Niche-Tactics: The Giraffe Model

Nature's unmotivated variation and the subsequent "editing" process outlined by Darwin (and still generally accepted today) is mirrored by a contemporary trend toward the production of variation in architecture. As scripts have become capable of generating multifarious options, evolutionary terminology has crept into the language of architecture: words such as *species*, *iteration*, *generation*, *variation*, and *mutation* have become commonplace.[1] While this interdisciplinary borrowing has enriched our ability to produce the unexpected and to think processually about architectural generation, the developments have tended to favor whole and decontextualized form and consequently to neglect the part, the systematic, and, perhaps most onerously, the contextual logics underlying the transformations.

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For this, the discipline of architecture owes much to D'Arcy Thompson, whose diagramming of species through continuous and simple geometric transformations marks a fundamental nexus between evolution theory and architecture.[2] The grid, representing the forces of deformation from one species to another, suggests an underlying ordering system in the natural world. 'Force,' as understood by Thompson is "the appropriate term for our conception of the causes by which these forms and changes of form are brought about."[3] However, while many environmental factors (gravity, energy, motion, and so on) are mentioned, and Thompson notes that transformations may depend on various things "from simple imbibition of water to the complicated results of the chemistry of nutrition,"[4] environmental forces are not specifically mapped in the transformations.

Further, in nature, the transformation of parts is not necessarily proportional to the whole. Thompson goes some way in illustrating the transformation of the part, for example, by relating the cannon bone of the ox, sheep, and giraffe (with the ratio $x'' = x/3$) and by demonstrating the smooth continuity of this proportion through a series of bones in the legs of those same animals.

However, he does not continue to diagram the parts *within* the whole; say for example, the leg bones of the giraffe inside its vast and differentiated

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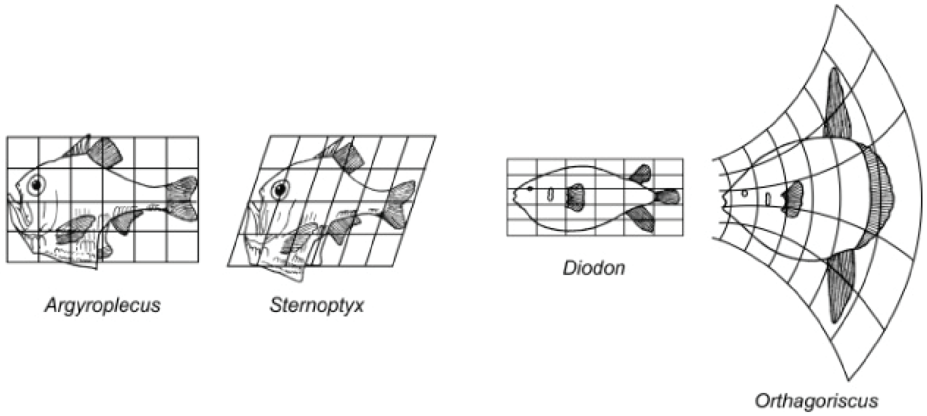

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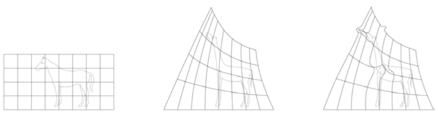

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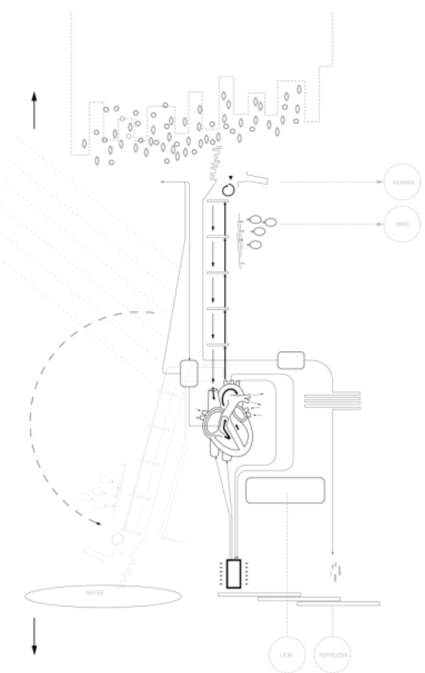

Figure 1: Evolution of body form. The transformation of Cartesian coordinates from (A) the body plan of the fish Diodon to (B) the closely related fish Orthagoricus. Thompson, (1917) p. 277.

Figure 2: Giraffe Diagram, after Thompson. Image courtesy of the author.

Figure 3: Giraffe Diagram. Image courtesy of the author.

body. Had this been attempted, a series of bulges would have appeared within the smoothness of the grid.

The giraffe's heart, for example, is much larger than normal for its body size: a consequence of pumping blood to its lofty head (the giraffe's heart is 2.3% of body mass, compared to 0.5% in other mammals[5]). In relation to this, the giraffe's neck contains several valves which prevent a rush of blood to the head when lowered for drinking, and its lower legs include a thick layer of tight skin—the "anti-gravity suit"[6]—because the blood vessels in the legs are under great pressure. This example alone illustrates a circulatory and mechanical response to a morphological condition, which in turn re-affects the material and formal components, all of which are neglected in Thompson's transformations.

Before species were understood as transformative in this way, new discoveries had been explained as combinations of known types. The binomial name of the Giraffe *Camelopardalis*[7] reflects this attitude: considered, as it was, to be a combination of the camel and the leopard. The error was a consequence of typological thinking, in which fixed types, though immutable, were combinable. Today's understanding of evolution is precisely the opposite: uncombinable species have transforming, diversifying boundaries. This conceptual shift—from combination to conversion—has percolated beyond evolution theory and into our cultural thinking in many fields. In 1992, Greg Lynn—one of the original proponents of evolutionary thinking in contemporary architecture—wrote: "The type or spatial organism is no longer seen as a static whole separate from external forces, but rather as a sensibility continuously transforming through its internalization of outside events."[8] Here, again, as in many other translations from evolutionary theory to architecture too numerous to cite,[9] mention is made of generic external events, but the specific relation between external force and resultant form are not pursued.

However, returning to Darwin, Thompson's *force* can be rethought as *fitness*: that is, the relationship between the animal and its environment. Random mutations in the organism that have a positive effect in the context of the organism allow that organism to gain advantage and thus continue its lineage along with that particular mutation, while mutations that have a negative effect contribute to the demise of the organism and the consequent eradication of that mutation. In Darwin's words: "Variations, however slight and from whatever cause proceeding, if they be in any degree profitable to the individuals of a species, in their infinitely complex relations to other organic beings and to their physical conditions of life, will tend to the preservation of such individuals, and will generally be inherited by the offspring."[10] This phenomenon is often illustrated by the thirteen species of finch identified in the Galápagos Islands, each having evolved, in relation to specific local conditions, from one original ground-dwelling, seed-eating finch.[11]

Some of the ground finches have developed large stout beaks for eating seeds of various sizes, while the tree finches have developed beaks that are better adapted to eating insects or nectar, or for wood-pecking. Further, these beak morphologies have been linked with foot and claw morphology,[12] (for clasping a branch versus walking on the ground) as well as overall size and song.[13] The bird diagram (Figure 4) implies all of these conditions—seeds, insects, nectar, wood, branches, ground, mates, other body parts—and cannot exist independently of them. Mapped in a Thompsonian manner, these birds would represent twelve steps in a smooth transition, without contextual information. Alternatively, we might envision a partner to the bird diagram that shows the environmental forces to which the birds have fit.

This complex symbiotic relationship—between the many qualities of the environment and the many needs of the organism—is fundamental to the work of perceptual psychologist J.J. Gibson, who writes:

It is often neglected that the words animal and environment make an inseparable pair. Each term implies the other. No animal could exist without an environment surrounding it. Equally, although not so obvious, an environment implies an animal (or at least an organism) to be surrounded.[14]

As the environment is described, the animal that inhabits it can be defined, and vice versa.[15] If it is hot and dry, if there is stalky yellowish grass underfoot, if Acacia trees are dotted around: giraffes may emerge; or conversely: if it is tall, long-necked, and dappled patterned: savannah emerges.[16] This relationship is what produces the ecological *niche*, and it is precisely this relationship, which has been lost in the translation from evolution to architecture.

Coined by the naturalist Joseph Grinnell in 1917,[17] a niche was initially understood to mean the collection of components of an organism's habitat imperative to its survival. Zoologist G. Evelyn Hutchinson[18] later elaborated the term, specifying that the multi-dimensional space of resources (e.g., light, nutrients, structure, etc.) within a habitat could be occupied by multiple species and that the niche was a subset of that habitat containing particular resources imperative to one particular species: whereas different species can occupy the same habitat, they cannot occupy the same niche. In Gibson's words, "Let us observe that in one sense, the surroundings of a single animal are the same as the surroundings of all animals, but that in another sense, the surroundings of a single animal are different from those of any other animal."[19]

This clarification is imperative in the understanding of the term niche for the architect. Merely defining an environment is not enough for a species to survive, much as the oft-misused strategy of the "site analysis" is not enough

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Figure 4. Darwin's Galapagos Finches and their contexts. Based on a drawing in "Biological Science: Molecules to Man," Houghton Mifflin Co., 1963. Courtesy of the Author.

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Figure 5. *Girabra, Elefaffe, Zion*. Image courtesy of the author.

for the generation of architecture. While the standard site analysis might be capable of describing a habitat for several species, it is too generic as a process to abstract in the way that would be necessary to create the diversity of species that exist in a single environment.

The standard site-analysis will, ecologically speaking, produce a generic animal. If done "thoroughly" (impossible as it is), the all-encompassing site analysis would lead to a non-descript hybrid of all species inhabiting one environment, like the greyish-brown blob of paint resulting from the mixing of many colors. This all-mapping, all-responding organism would lead, quickly, to its own extinction. In practice, because every constraint cannot be mapped and subsequently responded to, a series of potentially random aspects are collected, leading in practice to a weak hybrid that recalls the mixing of species represented by the Giraffe's mistaken identity as a combination of the leopard and the camel. Reacting to select but random or unbracketed elements in the site produces a weak hybrid: a *Girabra*, an *Elefaffe*, a *Zion*. This chimeric combination of species is the consequence of an imprecise and overlapping 'abstraction' of information from the environment. Instead it is the selective and subjective abstraction of components of a habitat that forms the conditions for a specific response.

The map of the niche, as an *abstraction* made by the giraffe, for example, is a map particular to the specific species, containing tree-tops, some watering holes, and some speedier predators (man and the lion are the giraffe's only real threats). Other species in the same habitat might focus on other factors: the zebra's map may be dominated by the lower canopies (on which to dine), the elephant may focus on the trunks (on which to scratch) and the lion may map the long grass (from which to pounce). It is not the defining of the context that allows the giraffe to emerge but the *abstraction* of that context.

The seemingly self-evident relationship of the giraffe's formal attributes with its environment has resulted in its use as an example in many evolutionary discussions. Jean Baptiste Lamarck used it to support 'Soft Inheritance,' a theory in which features acquired during the lifespan of the animal were inheritable by its offspring: in this case, the giraffe's habit of stretching of the neck and fore-legs. Darwin's subsequent theory proposed instead that these transformations were *unmotivated*: that is, the variations were not *striving* to reach the tree-tops, rather, that "those individuals which had some one part or several parts of their bodies rather more elongated than usual, would generally have survived. These will have intercrossed and left offspring, either inheriting the same bodily peculiarities, or with a tendency to vary again in the same manner; whilst the individuals, less favoured in the same respects will have been the most liable to perish.... By this process long-continued … an ordinary hoofed quadruped might be converted into a giraffe." [20]

Many subsequent theorists have proposed more complex alternatives: that the giraffe's neck is secondary to the elongation of its legs which served to outrun its predators;[21] that its increased surface area is primarily a function of cooling;[22] or that the use of the neck and head for fighting in order to gain social dominance is a primary concern.[23] Regardless of the specific hierarchy of these features, each theory points to some *abstraction* of the environment made by the organism.

Even considering the treetops as having been primary in the giraffe's abstraction; the relationship is much more reciprocal and complex, unraveling into a web of interrelationships with arrows in both directions. For example, studies have shown that the thorniness of the East African Acacia tree—the Giraffe's preferred food— is induced by herbivorous activity.[24] In return, the lips, tongue, and inside of the mouth of the giraffe are covered in papillae and its skin is thick, to protect against these thorns. Further, the aggressive ants which inhabit the Acacia appear to act symbiotically with the tree in its defense: the ants inhabit the shoot tips of the upper branches—the Giraffe's preferred plant part—and are more likely to inhabit trees with more foliage.[25] This is only one strand of a complex web of reciprocal relationships that exists for all species of plants and animals. There are many more relationships between the giraffe and other species (birds eat ticks that grow on the giraffe's skin, lions eat giraffes, giraffes trample grass eaten by grazing animals like gazelle and deer). A change in any of these values—ants, thorns, tongue, skin, ticks, birds, lions, grass, gazelle, deer—each of which is a consequence of other factors like climate, predators, hunting, etc. could affect the others. The constant adjustment and negotiation is what nudges evolution forward, niches and species, constantly moving forward and spreading outward.

A fundamental part of the process of *abstraction* is described by Gibson as the *affordance* of an object: "what it *offers* the animal, what it *provides* or *furnishes*, either for good or ill."[26] Affordances exist as "action possibilities" latent in the environment, existing independently of the animal's ability to recognize them, but always in relation to and dependent upon the animal's capabilities.

Alternatively, Jakob von Uexküll's notion of *Umwelt* suggests that the meaning is not intrinsic to the thing but *bestowed* upon it by the animal, "*acquired* by virtue of having been drawn into that creature's activity."[27] Thus, rather than the animal fitting to its environment, the animal fits its environment to itself through giving meaning to it through use. Von Uexküll describes the organism as being able to see only its own abstracted world: as being "so wrapped up in its own *Umwelt* that no other worlds are accessible to it… as though each one were floating in its own particular 'bubble' of reality."[28] This bubble making gives meaning to reality: a different reality for each animal. Moreover, the meaning is based on a need and therefore implies an action: it tells the animal how to act in its world. Since no animal (including the human one) is capable of observing from a position of neutrality, the very act of perception, in which the meaning of use is direct and primary, inevitably implies an action.[29]

Returning to the niche, then, the process by which an animal *abstracts* his environment can be considered to reside partially in the environment and partially in the animal. *Abstraction* involves an *extraction* but also a *projection* of some kind of meaning in order to isolate the specific and useful elements from the white noise of generic perceptual world. The *niche* can be considered to be a concise collection of *affordance-umwelt* arrows, back and forth, between animal and environment, each propelling the other forward.

A simplified version of this relationship has been fundamental to many vernacular architectures: the color and minimal fenestration of Mexican adobe construction as a negative response to solar incidence, the double-jigged entrance in the Scottish stone hut as a response to the treeless windy hillside, the steeply-pitched roofs of the Malaysian stilt-dwelling as a response to heavy rains and uncertain ground conditions, the domed form and interior step of the igloo for minimal heat-loss and pooling of cooler air below the sleeping surface, and so on. For a long time, even the high discipline of architecture maintained the feint traces of the vernacular responsiveness, embedded, as it was, in the strict laws of architectural orders. Marc-Antoine (Abbé) Laugier's Primitive Hut (1755), for example, was a reminder of the origins of architecture and a call, amid the high ornamentation of the Baroque, to return to essentials, to reconnect the elements of architecture with their responsive origins in nature, to remember "man in his first origin, without any help, without other guide, than the natural instinct of his wants."[30] In his famous etching, the architecture seems bound to its niche, having abstracted what is useful and having reacted to it.

Despite similar calls for essentialism, Modernism's preference for internationalism over any 'natural instinct' led to an architecture absolutely contrary to any niche-based architecture. It was a standardized and globalized style that aspired to smooth out all special diversity and responsiveness, and it is from this idea of the generic (and all of its misinterpretations which proliferate today) that we are attempting to escape.

So why all of this wandering around in the savannah, when the vernacular could be our model? An iterative process by definition, using local materials and traditional technologies handed down through the generations, such a model would seem appropriate, and less removed from the discipline at hand. However, it is important to distinguish the performative vernacular that occurs at the moment of invention, from the symbolic vernacular, which occurs at the moment of retrospect. Anthropologist James Deetz has explained the latter using the notion of the "*mental template,*" an ideal prototype, which, he suggests, exists in the mind of the vernacular maker as a preconceived notion of how things *ought* to be made.[31] Such a desire

ENDNOTES

1. This shift in thinking has been described as having shifted from a focus on form to one "focused on the process of formation, to dynamic constitutive systems and ecologies, to techniques, building blocks, modules, evolution and diversity." Detlef Mertins, "Variability Variety and Evolution in Early 20th Century Bioconstructivisms," in Research and Design: The Architecture of Variation, New York: Thames and Hudson, (2009) p.55.

2. The occurance of Thompson's work in architectural publications is innumerable. See, for example, Philip Beesley and Sarah Bonnemaison's *On Growth and Form Organic Architecture and Beyond,* Tuns Press and Riverside Architectural Press, 2008, which includes essays relating Thompson's work with Architecture, as well as a bibliography.

3. D'Arcy Thompson, *On Growth and Form,* Edited by John Tyler, Cambridge: Cambridge (1961) [originally 1917], p.11.

4. D'Arcy Thompson *On Growth and Form,* Edited by John Tyler, Cambridge: Cambridge (1961) [originally 1917], p.10.

5. Blood Pressure and Flow Rate in the Girraffe Jugular

for appropriate form is, as has been described, absent in evolution, and it is precisely the lack of appropriateness that allows the niche-thinking model to stealthily evade preconceptions of the expected.

The case for the vernacular model is further undermined by its increasingly retrospective associations. With the advance of globalization, and the increasing loss of original local architectures, "the vernacular itself becomes a lost world—and with it, its field of study becomes the exclusive domain of historians."[32] As local responses to context have become historicized, they have been further internalized into the culture and symbolism of the place, bound to their own self-image, trapped in a loop of continuity without change.

Limited to representing the image of their type, and like Thompson's transformations, vernaculars can miss the internal and systematic "bulges" that occur as a result of parts reacting to disparate but related elements. Niche-thinking encourages a shift in focus from enclosure to system, where form and skin are merely a part of a complex web of connections within both the animal and the environment.

In short, while the vernacular as a model of adaptation begins with the responsive impulse, its reactions, with each generation, can become dulled by its own self-image. On the contrary, the opportunism of niche-thinking opens up to the complexity and contingencies of contexts, in which the environment is not singular, but consists of different potential "umwelten." Niche-thinking might be considered to be tactical, based, as it is, according to Michel de Certeau's definition, on actions produced out of moment-to-moment reactions to localized constraints, "always on the watch for opportunities that must be seized 'on the wing' constantly *manipulat[ing]* events in order to turn them into 'opportunities.'"[33] Similarly, Darwin describes natural selection as "daily and hourly *scrutinizing*, throughout the world, the slightest variations; rejecting those that are bad, preserving and adding up all that are good; silently and insensibly working, whenever and wherever opportunity offers, at the improvement of each organic being in relation to its organic and inorganic conditions of life."[34] Evolution does not have any overview; it has no goal; it cannot plan. Evolution is the unmotivated reaction to the local, which, as evidenced by the giraffe, can produce surprising and monstrous effects.

Using the model described in this essay, what we might now more properly call "*niche tactics,*" initiates a suppleness in the design process, a reactiveness to the need- or desire-based abstractions of the complex context, without the shackles of fixed types embedded within local culture. It proposes a more nuanced response to site: a response not only to the visible, the whole, and the objective, but also to the hidden, the systematic, and the idiosyncratic. Each final design, like each organism, is the result of a series of iterations or tests. Its presence will inevitably affect changes and continuities in future versions of its type.

Today, the natural processes of evolution are circumvented by artificial means: life support systems keep bodies—and thus lineages—alive, independent of the organism's fitness to its environment. Likewise in

Vein, TJ Pedley, BS Brook, and RS Seymour *Philosophical Transactions: Biological Sciences* Vol. 351 No 1342, Julu 1996, p.855

6. Hargens, A. R., Millard, R. W., Pettersson, K. & Johansen, K. 1987 "Gravitational Haemodynamics and Oedema Prevention in the Giraffe" *Nature*, Lond. 329, p.59-60.

7. The giraffe was one of the many species first formally described by Carl Linnaeus in 1758. He gave it the binomial name Cervus camelopardalis in the 10th edition of his *Systema Naturae*. Morten Thrane Brünnich classified the genus Giraffa in 1772. Linnaeus, Carolus (1758) (in Latin). Systema naturae per regna tria naturae :secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis.. 1 (10th ed.). Holmiae (Laurentii Salvii). p. 66, and Dagg, A. I. (1971). "Giraffa camelopardalis". *Mammalian Species* 5: 1–8.

8. Greg Lynn,"Multiplicitous and In-organic Bodies," in Folds, Bodies and Blobs, Collected Essays (Books-by-Architects), (La Lettre Volée, 1998)

9. In "Doing What Comes Naturally: Morphogenesis and the Limits of the Genetic Code," Martin Kemp cites the work of artists Naum Gabo (which relates to architectural investigations by Frei Otto), Jackson Pollock, and Theodore Cook. Also, John Frazer, in An Evolutionary Architecture, continues earlier studies into three-dimensional morphology by Haresh Lalvani—itself based on Buckminster Fuller's, Anne Tyng's and Louis Kahn's investigations into geometric transformations.

10. Charles Darwin, *Origin of Species*: sixth edition (1872) p. 48

11. Three species of ground-dwelling seed eaters; three others living on cactuses and eating seeds; one living in trees and eating seeds; and seven species of tree-dwelling insect eaters

12. Grant and Weiner 1999, from Joseph M. Craine, *Resource Strategies of Wild Plants*, Princeton University Press, (2009) p.6.

13. Jeffrey Podos, Correlated Evolution of Morphology and Vocal Signal Structure in Darwin's Finches, *Nature*, Vol. 409, 11 Jan. 2001, pp. 185-8.

14. James J. Gibson, *The Ecological Approach to Visual Perception*, Lawrence Erlbaum Assoc. Inc. Publishers, New Jersey 1986 (Originally 1979) p.8.

15. Although, as Ingold notes in "Point, Line and Counterpoint" Gibson is ambivalent on the equality of this relationship.

16. This example is a paraphrasing of the example used in the Synergistics and Synaesthetics units of the Manchester School of Architecture's Bioclimatic School by Professors Greg Keeffe and Geoff McKennan.

17. J. Grinnell, "The niche-relationships of the California Thrasher" Auk 34: (1917) p. 427–433.

18. Hutchinson, G.E. (1957). "Concluding Remarks," Cold Spring Harbor Symposia on Quantitative Biology 22 (2): 415–427. Hutchinson's exact words (ref. 1, p. 416) were that the fundamental niche is a volume in which "every point... corresponds to a state of the environment that would permit the species ... to exist indefinitely"

19. J.J. Gibson, *The Ecological Approach to Visual Perception*,

Lawrence Erlbaum Assoc. Inc. Publishers, New Jersey 1986 (Originally 1979) p.7.

20. Charles Darwin, *Origin of Species*: sixth edition (1872) p. 177

21. Chapman Pincher, "Evolution of the Giraffe," Nature vol. 164, (1949) pp. 29-30.

22. A. Brownlee, "Evolution of the Giraffe," in *Nature* vol. 200, (1983) p.1022.

23. Simmons, Robert, and Lue Scheepers "Winning by a Neck: Sexual Selection in the Evolution of the Giraffe," *The American Naturalist* vol. 148, (1996) pp. 771-786.

24. A.V. Milewski, Truman P. Young, and Derek Madden, "Thorns as Induced Defenses," *Oecologia*, Vol. 86, No. 1 (1991), pp. 70-75

25. In addition, species of Acacia without the ants tended to have longer thorns. Symbiotic ants as an alternative defense against giraffe herbivory in spinescent Acacia drepanolobium: (Derek Madden and Truman P. Young, 1992)

26. James J. Gibson, The Ecological Approach to Visual Perception, Lawrence Erlbaum, September 1986, p.127 Italics in original. The term is similar to "aufforderungscharakter" coined by Kurt Lewin to describe this "invitational" or "demand" quality intrinsic to objects: the meaning that is perceived in an object, according to the needs of the observer. A mailbox, for example, only has a demand character only when I need to mail a letter.

27. Tim Ingold, "Point, Line and Counterpoint," in *Being Alive, Essays on Movement, Knowledge and Description*, Routledge, NY, 2011, 79, referring to J. von Uexküll, The theory of meaning, trans. B. Stone and H. Weiner from Bedeutungsslehre (ed. T.von Uexküll). *Semiotica* 41(1): 25-82 1982 [originally published in 1940], 27-29.

28. Tim Ingold, "Point, Line and Counterpoint," in Being Alive, Essays on Movement, Knowledge and Description, Routledge, NY, 2011, 80 referring to J. von Uexküll, A stroll through the worlds of animals and men: a picture book of invisible worlds, *Semiotica* 89(4): 319-391, 1992 [originally published in 1934], 338-339.

29. For more on the difference between Affordance and Umwelt, see Tim Ingold, "Point, Line and Counterpoint," in *Being Alive, Essays on Movement, Knowledge and Description*, Routledge, NY, 2011, 79-80.

30. Marc-Antoine (Abbe) Laugier, *An Essay on Architecture*, London (1755) p.9; http://www.archive.org/stream/essayon architect00laugrich#page/15/mode/1up

31. James Deetz, *Invitation to Archaeology*, Doubleday, 1940.

32. Marcel Vellinga, "The Inventiveness of Tradition: Vernacular Architecture and the Future" in *Perspectives in Vernacular Architecture*, Vol. 13, No. 2, Special 25th Anniversary Issue (2006/2007), pp. 115-128 (117).

33. Michel de Certeau, *The Practice of Everyday Life*, University of California Press, (1984) p. xix

34. Charles Darwin, *Origin of Species*: sixth edition (1872) p.65; three others living on cactuses and eating seeds; one living in trees and eating seeds; and seven species of tree-dwelling insect eaters

architecture, additive artificial systems—air conditioning, for example—allow habitation to venture into and survive in environments without any fitness in their inherent formal-mechanical-material systems. Thus, any potential response is superseded by the possibility of external solutions. While the discipline has already started to acknowledge that such architectural life-support has negative consequences for the environment, what is perhaps less acknowledged is the effect that the life-support systems (as well as some so-called sustainable responses) have had on the legibility of this relationship between the architectural organism and its niche.

In *Niche Tactics*, as the morphology and the system co-evolve, some awkward stretches, contortions, bulges, or splays may be fitting, in relation to opportunities and their counterparts in the environment. As the form strives to collect water, light, space; to mediate temperature, visibility, and solar gain; to dispose of waste; to defend itself; to attract, to display, to hide; and to do this in perhaps more extreme ways due to existing surrounding competition, new morphologies and systems emerge. These new forms do not fit into our expectations of known types but are a complex transformation of body and parts that is a specific response to environment, an abstraction that allows the environment to be reread in relation to its new species. ◆