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Editorial

ELEMENTAL VERNACULAR: DESIGNING BEYOND HUMAN AUTHORSHIP

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Bernard Rudofsky's *Architecture Without Architects* (1964) remains an homage to the vernacular, anonymous designs that lay unclaimed throughout remote parts of the world. The Moravian born Rudofsky was sensitive to the fact that architectural history from a Western perspective was often written with only a few select cultures in mind. To this end, his monograph featured nameless stone towers constructed as chapels, adobe-clad houses, and thatched huts that resurrected some of more of the primal mandates to which architects are bound (Figure 1). Even the Museum of Modern Art in New York called this architecture "non-formal, non-classified".[1] These types of non-pedigreed architecture were enthusiastically endorsed by Walter Gropius, Richard Neutra, Gio Ponti, José Luis Sert, and Kenzo Tange, among others. Moreover, more architectural historians such as Felicity Scott have revisited Rudofsky's oeuvre to reposition his work back into a longer history of modernism and environmentalism.[2]

To reassess Rudofsky's work, in essence, is to open a conversation about how architecture is created and ultimately received in disciplines beyond the boundaries of its own territory. The unclaimed and anonymous architectural designs that Rudofsky highlighted offer the possibility of buildings, and more broadly design, that existed without given provenance and without identity. It is perhaps not with this intention that Rudofsky sought to erase architecture of its signature imprimateur, but the images from 1964 present themselves as innovations that predate any human authorship. This imagistic possibility postulates that ingenuity and resourcefulness in the environment could come from outside human experience.

If architecture can exist without traditional authorship, it is also possible to think about design that does not require human intervention. In the same vein, this interpretation not only removes any type of classification from architecture itself, but allows for architecture to stand outside of human existence. Rudofsky cites the "rude architecture" evoked by the orangutans in Charles Darwin's *The Descent of Man* (1871), who covered their heads with leaves, and baboons who threw straw mats over themselves to shield their heads from the sun. For far too long, these examples of primal shelter have been relegated to the sidelines of fields like geography and anthropology. But such architecture, moulded by the "primeval forces of creation and

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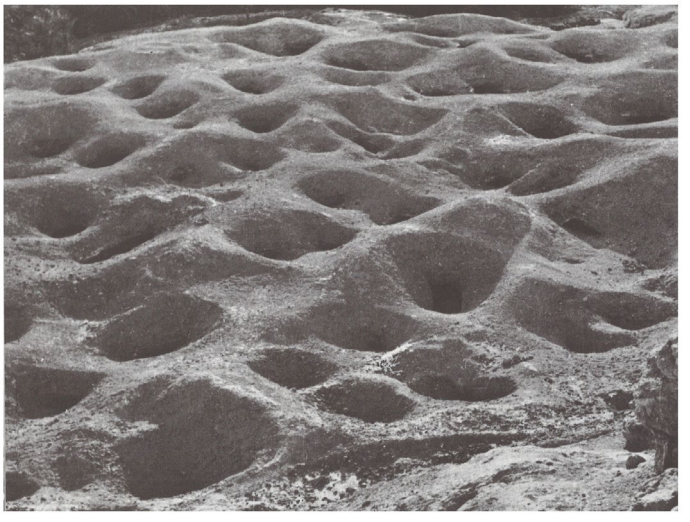

Figure 1. Bernard Rudofsky, photograph of the oasis of Siwa, Egypt (reprinted from *Architecture Without Architects*, 1964, 14).

occasionally polished by wind and water into elegant structures", required more communal enterprise.[3] Many of these primitive structures foretold of more contemporary solutions that would then borrow many of their techniques of technological management and environmental control from such generic matter. Yet, this assumption would miss a greater point that such architectural designs have existed long before the profession of architecture was codified as a practice in the nineteenth century.

The theoretical implications of a non-authored architecture resemble, in fact, an open-ended experiment that many historical and contemporary designers have tried to answer. In an age of digital 3D modelling and scripting, it has become possible to allow the design process to continue unabated without the need of further human decision-making. Rudofsky's images of vernacular architecture now emerge as a continuation of design that may progress without the required intervention of human hands. Certainly beyond what is considered man-made design, contemporary practices are filled with multiple techniques that draw upon precedents in the animal, mineral, and plant kingdoms.

This special issue of *Architectural Theory Review* explores the aesthetic and philosophical categories of animal, mineral, and vegetable in the light of architecture and design that blend these classifications together. Human beings could certainly be added to this classificatory scheme. The agency that is ascribed to animals, minerals, and plants has now been revived in the light of recent scholarship that has attempted to understand the meaning of the Anthropocene and human beings' impact on the earth. Architecture's engagement with the fields of art history, literature, and philosophy underscores how these definitions of the animal, mineral, and vegetable point to new models that exist beyond human authorship. Lively descriptions are

Figure 2. Dillon Marsh, Assimilation #7 (2010), Kalahari Desert, South Africa. Courtesy of Gallery MOMO, Johannesburg, South Africa.

given to inanimate objects with animalistic qualities and, likewise, human-like qualities are often ascribed to objects that possess anthropomorphic characteristics.

Animals acting as architects may have summoned some of the same design sentiments envisioned by Rudofsky's vernacular architectural examples—woven tightly from sticks and grass, the huge communal nests of the sociable weaver are large enough to host multiple generations (Figure 2). One nest, for example, can hold up to 100 pairs of birds. The inner chambers of the nest maintain a higher temperature at night, allowing the birds to stay warm.[4] Older birds often occupied the chambers with the warmest temperatures and where breeding activity was highest. As seen in the photograph taken by Dillon Marsh in South Africa (2010), sociable weavers in the Kalahari Desert are inventive in their use of materials and perhaps human infrastructure in creating new systems of shelter that take advantage of man-made landmarks. Similarly, the red ovenbird, the national bird of Argentina, builds its nests from clay, grass, and leftover detritus of nests that emulates an adobe technique found in places like the American Southwest. Baya weavers' elegant woven nests that hang from thorny palm or acacia trees possess their own design logic that belongs to materials such as mud or leaves.

The inherent rationality belonging to physical forms of fossils and rocks traces a new type of knowledge that is deeply connected to behavioral and material properties lodged within the composition of such stony material. Fractal geometries and the possibilities of biological systems found in corals and insects also may hold the key to unlocking the design potential of architectural typologies to evolve and transform of their own volition. As Richard Grusin reminds us, the complex assemblage of human and non-human actors has radically changed how designers have begun to relate to the environment around us. This "politically liberatory

project" also provides new pathways that open up discussions about conventional categories such as gender, race, ethnicity, and class, and their position in the twenty-first century.[5]

CONTRIBUTIONS

Itohan Osayimwese's article on armchair safaris examines how the staging of such visual representations resurrects challenging cultural attitudes around animal conservation, tourism, and migration. Safaris, and, similarly, zoos by extension, point to the capitalist exploitation of Western funds in order to provide a questionably authentic experience for foreign visitors. She argues that places like the Augsburg Zoo as a colonial site were still marked by modes of discrimination and racial difference. These institutions have quickly transformed into popular visual tropes detached from their more problematic projections of white saviours and naked warriors.

Christina Malathouni writes about Claude Bragdon's theory of projective ornament that proposed a fourth step of evolution based on a human paradigm. She posits that he desired to create a new humanist architecture that embraced the qualities of consciousness and spirituality—certain associations attributed with higher-dimensional entities, mainly in regard to an evolutionary progression towards more advanced forms of existence, reformulated human beings, and their "higher" attributes of consciousness. Bragdon's experiments sought to redefine space in terms of its extension and physical dimensions as well as through its mental properties. Architectural art became thus perceived as incorporating an "excess of beauty".

The isomorphic drawings of Gemma Anderson bring us back to an archetypal paradigm of natural history that involved the classificatory schemes generated by Linnaeus. Her artistic drawings reorganise the vernacular names raised by miners and English naturalists into suggested taxonomies designed to merge the visual resemblances of each museum specimen with the popular narratives that each one generates through the medium of drawing. Her project *Isomorphology* further speculates about how patterns found in nature can be articulated through direct observation and the collecting practices of scientific institutions like the Natural History Museum in London.

Dagmar Reinhardt's *Coral Colony*, displayed at the Australian Design Centre (2015), seeks to study the visual language shared between the fields of biology, mathematics, behavioural studies, interaction design, and architecture. Her collection of marine specimens, which range from corals to shells, are employed as design models for studies that are driven by computational media and processes. These natural precedents are recreated by transforming their mathematical principles into coded propositions to encourage sensory engagement through digitally fabricated objects.

Tim McGinley, Andrew Fotia, and Brett Abroe explore the edges of material science to propose an experimental method of morphogenetical prototyping. They eventually hope to grow buildings without designers, and in this sense, buildings could become intelligent beings that have moved beyond the human realm. In order to make use of biological homeostasis in architecture, they offer that architects need to look beyond the formal, mechanistic, and aesthetic

properties of animals and plants to investigate instead how they grow over time. They map the growth of *Drosophila melanogaster* as one example of a complex biological system that can be correlated to specific architectural typologies to model and manipulate their pseudo biological growth. Such an ontogenetical turn in architecture, as explored by these three researchers, would support an architectural synthesis of Linnaeus' three kingdoms, merging the categories of animal, mineral, and vegetable.

This special issue concludes with John Macarthur's review of the most recent book by Mark Dorrian entitled *Writing on the Image: Architecture, the City, and the Politics of Representation* (I. B. Tauris, 2015) and David Salomon's *Review of Niche Tactics: Generative Relationships between Architecture and its Site* (Routledge, 2015).

Disclosure Statement: No potential conflict of interest was reported by the author.

NOTES

1. Bernard Rudofsky, *Architecture Without Architects: A Short Introduction to Non-Pedigreed Architecture*, New York: The Museum of Modern Art, 1964.
2. Felicity Scott, *Architecture or Techno-Utopia? Politics after Modernism*, Cambridge: MIT Press, 2007, 125. See also Andrea Bocco Guarneri, *Bernard Rudofsky: A Humane Designer*, New York: SpringerWien, 2003.
3. Rudofsky, *Architecture Without Architects*, 2.
4. See René E. van Dijk, et al., "The Thermoregulatory Benefits of the Communal Nest of Sociable Weavers *Philetairus Socius* are Spatially Structured Within Nests", *Journal of Avian Biology*, 44, no. 2 (March 2013), 102–110, and Fred N. White, George A. Bartholomew, and Thomas R. Howell, "The Thermal Significance of the Nest of the Sociable Weaver, Philetairus Socius: Winter Observations", *Ibis*, 117, no. 2 (April 1975), 171–179. See also http://blogs.scientificamerican.com/culturing-science/sociable-weavers/ (accessed 1 June 2016).
5. Richard Grusin (ed.), *The Nonhuman Turn*, Minneapolis: University of Minnesota Press, 2015, xix.

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Armchair Safaris: Representations of African Cultures in Zoos

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Article

ARMCHAIR SAFARIS: REPRESENTATIONS OF AFRICAN CULTURES IN ZOOS

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One of the most jarring signs of the African diaspora in the twenty-first century metropolises of the world are zoo exhibits known as "African Villages". These exhibits present animals typical of some parts of the continent alongside cultural performances involving African people. Scholars and activists have criticised these displays for their reductive portrayals of Africa's diverse built environments and cultures, which contribute to the continued racialisation of people of African descent. This paper argues, however, that these performances of African culture and identity should also be understood in the context of migration and the global circulation of labour.

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In July 2015, an American big game hunter beheaded and skinned a lion in Zimbabwe named Cecil. Cecil was a famous tourist attraction, part of a research study on big cats, and a protected animal. His death sparked moral outrage that spread like wildfire within the international community via social media. This outrage in turn ignited indignation over the fact that the world community was more concerned about the death of a single lion than it was over the poverty and repression experienced every day by many Zimbabweans. Cecil's story brought visibility to a centuries-long debate between Western hunters and conservationists and local communities over East Africa's natural resources.[1] It highlighted the complex environmental histories of the continent, representations of these histories, and the relationships of unequal power that undergird them. It reminded us that the "African safari" is alive and well.

The safari originated with nineteenth-century hunting tourism in British Africa and India. Trophy hunting became a colonial ritual that maintained class tensions internal to European societies and enacted the colonial distribution of power. Interestingly, it was the colonial hunters who would plant the seed for conservation policies aimed at preventing the extinction of the very species that were their bread and butter.[2] Safaris, of course, have a particular materiality. Even those who have not engaged in the ritual recognise the signs: the Land Rover, khaki jacket, pith

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helmet, and white canvas tent complete with mahogany furniture and ostrich feather decorations. Hovering around the edges of this material framework, but indispensable to its workings, is a cast of characters that includes not only the "white savior" with a complex, but also "naked warriors, loyal servants, diviners and seers, ancient wise men living in hermetic splendor".[3] In many senses then, the safari is a kind of ethnographic display that combines representations of animals, humans, spaces, and objects with actual travel to places that are usually only imagined in such exhibits.

We conceive of the safari as a unidirectional vector moving Western visitors from the comfort of their advanced capitalist lives to highly structured packaged experiences in the savannas of eastern and southern Africa. We might concede that tourism brochures, fashion advertisements, personal snapshots, and film ensure a reciprocal flow of representations that shape related discourses about Africa in visitors' places of origin. But rarely do we recognise that these representations participate in a dynamic in which the safari experience is displaced to the society from which tourists usually originate. "African Villages" at zoos in cities around the world offer a jarring example of this phenomenon. These villages combine displays depicting African animals with cultural presentations developed around the physical presence of African people and the trope of travel. This article analyses such representations of Africa's natural and cultural environments in relation to animal conservation, tourism and "cultural economies", and African migration.[4]

One of the most popular recreational destinations in Bavaria today is the Augsburg Zoo (established 1937). The facility is located on the southern edge of the city. It includes large open-air facilities like a three-hectare Africa Panorama inhabited by endangered Rothschild (Uganda) giraffes and other exotic species; buildings like the Elephant House; and a variety of concession structures, including a gift shop, all picturesquely arranged following the English landscape tradition. Together, these exhibits provide an experience that has been likened to a safari.[5] Augsburg Zoo's design and operation is in line with a global trend toward more immersive zoo exhibits that both comply with modern animal husbandry requirements and attempt to meet visitors' ethical and recreational needs.[6] Nevertheless, the zoo's best-known exhibit, the Africa Panorama, and related programming have raised serious concerns.

The controversial nature of the zoo's immersive strategies erupted with the installation of an "African Village" in the summer of 2005. The Village was intended as a temporary market for African products and the celebration of African culture. It consisted of signage, a stage, food stands, and 40 portable canopies rented from a variety of providers and distributed throughout the grounds. Under the canopies were tables covered with wood carvings, furniture, drums, jewellery, and African-style clothing, most of which were not manufactured in Africa. The stalls were manned primarily by individual vendors—mostly African immigrants—and a few charitable organisations.[7]

Some academics and African immigrants were outraged by what they perceived as the zoo's insensitivity toward the historical oppression of people of African descent through displays at zoological and museological venues throughout Europe. Scholars have described these events, which were commonplace in Europe's large cities, especially in the nineteenth century, as "living

ethnological exhibits". Rather than consisting of dramatic objects placed into conceptual frames that required active intellectual engagement from the audience, living ethnological displays were immersive and experiential. Since they were modelled on the "experience of travel and pleasures of engaging the life world as the ultimate exhibition of itself", displaying humans—especially those who had served as guides to European hunters and collectors in the colonies—was crucial to the completeness of the exhibit. In their material character, live displays drew on either zoological traditions of showing exotic animals, theatrical modes of presentation, or some combination of the two.[8] Germany developed a very energetic practice of living ethnological exhibitions that included both self-consciously educational events like the "Native Village" at the 1896 Berlin Colonial Exhibition and the for-profit *Völkerschau* genre perfected by the Hamburg-based impresario, Carl Hagenbeck. As German Studies scholar Eric Ames has shown, Hagenbeck combined people, animals, artefacts, and built structures with theatrical lighting and novel performance techniques to create extraordinary spectacles that foreshadowed the contemporary theme park.[9]

Not surprisingly, an analysis of Augsburg Zoo's African Village reveals parallels with the historical *Völkerschau*. A large vinyl banner with the words "African Village" dominates the entrance to the zoo (Figure 1). Its wording, "African" and "Village", signifies the geographic entity and invented idea known as Africa, and the inferior pole in the modern rural/urban dichotomy that is the village.[10] With the scale and frontal placement of the banner, the entire

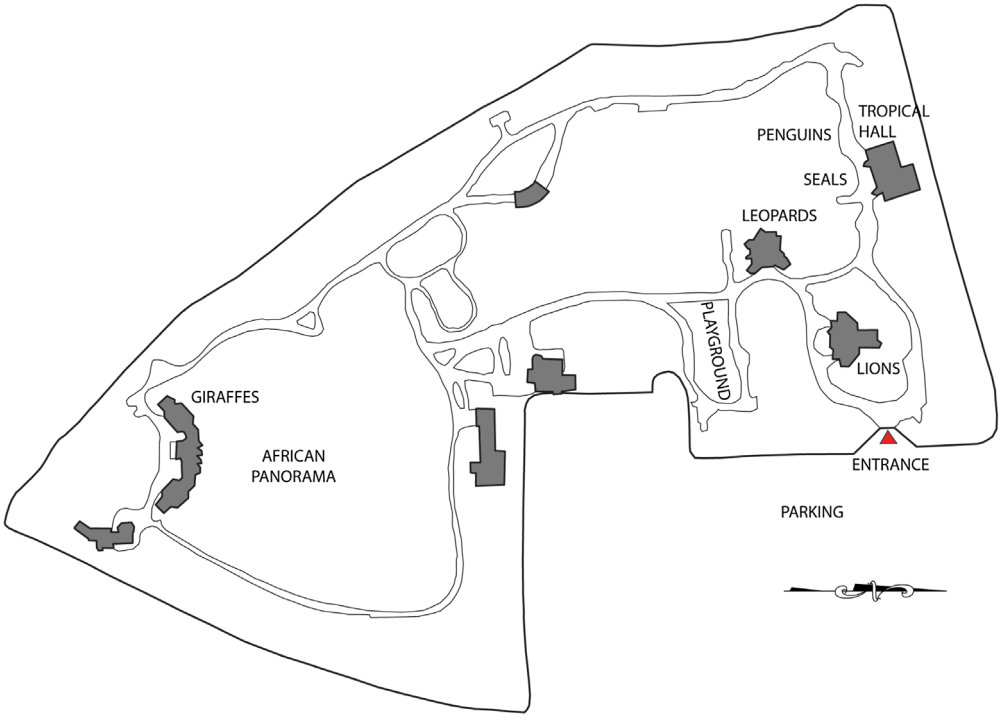

Figure 1. Site plan, Augsburg Zoo, Augsburg, Germany.

zoo becomes, albeit temporarily, an African village. Just beyond the entrance and in front of the lions' enclosure, another sign announces "Africa". This time, the words appear hand-lettered on a chalky background depicting a field of green grass and a glittering sky. Now, we are no longer thinking in terms of the differences between villages and cities. Instead, the entire continent is visually and semiotically linked with wild nature. This amounts to a conflation of nature (the zoo), culture (the African Village), and, by implication, race (the social construct that defines Africans as incommensurably different by virtue of biology). The conflation of nature, culture, and race has long been crucial to legitimising hegemonic forms of political representation, propagating social hierarchies, and sanctioning violent exclusions.[11]

When questioned by researchers, the African immigrant artists and entrepreneurs who paid to market their goods under the canopies expressed dissatisfaction with the event. They felt that the distributed nature of the Village and the absence of a designated, custom-designed space prevented them from making a profit—visitors seemed more interested in the lions than in the paintings presented in front of the Lion House. To counter this problem, the artists placed their wares directly in the path of circulation. Some vendors complained that they felt pressured to perform and market their "Africanness" (for instance, by drumming or braiding hair for an audience) in order to generate sales. Despite their best efforts, they recorded financial losses, which they attributed to the nature of the venue and the fact that visitors understood the zoo as a site for the consumption of spectacle, rather than for capitalist consumption.[12] Anthropologist Nina Glick Schiller has pointed out that some of the problems with the African Village were already present in other areas of the zoo: the nomenclature of the Africa Panorama—the only exhibit named after a continent—recall one of the first visual technologies used by Europeans to claim authority over Africa's landscapes and peoples. Panoramas, of course, informed the subsequent development of living ethnological exhibits in the second half of the nineteenth century.[13] Racialising visual representations of Africans as childlike and without voice and agency, seen in a concession stand sign in the zoo, were also part and parcel of the nineteenth-century exhibitionary complex that attempted to discipline Europe's citizenry into unified national identity by marking their distinctions from non-civilised others.[14]

As zoo administrators and city leaders emphasised, however, several things differentiated Augsburg's African Village from these highly problematic earlier attempts to represent African cultures: the fact that the event was temporary, had humanitarian objectives, was developed in collaboration with African immigrants themselves, and presented Africans as exhibitors rather than subjects of display.[15] None of these features is exceptional, however. In the nineteenth century, one of the attractions of living exhibits was their temporary nature: they were only around for a few weeks or months, but left an indelible mark on their hosts. Though its meaning differs in each context—salvaging cultures allegedly on the brink of extinction in the case of the *Völkerschau*, and raising money for homeless mothers in Togo or chimpanzees in the Republic of Congo in Augsburg—humanitarianism is common to both phenomena. Furthermore, scholars are beginning to plumb the question of the agency of individual "native" performers at nineteenth-century living exhibits. Just like the African immigrant vendors in Augsburg, performers at the 1896 Berlin Colonial Exhibition signed up to participate in what

they saw as an economic opportunity. Some like the young Cameroonian man, Bernhard Epassi, were disappointed when their hopes were not fully realised.[16] It is true, however, that the inhabitants of the African Village in Augsburg were not required to participate in staged recreations of cultural performances and were not locked up with animals in their habitats. But they did find themselves having to dramatise their quotidian activities and identity markers. Here, as in some historical examples, the line between exhibit and exhibitor became blurred.[17] As the example below illustrates, the economic instrumentalisation of culture is the linchpin between this kind of event, the problematic material, visual, and spatial representations that it sustains, and the people—African and otherwise—caught in its web.

Augsburg is only one of many "African Villages" across the world.[18] Seattle's Woodland Park Zoo (WPZ) hosts perhaps the best-known example. Designed in the English landscape tradition for the magnate Guy Phinney, Woodland Park became home to a fledgeling animal collection in the late nineteenth century. The renowned landscape firm Olmsted Brothers built on this early naturalistic orientation in their 1902 design for the park. Following English and French precedent, animals were housed in iron cages inside or next to buildings (Figure 2).[19] In the 1950s, designers added artificial stone formations imitating natural habitats to several buildings, but did not fundamentally change the nature of the exhibits, which favoured human desires over the needs of captive animals. Real change occurred in the 1970s when the zoo adopted a comprehensive plan with open-range exhibits that mimicked natural habitats by using simulated rockwork, concealed moats, and hidden clumps of vegetation as barriers. These devices allowed animal groupings to be seen in relation to each other as they are in nature.[20] This turn

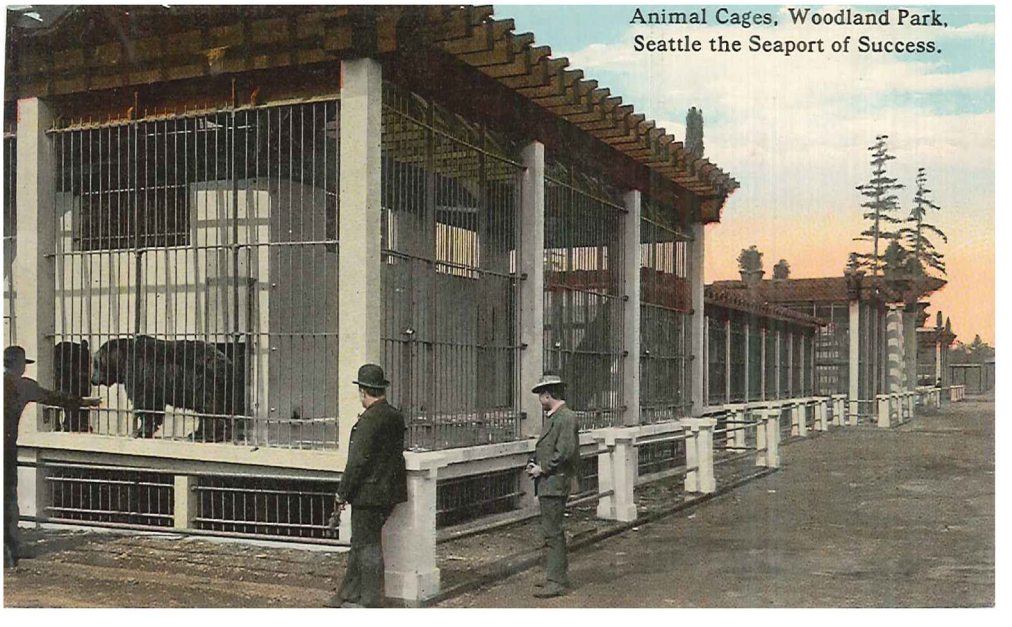

Figure 2. Old bear cages, Woodland Park Zoo, Seattle, *c.* 1916.

to barless zoo design paralleled a new understanding of humans as despoilers of nature, and a corresponding new emphasis on conservation.[21] Though Hagenbeck had pioneered such barless exhibits in Germany almost a century earlier, the new plan and the decision to hire an architect, David Hancocks, as zoo director placed the WPZ at the forefront of contemporary zoo management.[22] Hancocks was at the helm of a new strategy, "landscape immersion", which placed visitors inside the exhibit in order to highlight the symbiotic character of the human–animal relationship.[23] This emphasis on immersion resonates with earlier immersive efforts like the *Völkerschauen* that sometimes even incorporated animal acts.[24]

A flurry of construction activity followed the adoption of the plan. The African Savanna, designed in 1976–1979 by Hancocks and the Seattle firm, Jones & Jones Architects, was among the widely celebrated exhibits of the period (Figure 3). It consists of six acres of savanna animals, plants, and landscape modelled after East African savannas. Strangely, though the zoo is divided into bioclimatic zones, the African Savanna is the only zone that became the formal name of an exhibit.[25] This is a testament to the unique status of "Africa" as a sign.

The African Village, located at the southern entry to the African Savanna, was planned from the beginning as an interpretive complement to the animal and landscape exhibit. It was designed by the Seattle firm PJA Architects to illustrate a generic East African village and constructed in 2001.[26] In 2007, the Village consisted of a *Boma* (Swahili for fortified enclosure) built using cedar branches rather than the "thorny bushes" that the zoo noted would have been used in East Africa (Figure 4). An arched gateway provided access to the enclosure. Inside was a Teacher's House built of plastered concrete and corrugated metal; a traditional Kikuyu[27] house of clay, wood, and thatch on a round floor-plan; a concrete block primary school with windows overlooking animals in the savanna; a "*Banda* Hut" or community gathering place also of clay, wood, and thatch; and two circular granaries with woven walls. Each interior is outfitted with appropriate objects: a lesson plan in the Teacher's House; gourds on the women's side of the Kikuyu house and a bow and arrow on the men's side, etc. In the plaza at the centre of the Village are an "elder tree" and a well.[28] Labels explain the exhibit to visitors and inform them about programming and the zoo's conservation efforts in East Africa.

WPZ's African Village is unusual among zoo African villages in its scale. In fact, it represents the WPZ's efforts to maintain a leadership role. This is made clear in WPZ publications that theorise the Village as an example of "cultural resonance", which is an expansion of the earlier "landscape immersion" concept that aims to stimulate a "feeling of interconnectedness" between visitors and animals and reveal "our dependency on the planet for our humanness".[29] Cultural resonance specifies the means through which this goal can be achieved: it relies primarily on "the detailed presentation of appropriate vernacular architecture from around the world, where it supports and amplifies the natural habitat theme and demonstrates the importance of local peoples in sustainably sharing habitat with wildlife".[30] Architecture, then, and the "truth to materials" philosophy associated with the vernacular are crucial for creating a reality effect.[31] WPZ staff flew to Kenya "on their own time" to obtain construction materials and interior furnishings and hire local builders.[32] Thus, zoo visitors could be transported, via resonance and

Figure 3. Site plan, Woodland Park Zoo, Seattle, USA.

immersion, to another time and place, but employees too could go on safari. At the opening of the Village in May 2001, an African–American storyteller, Kibibi Monie, supplemented these cultural resonance efforts with a "Swahili welcome" and "African folktales".[33]

The WPZ launched a new initiative to revive the African Village in Summer 2007. Evocatively named "Maasai Journey", the program brought four "Maasai warriors" to the Village to serve as

Figure 4. Entrance, Maasai Journey exhibit, African Village, Woodland Park Zoo, Seattle, 2007.

"cultural interpreters". Their job was to explain objects inside the Village, sell Maasai crafts, and describe the zoo's collaborative conservation programs with their community in Kenya.[34] Though the zoo did not alter the physical structure of the Village to accommodate Maasai Journey, it did initiate a remarkable advertising campaign around Seattle and in the zoo. One billboard featured a close-up of a section of zebra skin with the phrase "This Close" overlaid in the lower left corner. Inset on the right was a postage stamp icon bisected by a spear, printed with the words "Maasai Journey" and ornamented with the silhouette of a zebra. In some examples, a Maasai warrior in profile replaced the zebra silhouette. Another billboard depicted a disembodied neck bedecked with polychrome beaded Maasai necklaces.

It is not surprising that Maasai Journey sparked controversy. The advertising campaign, which was built around the enticing trope of the journey or safari, forged visual links between animal and person and, by extension, between nature and the attributes of culture and race that seem to define the (Maasai) person. Visitors are invited to get "this close" not only to the animals of the African Savanna, but also to the people associated with it. The effect, intended or not, transforms the Maasai interpreters into objects of the ethnographic gaze.[35] Two earlier advertisements for the African Savanna operate on a similar register. One poster with the text "See the Painted Dogs of Africa: Like Monet, only Mangier" equates the painted dog habitat with

the entire continent. It also hints at one measure according to which "Africa" has been valued historically by Westerners: as a source for the expressive patterns and forms that fuelled modern art in Europe. Another poster emphasises the disturbingly human-like face and captivating gaze of a Patas Monkey accompanied by the caption, "Why Fly to Africa When You Can Walk? See the World, Never Leave Seattle" (Figure 5).[36] Though such advertisements cannot speak about the reality on the ground, they arguably set the tone for the visitors' experience at the zoo.

Because the zoo's mandate is to educate the public using visual and experiential means, cultural resonance invariably leads to gross generalisations.[37] Specificity is found only in planning documents and publicity material for the African Village.[38] These documents emphasise that the Village is modelled on Kikuyu villages. Admirably, with the inclusion of structures like the teacher's house and the school, the Village presents Kikuyu culture as dynamic in its response

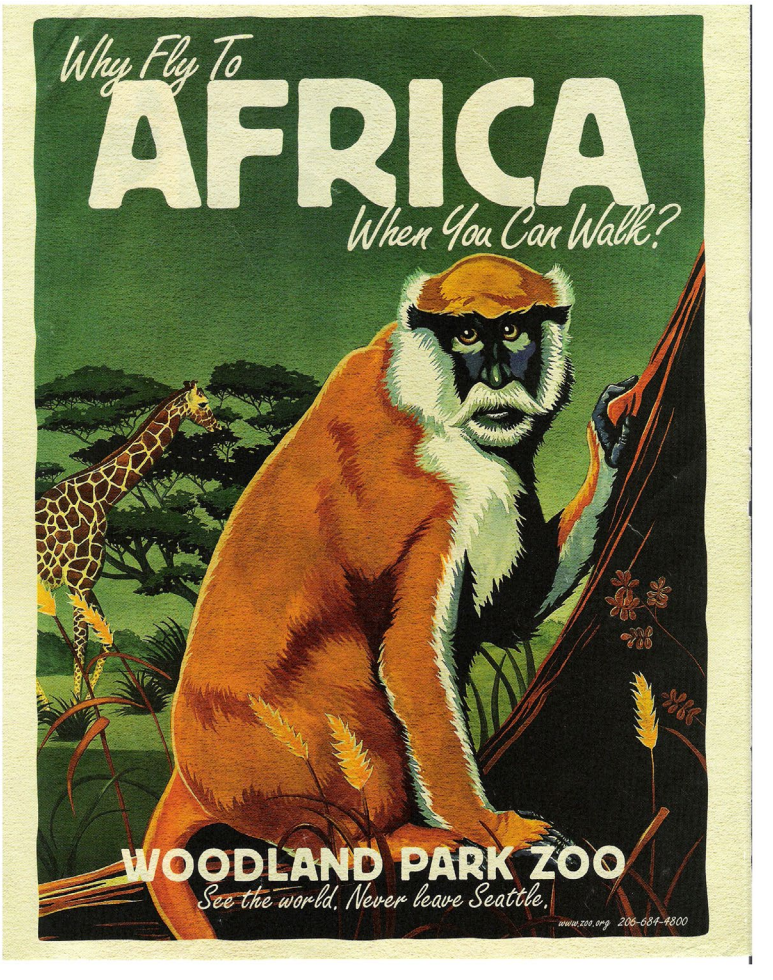

Figure 5. Advertisement for African Savanna, Woodland Park Zoo, Seattle, *c.* 1990s.

to social change. It must be noted, however, that the scale of the Village is misleading: it is closer in scale to a single fortified homestead than to a village—with communal settlement in villages being a relatively recent phenomenon in Kikuyu history. That this particular combination and arrangement of structures would never have been found in an actual village remains unsaid. Alterations made to these structures (such as the dual function of the schoolhouse as a space for learning and a "savanna overlook") are comparable to alterations made to the "indigenous" buildings that made up *Völkerschauen* to make them vehicles of colonial ideology.[39] It is ironic that the round Kikuyu architecture represented in Seattle no longer exists in Kenya today, except in a few simulacra created for institutions that package cultural heritage for public consumption.[40]

In its response to public criticism, the zoo presented the Maasai's role as a novel strategy. Zoo officials argued that the Maasai were not the subjects, but the interpreters of exhibits. Krista A. Thompson analysed a cultural presentation of African immigrant life at the "Festival of American Folklife" in Washington, DC, where curators drew a similar distinction between "tradition bearers" who pursued cultural activities, "presenters" who respectfully explained these activities, and exhibition audiences. As was the case at the WPZ, the local immigrant community's involvement in planning the event was seen as a safeguard against the limitations of an "outsider perspective". But Thompson found that the line between presenter and tradition bearer became blurred when presenters were drawn from the "tradition-bearing community". Furthermore, audiences generally ignored the verbal "interpretations" in lieu of a spectacular consumption practice that was premised on existing stereotypes about Africans.[41] In Seattle, the Maasai interpreters played this double role of culture bearer and presenter as unsuccessfully as their counterparts in Washington. WPZ officials pointed out that these cultural interpreters were not required to wear traditional dress that might have marked difference. As Barbara Kirshenblatt-Gimblett notes, however, self-representation is still a form of representation that essentialises and totalises.[42] In their obvious alterity (discernible from linguistic patterns, slight differences in dress and personal adornment choices, etc.) compounded by the advertising campaign, and their own claims to be bearers of unique knowledge about their community and its relationship to natural resources, the Maasai functioned as tradition bearers.

Lastly, the conservation argument used by zoo officials to justify Maasai Journey is profoundly problematic since pollution and demand for resources from developed societies have created an environment that necessitates conservation, and conservation, in turn, has led to large-scale displacement of people from traditional lands and consequent adoption of dependent lifestyles that benefit Euro-American capitalist economies. Thus, contrary to their dominant image as "traditional pastoralists" frozen in time, the Maasai are actually a prime example of what investigative journalist Mark Dowie has called "conservation refugees". Since the colonial period, historical Maasailand has been transformed into Africa's largest national parks and wildlife refuges. The Maasai have been gradually prohibited from practising their carefully balanced nomadic cattle-rearing system that preserved natural habitats and wildlife. As a result, many Maasai have been forced to practise their traditional lifestyle under highly constrained conditions or integrate with sedentary communities.[43] Dorothy Hodgson argues that the Maasai have

appropriated strategies from the indigenous rights movement in response to this situation and in an attempt to reclaim territorial resources and cultural autonomy. By positioning themselves in this way, Maasai manipulate their public image and identities in accordance with Western stereotypes and engage strategically with "transnational networks, international donors, and multinational organizations".[44] In Kenya, this strategy is sometimes manifested in a performance of the Maasai as "noble savage" in a carefully and *mutually* constructed ethnographic present involving anachronistic dress, on-demand dance performances and hunts, and buildings and villages performed for a tourist audience.[45]

While some Maasai communities rely on cultural heritage and ecotourism and conservation programs at home, others, like the community involved in Seattle's Maasai Journey, perform Maasai culture abroad. A quotation from one of the Maasai interpreters in Seattle illustrates how conservation, philanthropy, cultural heritage, and economics merge into a single project:

> A Maasai without culture is as a zebra without stripes. Maasai Association is committed to community building and sustainable development. We are preserving and celebrating Maasai cultural heritage. Help us to preserve our culture and a way of life.[46]

By being converted to economic goods, exhibits like Maasai Journey become tools in the rebirth of dying "sites, buildings, objects, technologies, or ways of life".[47] As Dell Upton points out, the commodification of heritage should not be understood as a confounding exception. Rather, it is an integral part of the definition of ethnicity, which is itself a role played for others.[48]

The Maasai case suggests a framework for understanding African Villages at zoos as sites of African immigrant agency in the global capitalist economy. These villages are peopled by Africans who have migrated in response to structural demands for cheap labour. The autobiographical novel *I Was an Elephant Salesman: Adventures Between Dakar, Paris and Milan*[49] describes the economic and political motivations for emigration as well as the affronts to human dignity, struggle to meet basic needs, and existential and physical angst experienced by African immigrants. Where the dream of economic opportunity fails, immigrants like the protagonist trade "elephants" or the small, mass-produced "trinkets" that are the lowbrow version of the trade in cultural heritage seen at the Augsburg and Seattle zoos.[50] Through this logic, migration and the global labour market are linked to culture and its economics.

Following this analysis, we can reimagine African Villages as sites in which global capitalism interacts with low-wage workers from the global south. What these immigrant entrepreneurs and the institutions that hire them have not adequately considered, however, are the insidious and cumulative effects of trading in racial and cultural difference.[51] African villages are also fundamentally concerned with the negotiation of African identity among organisers, vendors, and visitors. Both the physical presence of Africans and elements of material culture and the built environment, from wood carvings and beadwork to clay walls and corrugated iron roofs, shape this problematic.

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NOTES

1. Brian Clark Howard, "Killing of Cecil the Lion Sparks Debate Over Trophy Hunts", *National Geographic*, 28 July 2015, http://news.nationalgeographic.com/2015/07/150728-cecil-lion-killing-trophy-hunting-conservation-animals#.Veb6nXLZJDA.email (accessed 20 August 2015).
2. William Adams, *Against Extinction: The Story of Conservation*, London/Sterling, VA: Earthscan, 2004, 30; Mónica Cejas, "Tourism 'Back in Time': Performing 'the Essence of Safari' in Africa", *Intercultural Communication Studies*, XVI, no. 3 (2007), 121–134; Elizabeth Garland, "The Elephant in the Room: Confronting the Colonial Character of Wildlife Conservation in Africa", *African Studies Review*, 51, no. 3 (December 2008), 51–74; A. Norton, "Experiencing Nature: The Reproduction of Environmental Discourses through Safari Tourism in East Africa", *Geoforum*, 27, no. 3 (1996), 355–373.
3. Binyavanga Wainaina, "How to Write About Africa", *Granta 92: The View from Africa*, (Winter 2005), http://granta.com/issues/granta-92-the-view-from-africa/ (accessed 20 August 2015).
4. Barbara Kirshenblatt-Gimblett defines "cultural economies" as the valuation and valorisation, and consequent economic instrumentalisation, of heritage goods. See Kirshenblatt-Gimblett, "World Heritage and Cultural Economies", in Ivan Karp, Corinne Kratz, Lynn Szwaja, and Tomás Ybarra-Frausto (eds), *Museum Frictions: Public Cultures/Global Transformations*, Durham, NC: Duke University Press, 2006, 161–202.
5. With its display of exotic species, the Augsburg Zoo today follows a policy that contrasts radically with its original mandate to show "homeland animals of today, history, and prehistory" along with a model of an old Swabian farmstead. See Bernhard Gotto, *Nationalsozialistische Kommunalpolitik: Administrative Normalität und Systemstabilisierung durch die Augsburger Stadtverwaltung 1933–1945*, Munich: R. Oldenbourg Verlag, 2006, 262. For more on the history of the zoo, see Eva Maria Knab and Marcus Bürzle, "Wo die wilden Tiere wohnen", Stadt Augsburg, *Augsburg*, 5, no. 81 (April 2012), 44–45; Stadt Augsburg, *Augsburg: Ein Ratgeber für die Bürger der Fuggerstadt Interessantes und Wissenswertes von A wie Ämter bis Z wie Zoo, mit Stadtrundgang und Tipps für die Naherholung in der Region*, Schöffelding: Engelhardt Verlag und Werbestudio, 2006, 19; also see http://www.zoo-augsburg.de/aktuell/75-jahre-zoo-augsburg/ (accessed 22 July 2013). An annual "Jungle Night" fundraiser further cements the association between the zoo and safari tourism.

6. Britta Habbe, Udo Ganslosserand, and Norbert Puetz, "Zoo Exhibits in German-Speaking Countries—Design Trends and Educational Aspects", *International Zoo News*, 57/3, no. 380 (April/May 2010), 151–161.
7. Much of my discussion of the Augsburg Zoo controversy is drawn from Nina Glick Schiller, Data Dea, and Markus Hoḧne, "African Culture and the Zoo in the 21st Century: The 'African Village' in the Augsburg Zoo and Its Wider Implications, Report to the Max Planck Institute for Social Anthropology", 4 July 2005, Advokatenweg 36 06114 Halle/Saale, Germany, 23, 25.
8. Barbara Kirshenblatt-Gimblett, *Destination Culture: Tourism, Museums, and Heritage*, Berkeley: University of California Press, 1998, 3, 4, 41–61.
9. Eric Ames, *Carl Hagenbeck's Empire of Entertainments*, Seattle: Washington University Press, 2008, 98–102, 118, 154–157.
10. On Africa as a construct, see V. Y. Mudimbe, *The Invention of Africa: Gnosis, Philosophy, and the Order of Knowledge*, Bloomington: Indiana University Press, 1988.
11. Donald S. Moore and Anand Pandian (eds), *Race, Nature, and the Politics of Difference*, Durham, NC: Duke University Press, 2003, 1–39; Kay Anderson, "Culture and Nature at the Adelaide Zoo: At the Frontiers of 'Human' Geography", *Transactions of the Institute of British Geographers*, 20, no. 3 (1995), 275–294 (276); also see Jane Desmond, *Staging Tourism: Bodies on Display from Waikiki to Sea World*, Chicago, IL: University of Chicago Press, 1999.
12. Schiller et al., "African Culture and the Zoo in the 21st Century", 22–25.
13. See, for example, Dietrich Neumann, "Instead of the Grand Tour: Travel Replacements in the Nineteenth Century", *Perspecta*, *The Yale Architectural Journal*, 41, (2008), 47–53; and Denise Blake Oleksijczuk, *The First Panoramas: Visions of British Imperialism*, Minneapolis: University of Minnesota Press, 2011.
14. Schiller et al., "African Culture and the Zoo in the 21st Century", 18; Tony Bennett, "The Exhibitionary Complex", in Vanessa R. Schwartz and Jeannene M. Przyblyski (eds), *The Nineteenth-Century Visual Culture Reader*, New York: Routledge, 2004, 119–121.
15. Schiller et al., "African Culture and the Zoo in the 21st Century", 8–9; also see Cordula Grewe, "Between Art, Artifact, and Attraction: The Ethnographic Object and its Appropriation in Western Culture", in Cordula Grewe (ed.), *Die Schau des Fremden: Ausstellungskonzept zwischen Kunst, Kommerz und Wissenschaft*, Stuttgart: Franz Steiner Verlag, 2006, 13.
16. Jeff Bowersox, "Kolonial-Lehrling wider Willen: Bernhard Epassi in Deutschland 1896–1901", in Ulrich van der Heyden (ed.), *Unbekannte Biographien: Afrikaner im deutschsprachigen Raum vom 18. Jahrhundert bis zum Ende des Zweiten Weltkrieges*, Berlin: Kai Homilius Verlag, 2008, 107.
17. Cf. Kirshenblatt-Gimblett, *Destination Culture*, 45.
18. Other African villages have been documented in the United States (Cleveland, Houston, Seattle, The Bronx, and Palm Desert, California), England (Luton), Australia (Perth, Victoria), and Congo-Brazzaville. Cf. Schiller et al., "African Culture and the Zoo in the 21st Century", 41.

19. Cf. Seattle Municipal Archives Photograph Collection, Item No: 30844, Description: Woodland Park Zoo, Orig No. 17269, Date: 1911, Collection: Don Sherwood Parks History Collection, Record Series 5801-01, http://clerk.seattle.gov (accessed 1 April 2016).
20. David Hancocks, *Animals and Architecture*, New York: Praeger, 1971, 7, 106, 129; Don Sherwood, "History of Woodland Park Zoo", unpublished manuscript, manuscript page number 11; also "Chronological History of Woodland Park Zoo", http://www.zoo.org/page.aspx?pid=2170 (accessed 12 October 2013); "A Short History of a Community Tradition", http://www.zoo.org/page.aspx?pid=1999 (accessed 12 October 2013).
21. Anderson, "Culture and Nature at the Adelaide Zoo", 276, 281.
22. Barless, garden-type zoo design actually preceded Hagenbeck. According to Sherwood, it influenced the London Zoological Society in 1828, but only slowly gained a following (Sherwood, "History of Woodland Park Zoo", manuscript page number 2).
23. Grant Jones, "Beyond Landscape Immersion to Cultural Resonance: In the Thai Elephant Forest at Woodland Park Zoological Gardens", *American Zoo and Aquarium Association Annual Conference Proceedings (1989)*, 408–412; John Bierlein, "Exhibit Design and the Aesthetic of Nature", *AZA Communiqué* (March 2003), 8–10.
24. Kirshenblatt-Gimblett, *Destination Culture*, 41.
25. Hancocks, *Animals and Architecture*, 129–130. Also see Woodland Park Zoo, "African Savanna: A Self-Guided Tour for Teachers and Chaperones", www.zoo.org (accessed 1 April 2016); Jones, "Beyond Landscape Immersion to Cultural Resonance", 408; CLRdesign inc. Architects, Landscape Architects, Exhibit Designers, "Long-Range Physical Development Plan 2002: Development Guidelines, Non-Exhibit Recommendations and Exhibit Scenarios". The current (2016) site-plan of the zoo reflects the changing nature of exhibits in the zoo, some of which are now named after places other than Africa.
26. "Long-Range Physical Development Plan 2002", 4; Caroline Allen, "African Village Life is Newest Attraction at Woodland Park Zoo", *Seattle PI* (24 May 2001), Also see http://www.seattlepi.com (accessed 1 April 2016); Also see http://www.pjarchitects.com/Projects/wpzvillage.html (accessed 1 April 2016). Much of my discussion of the African Village is drawn from field observations made in Summer 2007 by myself and Catherine Claiborne, Jackson School of International Studies, University of Washington; and a community forum organised by Stephanie Camp, University of Washington, Catherine Claiborne, and myself on 8 August 2007 at the Langston Hughes Performing Arts Center in Seattle.
27. The Kikuyu are an ethnic group that has traditionally inhabited the Central Kenya region around the foot of Mount Kenya. Today, they are thought to be the largest ethnic group in Kenya. See Joseph Kamenju, "'Transformation of Kikuyu Traditional Architecture: Case Study of Homesteads in Lower Mukurwe-ini, Nyeri, Kenya", PhD dissertation, The Oslo School of Architecture and Design, 2013.
28. "African Village: A Self-Guided Tour", www.zoo.org; Allen, "African Village Life is Newest Attraction at Woodland Park Zoo".
29. Jones, "Beyond Landscape Immersion to Cultural Resonance", 412.

30. "Long-Range Physical Development Plan 2002", 57.
31. Bierlein, "Exhibit Design and the Aesthetic of Nature", 9; "Long-Range Physical Development Plan 2002", 60.
32. Allen, "African Village Life is Newest Attraction at Woodland Park Zoo".
33. Allen, "African Village Life is Newest Attraction at Woodland Park Zoo".
34. See postings archived under "New 'African Village' Exhibit at the Woodland Park Zoo in Seattle, WA", H-Africa Discussion Logs 9, 16, 18 July, and 1 August 2007, https://h-net.msu.edu (accessed 1 April 2016).
35. Cf. Kirshenblatt-Gimblett, *Destination Culture*, 55.
36. I thank Lynn Thomas at the University of Washington for sharing these advertisements with me.
37. Only a few other examples of cultural resonance (the temple-like structures of the Thai Elephant Forest and a pit house at the Northern Trail Tundra Center) exist at the WPZ, but they lack the human element of Maasai Journey and evince more specificity in their design and nomenclature.
38. Woodland Park Zoo, "African Savanna: A Self-Guided Tour", 2–4.
39. Steven Nelson, *From Cameroon to Paris: Mousgoum Architecture In and Out of Africa*, Chicago, IL: University of Chicago Press, 2007, 126.
40. Kamenju, "Transformation of Kikuyu Traditional Architecture", 4. On Kikuyu architecture, also see Kaj Andersen, *African Traditional Architecture: A Study of the Housing and Settlement Patterns of Rural Kenya*, New York: Oxford University Press, 1977.
41. Krista A. Thompson, "Beyond Tarzan and National Geographic: The Politics and Poetics of Presenting African Diaspora Culture on the Mall", *Journal of American Folklore*, 121/479 (2008), 97–111. This insistence on spectacularising the event can be compared to Coco Fusco's discovery of the ease with which the public assumed her fictional identity as an "undiscovered Amerindian" on display to be her real identity in a performance piece in 1992 (Coco Fusco, "The Other History of Intercultural Performance", *TDR*, 38, no. 1 (Spring 1994), 143–167).
42. Kirshenblatt-Gimblett, *Destination Culture*, 55.
43. Mark Dowie, *Conservation Refugees: The Hundred-Year Conflict Between Global Conservation and Native Peoples*, Cambridge, MA: MIT Press, 2009, 23–44; Shannon Joyce Prince, "Human Zoos, Conservation Refugees, and the Houston Zoo's The African Forest", www.racialicious.com (accessed 14 June 2010).
44. Dorothy Hodgson, *Being Maasai, Becoming Indigenous: Postcolonial Politics in a Neoliberal World*, Bloomington: Indiana University Press, 2011, 3–5, 23–61; Elliot Fratkin, "Review of Dorothy Hodgson, *Being Maasai, Becoming Indigenous: Postcolonial Politics in a Neoliberal World*", H-Africa, H-Net Reviews, May 2012, http://www.h-net.org/reviews/showrev.php?id=35552 (accessed 28 October 2013); Katherine A. Luongo, "Review of Dorothy Hodgson, *Once Intrepid Warriors: Gender, Ethnicity, and the Cultural Politics of Maasai Development*, H-Africa, H-Net Reviews, April 2003, http://www.h-net.org/reviews/showrev.php?id=7433 (accessed 28 October 2013).
45. Edward M. Bruner and Barbara Kirshenblatt-Gimblett, "Maasai on the Lawn: Tourist Realism in East Africa", *Cultural Anthropology*, 9, no. 4 (November 1994), 435. Also see Jeanne van

Eeden, "The Colonial Gaze: Imperialism, Myth and South African Popular Culture", *Design Issues*, 20, no. 2 (Spring 2004), 18–33.

46. "New 'African Village' Exhibit at the Woodland Park Zoo in Seattle, WA", 18 July 2007.
47. Kirshenblatt-Gimblett, *Destination Culture*, 151.
48. Dell Upton, "Ethnicity, Authenticity, and Invented Traditions", *Historical Archaeology*, 30, no. 2 (1996), 1–7.
49. Pap Khouma, *I Was an Elephant Salesman: Adventures between Dakar, Paris and Milan*, Bloomington: Indiana University Press, 2010.
50. On African "tourist art", see, among others, Christopher Steiner, "Authenticity, Repetition, and the Aesthetics of Seriality: The Work of Tourist Art in the Age of Mechanical Reproduction", in Ruth Phillips and Christopher Steiner (eds), *Unpacking Culture: Art and Commodity in Colonial and Postcolonial Worlds*, Berkeley: University of California Press, 1999, 87–103; and Zain Abdullah, "Objects of Desire: Shopping for Identity and the Meaning of Africa at the Harlem Market", *African Arts*, 44, no. 4, (Winter 2011), 8–21.
51. Cf. Grewe, "Between Art, Artifact, and Attraction", 20.

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Claude Bragdon's "Projective Ornament": Mineral, Vegetable, Animal, Human

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Article

CLAUDE BRAGDON'S "PROJECTIVE ORNAMENT": MINERAL, VEGETABLE, ANIMAL, HUMAN

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This essay discusses the work of the American architect, mystic, and theorist Claude Fayette Bragdon (1866–1946). It focuses on his "Projective Ornament", which, it is argued, puts forward a "higher" type of "organicism", which adds a fourth "step"—that of the human—to earlier theories that presented minerals, vegetables, and animals as part of an evolutionary, hierarchical sequence. In this connection, Bragdon's theories can be seen to develop a new type of "humanist" architecture that relates to the full scope of human nature, namely, embracing human consciousness, psychological attributes and spiritual qualities, as well as its embodied presence. This position serves to highlight the "subjective" aspect of "space", crucial for its adoption as a principal architectural category, and still topical.

Keywords: Fourth dimension; humanism; organicism; ornament; space
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INTRODUCTION

In 1915, the American architect, mystic, and theorist Claude Fayette Bragdon (1866–1946) had a new book published under the title *Projective Ornament*[1] (Figure 1). The book presented a new type of ornament that was heavily reliant on the representational method of projection as well as on the concept of the "fourth dimension" of space. His adherence to "ornament" and his leading role in the popularisation of the notion of the "fourth dimension" of space in America are indeed amongst the most characteristic, and therefore widely recognised, features of Bragdon's work. His writings on "Organic Architecture" have also attracted the attention of critics and scholars.[2]

However, Bragdon's deep-seated interest in the human has gained less attention to date, or is usually presented as supplementary to other key themes in his work. Equally, his pioneering role in the introduction of the term "space" into modern architectural vocabulary has only recently been acknowledged. What is more, to date, no attempt has been made to directly connect Bragdon's interests in "space" and "ornament". On the contrary, these two concepts are often considered as representing contradictory elements as regards architectural modernism. The

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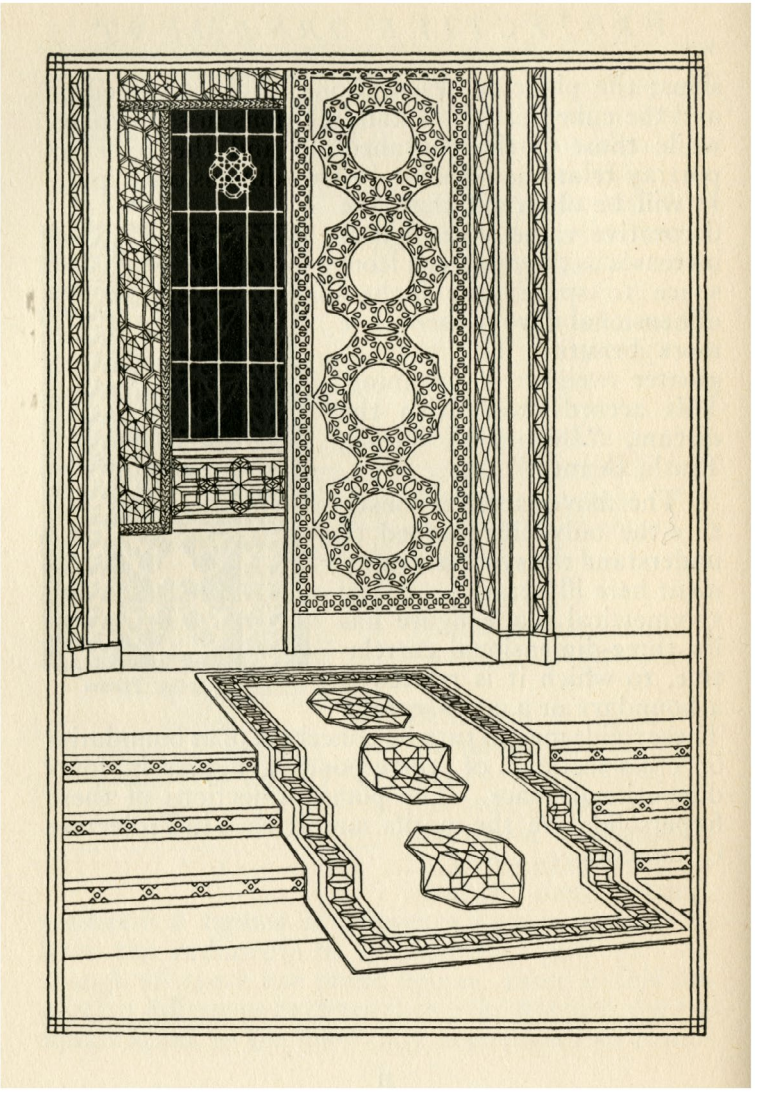

Figure 1. Claude Bragdon, *Projective Ornament*, Rochester, NY: The Manas Press, 1915, opposite p. 23. Courtesy of the Department of Rare Books, Special Collections and Preservation, University of Rochester River Campus Libraries, New York.

former is seen as marking a notable new direction in early twentieth-century architectural theory and practice, whereas the latter is commonly associated with remnants of earlier traditions.

This paper argues that the human has actually been a central consideration in Bragdon's world-view, which brings together a number of his diverse interests, such as mysticism, aesthetics, symbolism, and mathematics. It also argues that Bragdon built his position on the sequence "mineral, vegetable, animal", mentioned in one of his private notebooks as early as 1891,[3] which is implicitly related to his subsequent interest in architectural organicism too. An analysis of

the foundations of his Projective Ornament in parallel with his aesthetic philosophy and his particular interest in the "fourth dimension" of space suggests that Bragdon effectively put forward a new type of humanism. This new humanism related to the full scope of human nature, that is, it embraced human consciousness, psychological attributes and spiritual qualities, as well as its embodied presence.

It will be demonstrated that Bragdon's reference to the sequence "mineral, vegetable, animal" adopted an implied evolutionary hierarchy and further associated this to dimensional sequences. His subsequent adoption of theories of four-dimensional space would offer him the tool by which he could expand this sequence to include the "human", and, at the same time, graphic representations of the "fourth dimension" would directly feed into his proposed new ornament. Underlying all these is of course "space" and Bragdon's composite understanding of the notion as both physical extension and a mental property. As will be discussed, this foundation is also critical for the new type of humanism discussed here as the means by which the human relates to the external world in general and architecture in particular.

CLAUDE FAYETTE BRAGDON (1866–1946)

Bragdon lived and practised in the northeast of the United States of America. His practice, based in Rochester, became a successful one in the region in the first two decades of the twentieth century, and his built designs were popular. Before turning to architecture, Bragdon had variously attempted to become a wood engraver, get a job as a cartoonist, and become a draughtsman for architectural rendering; throughout his lifetime, he remained interested in different forms of graphic design. Between 1915 and 1918, he was involved in the popular "community singing" festivals of Song and Light, in the role of the "Master of Light", and became interested in the new art form of "colour music" (the art of "mobile colour"), which later evolved to adopt the newly developed technique of cartoon animation. In 1923, he called himself a theatrical designer, rather than an architect, and moved to New York City.[4]

In parallel to these design-related activities, from the early 1890s to the end of his life, Bragdon devoted a great deal of his time and energy to the development of his own theories as well as writing and lecturing on a broad variety of subjects, ranging from mysticism and Theosophy to architecture, colour music, and theatre. He was a prolific author. He had more than 20 books published during his lifetime and also numerous articles published in architectural, mystical, Theosophical, and popular magazines and newspapers on a wide variety of subjects that range from poetry to architectural history and mystical explorations. His principal books relating to architecture date from 1910 to 1932 and include the following titles: *The Beautiful Necessity* (1910), *Projective Ornament* (1915), *Architecture and Democracy* (1918), and *The Frozen Fountain* (1932).[5] From 1891 onwards, he also had architectural articles published in popular and influential professional outlets, such as *Architectural Review*, *Architectural Record*, *Architectural Forum*, *American Architect and Architecture*, *Interstate Architect and Builder*, *Brickbuilder*, and *Journal of the American Institute of Architects*.[6]

Bragdon was therefore not unknown to his contemporaries, including some leading figures of his time. He was personally acquainted with Louis Sullivan—and acknowledged as one of the earliest architects and theorists to have recognised the value of Sullivan's work[7]—and with Frank Lloyd Wright.[8] Lewis Mumford knew of Bragdon's Song and Light festival work in the second half of the 1910s and of his architectural writings.[9] Repeated complimentary mentions of his work were also included in the writings of his contemporary, art and theatre historian Sheldon Cheney,[10] and, through inclusion in William Lescaze's *On Being an Architect*,[11] Bragdon was quoted in Bruno Zevi's landmark study *Towards an Organic Architecture*.[12]

Bragdon's principal books were popular in the New York book world and re-published several times. By the time of his death, some of his writings had been translated into Italian, Japanese, and Russian.[13] An upsurge in their popularity was to occur in the late 1960s and early 1970s, and, even today, facsimile reproductions of most of Bragdon's books are available in print. Interest in Bragdon's oeuvre revived again in the early years of the twenty-first century. The first decade of the century saw four doctoral theses exploring different aspects of Bragdon's work, completed between 2001 and 2010.[14] One of these theses was published as a monograph in 2009,[15] and a second book on Bragdon's work was published a year later.[16] The latter comprises an exhibition catalogue and 11 essays by an equal number of scholars, contextualising Bragdon within American architecture and various facets of American culture. Various journal articles that focus on Bragdon's work have also been published in recent years.[17]

"MINERAL, VEGETABLE, ANIMAL, HUMAN"

Several of the recent studies mentioned above engage with Bragdon's interests that are central in the discussion here: "ornament", "space", the "fourth dimension", "organicism", and human subjectivity. However, to date, there has been no reading of the close association of all these elements as an expansion of the "mineral, vegetable, animal" sequence towards a new humanism, as proposed here.

First of all, the art historian Linda Dalrymple Henderson's seminal 1983 work *The Fourth Dimension and Non-Euclidean Geometry in Modern Art*[18] draws attention to Bragdon's advocacy of the "fourth dimension of space" by highlighting the central role that his fourth-dimensional writings played in the dissemination of this novel notion in early twentieth-century art circles in America. Her work, though, does not look any closer into any particular aspects of architectural theory or practice.[19]

Jonathan Rider Massey's 2001 thesis and 2009 book extensively discuss Bragdon's interest in human subjectivity, mainly by reference to his Theosophical beliefs and also via analysis of the implications of his preferred representational techniques, such as axonometric projection. Massey also interprets an original relationship between the striking flatness of the "Projective Ornament" and the actual three-dimensionality of physical structures as related to Riemann's 1854 definition of space as a dimensional manifold. He goes on to relate this engagement with dimensionality with what he reads as Bragdon's distinctive embracing of organicism: "a technique

of disjunctive synthesis between structure and ornament, based on the concept of space as a dimensional manifold".[20] Massey does not identify "space" as an area of innovation for Bragdon, but conversely considers his strong interest in ornament as confirmation of his lack of engagement with what Adrian Forty called "built space".[21] Nonetheless, Massey challenges Bragdon's virtual exclusion from modern architectural historiography through an extensive analysis of his use of ornament and the significance of its difference from decoration.[22] Finally, Massey also provides an extensive analysis of Bragdon's graphic work, including aspects of the Projective Ornament as well as a comparison to Sullivan's 1924 *System of Architectural Ornament* and how his use of geometry in this work compares to Bragdon's.[23]

The present author's 2010 thesis and three of my papers complement the above positions.[24] They acknowledge the significance of Bragdon's fourth-dimensional ideas, but also place particular emphasis on his earlier interest in the more generic notion of "space". This was innovative and groundbreaking and in effect constitutes the foundation for Bragdon's subsequent involvement in the "Fourth Dimension" tradition. My demonstration of the influence of nascent psychological and psychoanalytical ideas—especially that of the "unconscious" —on Bragdon's "spatial" thinking also partly prepares the discussion below.[25]

Finally, Eugenia Victoria Ellis' 2005 thesis follows a distinct path and therefore presents yet another reading of the notion of "space" within Bragdon's oeuvre by elaborating on spatial qualities in his built work. Ellis associates these qualities with Eastern philosophical ideas. On this basis, she too relates Bragdon's work to human subjectivity, as she puts forward a re-consideration of architecture by means of experiential spatial qualities instead of formal relationships, but does not provide any links to the evolutionary progression discussed here and its expression in Bragdon's Projective Ornament.[26]

Aiming to explain how diverse elements of Bragdon's oeuvre are brought together towards a revised sequence that would be more complete—"mineral, vegetable, animal, human" —the following sections will address specific parts of this position. Firstly, there is a discussion of Bragdon's composite understanding of the notion of space and how this made the human the central consideration within architecture. Secondly, Bragdon's approach to "ornament" will be considered, especially how this related to his architectural aesthetic theory, was linked to "organicism", and embraced the paramount importance of "life". Thirdly, the particular opportunities offered by the novel concept of the "fourth dimension" will be explored, both as a design tool for the Projective Ornament and as a symbol for human attributes beyond the first three stages of "mineral, vegetable, animal". This section will also compare the "higher" symbolism of the fourth-dimensional geometry employed for Projective Ornament to earlier representations of the human figure in Bragdon's oeuvre. On this basis, it will demonstrate how Bragdon expanded his engagement of the human in his design work by devising a symbolic representation of "higher" human attributes, such as consciousness.

BRAGDON'S "SPACE"

Although a remarkably novel idea, Bragdon's introduction of the term "space" into his architectural theories can pass unnoticed if considered from our contemporary perspective, according to which space is often held to be the indisputable essence of architecture. However, as I have demonstrated elsewhere, Bragdon's adoption of the notion of "space" holds a central position in his oeuvre and allowed him to stand out as a true pioneer in the introduction of the term into the modern architectural discourse. Through an extensive and complex intellectual construct, "space" serves as a pivotal concept in Bragdon's work that brings together the full scope of his diverse interests.[27]

The origins of Bragdon's "spatial" ideas can be traced in philosophical, Theosophical, mathematical, and scientific (or pseudo-scientific) sources. His exploration of spatial ideas expanded over numerous articles and books and he remained committed to these ideas to the end of his life. His most notable books as regards diverse aspects of the subject of space include: his principal architectural treatise, *The Beautiful Necessity: Seven Essays on Theosophy and Architecture* (1910); his principal introduction to the mathematical "fourth dimension", *A Primer of Higher Space (The Fourth Dimension)* (1913); the presentation of his own ornamental mode, *Projective Ornament* (1915); his discussion of non-mathematical aspects of the "Fourth Dimension", *Four-Dimensional Vistas* (1916); and, finally, his considerably later re-iteration of the significance of space in relation to design, his *Frozen Fountain: Being Essays on Architecture and the Art of Design in Space* (1932). In addition to these books, Bragdon also discussed space in a number of articles which were equally varied in their particular focus. Most notable in terms of timing or content are the following: "The 'Village Bank' Series: I" (1900), "The Music of Architecture" (1902), "L'Art Nouveau and American Architecture" (1903), "The Sleeping Beauty" (1903), "The 'Dead Hand' in Architecture; Or A New Space-Language For To-Day" (1914), and "The Fourth Dimension" (1927).[28]

Bragdon's writings also reveal his composite understanding of the notion: both as extension or dimension (for instance, by his references to "intervals of space") and as a mental property (most commonly referred to as one of our two "modes of consciousness"). His first reading of space—as physical extension or dimension—offered him a graphic tool for a direct connection to design. His second interpretation of "space" links back to Kant's reading of space and time as our two a priori intuitions. Interestingly, it is also directly linked to the origins of Bragdon's direct association of "space" and "architecture", first adopted from Arthur Schopenhauer's *Die Welt als Wille und Vorstellung* as early as 1891.[29]

"ORNAMENT", "BEAUTY", AND "LIFE"

Bragdon saw "ornament" as a necessary component of architectural art, essential for it to be distinguished from mere "building as a working mechanism".[30] This was to be most determinedly expressed when he devised his own ornamental mode and presented it in his 1915 book *Projective Ornament*, as well as in numerous articles.[31] The direct continuity from Bragdon's architectural

aesthetics in his 1910 *Beautiful Necessity* to his own ornamental mode in *Projective Ornament* in 1915 was to be demonstrated in his two Scammon lectures delivered at the Art Institute of Chicago the same year.[32] After presenting the "sum and essence of [his] æsthetic philosophy"[33] in his first lecture, "Organic Architecture", Bragdon concluded his talk by positioning himself with regard to this new phase in his work. He situated "ornament" within this theory and prepared his audience for the area he would subsequently focus on. Arguing that it was eclecticism that caused a discrepancy between "inner structure" and "its outward manifestation",[34] Bragdon named "outward expression"—or "the language in which the story is told to the beholder"—as the aspect that needed further attention. He made this the main subject of his second lecture, "The Language of Form", and set out to clarify how such a language could rise to the conditions of its time.[35] He distinguished between three main elements which "formulate the rhetoric of spatial expression"[36] and presented ornament as the second necessary element in a language of form.[37]

Bragdon's reference to the relationship between "inner structure" and "outward manifestation" is particularly important as it points to the most commonly accepted use of the term "organic" within architecture. That is, despite the mathematical origins of his ornament, which he considered to be the "solid", or "sure", foundation needed by the "ornamentalist",[38] Bragdon also embraced the role that nature can play as design prototype. In this connection, he effectively acknowledged Sullivan's leading role, yet at the same time, he also acknowledged industrialisation and urbanisation as indisputable conditions of contemporary life. He pointed out that he could identify two other possible sources for ornament: "the single-handed creation of an original genius" and the "conventionalisation" of natural forms. Yet, he explained, for different reasons, both of these were eliminated. The former could not guarantee the development of a new style[39] because it would be "calamitous to impose the idiosyncratic space rhythm of a single individual upon an entire architecture" and, as the example of Louis Sullivan has shown, the secret of such a genius is usually incommunicable. The latter source, nature, was of little help, Bragdon contended, in an age in which industrialisation and urbanisation have resulted in "our divorce from nature".[40]

Bragdon had followed closely the early phase of "functionalism", as this was linked to "organicism", through Ralph Waldo Emerson's texts of which he had been an avid reader from a young age.[41] Bragdon might not have read *English Traits* (1856), in which Emerson referred to Horatio Greenough's essay "American Architecture",[42] first published in 1843 in the *United States Magazine and Democratic Review*[43] and in which Greenough discussed all the principal positions that were to mark architectural functionalism.[44] Nonetheless, he was well versed in Emerson's *Conduct of Life* (1860, revised 1876) and therefore aware of the reference to the abridged English translation of Georg Moller's *An Essay on the Origins and Progress of Gothic Architecture, Traced in and Deduced from the Ancient Edifices of Germany*, published in 1824 by the London booksellers Priestley and Weale and therefore predating Greenough's articles.[45] Whether—upon Emerson's "suggestion"—Bragdon actually gained access to, and consulted, Moller's *Essay* or not, the fundamental functionalist position quoted by Emerson from Moller is openly embraced in his "Beautiful Necessity" essays. Both in his full-length series of articles

published in 1902 and in 1909 and in his book published in 1910, Bragdon firmly advocated this position about fitness and the adaptation of means to ends and its relation to nature.[46]

Bragdon adhered to his attribution of a unique role to ornament to the end of his life.[47] As mainstream "strip tease" modernism was gaining momentum in America in the early 1930s, Bragdon wrote a number of texts maintaining the necessity of "ornament" for architectural art and named it "the *flower* of architecture".[48] He re-asserted the primary role of "beauty" and "aesthetics", as regards architecture as a form of art, and distinguished this from building and mere engineering.[49] He also firmly adhered to "organicism" as the original version of Functionalism that was related to "life". Under the new circumstances of the machine aesthetic, the position of the "second generation of Functionalists", newly imported from Europe, Bragdon returned to Emerson's saying "To die for Beauty than live for bread"[50] and opposed the "machine aesthetic" as lacking connection to the "life element". The "excess of beauty" was seen as directly associated to an "excess of life", argued to be found everywhere in organic life, and realised in architecture by the addition of ornament to structure. Because "man cannot live by bread alone",[51] Bragdon argued that the "machine ideal applied to architecture" was inadequate and that a modern ornamental mode was required.

"FOURTH DIMENSION": "MEANINGFUL BEAUTY" AND "THE REBIRTH OF WONDER"

Inherent in Bragdon's emphasis on the "organic" and "life"—as re-asserted in his 1930s and early 1940s writings—was a strong evolutionary hierarchy. In this hierarchy, humankind featured as a higher form of life in comparison to vegetable or animal life. In this connection, Bragdon's association of "ornament" with the "life element" constitutes the first step towards the characterisation of his approach as "humanist". The next relates specifically to his employment of fourth-dimensional geometry as "raw material" for his Projective Ornament. Bragdon sourced this material from his own most comprehensive exposition of the "Fourth Dimension", his 1913 book *Primer of Higher Space*, as well as a number of other publications on the fourth dimension and "magic squares",[52] which varied from strictly mathematical articles to Charles Howard Hinton's *The Fourth Dimension* and texts on mathematical recreations.[53] In his endeavour to translate all this to his Projective Ornament, Bragdon concentrated on a limited number of regular polyhedroids (four-dimensional polytopes) and used a wide range of methods of representation, some of these already introduced in his *Primer* and some first introduced in his *Projective Ornament* (Figure 2).[54]

Although a full exploration of the "Fourth Dimension" of space is beyond the scope of this article, a brief introduction will be presented here. This was a code name used to denote fourth-dimensional geometry, which, in turn, was one version of *n*-dimensional geometry. *N*-dimensional geometry, established for the first time during the second quarter of the nineteenth century, together with Non-Euclidean geometry, first formulated in the 1820s, revolutionised the field of mathematics. These two "New Geometries"[55] were established as coherent

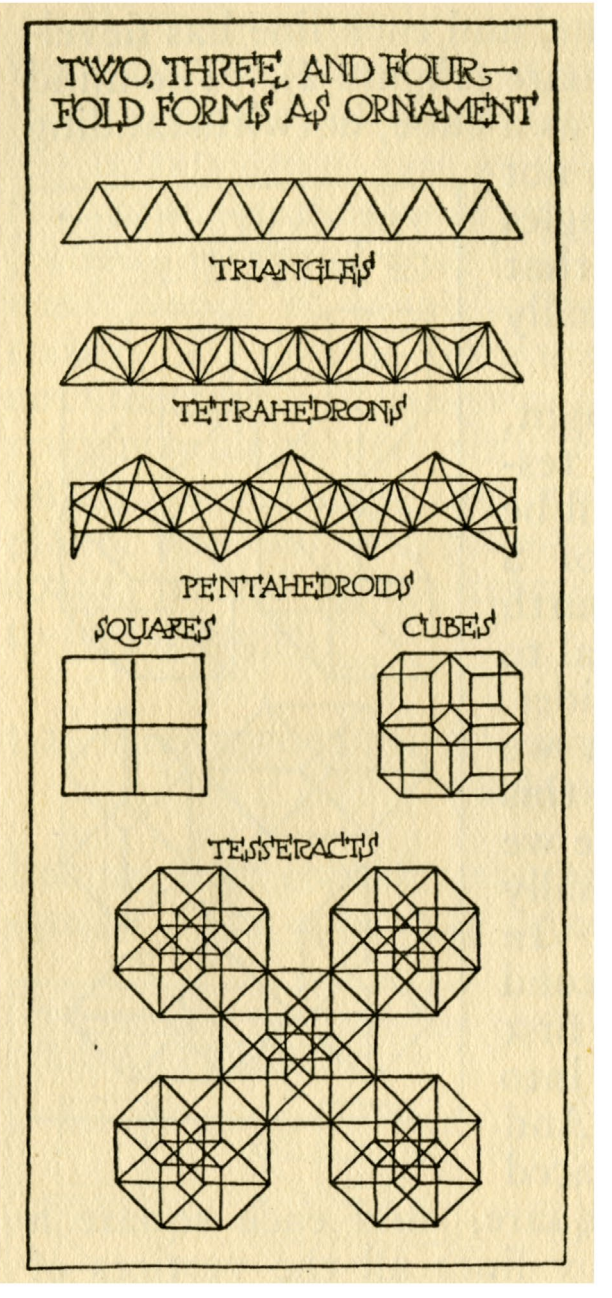

Figure 2. Claude Bragdon, *Projective Ornament*, Rochester, NY: The Manas Press, 1915, p. 20. Courtesy of the Department of Rare Books, Special Collections and Preservation, University of Rochester River Campus Libraries, New York.

geometrical systems after almost two millennia during the course of which Euclidean geometry had been thought to be the only possible geometry. They therefore raised crucial questions concerning the nature of geometrical axioms—which was linked to the possibility of attaining true knowledge—and the nature of space—which in its turn challenged the long-lasting influence of Kant's pronouncement of time and space as our two a priori intuitions—and therefore caused no small intellectual turmoil. Subsequently also associated with mystical ideas and the development of experimental psychology, both New Geometries were to have a widespread effect on the public imagination and artistic production, a phenomenon that has been systematically studied in Henderson's 1983 book.[56]

In his writings, Bragdon engaged with the alternative types of space put forward by the New Geometries, predominantly higher-dimensional and specifically four-dimensional space, but occasionally curved space too. He also explored their implications for our subjective existence and relationship with the external world. Interestingly, although largely overlooked in modern architectural historiography, the concept of a "Fourth Dimension" was widely known among other early twentieth-century artists and architects, as acknowledged by key architectural figures such as Frank Lloyd Wright and Le Corbusier.[57]

Four-dimensional space can be technically considered as part of Bragdon's first reading of space—as extension or dimension. Indeed, this aspect of it directly provided a design tool via graphic representations used as the "raw material" for Projective Ornament. However, "higher space", one of its alternative names as used by Bragdon, was also related to his second interpretation of space and therefore strongly linked to human subjectivity. It was via this second reading that this new type of space offered an opportunity for the expansion of "organicism" to a "higher" level that included attributes and qualities associated with the human.

As Bragdon explained his employment of four-dimensional figures for the generation of his Projective Ornament, he provided a strong statement as regards the symbolic strength of the "Fourth Dimension" and the particular benefit of employing this within ornament. Relating his discussion to his commitment to "meaningful beauty" as expressed in his 1901 article "Mysticism and Architecture",[58] Bragdon stressed that "ornament must not only satisfy the aesthetic sense but it must also be symbolically significant".[59] He proposed as the answer to this riddle the association between ornament and psychology and contended that "the problem may be solved by recourse to the fourth dimension of space". He identified "the fourth dimension of space" with "the rebirth of wonder"—witnessed, as he maintains, in the past few years in science, in philosophy, and in religion[60]—and accordingly pointed to the broad implications of this notion. The "Fourth Dimension" therefore made a markedly original contribution towards a new symbolism that departed from the "organic" level of the "vegetable" or the "animal", or even the human body, to that of the "human" as a more complex entity that comprises "higher functions of consciousness" too. To demonstrate this transition, Bragdon's earlier interest in representations of the human figure will be discussed below.

DIMENSIONAL PROGRESSION AND EVOLUTIONARY HIERARCHY

Bragdon first included the "human figure" in his 1901 "Mysticism and Architecture", alongside "nature", "mathematics", and "music", as the areas whose study could be beneficial to architects interested in participating in the "new movement towards a more sincere architecture".[61] This section expanded to become one of the essays included in all successive published versions of his *Beautiful Necessity* treatise between 1902 and 1909 and, of course, also in his 1910 book, under the title "The Bodily Temple".[62] Indeed, Bragdon's studies of the human figure were laborious and his sources varied from "a curious little book, *The Rosicrucians*, by Hargrave Jennings" to the more architecturally-focused Vitruvius or the more "scientific" *Art Anatomy* by Doctor Rimmer.[63] All of these sources can be traced back to his journals and notebooks of the early 1890s and provided Bragdon with a wealth of diagrams that illustrated the various ways in which the human figure could be analysed by means of numerical ratios, or regular geometrical figures, and therefore serve as a prototype for architectural beauty too (Figures 3 and 4).[64]

Since these early studies focused specifically on the human figure, but not any spiritual or intellectual human attributes, they can still be considered to fall within the broader category of the organic, no higher than the "animal" stage. It is argued here that it was through his employment of fourth-dimensional geometry for his new ornamental mode that Bragdon went on to raise this earlier symbolism of the human figure to a higher level that aimed to express human attributes beyond our bodily existence.

The symbolism of dimensional progressions was extensively discussed in Bragdon's short parable "Man the Square", first published in January 1912. This parable discussed the relationship between two and three dimensions and also adopted a model of geometrical symbolism for his discussion of human traits by means of imaginary two-dimensional beings (Figures 5 and 6). This little pamphlet thus provided a clear exposition of the ways in which Bragdon envisaged the "higher space" hypothesis as offering the possibility of representation of a higher level of human attributes. In the very first page, Bragdon made the basis of his position clear: the title under the illustration at the top of the page[65] read, "Man: A three-dimensional projection of a higher-space unity".[66]

Earlier ideas of dimensional progressions in relation to evolutionary hierarchy first appeared in Bragdon's notebooks of the 1890s. Although these lacked the fourth-dimensional extension that was to be added in later years, it is noteworthy that Bragdon wrote in his notebook on 10 February 1891, just one day before he quoted from Schopenhauer that "architecture is in space alone"—a most critical quote as regards his innovative association between architecture and space:[67]

> Everywhere is progression, that is evolution, the development of manifestation in space and time of that which is inherent. Points generate lines, lines surfaces and surfaces solids. The seed is a point, the stem is a line, the leaf is a surface, the fruit is a solid. In the mineral kingdom lines predominate, in the vegetable, surfaces, in the animal, solids.[68]

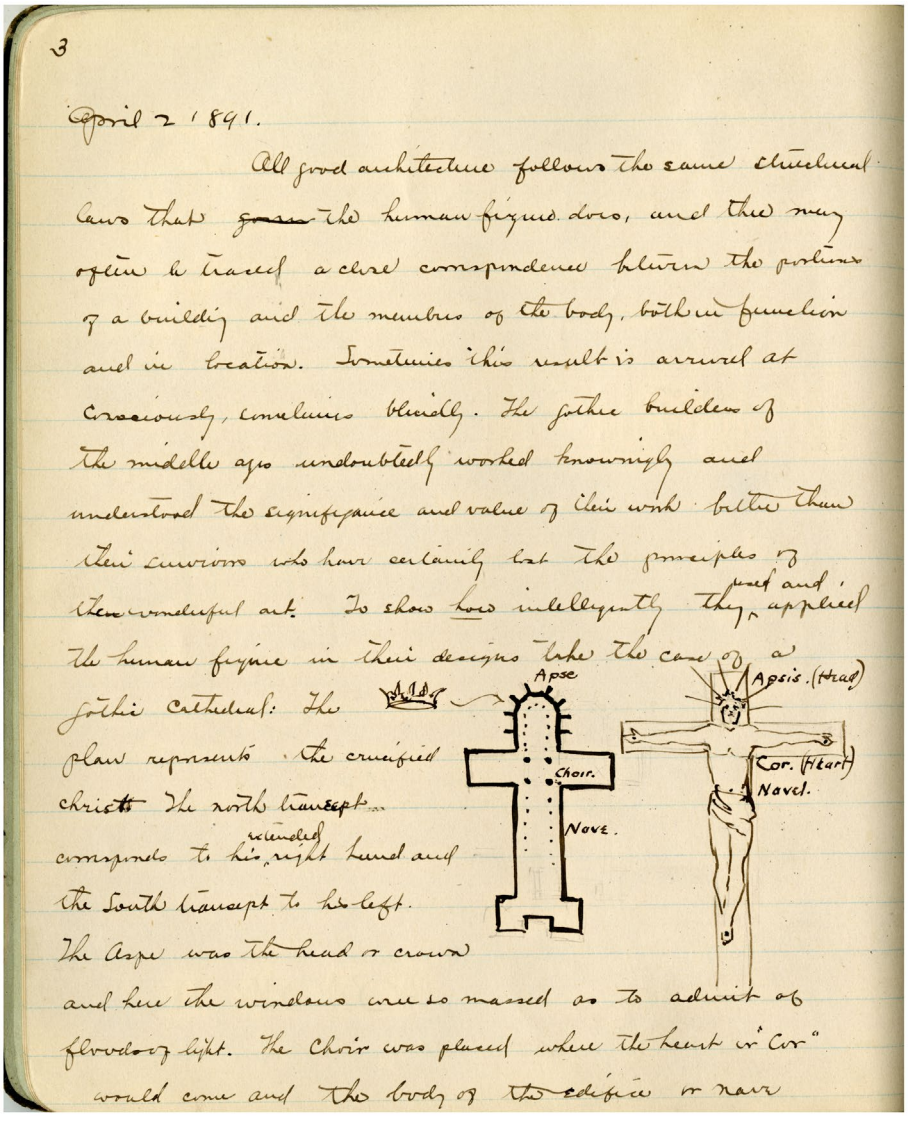

Figure 3. Claude F. Bragdon, "The Bodily Temple" (manuscript excerpt; BFP A.B81, 36:2, 2 April 1891). Courtesy of the Department of Rare Books, Special Collections and Preservation, University of Rochester River Campus Libraries, New York.

Although limited to the first three dimensions (point–line–surface–solid), suggestions as to the potential for an expansion to a higher level were not lacking. References to Theosophical books over this same period included particular mentions of Theosophical ideas such as the "higher plane" of existence, or "higher life", and also discussed the notions of evolution and involution and the role that "mathematics and high mathematics" could play in the past and the future of man.[69]

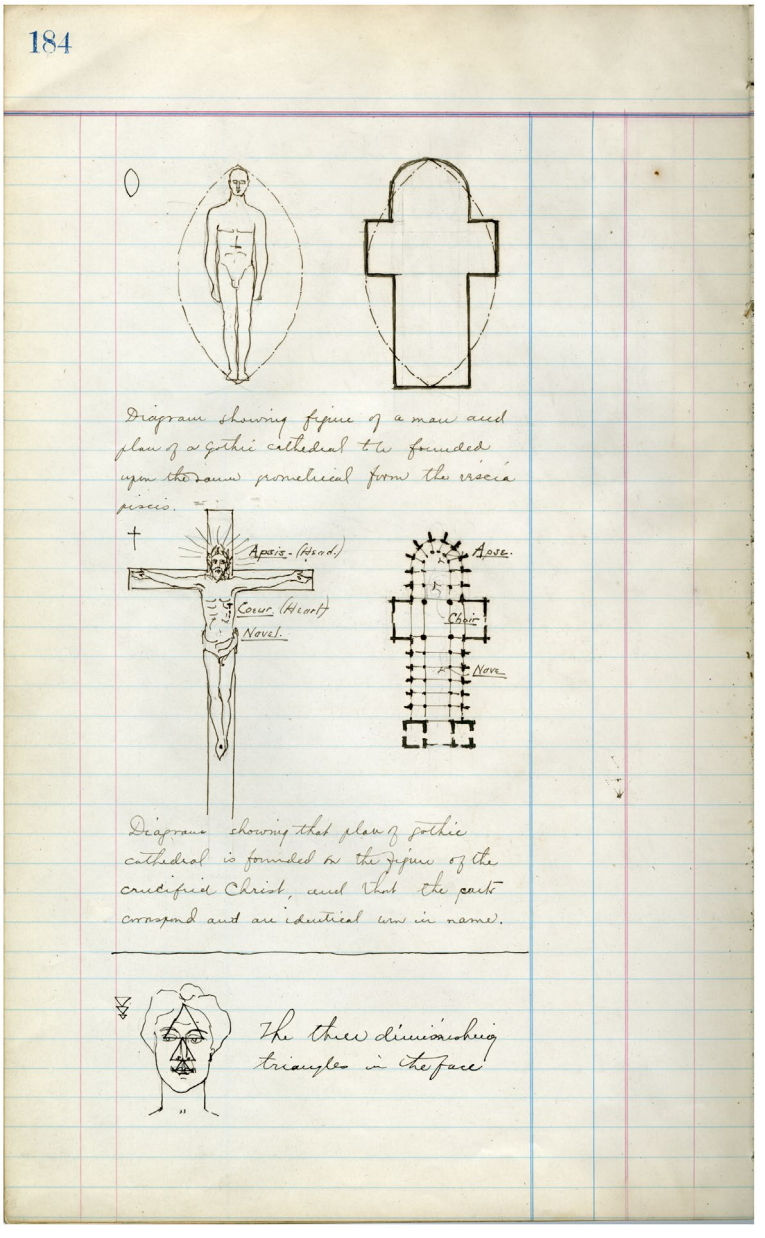

Figure 4. Claude F. Bragdon, "The Bodily Temple" (manuscript excerpt; BFP A.B81, 36:4, p. 184). Courtesy of the Department of Rare Books, Special Collections and Preservation, University of Rochester River Campus Libraries, New York.

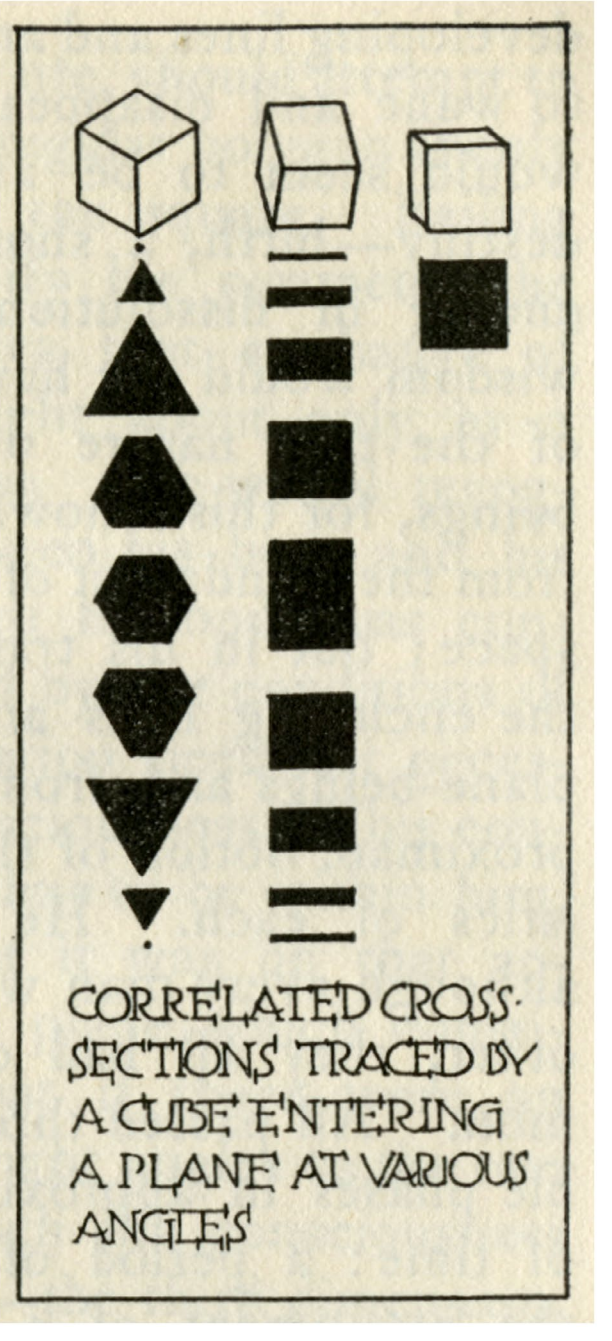

Figure 5. Claude F. Bragdon, *Man the Square: A Higher Space Parable*, Rochester, NY: Manas Press, 1912, Fig. 4. Courtesy of the Department of Rare Books, Special Collections and Preservation, University of Rochester River Campus Libraries, New York.

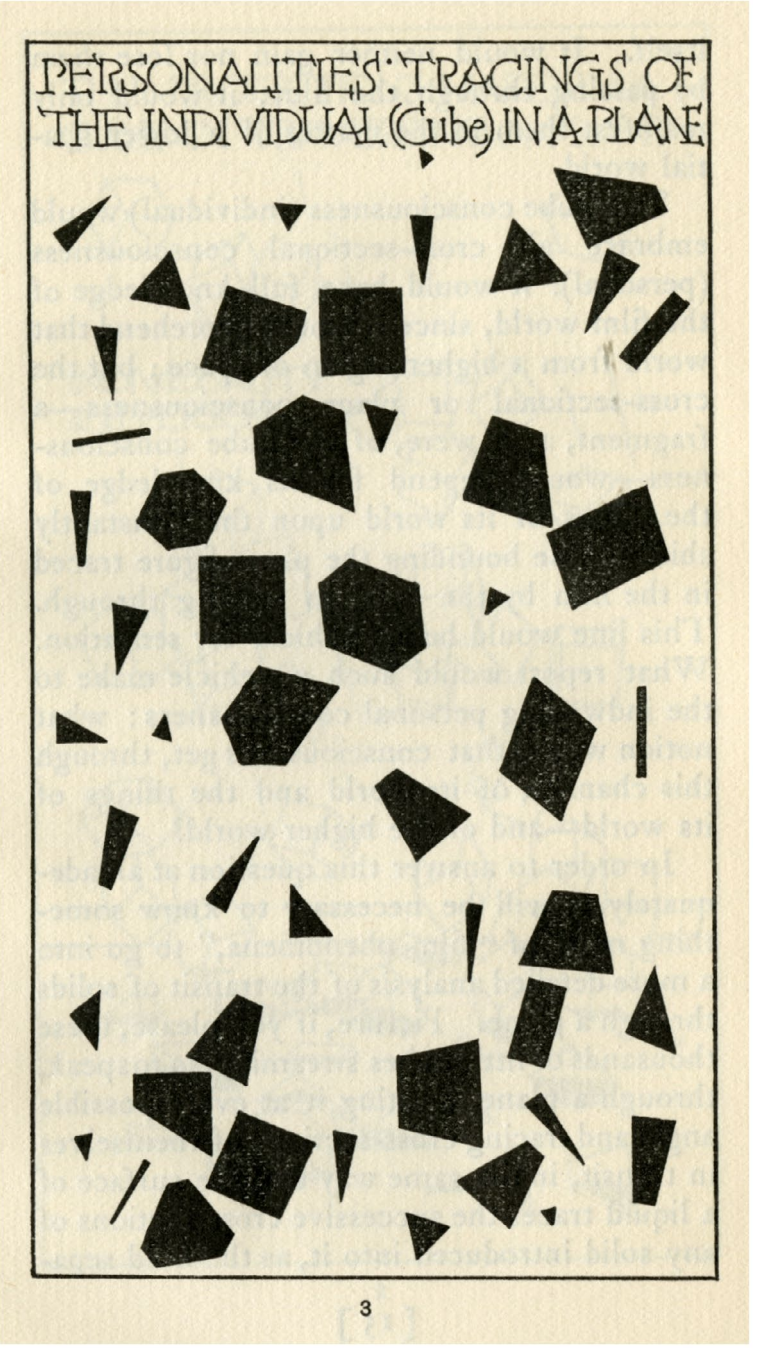

Figure 6. Claude F. Bragdon, *Man the Square: A Higher Space Parable*, Rochester, NY: Manas Press, 1912, Fig. 3. Courtesy of the Department of Rare Books, Special Collections and Preservation, University of Rochester River Campus Libraries, New York.

BRAGDON'S "NEW HUMANISM": "HIGHER SPACE" AND "HIGHER ORGANICISM"

Following these early associations between evolutionary hierarchy and a dimensional ladder, Bragdon's involvement in the "Fourth Dimension" tradition can clearly be seen as a natural development of his thought. From the proportional qualities of the human figure and the evolutionary hierarchy between natural forms, Bragdon's interest broadened to include those "higher regions of thought and feeling which man alone inhabits".[70]

The final part of his discussion in his "Man the Square" made these connections most evident. As Bragdon proceeded to his discussion of the world-Saviour, he signified this higher level of existence by raising his symbol of the square by one dimension to the figure of the cube. By "folding down" this higher-dimensional figure so that this could be perceived in the two-dimensional plane where the square is limited, Bragdon was able to relate this discussion to the symbol of the Cross (Figure 7). This "folding-down" of the cube-Christ, Bragdon argued, represents the incarnation of the saviour.[71] Quoting from what he presented as one of Christos' discourses that were preserved, Bragdon wrote:

> This is my body, broken for you. This cruciform figure formed by these six figures is not my immortal body; the squares are but boundaries of it, folded down into a lower-dimensional world. When my mission is accomplished and I ascend again into heaven, I shall refold these squares into a single symmetrical figure, my heavenly body, a solid of the higher-dimensional space beyond your ken.[72]

Such higher levels of existence, or worlds of different dimensionality, were not considered by Bragdon to be out of reach. Instead, Bragdon understood successive dimensionalities as part of an evolutionary process and adopted the notion of a "threshold of consciousness" from Carl du Prel's *Philosophy of Mysticism*.[73] Du Prel argued that it was such a "threshold" that marked the line at which the distinction between the "real" and the "transcendental" was drawn, but that this line was "movable". Bragdon commented: "if this shifting psycho-physical threshold is simply the dividing line between lower and higher spaces, then the whole evolutionary process consists in the conquest, dimension by dimension, of successive space-worlds".[74]

Continuing from his reference to Du Prel's "psycho-physical threshold" in his *Primer*, Bragdon again discussed the concept of "Evolution" as "Space-Conquest" in his second book on the "Fourth Dimension" *Four-Dimensional Vistas*,[75] first published in 1916. As he wrote that "Evolution is a struggle for and a conquest of space",[76] he extended this "conquest" to all manifestations of life: the birth and growth of organisms; the fight of nations over land; or the measure of individual success by means of the amount of space each commands as part of his property.[77]

Because Bragdon included architecture in humankind's creations, this point attains particular significance. He discussed the creation of architecture as a progression from one to three dimensions and, in this context, saw the tunnel and the skyscraper as the "third-dimensional

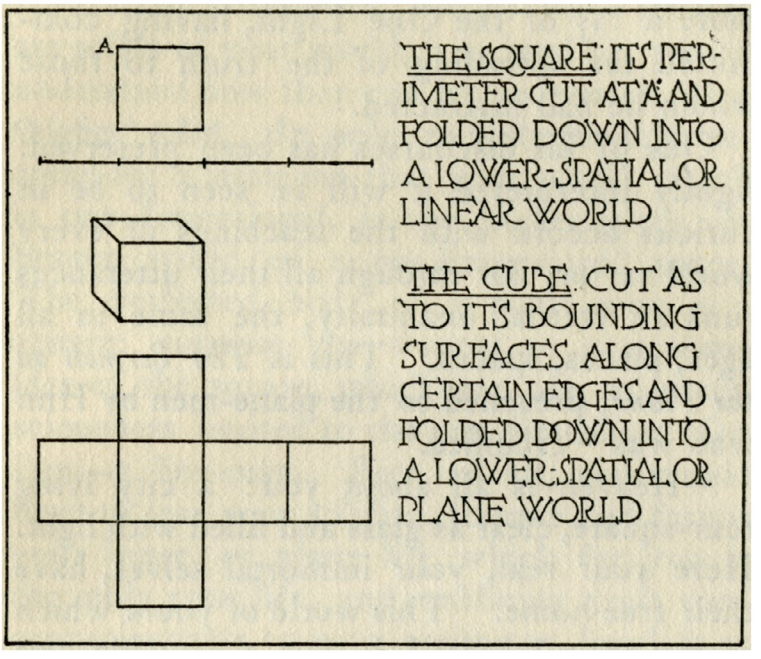

Figure 7. Claude F. Bragdon, *Man the Square: A Higher Space Parable*, Rochester, NY: Manas Press, 1912, Fig. 8. Courtesy of the Department of Rare Books, Special Collections and Preservation, University of Rochester River Campus Libraries, New York.

extension" of this conquest of space. In an interesting way, in these architectural examples, Bragdon did not proceed further than the third dimension. As in all his discussions about dimensional sequence in humankind's creations,[78] he justified this limitation to three dimensions as due to the difference between organisms and artefacts, that is, machines. He contended that man's creations cannot be compared to live organisms—and, in this connection, man's conquest of space by means of his own creations would stop at three dimensions.[79] In this context, it was his adoption of symbolism as a principal element of all his art[80] that allowed him to introduce "higher space" in his "Projective Ornament". Considering this particular approach to Projective Ornament in parallel to his emphasis on the association of ornament with beauty and life, it is argued here that Bragdon put forward a new type of humanist architecture that aimed to express the *higher* beauty of *conscious* life.

Indeed, according to Bragdon, the life principle, that is, the power of growth and renewal, distinguished the "most perfect machine" from the "humblest flower" and, in an analogous way, "the highest product of the vegetable kingdom" is inferior to man, since man "can reflect upon his own and the world's becoming, while the plant can only become".[81] It is precisely on this basis that Bragdon's use of fourth-dimensional geometry as the raw material for his Projective Ornament is interpreted here as "humanism"—or, a higher type of "organicism". This aimed to

represent not merely the human figure, but a more complete "picture" of human nature, including the "higher functions of consciousness—volition, emotion, intellection" that "according to the Higher Space Hypothesis" are "correlated" with "the higher powers of number, and with the corresponding higher developments of space".[82] It is in this same way that they are also the next step in the sequence, "line, surface, solid", which was associated with the mineral, the vegetable, and the animal "kingdoms" in the entry to his 1891 notebook.[83]

CONCLUSION

In his autobiography, Bragdon appears to distance himself from "Humanism", as he notes that, in *The Beautiful Necessity*, he "attempted to show forth a mystical and symbolical content traceable in the architectures of ancient Egypt, Greece, and northern Europe during the two mystical centuries of the Middle Ages, but lost sight of after the rise of Humanism".[84] However, closer study of his work reveals a deep affinity with "subjective" elements associated with the notion of space as well as a keen interest in developments regarding the study of human subjectivity, such as the transition from belief systems and metaphysics to nascent psychological and psychoanalytical explorations.[85]

Despite this apparent contradiction with Bragdon's rejection of Renaissance architecture in his autobiography, the adjective "humanist" is used here to explain a fundamental property of his work that developed from an interest in the human figure as a prototype for beauty to explorations of psychological and spiritual aspects of the human and their symbolic representations in architecture via his Projective Ornament. Although seemingly idiosyncratic, Bragdon's work actually reflects the wider intellectual milieu in which evolutionary theories, the two New Geometries, the composite nature of the notion of space, and psychological and psychoanalytical theories developed.

Considering the limited coverage of Bragdon's work and of "New Geometries" in relation to architecture, further research on the impact that special types of space had on architectural theory and practice is needed. This research is of historic interest, but also remains relevant to cross-disciplinary connections that continue to the present day, such as those between architectural theory and psychoanalytical or neuroscience studies. It can also contribute to critical engagement with contemporary developments regarding the use of electronic media for architectural representations, artificial intelligence, as well as virtual realities that continuously challenge the formal and material means of architectural expression and communication. As a result, thought-provoking ideas discussed by Bragdon resonate with contemporary challenges to proven or time-honoured approaches to architecture. A parallel consideration of Bragdon's work and current experimentation along these lines is therefore invited, as it could enrich the role that architectural theory and practice can play in linking together human and physical environments.

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23. Massey, "Architecture and Involution", 110–118; and Massey, *Crystal and Arabesque*.
24. Malathouni, "Claude Bragdon Reads"; "Architecture is the Pattern"; "Gradations of Consciousness".
25. Malathouni, "Gradations of Consciousness".
26. Ellis, "Squaring the Circle".
27. Malathouni, "Architecture is the Pattern".
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32. For a discussion on all six Scammon lectures presented in 1915, see Ch. 3 in Massey, "Architecture and Involution". More privately, Bragdon had given an interesting account of his plans for more writings to his second wife, Eugenie, in April 1912. (BFP A.B81 27:2, Letter from Claude Fayette Bragdon to Eugenie Macaulay Bragdon, 25 April 1912.)
33. Claude Bragdon, "Organic Architecture", in Ralph Adams Cram, Tomas Hastings and Claude Bragdon, *Six Lectures on Architecture: The Scammon Lectures at The Art Institute of Chicago*, Chicago, IL: University of Chicago Press, 1917, 143; Bragdon, *Secret Springs*, 180.

34. Bragdon, "Organic Architecture", 135–136.
35. Claude Bragdon, "The Language of Form", in Ralph Adams Cram, Tomas Hastings and Claude Bragdon, *Six Lectures on Architecture: The Scammon Lectures at The Art Institute of Chicago*, Chicago, IL: University of Chicago Press, 1917, 145.
36. Bragdon, "Language of Form", 145.
37. Bragdon, "Language of Form", 171.
38. Bragdon, "Mathematics as a Source of Decorative Design", 469.
39. Bragdon noted: "We do not want an ornament which is individual, but one which is universal; not one which has style, but one which *is* a style". Bragdon, "Language of Form", 160.
40. Bragdon, *Projective Ornament*, 3–5.
41. Bragdon, *Secret Springs*, 3; BFP A.B81 Box 33; and Malathouni, "In Search of the Beauty of Conscious Life", 69–72.
42. Horatio Greenough, "American Architecture" (1843), in Harold A. Small (ed.), *Form and Function: Remarks on Art, Design, and Architecture*, Berkeley and Los Angeles: University of California Press, 1958, 51–68.
43. Greenough, "American Architecture", footnote on page 51.
44. David Michael Hertz, *Angels of Reality: Emersonian Unfoldings in Wright, Stevens, and Ives*, Carbondale and Edwardsville: Southern Illinois University Press, 1993, 27.
45. Ralph Waldo Emerson, *The Collected Works of Ralph Waldo Emerson, Vol. VI: The Conduct of Life*, Cambridge, MA, and London, England: The Belknap Press of Harvard University Press, 2003, 196, n. 60.
46. See, for example, Bragdon, *The Beautiful Necessity*, 32.
47. Claude Bragdon and Cleome Carroll, "Art and Industry", *Outlook*, 158 (10 June 1931), 176–178; Claude Bragdon, "And What of Art?", in Part IV of *Where Theosophy and Science Meet*, Madras, India: Adyar Library Association, 1939, 191–192; Bragdon, "Art and the Machine Age", 9–10. See also Bragdon, *Secret Springs*, 168–169.
48. Emphasis in the original. Bragdon, "A New Ornamental Mode", 157; also repeated in Bragdon, "And What of Art?".
49. Claude Bragdon, "Abstract Thoughts on Concrete Bridges", *Architectural Record*, 53, no. 1 (January 1923), 2–10. Most of the discussion in this article is also copied in Bragdon, "Salvaged from Time". See also Bragdon's review of Le Corbusier's *Towards a New Architecture*, included in Bragdon's 1928 article under the same title: Claude Bragdon, "Towards a New Architecture", *The Outlook*, 148 (15 February 1928), 242–246.
50. See Emerson's essay "Beauty" in *The Conduct of Life* (1860, rev. edn 1876).
51. Bragdon, "Problem of Ornament", 320; also *The Frozen Fountain*, 70.
52. Magic squares constitute the second major source of "raw material" for his Projective Ornament. These are squares which contain numbers arranged in equal rows and columns such that the sum of each row, column, and sometimes diagonal is the same (Bragdon, *Projective Ornament*, 47–58).

53. Charles Howard Hinton, *The Fourth Dimension*, London: swan Sonnenschein, (1904) 1906; See "Credits" included in the Foreword of Bragdon's *Projective Ornament*.
54. For example, the method of inscribing regular four-dimensional figures in a hypersphere. See Bragdon, *Projective Ornament*, 26.
55. "'New geometry' is used as a relative term, in that the *n*-dimensional and non-Euclidean geometries, which seemed so novel and modern at the turn of the century, had actually existed since the first half of the nineteenth century"; Henderson, *The Fourth Dimension*, xx, n. 3.
56. Henderson, *The Fourth Dimension*.
57. Frank Lloyd Wright, "In The Cause of Architecture IX: The Terms" (1928), in *Frank Lloyd Wright Collected Writings*, New York: Rizzoli/Scottsdale, AZ: Frank Lloyd Wright Foundation, Vol. I, 1992, 310–316 (first published in *The Architectural Record*, December 1928); and Le Corbusier, "Ineffable Space", in Le Corbusier, *New World of Space*, New York/Boston: Reynal & Hitchcock, The Institute of Contemporary Art, 1948, 7–9.
58. Claude Bragdon, "Mysticism and Architecture", *Interstate Architect and Builder* (13 & 20 July 1901), 10–11, 13–14.
59. Bragdon, "Language of Form", 162.
60. Bragdon, "Language of Form", 162–165.
61. Bragdon, "Mysticism and Architecture", 10.
62. Bragdon, *Beautiful Necessity*, 64–75. Bragdon explained this title by quoting from Carlyle that "there is but one temple in the world, and that is the body of man" and further maintained that "a temple or any architectural art is a larger body which man has created for his uses". Bragdon, *Beautiful Necessity*, 50.
63. William Rimmer, *Art Anatomy*, Boston, MA: Little, Brown, 1877.
64. In addition to the essay "The Bodily Temple" in Bragdon's *Beautiful Necessity*, see his early 1890s notebook in BFP A.B81 36:2 and 36:4.
65. This illustration presents—within a semi-circular frame—a baby crawling; a young, upright standing adult (who looks like an ancient Egyptian); and a hump-backed old man leaning on a walking-stick.
66. Claude Bragdon, *A Primer of Higher Space, The Fourth Dimension* (to which is added *Man the Square, A Higher Space Parable*), London: Andrew Dakers Ltd, (1913) 1939, 63.
67. BFP A.B81 36:1, 11 February 1891; Arthur Schopenhauer, *The World as Will and Idea*, translated from German by R. B. Haldane and J. Kemp, 3 vols, London : Routledge & Kegan Paul, (*c.*1883) 1964, Vol. III, 239. See also Malathouni, "Architecture is the Pattern".
68. BFP A.B81 36:1, 10 February 1891.
69. See reference to G. W. – M. D., *Theosophy and the Higher Life* (London, 1880) (in BFP A.B18, Box 33, 20 March 1890) and notes from Two Chelas in the Theosophical Society, *Man: Fragments of Forgotten History*, London: Reeves & Turner, 1885 (in BFP A.B18, Box 33, 21 March 1890).
70. Bragdon, *Beautiful Necessity*, 49.
71. Bragdon, *Primer of Higher Space*, 75, Fig. 7.
72. Bragdon, *Primer of Higher Space*, 76–77.

73. Carl Du Prel, *The Philosophy of Mysticism*, trans. C. C. Massey, 2 vols, London: G. Redway, 1889.
74. Bragdon, *Primer of Higher Space*, 22–23.
75. Claude Bragdon, *Four-Dimensional Vistas*, 2nd edn, London: G. Routledge & Sons, (1916) 1923.
76. Bragdon, *Four-Dimensional Vistas*, 31.
77. Bragdon, *Four-Dimensional Vistas*, 31–32.
78. Bragdon's examples of dimensional sequences in humankind's creations include: architecture; ship design: points–lines–planes–solids; and books–shelves–racks of shelves–library rooms. Bragdon also writes: "Man has been called the thinking animal. *Space-eater* would be a more appropriate title, since he so dauntlessly and persistently addresses himself to overcoming the limitations of his space"; Bragdon, *Four-Dimensional Vistas*, 33–35, 127.
79. Bragdon, *Four-Dimensional Vistas*, 33–35.
80. For an extensive discussion of the "communicative" role of Bragdon's ornament, see Ch. 3 in Massey, "Architecture and Involution".
81. Bragdon, *Four-Dimensional Vistas*, 35–36.
82. Bragdon, *Four-Dimensional Vistas*, 36.
83. BFP A.B81 36:1, 10 February 1891.
84. Bragdon, *Secret Springs*, 254.
85. Malathouni, "Gradations of Consciousness".

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Article

DRAWING RESEMBLANCE: MINERAL NICKNAMES AND ISOMORPHOLOGY

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This article is about how the practice of drawing resemblances between animal, mineral, and vegetable species has been developed through my own artistic research. It starts from the historical example of mineral nicknames (names attributed to specimens depending on their resemblance to species from other kingdoms—animal and vegetable). I then explain the development of "drawing as a way of knowing" in my own artistic practice through the Isomorphology study. "Isomorphology" is the observational study of the shared forms and symmetries of animal, mineral, and vegetable species. It is a drawing practice that includes a set of experimental approaches such as interdisciplinary collaboration with scientists and museum collection study. This mixed method approach is conducted within the context of scientific institutions like the natural history museum, London. This research explores how the shared morphological characteristics (form and symmetry) of animal, mineral, and vegetable species can be identified and represented through the process and object of drawing towards an extra-scientific model of classification.

Keywords: Art; classification; drawing; epistemology; morphology; science
Article History: Received 3 December 2015; accepted 29 March 2016

INTRODUCTION

The concept of "resemblance" and efforts to represent visual connections between otherwise disparate objects have been consistent features of my drawing practice since my early years as a student.

In 2011, while researching in the catalogues of the Rashleigh Mineral Collection at the Courtney Library (Royal Cornwall Museum), Truro, I discovered a curious blend of poetic creation and scientific fact: a number of mineral specimens with nicknames given by Cornish miners based on their resemblance to other natural objects. These minerals and their nicknames became, for me, a means to explore the practice of "drawing resemblance" and a way to think about extra-scientific systems of classification.

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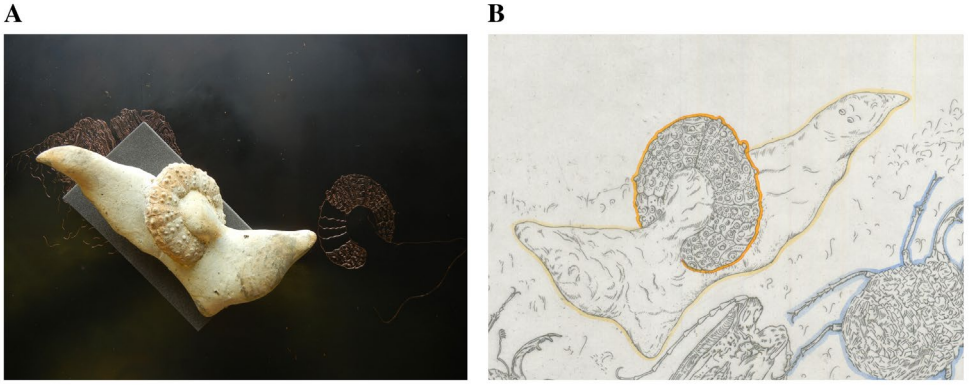

Figure 1. A. Flint specimen, 'Mollusc ore' (Rashleigh Mineral Collection, Truro Museum). Photograph: Gemma Anderson, 2012. B. Flint specimen, 'Mollusc ore', (Rashleigh Mineral Collection, Truro Museum). Copper etching and Japanese inks: Gemma Anderson, 2012.

Along these lines, Philip Rashleigh (1725–1811) collected Cornish minerals throughout his life. His collection, housed at the Royal Cornwall Museum, is known for the outstanding quality of the specimens and for Rashleigh's system of cataloguing. In October 2011, I visited the Courtney Library at the Royal Cornwall Museum to consult Rashleigh's mineral catalogue.[1]

Many of the minerals recorded were found in the depths of mines like Wheal Gunner and Wheal Towan (Cornwall, UK). Since many of these minerals had not been observed or recorded before in Cornwall, the association of the mineral forms to familiar objects through nicknaming served as a useful mnemonic device. Frequently, the descriptions in the Rashleigh catalogues use the term "resemblance": for example, the miners named a cassiterite specimen "wood tin" (Figure 1A), which was then described as "wood like tin ore, with fibrous or radiated texture, forming concentric circles like wood, resembling the colour and appearance of wood cut from a knotted tree".[2] Drawing on their own observations of the natural world, the miners projected familiar associations of physical form onto the unfamiliar minerals.

Based on the archival material surveyed as part of this research, I have created this list as a classification of all the specimens held within the Rashleigh Collection that have been given nicknames (Table 1).

In the process of this research, I met Courtenay Smale, a Cornish mineralogist who has studied the Rashleigh Collection. The imaginative nicknames the miners gave to the minerals inspired us to create our own nicknames for other mineral specimens in the collection. For example, I named a flint specimen (Figure 1A and B) "Mollusc ore". I also discovered that iron ore was much more wood-like than cassiterite and gave the nickname "wood knot ore" to the specimen (Figures 2A and 2B); further, Courtenay named a chalcedony specimen "griffin ore" (Figures 3A and 3B). This new tranche of nicknames combine with the old to inspire my own contemporary and visual taxonomy.

Table 1. Nicknames for minerals in the Rashleigh Collection.

Beetle ore	clinoclase
Blister copper	copper
Brick (tile) ore	cuprite
Cog-wheel ore	bournonite
Cube ore	pharmacosiderite
Goose-dung ore	ganomatite
Horn silver	chlorargyrite
Horseflesh ore	bornite
Horsetooth ore	siderite
Jack straw crystals	cerussite
Peacock copper	bornite
Ruby copper	cuprite
Sparable tin	cassiterite
Toads eye tin	cassiterite
Wood copper	olivenite
Wood tin	cassiterite

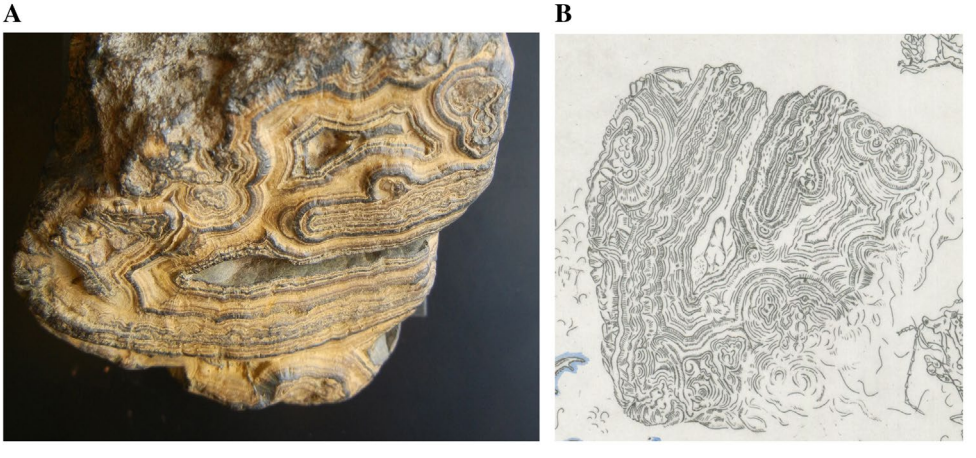

Figure 2. A. Wood specimen (Kew Gardens, Bark Collection). Photograph: Gemma Anderson, 2012. B. Wood tin specimen (Rashleigh Mineral Collection, Truro Museum). Copper etching and Japanese inks: Gemma Anderson, 2012.

I decided to explore the mineral specimens through drawing, focusing on the resemblances the miners and I have recorded as an ordering principle and basis for constructing an artwork. The artwork was developed through visualising each mineral within an imagined landscape as the object that it is said to resemble. For example, I drew rose ore in the theoretical position of a rose, and the mollusc ore was drawn as an animal beside the rose ore flora. In the etching "Rashleigh Mineral Nicknames" (Figure 4), specimens are drawn and composed on the basis of their resemblances; each specimen poses as the object it resembles, and the mineral origin of the specimen may not be perceived by the viewer. The etching indicates that, together, the minerals form a landscape of resemblance.

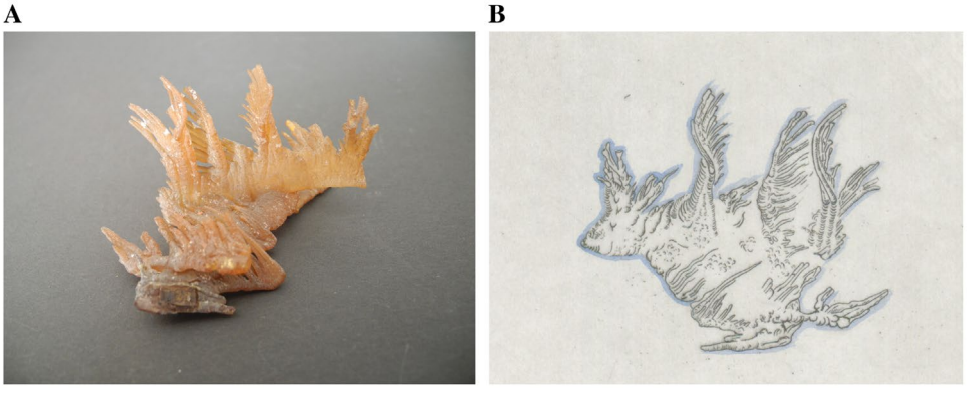

Figure 3. A. Chalcedony 'Griffin ore' (Castle Caerhays Mineral Collection). Photograph: Gemma Anderson, 2012. B. Chalcedony 'Griffin ore' (Castle Caerhays Mineral Collection). Copper etching and Japanese inks: Gemma Anderson, 2012.

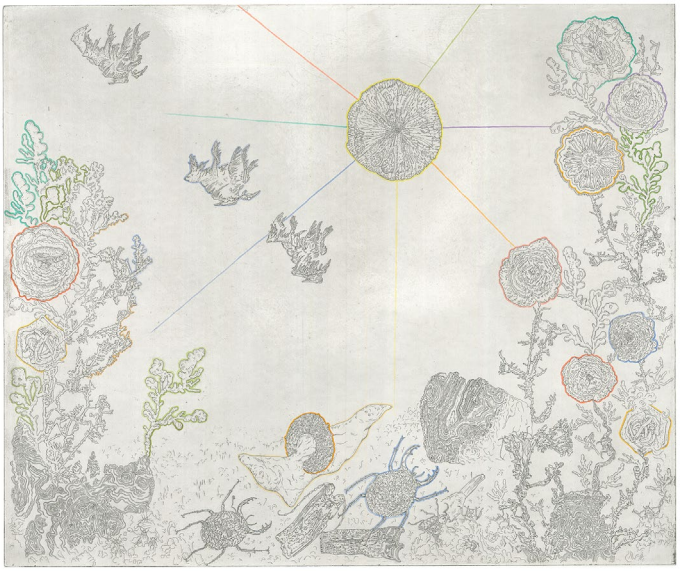

Figure 4. Rashleigh mineral nicknames (drawn from Rashleigh Mineral Collection, Truro Museum, and Castle Caerhays Mineral Collection). Copper etching and Japanese inks: Gemma Anderson, 2012.

Visual resemblance organises the relationships between the nicknamed mineral specimens in the Rashleigh Collection and their corresponding objects. Drawing can make resemblance visible through the extraction of the structure underlying the resemblance, which enables the form of the mineral to be exchanged with the animal or vegetable in the image space.

ISOMORPHOLOGY

Following on from this thread, the "Isomorphology" project involves observational drawing of resemblances between animal, vegetable, and mineral specimens. It has developed through engagement with scientific institutions and the direct observation of specimens held in scientific collections (The Natural History Museum, London [NHM], Kew Gardens, and The Grant Museum, University College London). As in the natural sciences, in this project, systems of classification are intended to organise information (biological, mineral, or animal) and to facilitate the recording and communication of this information. This artistic enquiry into morphological resemblance has uncovered an alternative, "extra-scientific" method of classification—stimulated both by the practice of drawing specimens and by literature that explores the philosophy of classification and the possibilities for alternatives to the standard Linnaean system.[3]

As my own observations of resemblances between animal, mineral, and vegetable morphologies of field and museum specimens accumulated, I began to imagine a visual scheme which extended to include animal, mineral, and vegetable forms. In order to establish if others had created documents which included images of resemblances between the animal, mineral, and vegetable orders, I began a search through contemporary and historical literature. This search found studies of "patterns in nature", which were mainly explored through photography rather than drawing, and the only example that addressed specific cross-kingdom resemblances between the animal, the vegetable, and the mineral was Antonio Lima-de-Faria's *Evolution without Selection*.[4] Lima-de-Faria's text applies twentieth-century knowledge of chemistry and physics to the study of the microstructure of nature and reveals that disparate classes of organic and inorganic matter were found to share important structural qualities. *Evolution without Selection* compiles images found in scientific texts that document the morphological similarities, which Lima-de-Faria calls "isomorphisms", between organic and inorganic life forms.

RESEMBLANCE AS A BASIS FOR CLASSIFICATION

Classifying organisms into non-overlapping kinds or species on the basis of morphological properties is thought to date back to Aristotle[5] and can be traced through works like *Phytognomica*[6] and *Evolution without Selection*. To give a philosophical context for the development of my own contemporary alternative or "extra-scientific" approach to classification, I draw on the work of the philosopher of biology, John Dupré.

Dupré, in *The Disorder of Things*, argues for a pluralistic approach to biological classification. He offers a philosophical justification for developing many classificatory systems, saying "there are countless legitimate, objectively grounded ways of classifying objects in the world and these may cross classify one another in indefinitely complex ways". He suggests ways of discovering alternative classificatory forms that can also be pluralistic, and argues that these may be "real" so long as they are based on objective properties of the objects of study.[7] This work centres upon specimens that have visible "objective" resemblances to one another, but does so through an artistic practice which also allows the imagination to enter the process of representation.

AN ALTERNATIVE APPROACH TO CLASSIFICATION: ISOMORPHOLOGY

Dupré's concept of classificatory pluralism establishes that there are many properties that classifications can be based on and implies that no single system of classification is unquestionably most useful. He also says, "Classifications, must, in some sense, be discovered rather than merely invented".[8] This is reflected in the array of priorities adopted by the various approaches of different epochs. As already discussed, I have realised through my own extensive drawing experience that behind observed resemblances are various "types" or "properties" of form and symmetry. I began with an intuitive group of form species (Figure 5), which provided a basis for "Isomorphology"—a neologism I have coined for a practice I define as "the study of the shared forms and symmetries of animal, mineral and vegetable species through drawing practice".[9]

> "Isomorphology", from Greek: *isos* | "same/equal", *morphe* | "form", *logos* | "study".

Isomorphology proposes visual "form species" which set priority on form and symmetry. These two properties turn standard classification on its head to show that there are alternative ways to classify natural life across kingdoms. As such, Isomorphology is in line with Dupré's pluralistic view.

The form species of Isomorphology draw connections between species that, according to the current Linnaean system, are unrelated. However, Isomorphology appropriates a base from the Linnaean system and simultaneously rejects and depends on both the Linnaean system and the museum curatorial system, which, although imperfect, provide an organisation of the natural world. Without taking advantage of these prior systems of collection and classification, such disorder would reign that any attempt at navigation would be impossible. Isomorphology is therefore an innovative and complementary approach, one that intends to blur normative animal, vegetable, and mineral boundaries.

The Isomorphology study—a project aiming to create a series of artworks that draw together specimens of each form species—began by visually listing a two-dimensional "bauplan" for each of the form species, informed by the images in *Evolution without Selection* and *Phytognomica*. Using these sources and my own observational drawings as a starting point, I compiled a list of specimens held within the NHM collections which relate to the form species of Isomorphology. This provided enough information to approach the NHM for permission to access its research collections. Of particular importance were the images in *Evolution without Selection* that pertain to Isomorphology's form species, as, for example, hexagonal patterns in body formation of mineral, animal (vertebrate and invertebrate), plant, and five-fold symmetry, ramified patterns in the body formation of molecules; protozoa vertebrate and invertebrate bodies; and leaf patterns (bilateral symmetry) in animal, mineral, and vegetable species.

These initial lists, which collected many more species names than could be drawn, operated as a flexible way to navigate the morphology of animal, mineral, and vegetable specimens within collections. This navigation aimed to select specimens to draw based on the criteria

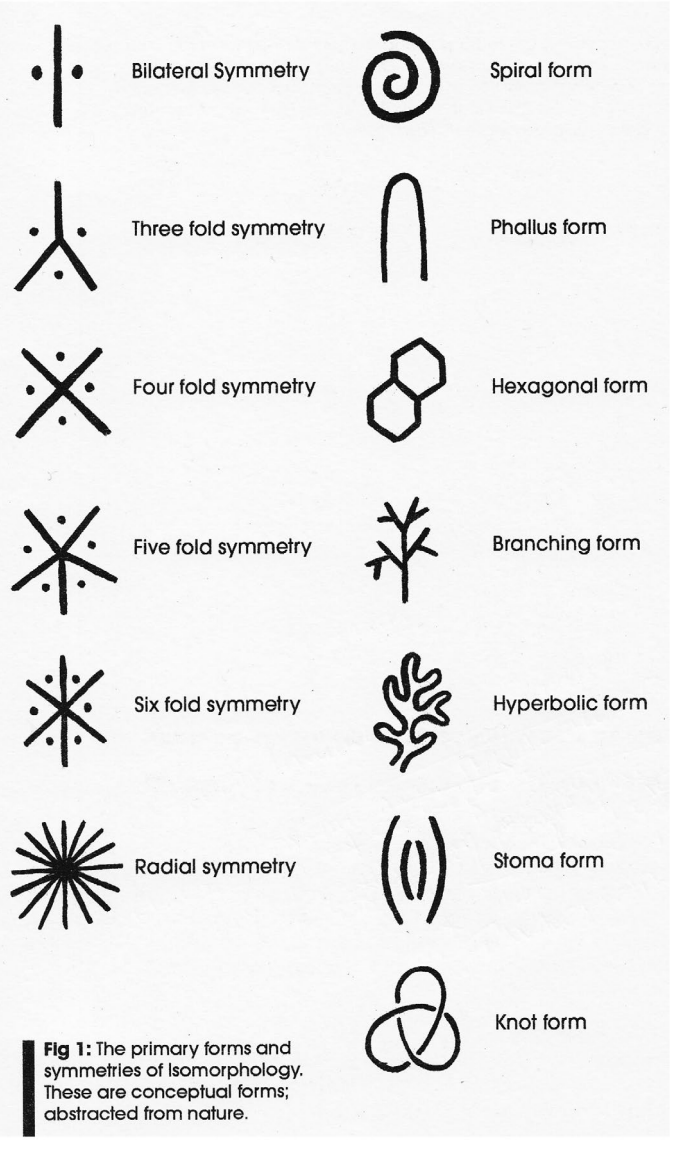

Figure 5. Visual list of forms and symmetries of Isomorphology. (Gemma Anderson, *Isomorphology: An Introduction*, London: Super/Collider, 2013, 5.

of resemblance to the form species of Isomorphology. The next stage utilised these lists as a guide to "screen" hundreds of specimens with curators in the zoology, mineralogy, and botany collections at the NHM. As this work entailed the observation of specimens, it was necessary to obtain permission to observe and to draw, a process which I coordinated on each occasion. Access to many specimens, especially valuable minerals in the NHM collections, is limited, and

Figure 6. View of designated bench space and specimens for Isomorphology study in the Sackler Lab, Darwin Centre, The Natural History Museum. Photograph: Gemma Anderson, 2013.

Figure 7. Copper etching plate of radial symmetry in progress. Photograph: Gemma Anderson, 2012.

Figure 8. Radial symmetry (drawn from The Natural History Museum collection). Copper etching and Japanese inks: Gemma Anderson, 2012.

one further benefit of this study is that the Isomorphology artworks offer an alternative mode of display and means of making these collections visible (Figures 6–10).

REFLECTION ON THE DIFFERENCE BETWEEN BIOLOGICAL TAXONOMY AND ISOMORPHOLOGY

The biological "type" method assigns the label of a "type" to a particular individual which then becomes the reference point for that species. In the biological sciences, the type must be given a name which follows the guidelines established in the 1930s in Cambridge (as a compromise between America and Europe to find a common language). The type is designated a posteriori after empirical research and observations of many individuals within this species (or whatever is available). The Isomorphology study does not employ the type method—I have not selected a specimen as a singular example of any particular form species and, most importantly, I do not give a name to any specimen. The blurring of the categories of animal, mineral, and vegetable

Figure 9. Bilateral symmetry (drawn from The Natural History Museum collection). Copper etching and Japanese inks: Gemma Anderson, 2012.

indicates the potential of artistic practice to act as a mirror to scientific practice, reflecting the unique values of both.

ISOMORPHOLOGY AS AN EXTRA-SCIENTIFIC WAY OF KNOWING

Isomorphology is intended to produce findings that will create a dialogue with conventional modes of scientific knowing. Classifying, understood by Dupré as "imposing conceptual order on diverse phenomena",[10] aligns with the aims of Isomorphology. Isomorphology parallels the scientific practice of taxonomy as a comparative, drawing-based method of enquiry into the shared forms of animal, mineral, and vegetable morphologies to find similarities, not differences. Unlike scientific taxonomy, Isomorphology is not seeking to establish a stabilised order. Here, there are two different "orders" at stake: the stability of the taxonomic account and the natural order itself. The first is constructed and the second is a kind of chaos that invites attempts at classification. Isomorphology provides one of many ways to navigate morphological diversity. As

Figure 10. Four-fold symmetry (drawn from The Natural History Museum collection). Copper etching and Japanese inks: Gemma Anderson, 2012.

it has no commitment to any unifactoral evaluation of phenomena, Isomorphology is not reductionist in approach. These similarities and differences make Isomorphology complementary to scientific classification. Isomorphology addresses relationships that are potentially undervalued by the scientific classification of animal, vegetable, and mineral morphologies and suggests that there are many possible ways to explore and organise the natural world.

Isomorphology is not a static system, it is always an evolving practice and a process. Isomorphology is a concept that depends on the purpose of the moment for which it is intended: to navigate, to observe, to draw, and to know the natural world. It is therefore a blending of scientific and artistic experimentation which brings with it new modes of seeing and classifying the natural world. By placing the making of observational drawings at the foundation of this artistic experimentation, Isomorphology demonstrates drawing's continued viability as an epistemic process and as a way of producing knowledge.

ON THE IMPACT OF ISOMORPHOLOGY

Isomorphology is a practice and theoretical framework that has been shaped by my engagement with a number of scientific institutions and practitioners and by my investigations into the history and philosophy of scientific knowledge. This artistic research can be understood as a practice that engages with scientific practice and institutions, and therefore as a strand of the current "Art/Science" field. Isomorphology depends on its tools and unique conceptual model and is consistent with what Brett Wilson describes as typical of the Art/Science process, which "may not simply be a question of looking for information in a different place (or time) with different detectors, but of learning to see in a different way by creating new conceptual models".[11]

Isomorphology "physically" brings specimens into relation to each other in an "extra-scientific" way. The order that Isomorphology creates does not otherwise exist in the museum. Gathering scientific specimens, in the name of art, is a necessary part of the observational drawing process. Thus, the request to "draw" rather than observe specimens validates a temporary disorder of and intervention in the museum system, which lasts only as long as the drawing process, after which only the drawn record of this active disorder remains. This creates a non-trivial intervention on the existing taxonomic model of the museum. The temporary display of specimens in my work space at the NHM, curated by an extra-scientific interest, generated interest from the scientists who called in or passed by, each time providing an opportunity for sharing ideas and questions.

Schiller once remarked that Goethe's interest in science was contagious.[12] I have sometimes felt that the study of Isomorphology has been "contagious" in the context of the Natural History Museum, as the nature of the study required scientists to re-order their materials in a new workspace and with new working groups. NHM staff have often offered me their personal reflections on how exposure to the Isomorphology study has influenced the way they conceive of their collections and has prompted them to their own "extra-scientific" questions.

CONCLUSION

Isomorphology relates to the work of other artists whose practice engages directly with science and systems of taxonomy, for example Mark Dion, but while Dion's work focuses on critiquing scientific method, or making art works that invite audiences to think differently about the world of science, Isomorphology is distinctive in its use of drawing as the primary means of observing morphology, which then leads to a novel drawn taxonomy. Isomorphology also builds on Goethe's morphology by establishing and visualising a set of form species, or *Ur* forms, and symmetries which can be observed in animal, mineral, and vegetable species. Although Goethe was open to comparing animal, mineral, and vegetable morphology, his morphology did not aim to construct a system for the natural world; rather, Goethe describes any "system of nature" as a contradiction in terms:

> Nature has no system; it has life, it is life and succession, life and transformations of form from an unknown centre to an unknowable circumference. The observation of nature is therefore endless, whether one wishes to investigate an isolated part or whether one wishes to pursue the traces in all directions.[13]

Isomorphology has focused on developing a cross-disciplinary or "extra-scientific" tool which can sit between disciplines. To practise Isomorphology is to play a game of observation; the aim is to derive understanding from direct experience. Training the eye to perceive abstractly and the mind to think creatively with a simultaneous and strong connection to the individual specimen is a complex practice. I believe this understanding can be shared with others as a playful educational model, one that engages science whilst allowing an altered perspective. Isomorphology places emphasis on questioning as a means to liberate form from the confines of the (scientific) conventions of animal, mineral, and vegetable. Isomorphology encourages both learning and "unlearning"; we are de-constructing inherited taxonomies in order to create new knowledge and new approaches.

While connected to and derived from the observable, Isomorphology functions as a symbolic system and a mode of abstraction. It is an epistemological approach that is coexistent with other epistemological approaches to classification. The Isomorphology study offers a relation between form and classification that is visual and developed in its process of abstracting from nature. The method has been shown to develop understanding about the importance of drawing in the identification of morphological features and in relation to classification.

> Though you hide yourself in a thousand forms
> yet most beloved, at once I recognise you;
> though you cover yourself in a thousand magic veils,
> yet, ever present, at once I recognise you.[14]

Goethe wrote this poem to express his experience of the *Urpflanze*. The practice of Isomorphology enriches the potential observation of nature's forms. As I walk through landscapes, Isomorphology has helped me to read nature's forms: spirals, hexagons, and symmetries which emerge amongst numerous plant forms in an experience which reminds me of Goethe's own reflections: "I cannot tell you how readable the book of nature is becoming for me; my long efforts at deciphering, letter by letter, have helped me; now all of a sudden it is having its effect, and my quiet joy is inexpressible".[15]

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Coral|Colony—from Singularities of Mathematical Code to Relational Networks

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Article

CORAL|COLONY—FROM SINGULARITIES OF MATHEMATICAL CODE TO RELATIONAL NETWORKS

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Coral|Colony discusses ongoing research that investigates a language shared between the fields of biology, mathematics, behavioural studies, interaction design, and architecture. It creatively deploys and explores such language by proceeding through series of speculative design research that rework natural paradigms. A collection of marine specimens (corals, shells) are here deployed as design models for a range of studies driven by computational media and design processes. Natural precedents thus become prototypes produced through digital fabrication; these are assembled in interactive and responsive set-ups, and performed and experienced as spatial installations. From a study of form and type in the natural precedents, the research expands this towards templates, codes, and systems for design applications that focus on processes and protocols of ongoing change. By exploring the way in which code becomes matter and coded matter parallels natural behaviour, this research project contributes to an interdisciplinary discourse whereby mathematical principles as found in natural form/formation are explored for their potential to encourage and trace sensory, emotional, and experiential engagement. In doing so, this project addresses contemporary architectural design, moving current applications of code towards modes of engagement and experience.

Keywords: Biological precedents; code; computational design; coral; design research; generative design

Article History: Received 31 January 2016; accepted 29 March 2016

INTRODUCTION: NATURAL FORCES, CONDITIONS, CODES

Nature, one might argue, is a laboratory filled with infinite and unique forms, variations of shape, and manifold phenomena and processes. This has long been a field for scientific observation and analysis, with precedents collected in archives of natural science museums that have inspired artists, architects, and designers (Figure 1). Its solutions are seemingly limitless in complex affordances of and relations between form, material, and structure, in relational networks and organisation, and in interactive behaviour. In nature, unique variations develop based on rules, and as a specific response of a species. Similar principles can be found in the way in which structures and relationships are constituted, information is processed, and matter and behaviour are

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Figure 1. "Coral|Colonies" ("Future Nature", 2015), exhibition table modelled after natural science museum displays, exerts of shell specimens and prototypes, sider mechanism, moulds, and slip-cast corals, working models for interlocking domes. Photographs: Vincent Buret.

organised. In nature, mathematical instructions exist for the solution of affordances—a logic of code that is universal in principle, and spelled out as individual form or formation, with a continuity of appearance in members of the same species (Figure 2).

Yet, in nature, forms are temporal expressions of mathematical codes; they are states shaped by forces that act upon them. Formal "solutions" follow: firstly, intrinsic forces—the geometrical, inherent logical or system-immanent forces that put the building plan into effect. They are also, secondly, conditional to extrinsic forces outside the system itself—to the particular context to which the organism adapts. In both, changes to the system are incorporated by way of changes to the coding sequence. As D'Arcy Thompson argued, "the form of an object is a diagram of forces; in this sense, at least, that from it we can judge of or deduce the forces that are acting or have acted upon it; in this strict and particular sense, it is a diagram".[1] Similarly, Greg Lynn describes form as "within a current of forces that can be stored as information in the shape of form".[2] Thus, forces represent complex diagrams of codes that accommodate multiple and ongoing impacts, mergers between ideal states, and local interventions that may have an effect on extended fields or even on the entire structure. Furthermore, nature's solutions develop as life-forms adapt to environments over generations and continuously in time, evolving new characteristics and new species that are able to occupy a niche.

As Peter Pearce states, "in nature, protocols of minimum inventory enable systems with maximum diversity".[3] This is significant because, in other words, diversity can be achieved through protocols that continue based on sequences of universal, mathematical code. This code

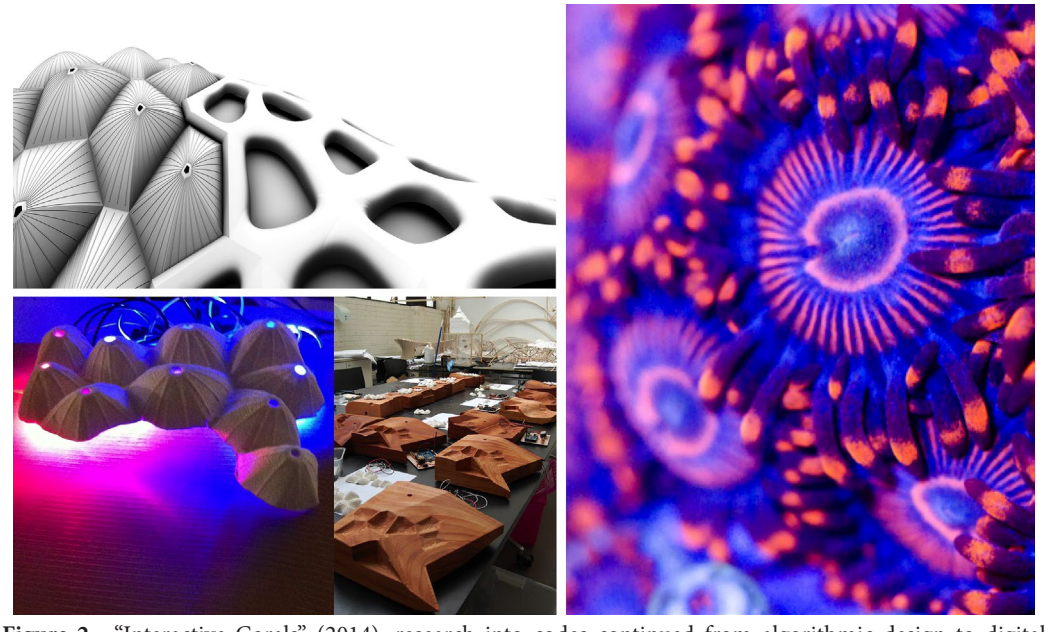

Figure 2. "Interactive Corals" (2014), research into codes continued from algorithmic design to digital fabrication and interactive animation.

must be relatively simple, widely available, individually transferable to matter formation, and adaptable to changes prompted by shifts in forces and conditions. Within combinatorial limits, the formative logic of processes leads to similar instructions for base plans and morphologies across a wide and diverse range of species in different settings. As a consequence, both diversity and similarity in patterns and formations can be traced within a species, as Thompson demonstrated in his "Method of Coordinates".[4] Moreover, commonalities between animal and animal, or even animal and vegetable, can appear; dynamic solutions based on similarities of code are then differentiated as species-specific base plans and characters (Figure 3).

Yet, code and consequential form cannot be divorced from material or structure; on the contrary, they are interrelated. Peter Pearce notes that "forms in nature are always generated by structures in nature".[5] Janine Benyus further states that "in nature, shape variations develop as more easily accessible, evolutionary solutions to 'material' affordances".[6] While in biological processes, formal differences and complexity are relatively variable through mathematical code, material distribution comes at the cost of being an integrated part of the organism. And nature produces forms in a wide range of materials, depending on the species. This stands, or rather has stood for centuries, in contrast to architectural or design practice, where raw material is affordable, but form is expensive due to skill and labour.[7] Specifically, complex geometries in architecture require systems for the organisation of surfaces, components, formwork, or multiple connections. To this end, solutions developed in nature can become a springboard for architectural practice: mathematical codes derived from natural precedents can be deployed as material or

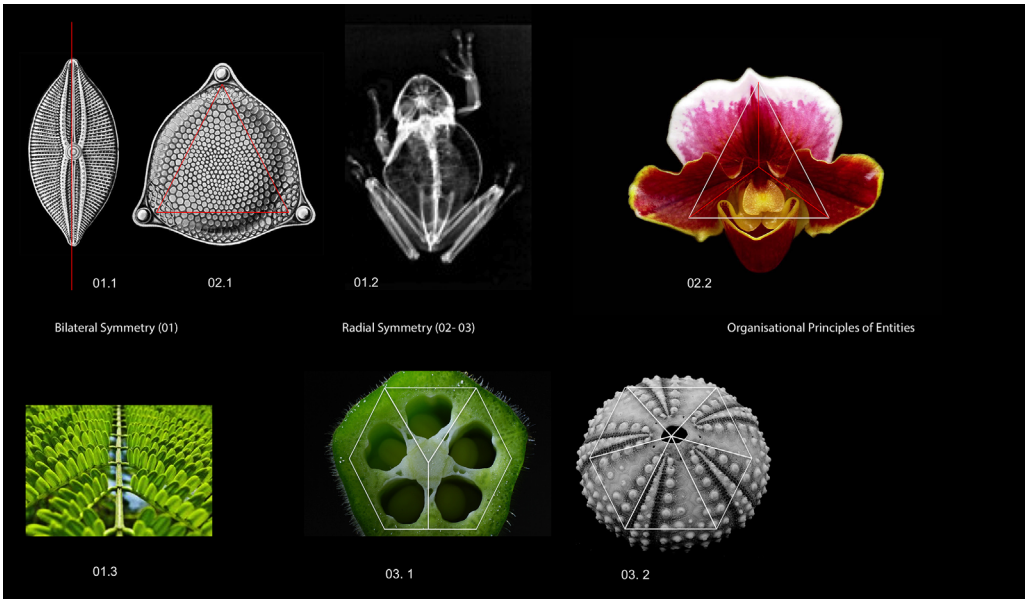

Figure 3. Shared generic base plans in animals and plans: bilateral and axial symmetries.

structural approaches for generating parts, sequences, and modules of construction, facades, or organisation in architectural design—and can be adapted to changes of the system due to design alterations, or economic or construction requirements.

Consequently, codes are significant in the translation of natural precedents. Codes exist as universal, mathematical, and geometrical principles. These can, within given combinatorial limits, be reviewed individually and expressed as singular forms or multiples. Forms are translatable to structures within material affordances. Formal variations can adapt to context and site conditions and, furthermore, interact within time as sequences, evolving into variations of species or new branches that constitute new species/approaches.

ARCHITECTURAL APPLICATIONS—CHANGING MORPHOLOGIES THROUGH GENERATIVE DESIGN

Biology as a discipline of science seeks principles of order by researching phenomena of the natural world through observation, measurement, analysis, and categorisation; this raw material may be deployed as an instruction manual in a design context. Consequently, biological shape precedents, systems of natural growth and formation, adaptations to shifts and changes in conditions have been embedded in the architectural discourse. Adopted in a contemporary context of computational design, these processes gain relevance as this field primarily works through code (Figure 4). Coding approaches inform modes of expression, interactivity, and experience; create links that may be shared with other related disciplines such as interaction design, music, and

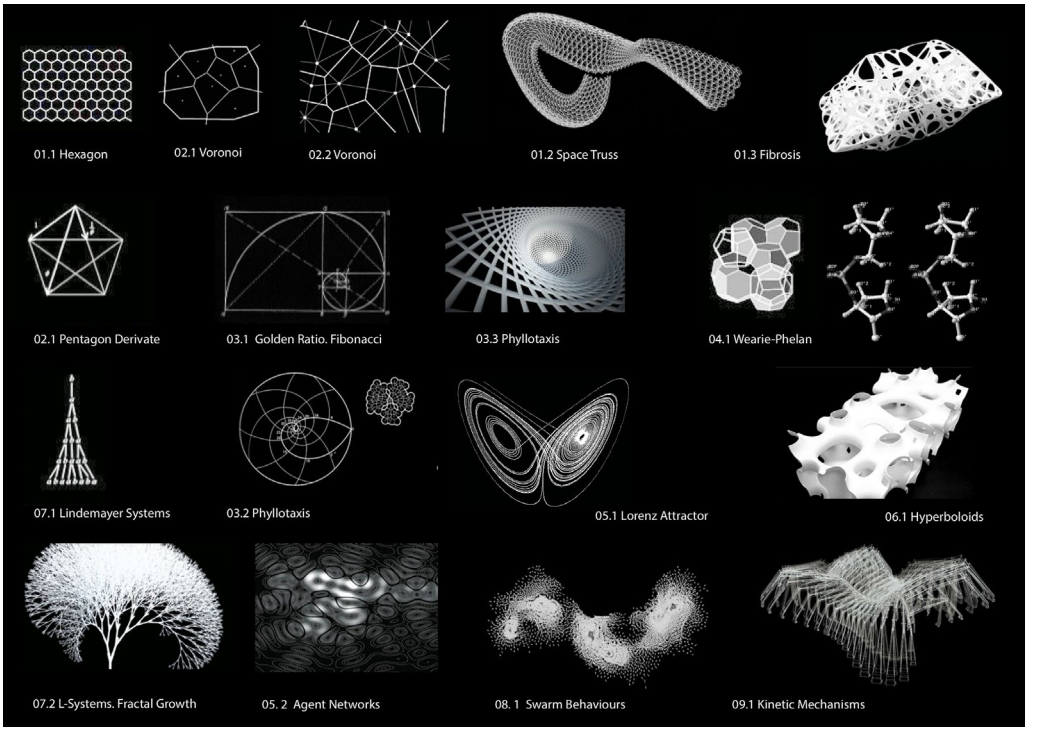

Figure 4. Different codes as diagrams of natural phenomena deliver prompts for architectural design (collage by author from varying sources, including: wingspace/atmosstudio; toyo ito/taichung metropolitan opera/toyo ito; agent networks/kokkugia; theverymany; biothing).

art; and shape approaches to design semantics. Coding has informed the shaping of matter by applying nature's principles, such as hexagonal geometries, Voronoi systems, L-systems, swarm behaviours, Fibonacci sequences, and Gaussian curvatures, to name but a few.

Architecture and engineering have referenced biological systems as found in nature to the design and construction of architectural systems. Precedents range from applications of biological systematisation (Greg Lynn's reversal of D'Arcy Thompson's "On Growth and Form"), structural analysis and remodelling of force systems (Frei Otto, catenary and branching structures), and translation of natural form into architectural geometries (Peter Pearce's node systems, Buckminster Fuller's geodesic domes). These approaches resulted primarily in design strategies for singular solutions, such as for roof structures, bridges, or building typologies, on the premise of shared formal principles or self-forming strategies. Continuing this in a contemporary field of computational design, architects, designers, and coders are increasingly working with rules that privilege the general over the specific and lead to series of design morphologies. When the end result is undefined but its rules are explicit, this can open design to a multitude of varied, unpredictable, and dynamic systems, patterns, and constructs. Architectural systems can then

continue adaptation to both intrinsic (such as force loads or occupation) and extrinsic (such as site or climate) requirements.

Applications of a mathematical logic can vary between parametric formulas, algorithmic scripts, and other processing codes. These techniques use sequences of instructions, expressed in mathematical language, for solving a specific problem. Differences exist here in the scope of dynamics provided by parametric, algorithmic, or evolutionary design processes:

A *parametric* design process is based not on fixed metric quantities, but upon consistent relationships between objects in a framework. Objects can vary according to their size, position, magnitude, and frequency, relative to any number of inputs. Changes to a single element propagate corresponding changes throughout the system.

An *algorithmic* design defines a number of clear instructions, which typically follow a step-by-step problem-solving procedure in a readable order of commands. Algorithmic design processes use simple iterative methods while preserving specified qualities. As Michael Meredith argues, "the algorithmic is a method of generation, producing complex forms and structures based on simple component rules".[8]

An *evolutionary* algorithm, based on Darwinian theory, will typically mimic the processes of natural selection and random mutation by breeding, selecting, and re-breeding possible designs to produce the "fittest offspring", solutions that adapt and survive.

Some examples will illustrate the differences between these applications. Parametric design varies the individual fish in one species, with consistent and relational changes to scales, bones, or eyes (or in the case of architecture, patterns/openings within a field, for example). Algorithmic design develops different species of fish, dependent on the shift of contextual parameters or changes to the overall framework (applied to architecture, the relationship between series of building components). Evolutionary design induces changes to the fish over multiple generations, extrapolating characteristics and radically excluding streams of development according to sets of contextual criteria, so that, for example, an amphibian life form may evolve. In a similar manner, a building morphology can be moulded to change in iterations of design processes.

Yet, in this adaptation of biological precedents, generative processes are radically limited by, firstly, privileging an intrinsic logic of codes and forces that give shape to form, and secondly, excluding a multiplicity of extrinsic forces, and the relationships of these with intrinsic forces, which determine in sum and in correlation any form. But forces are tendencies, not constants but fluid dynamics, and their velocity, strength, and directionality may change. Mathematical models therefore need to be treated as approximations of boundary conditions (which determine the threshold between virtual possibilities and actualisations). In this respect, Sanford Kwinter's discussion of the "chreod" (as a continuation of previous epigenetic landscapes) contributes a way in which multiple forces can be embedded in forms;[9] it allows forces to engage with one another, and as a consequence, they "integrate and produce geometrical, chemical and physical moduluses".[10] As forces organise within, they give shape to a virtual, developmental landscape, which serves as a non-rigid mould or template. These chreods channel all set forces into approximate pathways that interact with matter over time, so as to direct,

constrain, and protect the development of forms. While "chreods are motion templates, the geometrical equivalent and translation of algorithms",[11] they are following general rather than exact parameters that lead to their existence and thus to sections of developments. This is significant because Kwinter acknowledges time aspects that organise tendencies into a full range of force families, and thus opens the generative logic for intuition of variety while maintaining consistency of form kinship. This concept then also suggests the possibility of multiple codes that, as in the natural/actual realm, develop in interaction with each other within one species, across species, and over generations. Consequently, this expands the appropriation of code towards an understanding of force, time, material, structure, and form as a dynamic whole.

RESEARCH WORK IN DIGITAL NATURES: CORAL|COLONY

Coral|Colony reflects the previous discussion through a series of research investigations into natural morphologies and systems that form an ongoing body of work (Figure 5). Exhibited as part of "Future Nature" (Australian Design Museum, Sydney, November 2015–2018), Coral|Colony collates research prototypes and installations from 2010 to 2015.[12] It acts as an archive that bridges both found (marine specimens) and made (prototypes) boundary objects of nature, enabling a tactile and visual audience engagement and experience. The collection comprises a range of media: marine specimens found in the inter-tidal zones of Australian beaches between 2010 and 2015; video clips of scientific documentations; animations of 3D-modelling processes and segments of code; sets of prototype series with analogue models and digitally fabricated samples. The audience is invited to add diagrams, drafts, and descriptions of their own to existing sketchbooks, thus contributing on an individual level to the observations and the collection. The research work consequently triangulates between what Bela Banathy described as the three

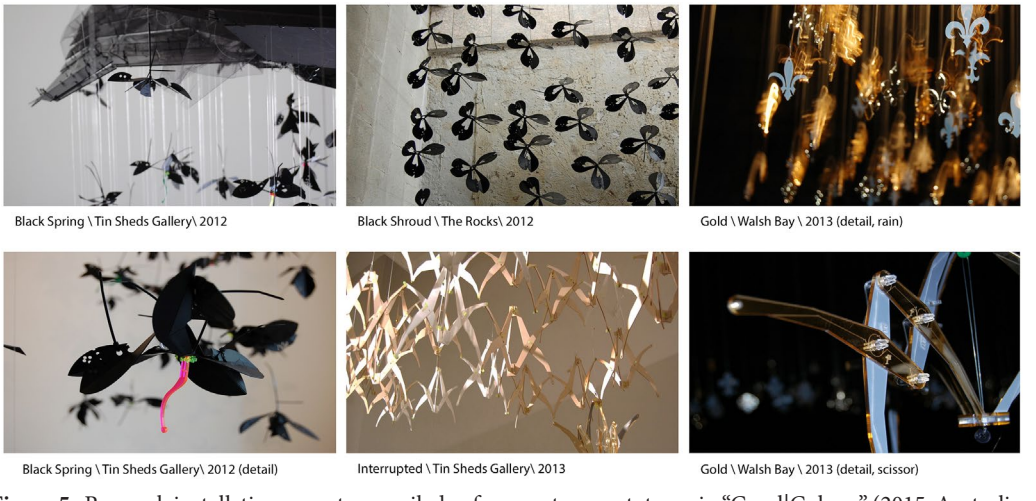

Figure 5. Research installations, exerts compiled as fragmentary prototypes in "Coral|Colony" (2015, Australian Design Center).

research cultures of Science, Humanities, and Design;[13] between those, it aims to advance our knowledge of the natural world, our understanding of the human experience, and our capacity for envisioning possible future realities—specifically in and for the discipline of architectural design.

Coral|Colony explores multiple heterogeneous systems whereby an organism formed of singularities (the coral) contributes to a multiple that forms a larger ecosystem (the colony). Within this natural phenomenon, the singularity of individuals and diversity in multiple codes, different life forms, and collectives of swarms play out as cohabitation. Its structures, growth patterns, and behaviour are not finite, but dynamic. The term "colony" is used here as a descriptor for the correlation and interchanges between numerous and different forms of animate and inanimate, mobile and stationary, temporal and generational dynamic systems that evolve continuously. The colony changes with shifts in intrinsic and extrinsic forces, with a choreography of balanced systems following, responding, and adapting by actuating inscribed mathematical, adaptable—and thus evolutionary—codes. In the colony, it is not the one, but the many that count—a circumstance which signals potential for architecture as a human habitat. The colony's mathematical codes and their interacting and integrated principles and systems can constitute a reference archive that expands the development and application of shapes, patterns, and morphological variations towards the totality of an environment. And while many codes are "shared" between diverse entities, no singular code is the exclusive driver for formations; on the contrary, apart from individual organisms, most species employ complex combinatory sets of code for their growth and development. Architecture has learned from nature in terms of organisational/constructive logic of parts for singular, yet relational networks in complex and integrated natural systems can provide further insights into the interaction of multiple entities—the dynamic temporal formations of the corals, their marine inhabitants, and the inanimate particles of sand and tidal currents that define their ephemeral environment. The research opens this discourse for an architecture context that bridges between human, matter, space, time, and behaviour through different descriptions of code, as a number of mathematical concepts that are explored in prototypes and spatial installations.

CODES BETWEEN MARINE AND TERRESTRIAL FORMS

Among the many mathematical codes that appear as basic building plans in different species, this research work explored: 1) the Fibonacci sequence; 2) hexagonal geometries and Voronoi systems; 3) Lindemayer systems; and 4) Turing patterns. These codes appear across terrestrial and marine life forms, where they shape surface tessellations, component arrangements, or structures in material relative to context.

One of the most generic organising principles of relations in growing systems is the *Fibonacci sequence* (a simple pattern in which each number after the second is the sum of the two preceding numbers, e.g. 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, and so on). This sequence describes the relative proportional value of two distances in relation to each other. It is further related to the Golden

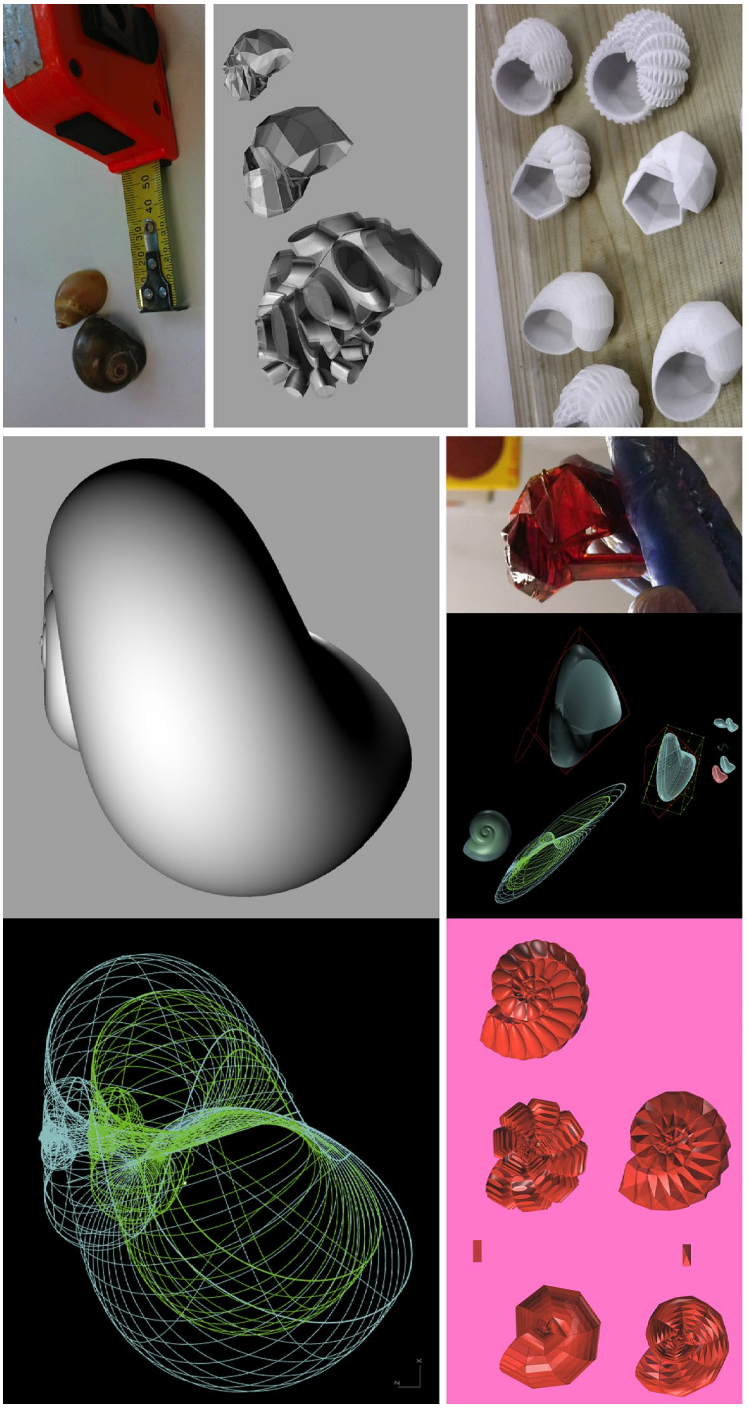

Figure 6. Fibonacci sequence for base geometries in "Remembering Home—Shells for Hermit Crabs" (2011), with a parametric sequence for plate distribution.

Ratio, which describes the relation between two numbers when the ratio of the smaller one to the larger is equal to the ratio of the larger to the sum of the whole (where $a+b$ is to a as a is to b). This ratio is expressed as the constant φ (phi)=1.618. Fibonacci sequences inform the spiral growth in families of shells and vegetables, just as they inform the relative proportions of human limbs. This can be embedded as a proportional system for the organisation of an organism, for parts within an organism, or movement ranges relative to the whole (such as the limb system for motored mechanisms) in a responsive architecture context.[14]

Hexagonal geometries consist of multiples of a unit with six corners at 60 degree angles, and constitute the basic building plans for the two-dimensional tessellation of surfaces in skins, cells, and plates. They are the most efficient periodic pattern for covering a whole region without overlaps. Hexagons are homogeneous surface divisions and, when extruded in the third dimension, result in stable honeycomb structures, or can alternatively be organised as hexagonal lattices that are deformable. Hexagons appear as compound eye cells in robber flies (*Holocephala fusca*) or as building cells in beehives. As a non-Cartesian system, hexagonal organisations are particularly useful for architectural computation of matter: as a tool for hybridisation between digitally fabricated organisations, and kinetic actuation.[15] A relative of the ideal hexagonal patterns is the *Voronoi pattern*, which offers deformations of the regular building plan. It divides space into a number of regions, following a set of points or generators that is specified beforehand, and according to the shortest distance to corresponding points in a region where points are closer than to any other. Regions are called Voronoi cells, follow a Delaunay triangulation, and are continuously adaptable by a strategy of "divide and conquer": when the position of a singular point changes, the individual cells and the overall cell morphology propagates changes to the system. Voronoi patterns appear as skin plates on gecko feet (*Hemidactylus frenatus*), or as in colonies of corals (in the genus *zoanthus*), as much as in many other natural phenomena. While Voronoi are commonly deployed to enrich architectural surfaces through intricate pattern organisation, the research adopted these to provide tactile engagement (Figure 7).[16]

Lindemayer systems describe growth patterns in multicellular organisms that develop though branching and bifurcation in two states: as growth (b) or as reproduction (a). This grammar contains an initial axiom, and a set of one or more transformation rules with strings of characters that form iterations. There are two transformation rules: (1) b>a, and (2) a>ab. The first rule states that occurrences of b are to be replaced with a, and the second rule states that occurrences of a are to be replaced with ab. The growth of an initial stem and a series of branches can thus be described as a simple code of n1=b, n2=a, n3=ab, n4=aba, n5=abaab, n6=abaababa, and so forth. This code can extend to any number of transformation rules of any complexity, with no limit to the length of the initial axiom.[17] Lindemayer systems can describe the branching in trees (group of *arbor*), families of algae, or some deep-sea corals (*Acropora florida*). The particular sequence of flow division through L-systems is basically a bottom-up or self-forming system, and is relevant to structural approaches in engineering and architecture, since the force distribution can be organised with branching into incrementally smaller structural members, relative to the surface area that accepts the primary force load.[18]

Figure 7. Voronoi systems for "Interactive Corals" (2014): a hybridisation between nature, matter, and digital fabrication.

Turing patterns or reaction–diffusion systems are a mathematical model that generates stable, periodic patterns on animal skin. By laying down positional information, the reaction–diffusion system forces waves of chemical reactions between two substances that cause the migration and positioning of pre-patterns for coat markings, whereby particle swarms cause a subsequent differentiation into specialised pigment cells that then appear as coloured. As a pattern coding strategy, properties of this system include the autonomous formation of patterns without any other positional information; the stability of the pattern once formed; and a capacity for regeneration when disturbed. While for mammals most of the patterns are laid before birth, the chemical processes involved in the reaction–diffusion system remain active in some species, which allows continued expression after birth, and interactive behaviour. Turing's reaction–diffusion system is expressed as genetic components that spontaneously self-organise into stripes, curves, or spots; examples include the unique patterns in a zebra's fur (*Equus quagga*), the scales of zebra fish, and the skeleton structures of brain corals (*Diploria labyrinthiformis*). For architecture, this holds the potential for dynamic systems organisation, where the propagation of (informal) data introduces local changes to the arrangement of components (such as distribution of façade elements, connectivity of nodes, or steering of information screens or infrastructural services, for example). More importantly, this can prompt a generative concept for architecture as choreography, whereby complex bodies are capable of expressive behaviours across virtual, physical, and interactional dimensions.[19]

While these codes inform material, structure or data flow, for the research of Coral|Colony, two aspects require further reflection: firstly, a common denominator between corals and shells are structures that these marine life forms grow from calcium over their life-span. Expressions of mathematical code are then static and non-adjustable through muscular movement—in contrast to the sum of skeleton, muscles, and skin in vertebrates. Corals and shells can thus be understood as exemplary sets of strategies in comparable matter, whereby mathematical codes provide the DNA for growth and formation, and lead to diverse solutions. And secondly, the study of corals offers also another reference point. On an abstract level and beyond observations of singular applications of code in the individual organism, corals exist as multiples and multiplicities across the dimensions of matter, space, and time. Their growth and formation comprise generations of specimens, of continued and continuous adaptations to changes in context and conditions, modelled by forces that interact and safeguard their organisation in their respective non-finite virtual landscapes. Over timelines that reach well beyond human understanding, they enable an audience to engage with a diversity of marine life, but more importantly to connect to time dimensions that expand current cultural agreements expressed in architecture. Visualising different codes as tendencies of formal expressions, as sections of developments, traces new architectural paradigms: by opening the archive of mathematical code as collated in Coral|Colony, access is given to the rich diversity that exists in the solutions of natural species.

CONCLUSION

Similar to biological systems, mathematical codes can respond and adapt to environmental stresses and dynamic loadings, to contextual extrinsic force flows, to changing data flows. Codes adopted for forms, concepts, and design systems then respond in evolution, developing continuously through degrees of redundancy, optimisation, and complexity, in material and structure, and over time. They can inform structure and skin, behaviour and interaction of buildings, and thus act as informational drivers, as design machines for a built environment that shifts from surface to system. Deployed as the logic of a mathematical framework or procedural invention in computational design, a shift takes place from result to protocol as a consequence of explicit rules that produce multitudes of dynamic systems, patterns, and constructs through energy and data in matter. And while the primary aim of the research has been to collate an overview of diversity, the consequence is a challenge for coding—from development of singularities in computational design towards approaches of relational exploration. As architecture requires energy to organise matter, synergetic effects of system organisation are more important than ever. Further research will need to be undertaken into the multiple, the colonies of many codes and coders, where everything is changing. And everything is connected.

Acknowledgements: "Coral|Colony" (2015) collates an archive of the following research works as partial prototypes and segments of installations, with acknowledgement of several contributors to creative work: "Remembering Home—Shells For Hermit Crabs" (2011, installation for "Right to the City" exhibition, Tin Sheds Gallery, Sydney), team: Dagmar Reinhardt, Alex Jung, Marjo Niemelä, Lisa Fathalla, Martin Tomitsch, Kate Dunn, Jonathan Newton, Steven Janssen. "Black Spring" (2012, installation for "Biome" exhibition, Tin Sheds Gallery, Sydney), team: Dagmar Reinhardt, Lian Loke, Alexander Jung, Jonathan Fernandes, James Ye Won Lee, Elmar Trefz. Continued in "Black Shroud" (2012, installation for "Organised Cacophony", The Rocks, Sydney), team: Lian Loke, Dagmar Reinhardt, Jodie McNeilly, Chris Law, Ingrid Pohl. "Gold—Monstrous Geographies" (2013, installation for "ILTS", Living Room Theatre, Pier 2/3 Walsh Bay, Sydney), team: Dagmar Reinhardt, Alex Jung, Lian Loke, Marjo Niemelä, Elmar Trefz, James Lee, Eduardo Barata. Continued in "Interrupted" (2013, installation for "Dis.sentience" Exhibition, Tin Sheds Gallery, Sydney), Dagmar Reinhardt, Alex Jung, Lian Loke, Paul Warren, with companion piece by Michaela Davies. "Corals" (2014, installation for The University of Sydney), team: Lian Loke, Dagmar Reinhardt, Jodie McNeilly, Chris Law, Ingrid Pohl, Kate Dunn, EndOfLine. Also displayed are test studies for the research of "Sonic Domes" (research 2012–) and "Robodome/pétillant" (Robotic 6-axis Milling of a Foamglass Pavilion (2015–, a prototype for the ROB|ARCH2016 Robots in Architecture Conference (2016), team: Dagmar Reinhardt, Densil Cabrera, Alexander Jung, Rod Watt, Gabriele Ulacco, Marjo Niemelä, Celeste Raanoja, Mitchell R. Page.

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Article

FROM HOPEFUL MONSTERS TO MORPHOGENETIC PROTOTYPES

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Linnaeus' original *Systema Naturae* taxonomy defined three kingdoms: animal, plant, and mineral. In this classification, animal architecture, such as termite mounds and beehives, is mineral. In human architecture, formal and functional imitations of animals and vegetables have frequently been used to decorate our mineral architecture. Advances in material science are blurring the traditional boundaries of these kingdoms in human architectural design. In the near future, it will be possible to grow buildings, initially conceptually and then materially, as if they were biological organisms. In preparation for this, we discuss theories of morphogenetic prototyping to conceptually raise these architectural hopeful monsters. The immaterial focus of this work means that it can act as a bridge between emerging architectural material potentials and the approaching architectural singularity where buildings will grow themselves and be as intelligent as their original designers and occupiers, or more.

Keywords: **A**rchitectural singularity; biomimetics; carving; drosophila; morphogenetic prototyping; ontogenetic turn

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Ray Kurzweil predicts that in the near future, humans and artificial intelligence will become indistinguishable; Kurzweil describes this as the "singularity".[1] Similarly, the *architectural* singularity describes a point in the near future when buildings will be at least as intelligent as their designers.[2] It is possible that, rather than augmenting human design skills, the approaching architectural singularity will make architectural design incomprehensibly complex for humans. In such a future, architects may find themselves falling into a flat spin of information overload if they dare switch off the design autopilot. Emerging digital design and fabrication tools provide a glimpse of this future. Such systems will model the proposed material architecture in direct response to the environmental, social, and technological ecosystem it inhabits. While this design technology offers significant opportunities to address the big environmental challenges of the

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twenty-first century, it also raises significant questions for architectural theory, pedagogy, and practice.

This trend towards automation will eventually make it difficult for classically trained human designers to control architectural design. To retain meaningful engagement in architectural design processes beyond the architectural singularity, it is therefore critical that architects define the theoretical foundations of these near-future design systems. We need to identify complex systems that we can use as analogues in proposing a durable understanding of architecture that architects can manipulate and control. Animals and plants provide analogues of complex systems that could help us to understand these emerging hyper-complex buildings. Stanislav Roudavski has proposed the use of animals and plants to act as interdisciplinary bridges between architecture and biology.[3] We seek to identify an appropriate biological perspective to support human design processes in the post Anthropocene.

The diversity of biology means that there is a wide variety of models to choose from, each with different architectural qualities. For instance, blue whales can be bigger, have longer life spans, and be significantly cheaper to produce than some contemporary architecture. However, it is not necessarily the formal qualities of animals that are most relevant to architecture, but how they come into being. Biological growth is typically organised so that the organism is in homeostasis at every stage of development.[4] Homeostasis provides an internal balance in the systems of the organism that reduces its load on its environment. A deep understanding of the homeostatic processes that result in the biological system's formation would have significant applications in architecture. This could result in an architecture that is significantly more cost-effective, efficient, sustainable, adaptive, and responsive than many contemporary buildings. To make use of biological homeostasis in architecture, we need to look beyond the formal, mechanistic, and aesthetic properties of animals and plants to how they grow.[5] This will enable us to map the growth of hyper-complex biological systems to specific architectural typologies, allowing us to model and control the pseudo-biological growth of the typology. We argue that an approaching ontogenetic turn in architecture will support the architectural synthesis and, ultimately, the control of Linnaeus' three kingdoms.

The animal selected for this essay is *Drosophila melanogaster*. *Drosophila* (also known as the fruit fly) is a very well-documented biological model organism.[6] It is one of the best known organisms to biologists. It is also remarkable in that many genetic mutations of *Drosophila* are extensively documented. Michael Weinstock, through a discussion of common *Drosophila* mutations, explores the idea of "hopeful monsters".[7] It is the idea that a single mutation could catalyse a new species.[8] Similarly to quantum evolution, this typically involves a spatial separation of the new species from its origin species and a lot of small changes over many generations, which, when viewed from a macroevolutionary perspective, could appear to be a single event. However, in seeking to appropriately apply such terms to architecture, it is important that we understand how they work. This is necessary in order to challenge the contemporary architectural status quo and prepare us for the approaching architectural singularity. Biologically, hopeful monsters, for instance, are more likely to arise from an adjustment of the timing when a gene is triggered than from a series of consecutive mutations that could instead have a lethal or non-advantageous

result. Extending this insight, architectural hopeful monsters may result from changes to the architectural design process, and not necessarily to changes to the designed architecture.

One approach might therefore be to take a macroevolutionary perspective on architectural design, so that the overall trends or *genes* are perceptible in typological *evolutionary* development. This would assign to the architect the role of running a pseudo-evolutionary process for a specific architectural typology—and waiting with finger hovering over the pause button for the hopeful monster to reveal itself. The architect could then identify a suitable progenitor for a new architectural response within a specific architectural typology. However, the lack of an evolutionary and environmental context could make it difficult to meaningfully simulate this pseudo evolution. Alternatively, if the idea of the "evolutionary program" could be expanded to include the "genetic" history of a specific architectural typology and its accompanying cultural, technical, and environmental context, this pseudo evolutionary development could provide a powerful tool to reflect upon and analyse architectural history and propose appropriate adaptations to contemporary typologies.

Therefore, while it is possible to evolve a new architecture in a single design iteration, it is probably not desirable or particularly useful without its own evolutionary context. This evolutionary developmental (evo-devo) perspective really means that any new robust architecture is unavoidably linked to its architectural history. In some ways, the search for the architecture of the future might involve activities more familiar to palaeontologists. By joining up architecture's history and future, these architectural archaeologists might be able to identify an architectural genetic code from architectural dinosaurs that we can use in our own architectural Jurassic Park[9] of prehistoric hopeful monsters for the future.

To capitalise on this opportunity, it is important to select a specific architectural typology to apply this biological lens to. The Adelaide cottage is chosen as the model architectural typology because it provides a simple architectural *model* and typically presents a symmetrical plan of three horizontal (lateral) rooms (segments), which is broadly analogous to the head–thorax–abdomen primary lateral subdivisions of the fly (Figure 1). This essay argues that beyond the immediate Jeff Goldblumesque hybrid fly–man connotations lies a promising approach to the design and analysis of architecture through the lens of biological sciences.

THE ONTOGENETIC TURN

Biology is a multi-faceted discipline. There are many potential behaviours, attributes, and processes that could be mapped from animals to an architectural typology. Nikolaas Tinbergen describes four questions of biology: ontogeny, mechanism, phylogeny, and adaptation.[10] These can be interpreted from an architectural perspective as an architecture's growth, function, history, and context (Table 1). The biological growth (ontogeny) of organisms is referred to in biology as morphogenesis. Morphogenesis describes an organism's development from genotype to phenotype (the final "adult" form of an organism). This is more complex than the architectural distinction between architectural drawings and the as built architecture. In reality, the staged execution of the genotype as DNA is more closely analogous to a generative computer program

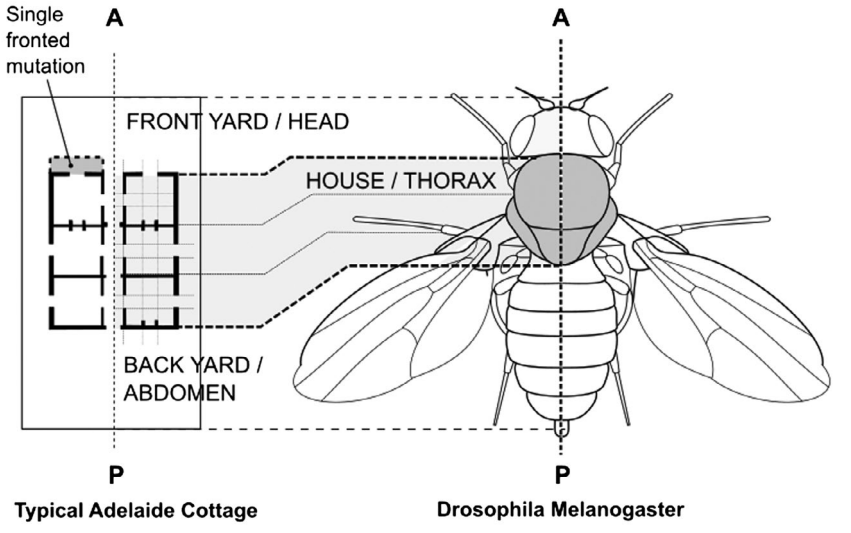

Figure 1. Mapping the animal "body plan" to an architectural typology. Image: Tim McGinley, Andrew Fotia, and Brett Abroe.

than the fixed solution of traditional architectural drawings. The genotype, in the case of the fly, could therefore be thought of as a series of coded interactions or steps that play out as it grows from a single cell into its adult form. These interactions encode everything in *Drosophila* from the 220 beats of its wings per second in flight to the ultimate morphology of its body plan. In this sense, the complexity of morphogenesis lies not in the sum of its reactions to context, or the length of its genetic code, but to an incomprehensibly complex series of orchestrated multidimensional reactions and processes within the organism that result in some of the most complex systems on earth.

Despite this, architects tend to focus on the morphological result of morphogenesis. The morphological phenomenon of morphogenesis is most famously explored in Darcy Thompson's *On Growth and Form*,[11] which was in turn inspired by the proportional studies of the human form by Albrecht Dürer. While this early work was based on references to real organisms, turn-of-the-twenty-first-century interpretations such as Greg Lynn's Embryological Houses reference biological concepts, but do not use explicit biological models.[12] In "Embryological House", Lynn explores the procedural development of a pseudo-biological architecture using computer code in an analogy to the biological genotype-to-phenotype process. Lynn uses an arbitrarily selected set of environmental influences to deform the morphology of the house,[13] resulting in a near-infinite series of houses. Lynn's work raises the question of the role of this pseudo-genotype, how it should be controlled, and the effect it should have on the architectural phenotype.

There is a contemporary architectural interest in and increasing familiarity with parametrics and generative design in architecture. However, the consideration of "digital morphogenesis" in architecture is commonly divorced from its biological origins.[14] In its place, contemporary digital

Figure 2. The *Treponema pallidum* protein interactome (biological network map). Image: B. R. Titz, S. V. Rajagopala, J. Goll, R. Häuser, M. T. McKevitt, T. Palzkill, and P. Uetz, "The Binary Protein Interactome of *Treponema pallidum*—The Syphilis Spirochete", *PLoS ONE*, 3, no. 5 (2008), e2292, figure 1. doi:10.1371/journal.pone.0002292. Reproduced under a Creative Commons Attribution 1.0. Full terms at http://creativecommons.org/licenses/by/1.0.

morphogenesis in architectural theory is interested in the *why* questions axis of Tinbergen's questions, that of evolutionary development (phylogeny and adaptation), as an analogy for design based on computational processes and geometrical systems. It is unclear why this happens, although it is possible that it is unlikely for an architect to have expertise in both biology and architecture. Perpetuation of the absence of real biological models in morphogenetic architectural theory risks a critique of a formalistic approach to "morphogenetic" architecture. Ultimately, this will not help us to address the sustainability challenges of the twenty-first century through the appropriation of staged homeostatic pseudo-biological development systems in architecture. We therefore need to identify the main concepts of biological development in relation to architecture and how these can support this new approach to architecture, which we call morphogenetic prototyping.

Firstly, biologists consider that growth happens in stages. It is important to developmental biologists not just where and how, but *when* a process occurs. Changes to when a process occurs, and for how long, can significantly change the resulting organism. This is the most likely explanation for hopeful monsters, for instance. It is theoretically possible to create a fate map[15] of a developing organism which would chart where, how, and when every change to the developing organism occurs. It should therefore be possible to produce a similar diagram for an architectural morphogenetic prototype. This might look something like a biological network map.[16] In such a map, the "fate" of every cell in the organism could be modelled. Figure 2 describes the protein interactions for *Treponema pallidum,* a relatively simple bacteria. Even at this simple scale, it is

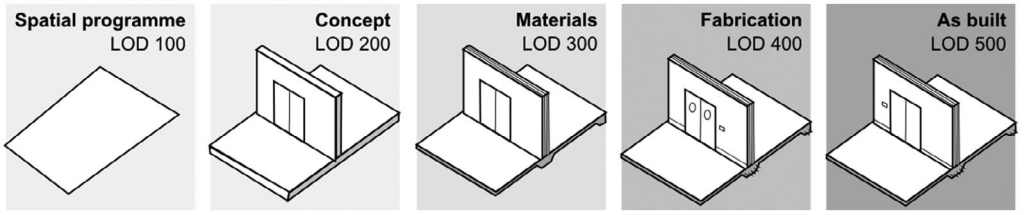

Figure 3. BIM level of detail (LOD) provides a hierarchical model of buildings. Image: Tim McGinley, Andrew Fotia, and Brett Abroe.

clear that it is difficult to interpret the map and certainly would be difficult to manipulate and use as a design tool. The interactions in the pseudo-development of a building would therefore be a very complex hyper-dimensional drawing. Accordingly, it is important that any digital representation of architectural growth can be considered in stages.

Secondly, biological growth is hierarchical. For instance, it is possible to view complex organism development as a smaller number of macro processes, each of which describes a collection of sub-processes. This should reduce the number of processes to view so that they can be meaningfully interpreted. The uptake of visual coding parametric design systems such as Grasshopper in architecture has meant that there is an untapped potential to produce "generative architecture" that could be described as "digital morphogenesis", except that it lacks the greatest asset offered by biology—control. In contemporary parametric systems, accessibility to all the constraints of the design at the same time without a clear hierarchy has led to increased complexity and uncertainty in the design process through the unstructured representation of the design variables. In digital architecture, it is easy to become lost in the sequence of processes. In contrast, in biological development, biologists make sense of the "design variables" by framing behaviour at specific stages in the development process. This means that, in the early stages of development, few genes are actually being triggered. One approach is to use this concept of developmental biology stages[17] to frame the management of variables in architecture. In this way, developmental biology stages could be mapped to the building information modeling (BIM) level of detail for instance, to provide pseudo building development stages.[18] These pseudo-developmental stages to BIM levels of detail (Figure 3) could be thought of as levels of abstraction for the building. Using this approach, it would be possible to "map" generic biological development stages to hierarchical levels of building abstraction.

Thirdly, biological development takes time, the order in which genes are triggered in biology is described over time, and each of these stages needs to take a discrete amount of time for the physical biological computation to happen. By contrast, in digital architecture, the time the code takes to resolve the architectural "adult" is dependent on the computational platform. It is therefore possible to imagine that with a suitably powerful computer platform, for instance in a quantum computer, the (computational) growth could be instantaneous, or nearly so. This could mean that time is potentially negligible in morphogenetic prototyping, or, more accurately, that

different developmental stages can be explored in parallel in digital morphogenetic prototyping. Therefore, when applying the developmental stages from biology to architecture, we are not implying that the architecture grows temporally, but that it grows hierarchically as a network. Figure 4 shows that the main axis of the house is defined in a first stage/level of abstraction prior to the segmentation of the rooms (analogous to the head, thorax, and abdomen divisions). The window openings would then be processed in a later (less abstract) developmental stage.

In biology, according to the second law of thermodynamics, it is not possible to reverse the stages in the biological development processes. However, in simulated pseudo development, growth can be reversed. Digital morphogenetic prototyping can therefore jump forwards and backwards (upstream and downstream in the hierarchy). In software programming, human readable code is typically compiled into machine readable instructions, and at this point, the programmer can no longer change the code without "reverse engineering" the machine code. Reverse engineering has been previously applied in CAD to extract parametric constraints from static digital models.[19] Taking this idea one step further, morphogenetic engineering proposes to reverse engineer the pseudo-biological development of engineered objects.[20] This has been explored previously in the reverse engineering of a military robot.[21] We have previously discussed how this would affect the design experience.[22] However, it should be possible to adapt traditional CAD systems to describe views of different stages of the pseudo-development of a morphogenetic prototyping process as a series of snapshots of growth. These snapshots could be captured over a series of windows or views representing different developmental stages.

Finally, growth is adaptable. In biology, adaptation is constrained within limits due to the phenotypic plasticity of the organism, which limits the adaptation to non-lethal results in the phenotype (hopeful monster success). However, no such constraints exist in digital architecture. It is therefore critical to encode the prototype's genotypic response to its experience of potential environmental conditions. Architects typically design a building in response to its context. Similarly, in this case, the building's ability to adapt to its context within predefined limits should be orchestrated by the architect. The coding of these behaviours would enable the building to adapt to a range of site conditions that are predicted for a typology based on historical models of previous contextual interactions.

DISCUSSION

In contemporary architectural practice, biology can be used to justify the existing approaches and interests of architects, rather than analyse and redefine them. This misses an opportunity to apply much-needed contextually homeostatic models in architecture through the application of a pseudo-ontogenetic perspective to architectural models and the ontogenetic turn in architecture. This ontogenetic turn describes architecture as staged, hierarchical, instantaneous, reversible, and adaptable. It promotes a procedural expansion of the developmental stages to enable the designer to synchronously and collaboratively make alterations at multiple stages in the pseudo-development of a morphogenetic prototype. The ontogenetic perspective in architecture

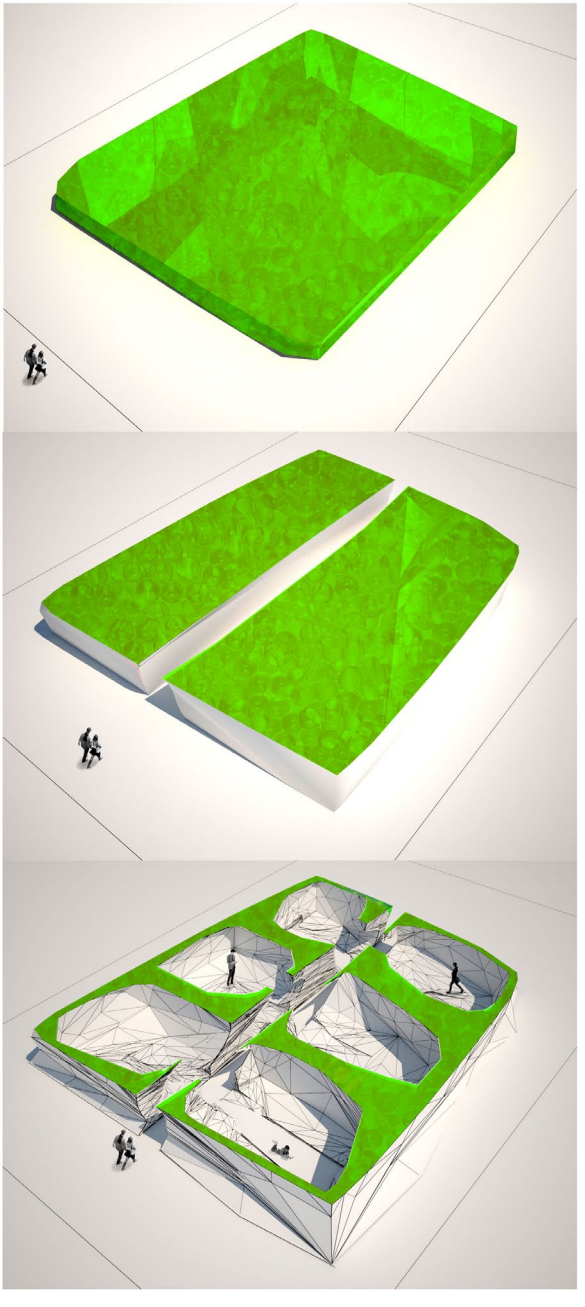

Figure 4. Three development stages of the Adelaide house morphogenetic prototype. Image: Tim McGinley, Andrew Fotia, and Brett Abroe.

revealed that the temporal development stages of organisms could be mapped to the hierarchical models of architecture that are being generated in architecture through the uptake of BIM. In this way, it will be possible to apply ontogenetic ordering mechanisms to architecture to hyper-complex near-future building parametric design systems. While it would be possible to present such a multi-stage approach in a traditional CAD metaphor over multiple windows, this may not be suitable as a twenty-first-century design interface. The ontogenetic turn points to a new design experience in architecture. It is clear that the analogy of animal growth is relevant to the future of architecture. The application of biological mechanisms to architecture at specific pseudo-developmental stages should help avoid the recreation of Frankenstein's monster in the design solutions. The modelling of architecture as a hierarchical object-oriented system is required in order to support the mapping of the building development stages. This would provide the ability to model the hierarchy and temporal development of ontogenetic processes in architecture.

If architects could be trained to take advantage of this turn, it could offer them unprecedented control of their architecture. The ontogenetic process provides us with a multidimensional view of architecture that looks more like a designerly genotypic computer program than a series of schematic drawings of the phenotype. This essay proposes the need to construct a new immaterial theory of architecture influenced by biological systems and organised around specific biological development stages in buildings to organise the information and variables in a building into discrete stages of development. The ontogenetic turn requires Building Development Stages (BDS) to frame the ontogenetic perspective for an architecture.

Furthermore, the ontogenetic turn requires the identification of an architectural genotype. One approach to achieve this is to reverse engineer the adult phenotype to identify the genotype. This would result in the identification of "designGenes", which could then be manipulated to regrow an alternative architecture analogous to Weinstock's hopeful monsters, but with less emphasis on supernatural fortuity. The morphological implication of triggering particular genes can be constrained to each developmental stage; this mirrors real biological development and helps to organise the building's design, material, and fabrication information systems. The detailed observation of the development of a real biological organism could provide a robust developmental framework that could be used in architecture to reverse engineer architecture to establish the morphogenetic principles for an ontogenetic reference model, ultimately pointing to the establishment of a multidimensional typological referenced morphogenetic database of architecture.

Finally, morphogenetic prototyping offers an ontogenetic perspective that architects can use to better understand and link the past, present, and future of architecture. This ontogenetic turn calls for a new approach to designing and analysing architecture, ultimately supporting a new era of architectural design that more closely resembles contemporary synthetic biology and bridges Linnaeus' three kingdoms. This is a fertile area for architecture that aims to make sense of contemporary challenges such as spaghetti-generating parametric models and Frankenstein's-monster dangers of non-ontogenetically referenced biomimetics.

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Writing on the Image: Architecture, the City, and the Politics of Representation

John Macarthur

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Book Review

WRITING ON THE IMAGE: ARCHITECTURE, THE CITY, AND THE POLITICS OF REPRESENTATION

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Mark Dorrian, *Writing on the Image: Architecture, the City, and the Politics of Representation*, London, I. B. Tauris, 2015. ISBN 9781784530389

The collection of Mark Dorrian's essays recently published by I .B. Tauris as *Writing on the Image: Architecture, the City, and the Politics of Representation* is something of a model of the value of architectural theory, assailed as it is today by robot manufacture, religiose neo-vitalists and the eternal return of participatory design. These writings are exemplary in avoiding claims to some fundamental understanding of architecture visible beneath its technical determinations or historical roles. Dorrian's essays are about representations of socio-political circumstances and about how representation itself is staged spatially. His work is thus grounded in history, yet the objectivity that Dorrian exercises in these analyses is not one of temporal distance, but, rather, a kind of topography that can range across physical sites and discourses found in the historical sediment. Despite the widespread sense that the "theory moment" has passed, Dorrian holds open the possibility of a critical thinking in architecture. This is not some romance of architecture's innate political potentiality, but, rather, that the imminent politics of the material and Dorrian's treatment of it unfolds to a wider socio-historical politics. And, last but not least, the book gives something of a model of how intellectual written work on broad cultural themes can be "architectural".

Dorrian's is not the kind of writing that could be done without training and a deep engagement in architecture. At the same time, it is written for an audience across the humanities, without assuming knowledge of architecture or any particular interest in the issues of the profession. It is this sense of architectural theory, not as a pre-existing authority exercised over architectural problems, but as a kind of thinking that comes to the fore in tactically chosen encounters in a wider cultural history and politics, that I value in *Writing on the Image*. This is a work in which architecture is not the object for consideration in and of itself, but rather a lens through which to apprehend a broader set of relations.

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The objects and scenes that fall under Dorrian's lens in this collection vary from the itinerary of George IV's entry into Edinburgh to Google Earth, from artworks to theories of disciplinarity in the arts, from Ferris wheels to socialist realism, with known "architectural" works (Foster's London City Hall and Diller Scofidio + Renfro's *Blur*) taking centre stage occasionally. Dorrian has selected and arranged his previously published essays so that their subjects are roughly chronological from the early nineteenth century to the present; as it happens, they are also, roughly, in order of his writing, from 2002 to 2013. One can thus follow the development of the themes that have interested Dorrian, particularly the way that cities seem to become visible as a whole through high vantage points and iconic buildings. Of course, cities are larger than any field of view, and the values that a city holds for us go beyond visibility to abstract relations of sovereignty and franchise. The exceptional view, from a privileged place such as the Ferris Wheel, of the Chicago World Fair of 1893, Stalin's gift to Warsaw of the towering Palace of Culture, or the large aerial photograph of London on the floor of its City Hall—each produces a kind of utopic moment in which a city might become actually visible. The essays thus show the duration and depth of Dorrian's investment in research that also resulted in the book he commissioned and edited with Frédéric Poussin, *Seeing from Above: The Aerial View in Visual Culture* (I. B. Tauris, 2013).

Dorrian's writing is well pitched to the genre of the essay. He engages the reader around an idea or a constellation of factors that are assayed for their wider significance. While Dorrian's scholarship is prodigious, and each of the essays is based in not inconsiderable primary research, there is no showy display of erudition. Rather, the essays remain, as the genre demands, the author testing a point by persuading the reader to share in the inherent interest of the material. It is not surprising then that in this collection of "architectural theory", we do not find Dorrian propounding any theory of architecture. We can, nevertheless, read a number of presuppositions underlying the essays. These suggest that beyond acuity of perception, there are some general conditions to the wide remit that Dorrian allows himself in writing on the image.

One of the thorny questions of recent architectural theory is whether architectural practice can be critical of the socio-political circumstances in which it is imbricated. The essays show us, case by case, that buildings and cities are socio-political objects that are inherently capable of giving us a critical viewpoint, but this is as much because of the over-reach of client bodies, and the over-determination caused by pushing technological limits, as it is any will or power of a designer. The staged entry into Edinburgh of George IV is a famous example of the invention of tradition, where the novelist Walter Scott re-dressed urban Edinburgh in a fantasy of Highland tartan. The religious and class conflicts underlying the Jacobite rebellions, the contradictions of a Union of nations under two crowns, a nascent republicanism—these complexities are not resolved, but somehow sublimated in the success of arranging a route, rituals, and *tableaux vivants*, which produce the image of a King and a city witnessing one another. The cultural and political predeterminations of the event had over-reached and produced an image of Scotland that has remained stable despite the contradictions visible in it. When Dorrian reopens another famous spectacle, that of the Eames' instructional film, *Powers of Ten*, we see a similar case where understanding scale is inseparable from cold-war technological rivalry. The conquest of space

and the inner space of microbiology are as much about the expanded field of weaponry as the aesthetic lesson of scale, sequence, and reversibility that *Powers of Ten* has become.

Architects necessarily realise tensions such as these in any project. While better architects might force these tensions into visibility, they are equally likely to explode or collapse spectacularly under their own weight, as Dorrian points out with the success of the London Eye and the equally spectacular failure of the Millennium Dome. If Dorrian offers much in showing what it is to see as an architect, he has little explicit advice as to how to act as an architect. His aim in writing he sums up with a quotation from Theodor Adorno, who says that the aim of writing an essay is to come "so close to the here and now of the object, up to the point where the object…dissociates itself into those elements in which it has its life". Could we surmise that this description of the written essay would also apply to the aims of a critical architecture in the making of those objects? That, somehow, the "here and now" that is the inescapable condition of building should not cause the conditions of building to be so self-evident, but remain open to questioning?

The historical specificity and density of the topics Dorrian takes on implicitly question the possibility of a history of architecture somehow discrete from a general history, or indeed from the great stew of histories of nations, ideologies, technologies, myths, and natural events. In this book, we rarely find circumstances where a sequence of the unfolding of concept or pattern within the discipline of architecture has much bearing. The closest Dorrian comes to this is in his interest in atmospherics, which touches on Peter Rayner Banham's story of the rise of service technologies driving architecture, and within which Dorrian gives a privileged place to Diller Scofidio + Renfro's *Blur*. But again, what *Blur* and artificial ski slopes in Dubai tell us is little about architecture's self-consisting and more about how architecture intersects with the possible weaponisation of weather, the long history of utopian thought on climate, and the idea of forms that surpass visibility.

Despite the word "architecture" appearing in the subtitle, it is not at all clear that this is a book *about* architecture, and there is a further complexity in that it is largely unmentioned that this is a book *by* an architect. It is difficult to glimpse what Dorrian makes of the relation of discourse and practice in architecture, whether we can or should distinguish between theory and practice, or writing and drawing or building. This is, however, raised in Ella Chmielewska's "Afterword" to the collection, where she refers to Dorrian's practice with Adrian Hawker and his studio teaching. The atelier *Metis* produces projects and installations of an exploratory and critical nature that, Chmielewska reminds us, are kinds of semantic engines and use a lot of text. The studios, based on an intense, two-year-long engagement with a particular city through speculative design, are the kind of research that underlie the essayistic approach, and which are crucial, for instance, in the essay on Warsaw's Palace of Culture in the present volume. Chmielewska claims that there is a drawing-like spatial quality to Dorrian's writing, and that raises the further question of whether what is "architectural" about this "theory" arises from the expertise, authority, or life experience of practising architecture.

In the last essay of the collection, "A-Disciplinarity and Architecture", Dorrian spends some ink explaining why he would refuse these questions. The question of the authority of practice

over theory and vice versa assumes that there is a discipline of architecture to make whole and have the right way up. Perhaps, it is obvious not to entertain such essentialism, but Dorrian goes further and also rejects the idea that art disciplines are defined not by their inherent traits or by media, but as a differential structure (sculpture being not-architecture and not-landscape, and so on). What interests him is not the definition and delimiting of disciplines that this kind of cultural logic produces, but, rather, what escapes it. Louis Marin called this "the neutral" or "utopia" and Dorrian sees it in Diller Scofidio + Renfro's *Blur* as a figure of radical neutrality. For Marin, utopia is a moment where there is a figure or diagram of a thought, the proper concept of which is yet to be developed. For Dorrian, then, an a-disciplinary architecture is just such a utopic moment, a finding of a neutral place or moment when the image of something not yet thinkable appears.

The usage "architectural theory" is easily said, but semantically confusing. What is a theory that is architectural that is somehow not a theory of architecture? Perhaps, Dorrian can write as he does because he does so from a non-position of "the utopic". A-disciplinarity is not a proscription for an unconstrained architecture, nor for a self-affecting circuit of architectural practice and theory—rather, it is to wilfully forget the compulsion and obligation to name what we do and where we stand. If correct terms for a theory of architecture are lost, forgotten, or yet to be found, then the writing of an a-disciplinary architecture is not "not-practice", but something else. Dorrian's neutrality on what might seem to be these fundamental issues of theory, practice, and disciplinary authority has allowed him the licence to write these exemplary architectural essays.

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Niche Tactics: Generative Relationships Between Architecture and Its Site

David Salomon

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Book Review

NICHE TACTICS: GENERATIVE RELATIONSHIPS BETWEEN ARCHITECTURE AND ITS SITE

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Caroline O'Donnell, *Niche Tactics: Generative Relationships between Architecture and its Site*, London: Routledge, 2015. ISBN 1138793124

Ecology is elastic. As a word and a concept, it can be stretched quite far without breaking, yet is always able to return to its original state. This is the point of origin for the elegant definition of ecology as the relationship between an organism and its environment. This relationship, and this elasticity, are at the core of Caroline O'Donnell's gentle manifesto, *Niche Tactics: Generative Relationships between Architecture and its Site* (Routledge, 2015).

Specifically, O'Donnell uses the biologist Jakob von Uexkull's notion of an *umwelt* (or environment or surroundings) as the grounding analogy for her investigation into the ways in which architectural organisms interact with the many physical and cultural environments in which they exist. Von Uexkull's theory stresses that individual species engage their milieu in highly specific ways, to the point where they only "perceive" a very small portion—or niche—of their larger habitat. In biology, a niche is both the location of and the interface between a specific organism and a *limited set* of the living and non-living things surrounding it. It is the ecosystem particular to a singular species, like the one that combines the koala bear, the eucalyptus tree, and the climate of eastern Australia.©

In architecture (where the term was used 300 years before it was imported by biology), a niche is a relatively small recess within a wall, often occupied by a sculpture. In marketing, a niche describes a narrow but intense relationship between a limited number of producers and consumers. In all contexts, niches are subsets of something else; they are small, specific, and specialized. They are spaces—both physical and conceptual—where extreme, distinct, and often odd effects are produced. For O'Donnell, the advantage of such oddities—architectural or otherwise—is that these strange strangers (to use Timothy Morton's phrase for hyper-objects) are at once unique yet fully enmeshed with their surroundings.

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Surprisingly, biological and evolutionary analyses figure prominently in only a few of the book's 13 sections. These examine Von Uexkull's notion of environmental bubbles, the strange case of the giraffe, and genetic "monsters". Placed at the beginning and end of the text, they serve to establish and then remind one of the book's overarching theme. Between these poles, the ecological analogy is severely stretched. This middle section is taken up with case studies which look at alternative ways to understand the conventional architectural ideas of site and context.

Contextualism was an influential architectural idea attributed to Colin Rowe, and propagated by him and his students at Cornell in the 1970s and 1980s. As O'Donnell (who teaches at Cornell) notes, Rowe's conceptualising of context was limited to other buildings and did not take into account ambient or ecological factors. O'Donnell does. The contexts she understands as having the capacity to influence architecture include urban, topographic, art historic, filmic, comic, and architectural ones. The various architectural examples used to illustrate her argument are well known. They include Palladio's villas, ideal Renaissance cities and churches, Le Corbusier's Ville Contemporaine, Stirling's Neue Staatsgalerie, and Peter Cook and Colin Fourier's Kunsthaus Graz. These serve—often in altered or adapted versions drawn by the author—to show how even the most stable, the most seemingly autonomous, architecture can be morphed when their own *umwelts* are expanded, showing what happens when architecture accepts a more niche-like relationship with the multiple contextual forces surrounding it. Among the most convincing is the merging of the seemingly symmetrical plan of Santa Maria della Consolazione in Todi into its hillside site.

At first glance, the expansion of the niche logic into semiotic contexts—like film and humour—seems too far removed from the book's biological beginnings. However, the emphasis on meaning and communication is consistent with Von Uexkull's biological theory, a theory that included a proto-cybernetic understanding of the communication loops between organisms and their environments. His work helped create the field of biosemiotics—a field that studies the sending and receiving of codes (e.g. DNA) and signals between biotic and abiotic matter. In other words, it investigated how biological and ecological systems are—like architecture—as much informational systems as they are physical ones.

The readers are not supplied with such conclusions, however. They have to make them by themselves. Those not versed in architecture's recent interest in ecological theory may at times find it hard to make these connections, though they are no doubt there. Also unstated is how the trajectory of transforming architectural ideals found in Greg Lynn's *Folds, Bodies and Blobs*, and extended in Reiser + Umemoto's *Atlas of Novel Tectonics*, is extended in *Niche Tactics.*

The plurality of the (non-biological) influences and techniques presented is one of the strengths of the book. At a time when a particular and ultimately limiting definition of ecology is being advanced, namely, as a synonym for "environmentalism" and its emphasis on the "protection of the air, water, and other natural resources from pollution or its effects", and when architectural autonomy and authorship are offered as an alternative focus, O'Donnell's book is an optimistic reminder that ecology and architecture are far more supple than either of these extreme positions. The book presents a way of thinking about ecology in which the conservation of resources is only one part of a more inclusive and interactive whole, a whole which includes

cultural and natural forces—a complex whole which must be embraced if new niches and new architectures are to emerge and survive.

As is the custom with (even gentle) manifestos, the book ends with examples from O'Donnell's architectural practice, CODA. Here, one finds the most convincing example of her expanded notion of ecology. The *umwelt* in which her Party Wall sits—an installation built for MoMA's PS1 in Long Island City, NY—includes the giant billboards found nearby, the refuse from a skateboard factory near Cornell, contemporary architecture's fascination with dynamic patterns, and the requirement for shade and places to sit in during the hot New York City summer months. A narrower understanding of ecology would only have addressed the latter issue, an autonomous position, none of them. By expanding the niche to include semiotic, economic, and climatic concerns, the project—and the book in which it is illustrated—reminds one that architecture always is asked to accommodate many masters, and that doing so requires elastic, ecological ideas and forms.