people run the risk of being 'constrain[ed] to adjust to [physical and conceptual environments shaped by technologies], thus inadvertently becoming part of the infosphere' (Floridi, 2014).

Given that technology is never neutral (Penny, 2013), customized umwelt is never neutral either, but instead potentially nudging (Thaler and Sunstein, 2021). Pervasive technologies are the 'choice architect' responsible for organising the context in which space users make decisions in smart environments while mediated umwelt becomes the 'choice architecture' where it all happens. Perry (1953) points out that 'whoever determines what alternatives shall be known to man controls what man shall choose from. He is deprived in proportion as he is denied access to any ideas or is confined to any ranges of ideas short of totality of relevant possibilities'. Customised umwelten are essentially scripted umwelten. This turns the user's right to action into an obligation to select from a given set of interactions which are part of broader patterns beyond the user's awareness. Because it carries less potentiality and enables little to no projectuality, scripted umwelt is paradoxically a poorer umwelt than Uexküll's ambient intelligence-free umwelt.

Nudging is greatly facilitated by the difference between the temporal regimes of human consciousness and machines. In smart environments, there is 'a separation between operationality and awareness, such as the latter always comes after the fact, and is characterized by a distinctive temporal belatedness' (Hansen, 2012). This leaves human consciousness vulnerable inasmuch as 'the messages are not simply coming from the body's sensory interfaces with the outside world (as well as from internal sensing mechanisms) but rather are targeted by corporate interests specifically to create a propensity toward certain kinds of information …' (Hayles, 2021). Hayles (2021) underscores the ability of pervasive technologies 'to address humans in the microtemporal regime, underneath the temporal horizon of consciousness'. The consequences of a nudging umwelt are far-reaching.

Fundamentally, research shows that knowledge of the environment, and ultimately the freedom that this knowledge brings, depends on umwelt. For Merrell (2001), 'umwelten let us know what we know'. He asks: 'how much freedom does [human umwelt] allow us regarding our perception and conception of time and space and causality and many other things within human societies past, present, and into the unknown future? What, ultimately, are our limitations and constraints, and what our parameters, of freedom?'

The cyber-dasein model applied in the economic framework developed in Lecomte (2021) can shed some light on these questions. Human umwelten are imbued with smart environments' unrelenting search for value creation, their extreme utilitarianism hidden in plain sight as user centricity. Because smart space depends on algorithmic interactions necessarily coded to trigger acts, it is always a purpose driven, value-creating space for its producers (i.e., those who can dominate and appropriate it) and a utility-generating space for its users (Lecomte, 2023). In Heidegger's parlance, the users immersed in invisible technologies, without any perception of affordances,

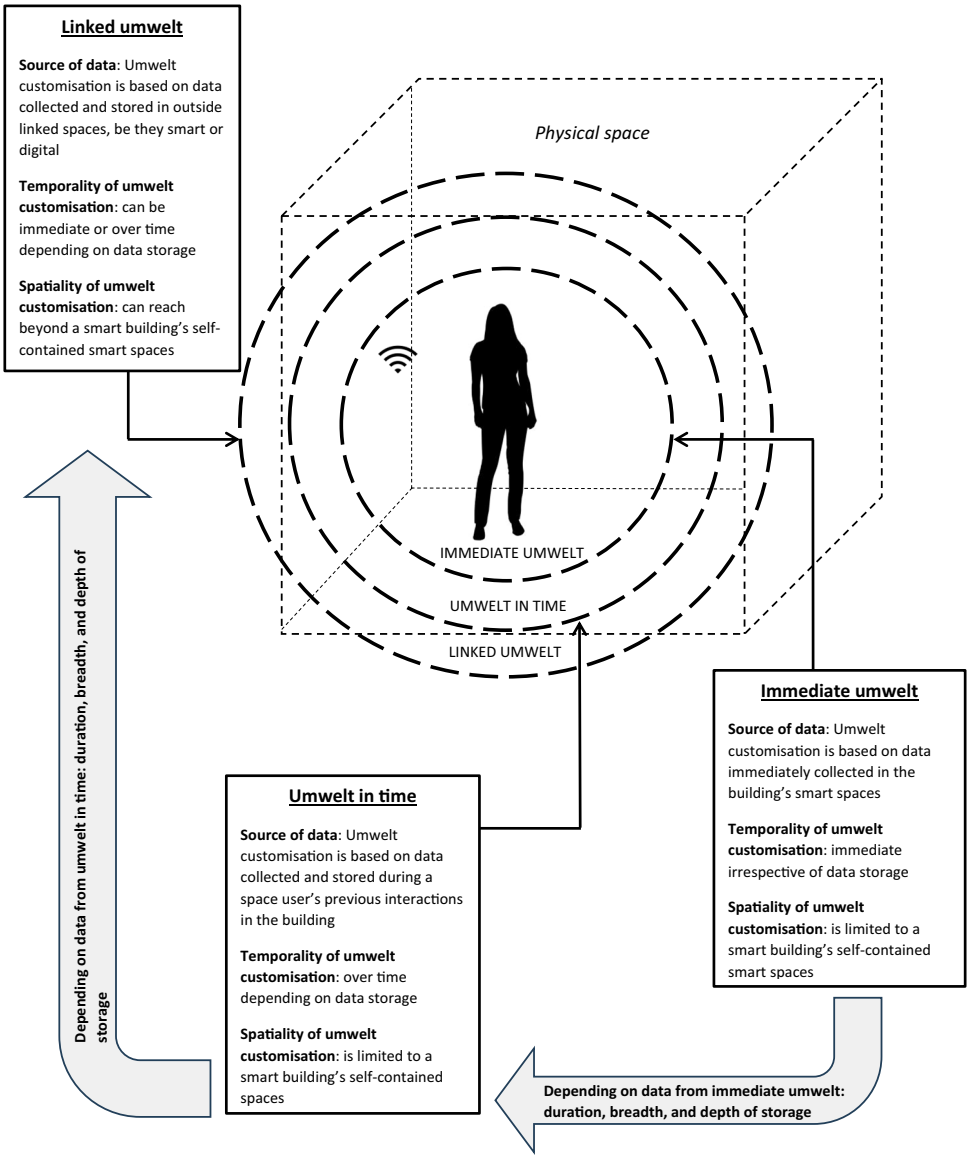

Fig. 1 Representation of a space user' umwelt in smart environments. Umwelt is broken down into three components depending on the temporality and spatiality of data sources: immediate umwelt, umwelt in time, and linked umwelt.

can only interact with space in a constant state of 'readiness-to-hand' whose ultimate objective is the 'maximization of jouissance' (Rouvroy et al. 2013). Such prevalent readiness-to-hand prevents space users from being present-at-hand. This puts a person in precisely the same condition as an animal, 'open to its surroundings but not as a world that is coextensive or reducible to the prejacent environment' (Bains, 2001). In other words, umwelt customisation fundamentally limits space users' ability to gain knowledge from their interactions in space. Their understanding of the surrounding world is optimally guided by pervasive technologies. Customised umwelten are algorithmic umwelten constrained by a world picture 'formed through the digital network based on patterns and repetitions of digital matter' (Hui, 2010).

In this respect, whether human identity can freely develop or even form at all, in smart environments is questionable (Cheney-Lippold, 2017). Andersson Schwarz (2019) assesses, 'It is here where the current, corporate [big data] model, where categories are assigned to individuals without their genuine participation in the process, is most deeply problematic… It defines you from afar, thus … denying you your self-determination'. Customised umwelt participates to the objectification of space users who become subjects of ambient intelligence[4] .

Umwelt and the governance of human-environment interactions

Umwelt and environmentality. As human freedom is curtailed in modern capitalist societies, control of human beings as economic agents sets in. Control has taken many forms over the centuries (Beniger, 1986). Its latest embodiment is *environmentality* that Foucault (2004) describes as 'an environmental type of intervention instead of the internal subjugation of individuals'.

In a seminal lecture at the Collège de France in March 1979, Foucault (2004) explains: 'From the intangible partner of the laissez-faire, *homo oeconomicus* now becomes the correlate of a governmentality which will act on the environment and systematically modify its variables.' According to this view, space users in smart environments are rational economic agents who are governable, because they '[respond] systematically to systematic modifications artificially introduced into the environment' (Foucault, 2004). Systematic umwelt customization thus becomes a mode of governmentality. By acting on umwelt at the

most micro-level, the digitalisation of space becomes the catalyst for technology powered environmentality in the built environment. For Hörl (2018), environmentality marks the peak of cybernatisation.

Our new 'techno-ecological condition' (Hörl, 2018) has not appeared out of nowhere, but instead emerges from in-depth research conducted by behavioural psychologists over decades. Chief among them is Harvard University professor Skinner who is singled out by Foucault (2004) as the inventor of 'the purest, most rigourous, strictest or abherrant' ideas about environmentality. Skinner proposes a scientific approach to behavioural control based on modifications of the human environment, a so-called 'technology of behaviour' that aims to reach beyond dignity and freedom. He explains (2002), 'the environment acts in an inconspicuous way: it does not push or pull, it selects… A scientific analysis of behaviour dispossesses man and turns the control … to the environment. He is henceforth to be controlled by the world around him, and in large part by other men.'

To foster effective behaviours, technology should eradicate distractions while opening up opportunities. For Skinner, controlling the environment means first and foremost arranging contingencies responsible for the change in behaviour to be observed, 'rather than the unfolding of some predetermined pattern'. Noticeably, algorithms which rely on patterns to pre-empt behaviour through advanced profiling techniques go much further than Skinner's scientific endeavours in their efforts to control people's actions[5].

While it is key to balance the protection of people's freedom with their propensity to make bad decisions, control in the environment should preferably be human made. The fact that the environment is human made provides reassurance to Skinner as far as people's ability 'to make himself [or herself]'. For instance, Skinner argues in line with 18th century French philosopher J.J. Rousseau that depending on human-made constructions in both the physical and social environments to learn about the world is preferable than relying on other men, as these things, such as 'the surfaces a person walks on, the walls which shelter him, the clothing he wears …, the tools he uses, the vehicles he moves in …, the language a person speaks', provide a more precise knowledge of the world. Nonetheless, Skinner (2002) points out that 'the control exercised by things may be destructive [because] the world of things can be tyrannical.'

Unsurprisingly, shifting the responsibility of human behaviours to the environment is associated with countless ethical issues. Skinner (2002) asks: 'As the emphasis shifts to the environment, the individual seems to be exposed to a new kind of danger. Who is to construct the controlling environment and to what end? Autonomous man presumably controls himself in accordance with a built-in set of values […] But what will the putative controller find good, and will it be good for those he controls? […] Does man not become merely a victim or passive observer of what is happening to him?' Of special concern are technologies of behaviour that would not trigger a willingness to escape by space users, notwithstanding their adverse effects. Lecomte (2023) shows that pervasive technologies in the built environment fit into that category by procuring unaware space users with ever increasing levels of user-centric utility at the expense of their freedom of action.

In addition, Skinner's recommendation that a constructed environment acts as a safeguard against stifling control does not translate easily into the governance of smart environments. Indeed, are customized umwelten human-made in the same sense as the physical and social environments? Can space users rely on pervasive technologies, especially algorithms, to learn about their environments when the former are constantly and inconspicuously reshaping the latter? Do machine learning technologies embedded in the built environment, such as artificial intelligence, qualify as human-made insofar as they keep evolving out of human stewardship? Are spaces powered by Internet of Things devices comparable to a wall that shelters or a surface to be walked on? Most space users are unaware of the technological apparatus they interact with, to the point of complete technical alienation (Hui, 2016), so how does this affect pervasive technologies' power, or even tyranny to paraphrase Skinner (2002), over them? Answering these fundamental questions goes beyond the scope of this article, but the concerns they raise must be part of any recommendations for an ethics of smart environments.

Umwelt as a resource in capitalism. As environmentality becomes the dominant mode of governmentality in modern societies, a 'new behavioural economy' arises (Hörl, 2018) in which '[power] is identified with ownership of the means of behavioural modification' (Zuboff, 2015).

In this new economy, the right to shape umwelt for profit becomes a core resource. This right materializes as de jure or de facto *digital usage rights* in a property rights regime pertaining to the production of space in smart environments. Lecomte (2021) notes, 'Whoever owns digital usage rights is entitled to employ smart space to create value in space… Through data collection and analytics applied in smart space, digital [usage] rights refer to the optimisation, or to put it more bluntly the control, of space users' experience in smart real estate… Digital Usage Rights carry with them the right to monetize space users' umwelt'.

'The environmental becoming of capitalism' (Hörl, 2018) in smart environments epitomizes the ontological dimension of capitalism in the digital age, a capitalism of umwelt that turns people's very being in space, their phenomenological interactions with the environment, their capacity for sense making and to construct meaning, into a resource to be harvested. Surveillance is part of it, but it is not the full story. As '[spaces] now turn out to be directly entangled in processes of becoming […]' notes Hörl (2018), there is a strong spatial component to this new capitalism with the built environment at the heart of the 'great environmental switch'.

Noticeably, the emergence of this new form of capitalism, where human umwelt becomes the object of complex modelling techniques and real time optimisation, is rife with paradoxes. As highlighted by Rouvroy and Berns (2013), even though it creates 'hyper-subjects', personalisation powered by algorithms is profoundly indifferent to individuals as singular beings. Thus, umwelt customization does not enable space users to better appropriate their space in smart environments in order to make it their true own space. Instead, it indicates 'an ever-tighter domination … of building occupants' unique ontological perception of their digital surrounding worlds', by parties who own or have seized the right to shape space users' umwelten (Lecomte, 2021)[6].

To illustrate this analysis with concrete examples of environmental capitalism in action, Table 1 presents four vignettes illustrating umwelt customisation in various smart commercial real estate settings. Technologies employed for customisation are actual technologies being currently developed or offered for deployment. Case 1 describes the productive space of an office building. Case 2 describes an airport. Case 3 focuses on a shopping mall while Case 4 showcases umwelt customisation in a retail store.

Blueprint for an ethics of umwelt in smart environments

Guidelines for an ethics of umwelt. As governmentality becomes environmental, a set of ethics principles is needed to guide environmental capitalism's appropriation of human umwelt.

Table 1 Four vignettes of smart environments in smart commercial buildings.

Smart environment	Scenario	Ethical principles
Smart office	As an employee equipped with smart contact lenses enters a smart office building, a holographic receptionist greets her and points her to the lift. As she alights, the building's navigation system helps her find her hot desk for the day thanks to signage on the floor. While walking through the workspace, she has no face-to-face impromptu interactions with her colleagues. All her social interactions are planned and mediated by technology. During the day, data collected from inbuilt 'sensors to make her day more productive' (JLL, 2016) feed an activity report that analyses her usage of the smart spaces, activities, as well as her mood. As she leaves the building, a friendly voice prompts her to share her daily usage data with the building management system. She then switches off the building's navigation system for the evening. *Sources: Jones Lang Lasalle: Workplace of the future: how will you work in 2030? (video), Mojo*	PICT principles: transparency, informed choice, privacy Umwelt ethics principles: non-objectification, neutrality, interconnectedness
Smart airport	While checking in, a passenger opts in for personalised experiences thanks to the airlines' digital ID facial recognition system. As he walks through the airport, Parallel Reality ™ screens send him personalised messages. These screens are designed to send 'different colours of light in tens of thousands of direction—so while one person perceives one colour, the person next to them can see another', thereby enabling fully personalised displays in a crowd (Delta Airlines). To achieve the best personalisation, a relationship between the passenger's identity and his position, i.e., location tracking, must be established so that motion cameras follow his shape. The technology has the capacity to detect and capture a myriad of personal information about the passenger. However, to assuage space users' concerns about privacy and surveillance, it can be configured to collect only data necessary for immediate umwelt customisation without any storage. *Sources: Forbes (2022), Misapplied Sciences.com, Delta Airlines*	PICT principles: informed choice, privacy Umwelt ethics principle: non-objectification (either commercial or security related)
Smart shopping mall	As a shopper enters a smart shopping mall, the embedded technologies propose to add a geo-layer to her perception of physical space. A geo-layer detects a user's location through GPS and 'augments the space around the shopper with digital objects that may or may not be linked to specific geo-locations, typically using privately owned devices triggered by the user' (Scholz and Smith, 2016). The marketer's objective is to attract customers to one's store thanks to an 'experience scape' (Scholz, 2021). Experience scapes rely on geo-layers to 'put up blinders and neutralize threats [from other brands] … so that customers just focus on the brand's experience' (op. cit.). The immersive experience's content has to be emotionally appealing so that the brand can 'gain control over customers' attention and entice them in its retail setting' (op. cit.). As the shopper progresses through the mall according to a journey defined by the geo-layer, her attention is fully focused on the digital objects which seamlessly lead her to the brand's retail outlet. *Sources: Scholz and Smith (2016), Scholz (2021)*	PICT principles: informed choice, privacy, maximum access Umwelt ethics principles: non-objectification, neutrality
Smart retail outlet	As a shopper steps inside a fashion retail outlet, a personalised audio beams into his ears while a holographic salesperson suggests a few products to suit his style as analysed by the brand's in-store AI system. He opts in for a personalised shopping experience. A smart mirror displays images of the shopper wearing these products and indicates their position in the store. The technology then nudges the shopper into a specific route within the store to optimize his customer journey. Along the way, customized audio messages encourage him to try on complimentary products as part of cross-selling. Beacons and geofencing gauge the shopper's visit time in different sections of the store while an analytics engine analyses his behaviour based on his past in-store activity if any. As he self-checks out, data collected are shared with other outlets of the brand and brand partners to further improve his customer experience in the future. *Sources: H&M (smart mirrors), Noveto, Scholz (2022)*	PICT principles: informed choice, privacy, transparency Umwelt ethics principles: non-objectification, neutrality

The above scenarios describe a space user's interactions with smart environments in three different commercial property types: office, infrastructure (airport), and retail.

Floridi (2014) mentions the need for an *e-nvironmental ethics* to provide the framework of 'a new environment worthy of the moral attention and care [of people]', lest humankind's future is at risk. New ethical rules should form part of the effort to provide people with guidelines for consciously and harmoniously dwelling with cognitive devices in a world of ambient intelligence.

What I propose is an applied ethics of umwelt, that is an ethics of cyber-dasein's being in smart environments. In line with Deleuze (1992), an umwelt ethics should distinguish how pervasive technologies embedded in the built environment influence 'what we are, what we are no longer and what we are in the process of becoming'. Donati (2021) underlines how hybridisation, the blending of the real and the fictitious, the analogue and the digital, must be considered as 'a morphogenic process that leads from entities structured in a certain way to entities structured in another way'. For Stiegler (2019), this process ultimately leads to the 'exosomatisation' of humans' fundamental activities such as thinking.

Thus, it is crucial to understand how human functions are externalised in smart environments, including pervasive technologies' impact on 'the psychic capacities of memory, perception and anticipation, and on the collective capacity of deliberation or decision' (Alombert, 2021). The analysis of the '*proprium* of the human in the hybridisation process' (Donati, 2021) can give directions for an umwelt ethics with core principles that rest on the distinctive features of human umwelt introduced previously in this article (Tønnessen, 2003). Sunstein's (2015) discussion about the ethics of nudging can provide some clues: welfare, autonomy, dignity, manipulation, and bias are all ethical issues linked to the implementation of nudging which are also shared with the customisation of human umwelt.

Overall, I have singled out 10 ethical issues afferent to umwelt customisation (in alphabetical order): i) autonomy, ii) consciousness, iii) dignity, iv) dwelling, v) sense-making, vi) socialisation, vii) subjectivity, viii) technical alienation, ix) umwelt commodification, and x) umwelt manipulation.

To ground the analysis, it is helpful to position smart environments in their functional and technological dimensions. Firstly, smart environments are implemented in smart buildings which are themselves an integral component of smart cities. Whilst ethical issues have been clearly identified for smart cities (e.g., Kitchin, 2016) and attempts have been made to define principles of an ethics of smart city (Calvo, 2020), the ethics of smart building is still underdeveloped as it focuses almost exclusively on privacy (e.g., Keeling et al. 2013). For that reason, an ethics of smart building cannot provide solid foundations for an umwelt ethics.

Secondly, from a technological standpoint, ambient intelligence (Aml) is made possible by the convergence of several technologies, including Internet of Things (IoT), big data, ubiquitous computing, 5G, augmented reality (AR), artificial intelligence (AI). These technologies are governed by their own ethics: IoT ethics, data ethics, AR ethics, AI ethics, pervasive information and communication technologies (PICT) ethics, and Information ethics. Thus, a focus on the smart environment as a quintessentially technological space and theatre of ambient intelligence deployment provides a rich perspective on umwelt ethics. Among the above-mentioned ethics, Kenneth Pimple's (2014) Pervasive ICT (PICT) ethics is of special relevance.

Pimple starts by identifying a set of values, or root principles, derived from the 1979 Belmont report on bioethics: beneficence and non-maleficence, respect for persons, justice, and other principles including loyalty, respect for authority, reparation and honesty. Beneficence is a widely mentioned value underpinning many proposed ethics of intelligent systems, such as Jones et al.'s (2015) ethical framework for intelligent environments development. Beneficence as 'a superset of human rights' also tops the IEEE Global Initiative to establish ethical principles for autonomous and intelligent systems (2019).

Pimple's PICT ethics include eight principles:

1. *Anticipatory ethics* to ensure that 'ethical analysis and technological innovation… proceed hand-in-hand' (PICT#1);
2. *Extended consequences* so that developers of pervasive technologies 'account for effects of deployment and use beyond the local' (PICT#2);
3. *Anti-malice* to protect against 'malicious uses of the technology' (PICT#3);
4. *Proportional safety* between the safety of a system and 'potential negative consequences of its misuse or failure' (PICT#4);
5. *Transparency* allowing 'individuals to know what PICT systems do and where they are' (PICT#5);
6. *Informed choice* enabling individuals to 'be able to opt out of involvement with PICT' (PICT#6);
7. *Privacy* so that 'the identifiable person is not a commodity' (PICT#7);
8. *Maximum access* guaranteeing that 'the digital divide… is not widened' and that 'the underpriviledged, including poor and disabled people, do not bear a disproportional share of the burden of technological and social changes' (PICT#8).

Markedly, these principles account for two important phenomena: (i) PICT#1 underlines the fact that the changes brought by technology tend to outpace society's ability to adapt its legal rules and ethical practices. This point is central to Stiegler's (2019) analysis of the digital disruption which deprives individuals of agency, thus driving them to the point of 'madness'; ii) PICT#2 stresses the need to have a comprehensive perspective on what technological changes might bring for people, 'society, the economy, the environment, and the commons'.

In addition to these eight ethical principles, I propose to add the principle of physical, psychological and environmental sustainability as highlighted in the EU's early report on Aml (European Commission, 2001). Even though it overlaps with PICT#2, the principle of sustainability underscores the importance of sustainable development as a guiding principle of smart environments, specifically in the context of property owners' social and environmental responsibility when implementing and operating Aml in their buildings.

These principles can address many ethical issues afferent to Umwelt customisation:

> PICT#5 brings transparency to the fact that people's perception time, which is umwelt specific (Uexküll, 2010) cannot keep up with the speed of technologies (Hansen, 2012; Hayles, 2014).
> PICT#6 (informed choice) supports occupants' autonomy by opposing technology paternalism. Noticeably, the principle whereby Aml is controllable by ordinary people is in tension with the ubiquitous computing paradigm of a calm technology permanently available at the periphery of users' attention (Weiser and Brown, 1996).
> PICT#8 and sustainability foster distributive justice in the context of consumer capitalism where Aml is deployed, such as with respect to the scarcity of energetic resources in a city, for example.

Principles of umwelt ethics. To complement the above-mentioned principles, I propose three principles for an applied ethics of umwelt. By their nature, pervasive technologies are choice architects. Customizing umwelt means manipulating it. My objective is to define ethical principles anchored in the umwelt theory that foster the opportunities of smart environments for all building occupants, while preventing harm from umwelt customisation. Harm "can be individual or collective, and can include intangible harm to social, cultural and political environments" (European Commission's ethics guidelines for trustworthy AI, 2019).

Principle of umwelt neutrality. Root principles: non-malificence, respect for persons

Umwelt customisation does not interfere with a building occupant's umwelt components, capacity to make sense of her environment, and mood.

This principle includes three elements:

> *Umwelt components (after* Tønnessen's (2015) *tripartite model)*: Engineeering human umwelt in smart environments must respect the balance of its components so that mediated umwelt does not cannibalise core and conceptual umwelten.

Sensemaking in smart environments (after Sharov, 2001*)*: by customising umwelt, pervasive technologies might impact a space user's capacity to make sense of the environment. Aml sponsors and operators must opt by default for semiotic neutrality in smart environments.
Subjectivity (after Uexküll, 2010*)*: Mood and tone influence how building occupants perceive their umwelten. Through mood, 'effect images gives tone to the perception image' (Uexküll, 2010). As visual space is especially important for human beings, interfering with mood and tone has a widespread effect on space users' behaviours in the built environment.

Principle of umwelt interconnectedness. Root principle: respect for persons

Umwelt customisation does not limit the interactions of human umwelten (after Tønnessen, 2015*;* Schroer, 2021*;* Bueno-Guerras, 2018*)*.

Umwelt customisation relies on hyper-segmentation of experiences in space, which constrains human umwelten's intrinsic interconnectedness. That is, customisation jeopardises human umwelt's ability to connect with other umwelt objects, and other human umwelten in particular. such that it might easily result in social alienation and isolation.

Principle of umwelt non-objectification. Root principles: respect for persons

Human umwelt is not a commodity to be appropriated for profit by parties with control of the technologies, and/or the real estate industry.

This principle is driven by the respect of human dignity, which considers personhood as an end in itself and not an object (Kant, 2012). In smart buildings, smart environments are implemented and operated by parties involved in the capitalist economy, meaning they are economic agents aiming to maximize their profits, such as technology companies, real estate investors. Pimple (2014) lambasts consumer capitalism as an "unacceptable moral foundation" to PICT. He writes, 'the potential for PICT to serve consumerism is virtually unlimited. The danger is that the development and distribution of PICT will be justified simply by the fact that it can make money'. As Aml becomes an engine of the digital economy, human umwelt turns into a commodity which can be monetised through data collection and management, automated profiling, human-computer interactions design, AI predictive behaviour modelling, targeted marketing and advertising. Therefore, the principle of non-objectification of human umwelt is intended to counteract the datafication of human experience in smart space, for instance by implementing data ethics' principle of purpose limitation (Hildebrandt, 2015). Case 2 in Table 1 illustrates how in accordance with PICT#7 (privacy) and the principle of umwelt non-objectification, corporations may decide not to collect data from umwelt customisation even though embedded technologies in smart buildings would make data collection, storage and linkage easy and potentially profitable.

All in all, an umwelt ethics must be anchored in life and serve life. Thus, the overarching principle of an umwelt ethics must be the protection of what Ortega y Gasset calls lived reality, 'the experience of life, living without limitation' (Conill, 1998). As 'man forms and informs his being through living' explains Ortega y Gasset (1983), protecting one's ability to experience life is essential. Aml can easily tamper with the experience of life in smart environments even though they are supposed to be 'uncompromising experiences'. An umwelt ethics must, therefore, safeguard people's ability 'to deal intelligently with the world, a dramatic incident, what happens to us, the coming about of a world that allows itself to be driven by desire' (Conill, 1998). In smart environments, spontaneity, and 'what we really are' (Ortega y Gasset, 1983), must not be cancelled out by a new form of reason driven by algorithms, AI, and embedded technologies.

Instruments for umwelt ethics. An ethics of umwelt should be ingrained with the notion that a multiplicity of safeguards are required to protect human living against technology's stranglehold on world making. This section introduces three important types of instruments to address concretely the ethical problems identified.

Legal and regulatory safeguards.

- *Smart environments as digital territories*: a digital territory, i.e., a smart space with boundaries, can effectively limit smart technologies' intrusiveness, fostering trust and transparency by enabling a 'better clarification of all kinds of interactions' (Wright et al. 2008). Beslay et al. (2007) explain: "without digital boundaries, the fundamental notion of privacy or the feeling of being at home will not take place in the future information society". To appropriate space, space users need clearly defined boundaries. Thus, it is fundamental that, as part of an applied umwelt ethics, the space of smart environments must, not be infinite, but rather susceptible to delineation and partitioning. This also involves smart environments' inherent capacity to link different spaces into one total space under their control (for example, a space user's online activities in digital space and visits to a smart shopping mall) resulting in linked umwelt, which should be controlled by law (Lecomte, 2023).
- *Property rights in smart space:* a regime of property rights in smart space (e.g., *digital usage rights* after Lecomte (2021)) is an efficient way to bound smart environments, by establishing de jure *digital rights* of smart space, for instance based on property rights in physical space. It makes it possible to allocate sub-rights among all parties including building occupants, and opens the door to commons in smart environments after Elinor Ostrom's Nobel prize winning analysis. It also facilitates the implementation of ethical principles, such as PICT#3 (malicious use), by clearly defining the rights and responsibilities of each party with respect to the development and operation of embedded technologies in smart buildings. This latter point includes issues related to data collection, management, and ownership.
- *Spy-free territories:* building occupants (e.g., scenario 1 in Table 1) must be offered spy-free territories to escape Aml, such as 'physical spaces at work without surveillance technologies, e.g., social areas where the individual can take a short break…' (Wright et al. 2008).

Social and environmental responsibility of the real estate sector.

- *Corporate governance*: to guarantee transparency and best practices in accordance with the ethical principles mentioned previously, operators of smart environments should add provisions related to umwelt customisation and use of pervasive technologies in smart buildings to their code of corporate governance. Parties involved include property owners who monetize smart spaces, tenants who employ smart environments in productive processes, and property managers who spearhead the functioning of smart environments.
- *Ethical guidelines for the property industry*: Guidelines highlighting ethical challenges facing the property industry issued by industry organisations, professional bodies, or not-for-profit foundations such as the Real Estate Data

Foundation's (2022) Data Ethics Playbook, must cover principles of umwelt ethics.

Norms for smart buildings and certifications of smart environments.

- *Norms for smart buildings*: ethical principles of umwelt ethics must be embedded into norms and industry standards for smart buildings. IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems (2019) suggests that a norm prioritise human rights, well-being, data agency, effectiveness, transparency, accountability, awareness of misuse, and competence. Norms are rarely universal. For instance, the EU's Smart Readiness Indicator for smart buildings focuses on environmental sustainability in contrast to other assessment programs such as the SPIRE built by the US Telecommunications Industry Association. Establishing a norm encompassing ethical principles of umwelt ethics is complex insofar as it requires agreement on metrics assessing umwelt customisation.
- *Certifications of smart environments*: certifications of smart environments, and their embedded Aml systems, must include principles of umwelt ethics. These certifications designed to bring transparency and build trust in the smart real estate sector are comparable to other certifications applied to buildings, e.g., LEED certification for sustainable buildings. Their design must be free of interferences by special interests. In accordance with PICT#5 and PICT#6, certifications of single smart environments should be readily available to all building occupants, for instance via easy-to-understand scores available online.

Conclusion

In this article, I analyse the role that umwelt, a concept introduced by ethology pioneer Jakob von Uexküll, plays in smart environments. Umwelt customization underpinned by ubiquitous computing ushers modern capitalist societies into environmental capitalism, an ontological form of capitalism which turns human umwelt into a resource to be harvested for profit. The built environment, and more precisely smart space- the new space of smart environments where analog and digital spaces meet- occupy centre stage in this process.

In addition to being environmental, the mode of production enabled by ubiquitous computing is inherently spatial. Pervasive technologies' unprecedented ability to customise space users' experiences in the built environment relies on their control over space. The resulting commodification of umwelt marks yet another stage in technology's spatial appropriation. To account for the risks that pervasive technologies may pose to human beings, I propose a series of principles for an applied ethics of umwelt as part of a broader ethics of smart environments.

Umwelt theory provides a powerful framework to analyse the ingression of pervasive technologies on human beings' capacity to dwell consciously in space. Research conducted in this area is relevant not only to studying smart environments in the built environment, but also to analysing the impact that immersive technologies, such as virtual reality, may have on their users' world making in digital environments (e.g., Metaverse). Because these technologies are part of production processes aimed at optimal value creation for their sponsors, there is a need for umwelt studies to extend into the fields of real estate economics and ethics in conjunction.

My views inferred from economic analysis are that umwelt ethics, and the real estate industry's associated code of corporate governance and ethical guidelines, may not be sufficient to counteract structural power imbalances in smart environments. Parties holding de jure or de facto rights over smart space (e.g., property owners, technology companies) have overwhelming incentives to maximise their own utilities through space users' umwelt customisation, irrespective of adverse consequences for the latter. In this respect, the ethical principles presented here could serve as preliminary guidelines to future legal and regulatory endeavours of smart environments.

Data availability

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

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Notes

1 Smart real estate encompasses any buildings with embedded smart technologies mediating space users' interactions in space, e.g., smart homes and smart commercial buildings. Smart real estate is 'essentially about access and interactions rather than enclosures' insofar as smart buildings serve as platforms to digital space (Lecomte, 2019).
2 Sharar (2011) defines projectuality as 'individuals' pursuit of goals in an attempt to project their true self into the future [which is] a key characteristic of humanness'.
3 Linked umwelt is the product of spatial linkages between smart spaces (within a building) and outside spaces, be they digital in cyberspace and/or smart. Linkages can be inward (from digital spaces to the building's smart environments} or outward (from the building's smart environments to digital space). Linking a building occupant's history of online searches with her umwelt in a shopping mall illustrates an inward linkage. Depending on the ability to store data stemming from linkages, inward linkages can have immediate effects on umwelt customisation, or prolonged effects over time.
4 For Heidegger (1938), when human being becomes the subject of technology, 'the essence of humanity altogether transforms itself'". He explains, 'the objectification of beings is accomplished in a setting-before, a representing …, aimed at bringing each being before it in such a way that the man who calculates can be sure- and that means certain- of the being'. Customised umwelt is the setting-before of human being's objectification owing to ambient intelligence. The view that modern technologies aim to annihilate any randomness in human behaviour is common between Heidegger (2013) and Wiener (1964), the father of cybernetics.
5 Rouvroy (2013) notes that 'smart environments, ambient intelligence, … appear primarily, as solutions to an epistemic governmental problem: the radical indeterminacy and incommensurability of contexts and behaviours.'
6 A concrete illustration of the concept of spatial appropriation is augmented reality's systematic interference with users' visual environment space, which may include eye movements tracking.

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