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Zany beetroot: architecture, autopoiesis, and the spatial formations of late capital

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Abstract
Using a pedagogic experiment at an architectural school in Tallinn as an empirical and conceptual starting point, this article explores the significance of autopoiesis in contemporary urban design. We suggest that organic processes—in this case the use of vegetable peels as a novel substrate—have been widely deployed in architectural discourse as a form of biomimicry. At a theoretical level these conceptual moves mark part of a wider set of dialogues between the arts and the sciences that rest on a form of degraded or even "phantom" modernism. The article draws on various insights, including the recent work of Fredric Jameson and Sianne Ngai, to explore the changing relationship between aesthetic categories and critical theory in the urban arena. We argue that aesthetic motifs derived from nature, including various forms of organicist architecture, are being effectively recycled under the aegis of late capital.

Keywords
Autopoiesis, biomimicry, cultural theory, modernism, organic architecture

> Zaniness not only requires but promotes a sense of remove from the situation of precarity it invokes.
>
> Sianne Ngai[1]

During a graduate workshop held at the Estonian Academy of Arts in Tallinn in October 2016, the architectural theorist and urban designer Claudia Pasquero, founder of the London-based EcoLogicStudio, invited students to grow a series of "microlandscapes" on a medium derived

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from algae, fallen leaves, and discarded beetroot peels. A cellulose layer had been cultivated by combining these materials with a blend of tea, sugar, and vinegar, after which the mixture was applied to a custom-made "substratum" and allowed to dry. The students were asked to look at these creations as "microlandscapes" and to reflect on their potential for designing "macrolandscapes" beyond the classroom. One of the workshop reports stated that:

> As the close-up photo of the dried beetroot fed skin looked like a strange landscape of its own we took the extra effort and used a Grasshopper code to generate the contour lines of its weird Martian world.[2]

When, during the final presentation, a student explained that he had difficulty in getting the bio-layer to adhere to the substratum, and had to force it, Pasquero countered by questioning the desirability of perfect adhesion. Instead of forcing the biological material, she contended, it might be better to observe how cellulose acquires its own behaviour in relationship to a specific substrate. Pasquero suggested that it would make better sense to make a time-lapse recording of the process and then use a computer to iterate the outcome with varying parameters thereby enabling a dynamic representation of biomimicry in practice.[3]

In this article, we examine how biomimetic ideas influence architects and urban designers. Previous studies have discussed biomimicry in the context of the bioeconomy and theorized the biotech revolution as a form of capitalist accumulation at the cellular level. Melinda Cooper (2008), for instance, has explored the expanding reach of bio-capitalism across multiple fields. In a similar fashion, Jesse Goldstein and Elizabeth Johnson (2015: 62) have shown how the "biomimetic imaginary" has informed the delineation of a variety of new extractive frontiers for capital accumulation.[4] What has been less systematically explored, however, is the influence of biomimicry on late-modern urbanism spanning architecture, design, and the conceptual parameters of urban theory.

In this article, biomimicry is construed broadly as a form of biologically inspired innovation as well as influential extensions of biological analogies into the cultural domain. We develop a critical perspective on biomimetic design by asking what architects do when they utilize biology to experiment with new forms for human habitation and extrapolate biological insights as a variety of urban theory. The EcoLogicStudio, for example, aspires to "remodel the Urbansphere as an augmented biosphere" (Pasquero and Poletto, 2016: 13) and extend scale "from the micro to the macro and from nanotechnologies to urban networks" (Poletto and Pasquero, 2014). These interventions are marked by an interchangeability of scales that blurs the boundary between natural, technoscientific, and political dynamics. The studio's output consists primarily of what they call "biodigital sculptures," treated as prototypes for an experimental "architecture of symbiosis" and as focal points for overblown claims about their "co-evolution within an urban milieu" (Poletto, 2014: 4).

Interventions in the emerging field of "biomimetic urbanism" look to nature not simply to imitate organic forms but as a model system, encompassing a series of dynamic, self-organizing properties that can be exploited to shape urban change. In keeping with the conceptual swerve towards certain strands of new materialism there is a move from mere abstraction towards in-vitro forms of experimentation where the distinctions between production and interpretation become progressively blurred. The political mediation of social and spatial forms is eclipsed by an illusory quest to "breed" cells into urban form, thereby radically extending the principles of synthetic biology into projective dimensions to urban space.[5]

This article engages with an emerging orthodoxy that seeks to render organic processes as a heuristic resource for design innovation and pedagogy. We focus on two aspects: First, we trace the biomimetic turn to the epistemology of complexity and the concept of autopoiesis,

particularly in the work of biologists Humberto Maturana and Francisco Varela, and sociologist Niklas Luhmann. These different strands of thought converge on the idea of life as a field of immanent differentiation, destabilizing the boundary between ontology and epistemology. The idea that cities are not only *like* biological systems but *are* biological systems aligns with elements of neo-vitalist philosophy and non-representational theory. For example, the architectural theorist Maria Hellström Reimer suggests that "life does not unfold as a value 'above' or 'beyond,' but as conditioning 'within'; an onto-aesthetic principle, concerning no less than 'the whole', the raw and unintended micro-physicality of human-nonhuman interaction" (2010: 32).

Second, we bring out the tensions inherent in biomimicry between making design more attentive to more-than-human life and positioning the figure of the designer as uniquely capable of manipulating emerging forms of techno-natural hybridity. In an act of apparent humility towards nature, architecture stages the effacement of itself (appearing to dissolve into biology) as a kind of ethical gesture that echoes "new materialism".[6] Yet this effacement is premised on a naturalization of both scientific metaphors and capitalist urbanization as part of a functional totality that is responsive to performance-based criteria and optimizing strategies.[7] We argue that the analysis of postmodernity is apposite to the work of biomimetic designers, turning to Fredric Jameson's dialectical reading of autonomy and "total flow" (1991: 76), and Sianne Ngai's emphasis on the zany aesthetics of "incessant activity" under late capitalism (2015: 185). De-differentiations between architecture and economy, affect and efficiency, or play and labour, discussed by Jameson and Ngai as quintessential to postmodernity and to the aesthetics of the zany, are all at play in the culture of biomimicry. The idea of de-differentiation goes a long way towards explaining how a sense of humility towards nature coexists with the power of bio-architecture to stage organic matter as lively and thereby make it into a potential frontier for technological innovation.

The performative use of biological processes in architectural schools, exhibitions, and other venues points to the influence and limits of non-representational ontology in design culture. As the use of architectural design software to "augment" the dried beetroot skins in Tallinn illustrates, biomimetic design connects with forms of algorithmic rationality that circumvent deliberation, contestation, and other democratic procedures.[8] It is this "machinic unconscious," to use Félix Guattari's expression, allied to the rise of various forms of autonomous governmentality, that pose a series of ethical and political questions that architectural theory has yet to engage with. If Jameson's argument that "all forms of aesthetic production consist in one way or another in the struggle with and for representation" (1990: 348) holds, then Ngai's zany, "a style explicitly about mimetic behavior" (2015: 8), centres the performative dimension of representing life as unrepresentable.

The work of the London-based EcoLogicStudio provides an ideal entry point for a critical engagement with current trends in biomorphic architectural theory marked by their emphasis on the idea of cities as biological computers, the centrality of material experimentation, and the extensive probing of the human/non-human boundary in the urban field. Other comparable interventions include Rachel Armstrong's idea of "vibrant architecture" motivated by "enabling architects to co-design in partnership with human and nonhuman collectives" (2019: xi–xii). Armstrong draws directly on Jane Bennett's theory of "vibrant matter" to conceptualize biological processes as replicable instances of resilient engineering: the underlying assumptions are similar even if the practical applications are different. The studio of the architect and MIT Media Lab professor Neri Oxman (2010) has similarly promoted a conceptual merger of biology and architecture in which nature is presented "as the primary client" marked by the recent exhibition *Nature x Humanity* held at the San Francisco Museum of Modern Art in 2022. Oxman suggests that the purpose of design

is to "help material be what it wants to be".[9] Other influential figures include Patrik Schumacher, principal architect of Zaha Hadid Architects. His two-volume manifesto entitled *The autopoiesis of architecture* relies on Luhmann's autopoietic social theory to draw a distinction between politics and professional practice. In a series of more recent interventions Schumacher (2022) has consistently sought to combine selective scientific metaphors with a radically market-oriented policy agenda that is hostile to any kind of regulation.

A key justification for biomimetic design is the purported moral advantage of a creative practice that challenges the primacy of authorial intent from a position that embraces the principle of "flowing smoothly with the very structure of what exists."[10] "The advancement of biomimetic architecture," argues architect Achim Menges, "may only be feasible if the design process itself is biomimetic" (2012: 795). The superiority of process-based over form-based approaches to biomimicry, which is now widely accepted among designers (and their new materialist interlocutors), goes together with the conceptualization of design as "a technology of nature".[11] By contrast, we contend that schematic instrumentalisations of sustainability at the level of individual buildings or surfaces connect with the extension of synthetic biology into urbanism and design. What does it mean to bring these scientific metaphors into closer dialogue with architectural practice and urban theory? And what is the precise relationship between bio-architecture and capital under late modernity?

Organicism and autopoiesis

The advent of various forms of "organicism" has been an influential strand within modernist approaches to architecture, sociology, urban planning, and related fields. Such diverse figures as Ebenezer Howard, Erich Mendelsohn, Hans Scharoun, and Bruno Zevi, all imagined social and spatial forms in organic terms. The metaphor of organism was employed for the interpretation of social phenomena and also as a kind of "blueprint" for practical interventions in fields such as architecture, design, and spatial analysis. The putative existence of a "natural order", even if it held little scientific weight within a geological or evolutionary time frame, was nonetheless an influential focal point for a new kind of "social imaginary". The urban question adopted an especially ambivalent position in relation to these discourses since "the city" was understood in organicist terms yet the disordered materiality of capitalist urbanization appeared to present a type of socio-spatial aberration, or at least a dysfunctional tendency within the progressive impulse of utopian modernist thought. More intriguingly, the organicist impulse has undergone various permutations under late modernity to withstand the emerging critique of modernist design and its concomitant epistemological frameworks: we find that if anything the organicist approach has gained a degree of philosophical salience under the putative paradigm switch beyond modernism (even if we are ill-served by available conceptual categories for this apparent design transition).

From its early association with urban planning, through the Bauhaus ideal of design as a *Gesamtkunstwerk*, to the revival of ostensibly natural forms of early urbanization in Camillo Sitte's architecture, the notion of organicism has become gradually detached from progressive social aims. For Marxist architectural theorists such as Aldo Rossi (1984[1966]) and Manfredo Tafuri (1990[1987]), the exhaustion of modernism as a political programme as well as a liberating aesthetic form was the defining aspect to the post-war dissipation of utopian urbanism. The identification of patterns and commonalities across time, as advanced more recently by the conceptual corpus of space syntax, for instance, serves as an epistemological quest for an intrinsic spatial logic to urban form that transcends the particularities of historical or geographical circumstance in a curious yet complementary

obverse to the recent emphasis on micro-differentiations and the enhanced significance of "place" within various forms of cultural analysis. What is lost, however, is a critical or reflexive sense of how these different urban discourses have been generated: the imbrication of design with power is effectively occluded. The emerging critique of modernity, and its manifestation in self-consciously post-modern design perspectives, highlights a series of transformations in the terminology of critique within which "a return to nature" has accrued a new degree of cultural and political salience.

Holding that the notion of organism is inherently totalitarian, a number of influential theorists embraced the conception of life as a process of continuous morphogenesis. However, the scientific focus on organic development through cellular differentiation has been extended to a wider set of influences from neo-vitalist philosophical traditions. In their book *A Thousand Plateaus*, Gilles Deleuze and Félix Guattari (2005[1980]) challenged the idea of the organism as a discrete bounded entity, in an echo of their broader critique of the post-Cartesian humanist subject. The book had a major influence on the development of architectural theory in the 1990s.[12] Drawing on the insights of the biologist Jakob von Uexküll and the philosopher Gilbert Simondon they substituted the notion of individual organism by a milieu of individuation. This was a "body without organs," structured by flows of intensity, communication, and energy, the becoming-form: "An animal milieu . . . is no less 'morphogenetic' than the form of the organism" (p. 51). A body without organs, Deleuze and Guattari wrote, "is opposed not to the organs but to that organization of the organs called the organism" (p.158). Conditioning the liveliness of the body without organs by its "blow[ing] apart the organism and its organization" (p.30), they named "the Earth . . . the Giant Molecule" as one instance of this, "a body without organs . . . permeated by unformed, unstable matters, by flows in all directions, by free intensities or nomadic singularities, by mad or transitory particles" (p. 40). Notions of complexity rooted in a radical destabilization of categories of life become a fundamental component of biomimicry in architecture and urban design.

If we consider the lineage of biomimicry through architectural design three elements stand out: first, the direct mimicry of natural forms, related very much to the external appearance of structures; second, the emulation of naturally occurring materials, with links to structural engineering; and third, the mimicry of biological processes, including the organizational dynamics of cellular structures. Examples of biomimicry as formal elements in architecture and design include Kisho Kurokawa's Helix City Project in Tokyo, completed in 1961, that imitates the double helix structure of DNA, and Mick Pearce's design for the Eastgate Centre, Harare, completed in 1966, that has a ventilation system modelled on a termite mound. Another instance that is arguably closer to the biological understanding of mimicry as a form of defensive crypsis is to be found in the use of camouflage patterns for military installations. In terms of the biomimicry of materials a key example is that of Frei Otto's research into lightweight engineering at the University of Stuttgart, carried out in the 1960s and 1970s, and still influential in the design field (see Hensel and Menges, 2006; Knippers et al., 2016).

It is the process-oriented approach, however, that relates most closely to recent efforts to merge architecture and biology. The emphasis on instilling a "biomimetic imaginary" within all aspects of urban and environmental discourse has a number of earlier antecedents in, for example, the work of John Frazer (1995) and Kenneth Yeang (1995). These authors dwell on imitating natural evolution as a method for solving issues ranging from pollution to suburban sprawl. Another early example that combines elements of both materials and process-oriented mimicry is William Katavolos's (2007[1960]) "chemical architecture" that aimed to grow furniture, buildings, and even entire cities from polymers.

It is important to stress how the biomimetic imaginary has a strongly performative dimension, both through the incessant activities of its main proponents, that we might gather under the conceptual aegis of Ngai's identification of the zany within late capitalism (which we elaborate in greater detail later in this article), and also through a characteristic mix of intellectual underpinnings that draws on key elements of post-structuralism and neo-vitalism. The emphasis on process oriented conceptions of biomimicry connects the most recent developments in architectural design to earlier scientific interest in the theorization of complexity.

Deleuze and Guattari's critique of the organism resonates with the conceptualization of late modernity as a space of flows. In a more enduring sense, however, the substitution of the organism by an emphasis on life as a system of flows, and its subsequent instrumentalization by architecture and urbanism, was underpinned by theories of complexity. These theories stressed the impossibility of an external observing position in the world comprised of self-organizing, coevolving systems (in a partial departure from post-war cybernetics that placed military tacticians and logician-scientists at the helm of systems control). The anthropologist Gregory Bateson, a leading proponent of this position (and the author of the notion of "plateau", borrowed by Deleuze and Guattari), argued that:

> the nature of 'meaning,' pattern, redundancy, information and the like, depends upon where we sit. In the usual engineers' discussion of a message sent from A to B, it is customary to omit the observer and to say that B received information from A . . . But in a wider universe, i.e., that defined by the point of view of the observer, this no longer appears as a 'transmission' of information but rather as a spreading of redundancy (1978,: 407).

While the acknowledgment of positionality challenged the simplistic models of mechanical causality, Bateson's theory of circular causality appears to disregard the significance of historical change as a form of structural causality. It is an internally consistent nostrum wherein any change in the underlying parameters remains a matter of epistemological obscurity.

Contra the negative feedback logic, underpinned by the equilibrium operations of a planned economy and the geopolitical terrain of the Cold War, Deleuze, Bateson and other post-structuralist thinkers foregrounded a series of dynamic processes characterized as emergent and self-organizing, associated with positive feedback loops and the nascent post-Fordist impetus behind late capitalism. This perspective lent itself to diverse expositions, ranging from the cautious take-up of the idea of disequilibrium in Jay Forrester's (1999) system dynamics modelling and the ethically contentious Club of Rome's *Limits to Growth* reports during the early 1970s, to the normalization of chaos in the theoretical constructs of Ilya Prigogine and Isabelle Stengers (1984), to the elaboration of complexity theory by biologist Stuart Kauffman (1995), and the insitutionalisation of disciplines such as Earth system science.

The Biological Computer Laboratory at the University of Illinois, founded and led by Heinz von Foerster, is one of the birthplaces of complexity theory. Because "observations are . . . relative to the observer's point of view . . . [and] affect the observed so as to obliterate the observer's hope of prediction," von Foerster argued, "life cannot be studied *in vitro*, one has to explore it *in vivo*."[13] The biologist Humberto Maturana developed this insight by combining the focus on biology with an emphasis on cognition as a form of computation. It was at the Biological Computer Laboratory that Maturana wrote in 1970 "Biology of cognition," an early draft of the influential book *Autopoiesis: The Organization of the Living,* co-authored with Francisco Varela (Maturana and Varela, 1980[1973]). In it they

sought to overcome the mechanistic-vitalist dispute by offering a "phenomenology of living systems".

Maturana and Varela theorized the living system as a self-organizing, autopoietic machine that "continuously generates and specifies its own organization through its operation as a system of production of its own components, and does this in an endless turnover of components under conditions of continuous perturbations and compensations of perturbations" (1980 [1973]: 79). In other words, the organization of an autopoietic system was defined not by its components, or a structure thereof, but by "a particular network of processes (relations) of production of components" (p. 79). This is the core tension running through Maturana and Varela's theory that became manifest in its reception outside of biology, namely that autopoietic organization pertained not to organism as its purpose, but to purposeless living systems. Not only was the centrality of the relations of recursivity to living systems repeatedly underlined, but the argument itself was poised to become recursive. While "autopoiesis . . . implies total subordination of the phenomenology of the system to the maintenance of its unity," claimed Maturana and Varela, they held simultaneously that "autopoietic unity is maintained as long as it remains autopoietic" (p. 97). The theory staked everything on the nostrum of self-organization yet in doing so Maturana and Varela opened the notion of self-organization to a series of arbitrary interpretations.

Reflecting on the political meaning of their theory, Maturana and Varela charged Darwinism for "the subordination of the destiny of the individuals to the transcendental values supposedly embodied in notions such as mankind, the state, or society" (p. 117). They argued that "biology cannot be used anymore to justify the dispensability of the individuals" because "biological phenomenology is determined by the phenomenology of the individuals" (p. 118). While the association of autopoiesis with liberal democracy was loosely implied, this lied in tension with the reduction of the human subject to little more than a purposeless living system. The uncertain ramifications of biological autopoiesis for social theory clearly emerge in the conclusion to *Autopoiesis* where it is noted that "we—Maturana and Varela—do not fully agree on an answer to the question . . . [and] we have decided to postpone this discussion" (p. 118).[14]

This is not the case with the German sociologist Niklas Luhmann, however, who was in contact with Maturana and Varela and sought to extend autopoiesis into the social realm through his "society of society" theory.[15] Luhmann (2006[1991]) interpreted autopoiesis as a "circular self-production" (p. 46) analogous to social communication, where "'communication' is the structural equivalent of biochemical statements by means of proteins and other chemical substances" (p. 47). He conceptualized differentiation as an abstract, recursive process of delineating boundaries between and within different functional subsystems, a process that "can set in spontaneously" and through which "the system multiplies itself . . . within itself".[16] In an apparent reversal of Talcott Parsons's structural functionalism, Luhmann described his own approach as "functional structuralism," substituting action with communication and foregrounding differentation instead of integration. Yet Luhmann's social theory has a similar conservative import when social change is theorized as a form of autopoietic evolution.

Drawing on Uexküll's concept of the *Umwelt*, Luhmann (2006) understands social change as a process of self-generating "environmental" differentiation: the subsystem "art," for instance, develops through what he calls an operational closure from "economy," "politics" and other social subsystems, which as a whole become for "art" an environment that is inaccessible other than through distant observation. It is precisely because subsystems are thus "imprisoned," inaccessible to each other on a microlevel, that they can be subsumed

into an already given order on a macro level as a completely dependent part of it.[17] In this fashion Luhmann presents an internally consistent theory of structural and linguistic correspondence that is allied with a narrow sense of epistemological veracity.

The insights of Luhmann are helpful in elucidating an inherent tension between system and environment where no organizational system or structure can ever encompass the full complexity of its setting or environment: in our context Luhmann points towards the limits of simplification that are inherent within the urban design process. Part of the allure of autopoiesis for designers is that a theoretical model of self-organizing complexity is substituted for an engagement with the external structural or relational dimensions to the complexity of real human societies. It is this "reductive complexity" that marks out the contemporary appropriation of ecological metaphors within urban discourse and their practical realization through the experimental procedures used at the architectural school in Tallinn. The autopoietic mask serves to obscure the ideological parameters of the task. The varied incorporations of scientific metaphors within the existing design paradigm and its institutional coordinates serves as an illustration of Luhmann's conceptualization of "structured openness" as a characteristic feature of professional fields (or "subsystems" to use his term) of architectural design in a conceptual manoeuvre that echoes Pierre Bourdieu's analysis of the cultural field. But it also points to a degree of "environmental" mirroring in that organizations or professional fields produce their own representations of an external reality: in this case demonstrated by the use of organic architectural models that purport to correspond with an external set of conditions. These configurations, not unlike cartographic projections, serve to render different forms of complexity "knowable" and hence amenable to different forms of human intervention.

Luhmann's accent on the autonomy of functional subsystems is consistent with a corporatist vision of society in which the vertical integration of functions gains prominence over forms of horizontal politics oriented around the principle of equality. Put otherwise: if politics designated for Luhmann an operationally closed subsystem like any other then, by the same logic, politics is also differentiated from the other subsystems in economics, law, art, and other fields as something that is external to them. Similarly, social theory is conceived as a series of self-referential descriptions of specific societal milieu rather than testable hypotheses.[18] From an architectonic perspective, this sense of theory as a form of semantic rhetoric geared towards specific instrumentalizations is extremely useful. The question of whether aesthetic postulates in the field of design are either "true" or "false" is beside the point in this context: what is of interest here is the emergence of identifiable terrains of urban intervention that draw on specific conjunctions of rhetoric and expertise.

From an autopoietic perspective, social change is represented as a natural process of self-generated differentiation. This has dire implications for design education. Since the 1990s, Tafuri's neo-Marxist interpretation of architectural history, along with other approaches that place architecture in a social history context, have taken a back seat to perspectives that see the architecture–society relationship as the architect–client relationship. A recourse to biomimicry and other affective embodiments of self-organizing nature works in this situation as a shield that insulates the student of design from concerns with the purpose and clients of architecture. Having led students to think of politics or economy as extraneous professional fields, to which they by virtue of their own positionality in a different field cannot contribute, a culture of experimentation is kept within its narrow disciplinary bounds marked by a resigned acceptance that architecture cannot but serve the interests of the most powerful social groups. Concomitantly, an autopoietic perspective has contributed to a politics of knowledge in architecture that relies on a reductive, instrumentalized form of interdisciplinarity: research as a "diagram of everything".[19] To outcompete a fellow

student or colleague, there is a compulsion to imbue architectural "micro-agendas" with a veneer of sophistication by combining rudimentary insights extracted from biology, ecology or any number of other disciplines often on the basis of scientifically thin analogies.

More specifically we might ask how architectural theory serves capital? What representational strategies are at play in the patterning and interpretation of urban environments? The logical consistency of knowledge production is not to be found within specific cultural texts—and their putative scientific merit—but in their relational facilitation of the system as a whole, which in this context refers to the circulatory dynamics of capital under what Elizabeth Povinelli (2016) has usefully referred to as "late liberalism". We note, for example, Povinelli's hesitancy in embracing the neo-vitalist emphasis on "the vibrancy of the assemblage" (p. 55) in comparison with what she terms "geontological power" and its multiple extractivist frontiers as part of her wider intellectual project to de-centre biopolitical thought. Unlike much of the neo-vitalist literature, with its overextension of biological metaphors, Povinelli emphasizes the multiple forms of violence that underpin "the production of materiality" (p. 4). Like a number of scholars in the environmental humanities Povinelli has emphasized how specific cultural idioms—within which we could include architecture and design—reflect the stratigraphic interweaving of geohistory with material culture.

Zany modernities

Contrary to Luhmann's view of modernity as an indefinite expansion of (rhetorical) differentiation, we find that the disappearance of differentiation, or "dedifferentiation", is at the centre of Fredric Jameson's analysis of postmodernity.[20] Jameson accords architecture a central role in this process: "of all the arts," he writes, "architecture is the closest constitutively to the economic" (1991: 5). The interrelationship of these two spheres is "virtually unmediated" as far as commissions and land values are concerned, but also rests on an "even deeper dialectical interrelationship" when it comes to the role architecture has played in colonial domination as the underside of postmodern culture (p. 5). Jameson rejects Luhmann's ahistoric metaphysics of differentiation but does not go as far as non-representational claims that would dispose of a necessity to mediate between the aesthetic and the economic altogether.

The intersection between architecture and critical theory marks an important counter narrative to the formalist impulse that has underpinned conventional narratives of urban design. In the kinetic spectacle of the Los Angeles Bonaventura hotel interior Jameson discerned, in the 1980s, an immersive hyperspace enveloping the subject.[21] For Jameson, postmodern space (if we can deploy that recent anachronism) itself functioned as an ideology to the extent that it circumvented cognitive representation by all sorts of affects and atmospheres. This is consistent with Jameson's (1991) other characterization of postmodernity as "the waning of affect" (p. 10), a notion, he underscores, which should not be taken to mean that postmodernity is "utterly devoid of feeling, but rather that such feelings . . . are now free-floating and impersonal" (p. 16). Such becoming-affective, or "becoming-intensive" of space, as it were, is then consistent with the privileging of flows and fluxes in the postmodern representation of space, a point that could be extended to the ideologies of complexity and autopoiesis themselves as representations that insist on their non-representational status.

The corollary of the epistemologies of perpetual change and differentiation is the fading of history itself from representation. A surge in pastiche and nostalgia, which commentators associated with postmodern aesthetics stress again and again, is then merely a symptom of

this larger process. In architecture and urbanism, the term "postmodernism" has been itself understood in stylistic terms as a "collage," in the vein of which it was deemed over by the 1990s, only to forcefully return, in recent years, as a topic for historians and conservationists.[22] Yet the stylistic interpretation of postmodernism glosses over the more enduring sense of postmodernity as a fundamental disturbance of the sense of history and space by the non-representational culture of complexity, a confusion to which Jameson's use of the word postmodernism (rather than postmodernity) contributed itself.[23]

It is in relation to the biomimetic turn, we claim, that the analysis of postmodernity remains especially pertinent to architecture today. The surge of morphogenetic aesthetics, pertaining less to organic forms and more to life conceived and captured as a formation or flow, has as its corollary the process of unsettling the "traditional" aesthetic categories of beauty and the sublime. With the term "hysterical sublime," integrating Kant's and Burke's classic notion with Susan Sontag's aesthetics of "camp," Jameson aims to relate this process to late capitalism. Specifically, and decisively for our present aims, Jameson associates the hysterical sublime with "a radical eclipse of Nature itself" so that "the *other* of our society is . . . no longer Nature at all," but computer technology as an apotheosis of late capitalism (1984: 77). Developing Ernest Mandel's tripartite schema of capitalist technology (steam, combustion and electronics), Jameson suggests that "we may speak of our own age as the Third (or even Fourth) Machine Age" (p. 78), pointing—by this very hesitation—to the way in which the eclipse and colonization of nature is grounded in war cybernetics (a post-analogue reworking of Mandel's late capitalist electronic apparatus), and also extends beyond it in some yet-unmapped ways. In contrast to the modernist technological sublime of steam and combustion engines,[24] which overwhelmed yet simultaneously preserved the individual subject, the hysterical sublime is quintessentially postmodern in so far as it points to the aesthetics of non-representable life conceived as a kind of data flow.

We can extend Jameson's hysterical sublime to the zany, an aesthetic category that the literary theorist Sianne Ngai associates with the transformation of the labour process under late capitalism. Ngai's zany is an aesthetic about the impossibility to distinguish between the productive and affective dimensions to immaterial and service work. Looking more closely at Ngai's definition of the "zany" there are three key elements that stand out: first, the performative subjectivity of "an absolutely elastic subject" (p. 174), characterized by "a style of incessant doing" (p. 181); second, she connects zany aesthetics with forms of perception that prioritize flux (or process) over form, along with a lack of resolution between axiologically divergent affective states; and third, she emphasizes the proliferation of project-based, precarious forms of labour with no clear boundaries between work and free time (a scenario that is rife within higher education). As a unique category that has a noun form, the zany reflects forms of derivative subjectivity or compliant personhood: life is conceived as "a rapid succession of projects as these become immediately dissolved into an undifferentiated stream of activity" (Ngai, 2015: 231). Drawing on Paolo Virno's theory of immaterial labour (2004), Ngai develops the idea of zany aesthetics to ask how demands for performativity and performance in the capitalist service economy shape "the style of a kind of person defined by a specifically nonspecific kind of work" (Ngai, 2015: 194). The "aesthetic of nonstop action and movement" that define this style registers "a waning of the subject's aesthetic capacity to perceive action and movement *as form*" (2015: 230, italics in the original). Thus the zany marks a crisis of representation: unlike the beautiful or the interesting (another postmodern category discussed by Ngai), it is absent from an everyday lexicon. Like Jameson's "hysterical sublime", the zany is best read symptomatically, as an unconsciously registered aesthetic category that is less about forms than about flux and flow.

Ngai's definition of zany labour as an "undifferentiated stream of activity" (p. 231) clearly lends itself to a conceptual merger of human and non-human forms of labour. "Zaniness," notes Ngai, "has always been an aesthetic category about unevenly distributed, yet socially compulsory affective work—work historically performed by certain groups of subjects as opposed to others."[25] We can extend Ngai's observation to encompass multiple configurations of both paid and unpaid labour that inhere in both life-sustaining activities and specific material artefacts such as buildings (including their design and maintenance). Ngai's original insights can be further extended to include the work of nature itself on behalf of capital. In this instance, however, we are not contending with a straightforward instrumentalization of "ecosystem services", or some other utilitarian field, as exemplified by the use of insects for the pollination of agricultural crops, but rather with the elision of the performative and performance-oriented work undertaken by micro-organisms in an architectural studio setting.[26]

Ngai's concept of zaniness clearly resonates with the performative work of the biomimetic designer in terms of not only the flattening of any definition of work to include non-human elements but also the "demonstration effect" to be encountered in a variety of experimental settings such as classrooms, studios, and exhibition spaces (or TED style talks for that matter). Similarly, in relation to a process orientated aesthetics we can see how an emphasis on forms of autopoiesis or self-organization systematically obscures the structural dimensions to the production of human environments or the pervasive forms of inequality and injustice that underpin late-modern production systems. Rather than material artefacts being viewed in relation to longer commodity chains, including various kinds of extractive frontiers, the object of design is suspended amidst a spider's web of analogies.

Ngai's zany stands out from other aesthetic categories in that it describes free-floating forms of impersonal affect. The advantage of using zany as a portal onto biomimetic design is not only the concept's resonance with an aesthetic of biomimetic artefacts such as computer-enhanced organic matter but also its connection with an affective dimension to biomimicry considered as a cultural, and specifically pedagogic, practice. The significance of modifying and staging biological material as a way of demonstrating the potential of architecture to offer innovative solutions belies the ethically-inflected claims that biomimicry learns from and gives priority to nature. At the same time, this contradiction is echoed within the field of design education, suspended between a performative emphasis on creative thinking and problem solving, and the reality of teaching as heavily underpaid intellectual labour. This is an argument about moving the aesthetic discourse that surrounds architecture, including the generation of affective atmospheres, firmly back into the realm of late-modern systems of production and consumption.

Conclusions

In October 2017 the remnants of the architectural experiment were still on display on the upper floor of a dimly lit stairwell in the Estonian Academy of Arts. The desiccated beetroot peels had become curled and misshapen, their uncanny haptic and olfactory characteristics belied their earlier pedagogic role. To encounter such an odd set of objects highlights the equivocal relations between zany cultural practices and contemporary architecture. In her theoretical exposition on new aesthetic categories Ngai highlights the connections between zaniness and mimicry. In our article we want to extend the idea of zaniness further to explicitly incorporate the work of non-human others. In this instance, however, we are not highlighting direct forms of non-human labour such as pollination but the performative role of nature within the wider field of bio-architecture and the "ecologization" of cultural

and political discourse. Ngai, following Adorno, insists on the multiple entry points enabled by a relational theory of cultural practice. In this sense, a few vegetable peels become not just the focus for an architectural studio but also the point of departure for our reflections on the role of biological ideas in architectural theory.

The concept of zaniness, as elaborated by Ngai, has multiple implications for architectural theory and the production of urban space. An extended conception of labour in all its forms spans both non-human elements and also multiple forms of affective or occluded human labour. We began the article with a pedagogic example that highlights how creative forms of reproductive labour—often unpaid—suffuse the wider landscape of design schools and higher education with their armies of adjunct staff, precarious contracts, and even core faculty working far beyond their contracted hours of service. Under this late-modern hubbub of studio-cum-workplace signs of zaniness are everywhere to be seen. Ngai (2012: 182) notes, for instance, how zany situations often involve messy or chaotic configurations of agency, an observation that we might extend to the human–beetroot peel interactions used in our opening vignette. The conceptual field of zaniness also resonates with the increasingly frenetic emphasis on various forms of innovation that has come to characterize late capitalist economies.[27]

As Elizabeth Johnson (2016: 269) and other critical scholars have shown, mimesis presents a chimerical "way out" from confronting looming political crises such as generalized ecosystem collapse: biological life becomes a force rather than limit for production. This process involves the epistemic work of theorizing nature as a kind of magical release from the contradictions of capital. We suggest that the field of architecture contributes in no small part to exploiting organic processes as a source of creative innovation. Our key concern is the significance of design, and specifically design education, as a setting where nature-based ideas are repackaged as a form of urban theory. This is an argument about the potentially mystifying role of new materialist inspired vibrant epistemes, the cultural allure of evolutionary architecture, and other ostensibly unconventional mergers of biology and architecture.

To highlight the performative role of vegetative matter within contemporary architecture adds to the growing literature on "plant geographies" and contributes to current interest in non-human forms of labour.[28] Crucially, the kind of performative labour that we outline here moves beyond the material inputs of animals and plants to the functional integrity of modernity but highlights more indirect forms of performative labour and ideological work. Using vegetative growth cultures as a heuristic device for architectural innovation is consistent with the current impetus towards ecologically inflected forms of urban design. The point of tension, however, is that biomimesis, in its various forms, does not provide a critically reflexive or historically contextualized response to capitalist urbanization. The diffusion of scientific metaphors across radically different disciplinary domains has tended to obscure rather than reveal the shifting scope and context for architectural interventions in urban space.

Biomimetic design and other contemporary forms of neo-organicism have replaced an earlier emphasis on organicism within modernist architectural discourse. Perhaps inadvertently, Luhmann's engagement with autopoiesis poses a series of interesting questions about the functioning of complex systems in urban space. His non-normative evaluation of how modernity operates in practice illuminates some interesting aspects to the influence of autopoiesis in urban design on two levels: firstly, the use of self-organizational metaphors in urban theory; and secondly, the production of self-differentiating professional milieus within the fields of architecture and urban design. We are not concerned here with whether the interpretation of cellular cultures in an architectural studio is "true" or "accurate" but

rather with the performative role of vegetative matter within a sub-set of internally consistent systems of meaning that align with capitalist urbanization.

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Notes

1. Ngai (2015): 241.
2. *Biocomputation and urban protocols in Tallinn* (2016): 74.
3. The above description is based on notes from the workshop made by Maroš Krivý (18 October 2016).
4. See also Johnson (2016) and Rajan (2012). In Rajan's detailed overview of the emerging intersection of biology and capital, for instance, it is notable that there is no specific engagement with the fields of architecture and design. More recent contributions include Borg and Policante (2022).
5. See, for example, Hensel and Menges (2006); Armstrong (2016). Compare the use of cellular automata models to "breeding" urban forms in Batty and Xie (1994); Batty (2009).
6. For Jane Bennett, the neo-vitalist conception of vibrant matter has ethical implications since "encounters with lively matter can chasten my fantasies of human mastery" (2010: 122).
7. See Battistoni (2017); Paxson (2018).
8. See Rouvroy (2012); Rouvroy and Berns (2013).
9. Quoted in Fisch (2017): 808.
10. Stefano Serafini, the Secretary General of the International Society of Biourbanism, as quoted in Spencer (2014): 113.
11. The phrase "technology of nature" is from Fisch (2017): 795.
12. See, for example, Brott (2010); Spencer (2011).
13. "Observations. . .": von Foerster as quoted in Wolfe (1995): 49; "life. . .": von Foerster (2002a): 248. On BCL and von Foerster see also Perera (2017).
14. See also John Protevi's explanation that "Varela refuses to countenance the use of autopoiesis as a model for social systems" because in that perspective "social systems become obsessed with physical boundaries, leading to a fratricidal zero-sum competition" (2009: 95).
15. Interesting in this regard is Varela's remark that "Luhmann was the worst thing to have happened to [me]," as quoted in Hansen (2009): 131.
16. Luhmann (2013): 3. Communication is autopoietic for Luhmann in that it "can be produced only in recursive relation to other communications" (2012: 42). Recursivity is a defining feature of second-order cybernetic writing. Luhmann's main work is titled *Die Gesellschaft der Gesellschaft* (the sense of which is lost in the English translation as *Theory of Society*). Von Foerster (2002b)

made a conference speech "Cybernetics of cybernetics," which was republished in a collection of his papers titled *Understanding Understanding*. Gregory Bateson noted that "the problem of how to transmit our ecological reasoning to those whom we wish to influence in what seems to us to be an ecologically 'good' direction is itself an ecological problem" (1978: 504).

17. We are paraphrasing the interpretation of Uexküll's *Umwelten* by Schnödl and Sprenger (2021): 229.
18. Brans and Rossbach (1997): 41.
19. Djalali (2016): 4; The phrase "diagram of everything" is from Koolhaas (2004).
20. Interestingly, Jameson refers to an "immense, well-nigh global dedifferentiation in Luhmann's sense" (2016: 111), despite the fact that Luhmann demurs at the understanding of "postmodern thinking as dedifferentiation" (2013: 346) and foregrounds the processes of "operational closure and self-organization" (2012: 304).
21. Jameson (1984). The double role of John Portman as the architect and developer of the Bonaventura hotel provides another illustration of the dedifferentiation of economy and architecture.
22. See, for example, Lavin (2020); Moravánszky and Lange (2017); Meijer (2016).
23. When Jameson recently reflected on his theory, he said that "the word I should have used was not postmodernism but rather postmodernity: for I had in mind not a style but a historical period" (2015: 104).
24. See Nye (1994).
25. Ngai (2017) interviewed by Mikkel Bolt Rasmussen and Devika Sharma.
26. Consider in this regard how the promise of synthetic biology for design is framed in terms of instrumentalizing the "performative capacity" of "cellular differentiation and proliferation" (Hensel and Menges 2006: 44).
27. In connecting specific aesthetic developments to post-Fordist or late-capitalist patterns of production Ngai draws especially on the analytic schema of Fredric Jameson.
28. See Ernwein et al. (2021).

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