Techniques and Natures. For an anthropological approach to biomimicries

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TECHNIQUES AND NATURES

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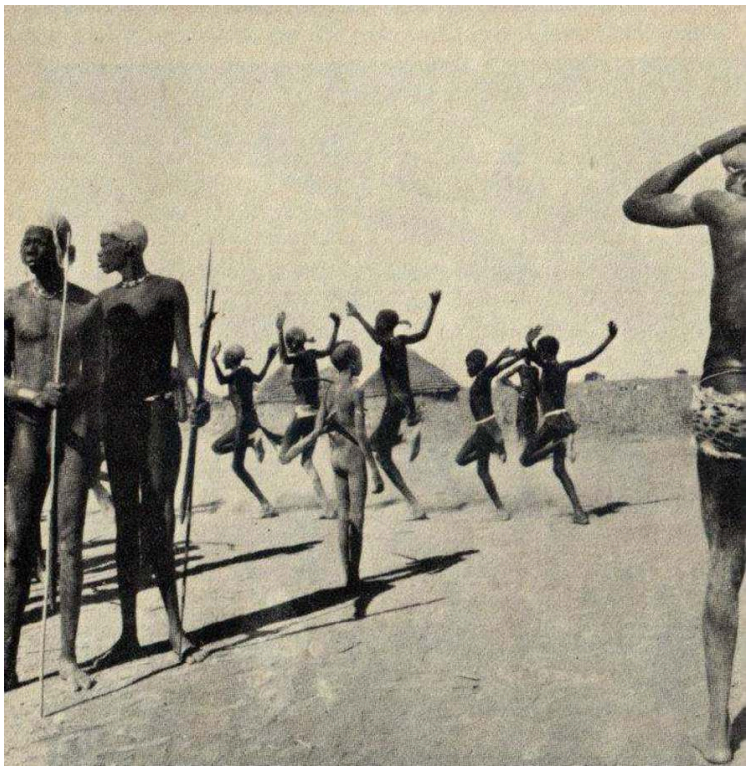
Opening image.



In *Divinity and Experience: The Religion of the Dinka*, Godfrey Lienhardt publishes a photo of young boys imitating cattle in a dance. The curvature of the arms is presented as a graceful body posture that men adopt for their own pleasure when alone with their herd.
2003 [1961] NY : Oxford University Press

Biomimicry refers to a set of processes and procedures of making that seek to imitate nature and living systems in order to invent and build objects or processes useful to humans. Since the imitation may be more or less faithful or complete, the concept of bioinspiration is often used, to point to the fact that the observation of nature provides the general orientation that stimulates biomimetic technical projects. Since the publication of Janine Benyus's book *Biomimicry* (1997), biomimicry seems to have been established as the new way of doing things—or even a revolutionary paradigm—which scientists and manufacturers must adopt in order to make discoveries and develop original technical projects that will both be less destructive to the environment and will encourage economic development. Although this new way of doing things is presented as an urgent solution to ecological, economic, and social crises, it is important to slow down and take time to consider and reflect on it. The need for a technological paradigm shift in order to avoid aggravating ecological catastrophes and the extinction of living species means it is necessary to be vigilant and rigorous when it comes to sketching out ideas that will guide new models of individual and collective action. The American biologist Benyus pleads for an approach to innovation that would respect certain principles defined as "a canon of nature's laws, strategies and principles" (Benyus 1997: 7). On the website *AskNature*, which was launched in 2008 and explains the author's theory for a large audience, nine "Life's Principles" are presented. These "laws" of living nature state that nature operates on sunlight, valorizes local expertise, and recycles everything. For Benyus, it is a matter of considering nature not as a source of materials to be extracted, but as a model, a master creator whose work

should be imitated. These ideas about nature are summarized in several statements at the beginning of her book:

> 1. Nature as model. Biomimicry is a new science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems [...]
> 2. Nature as measure. Biomimicry uses an ecological standard to judge the "rightness" of our innovations. After 3.8 billion years of evolution, nature has learned: What works [...]
> 3. Nature as mentor. Biomimicry is a new way of viewing and valuing nature. It introduces an era based not on what we can *extract* from the natural world, but on what we can *learn* from it. (Benyus 1997: front matter, no page number).

1 These propositions make biomimicry a favorable domain for reflecting on the relations between nature and techniques from an anthropological perspective, beyond the philosophical opposition between projects to master nature through technique and critics of such projects (Descartes 1999 [1637], Dagognet 1988, Ellul 1964, Heidegger 1993). André Leroi-Gourhan (1993 [1970]), who describes the emergence of techniques within the natural world, and various authors in the fields of Science and Technology Studies (Latour 1993), the anthropology of nature (Descola 1996), and anthropology inspired by phenomenology (Ingold 2000) demonstrate that studying technical processes allows us to go beyond the nature/culture dichotomy—in particular when we view productive practices (i.e. agriculture, livestock raising, medicine, fermentation, etc.) through the lens of their relations to biological processes (Coupaye 2013; Pitrou, Coupaye & Provost 2016). From this point of view, biomimicry refers to technical activities and conceptions of nature that are more complex than those identified by Benyus.

2 Benyus's book *Biomimicry* invites us to look with marvel and admiration upon nature, which "does" things so well. This enthusiasm for the "wonders of nature" is in direct line with the tradition of *curiositas*, which was behind the creation of "cabinets of curiosity" in the 16th century. These cabinets testify to an "interest in observing nature in order to know it better" (Rivallain 2001: 18-20). It was during this period that Leonardo da Vinci, who himself owned a cabinet of curiosities, composed his *Codex on the Flight of Birds* (1505), in which he observed the flight of birds in order to invent a flying machine. Da Vinci is often presented as the first biomimic, the forefather of a long line of engineers that includes Gustave Eiffel, architect of the Eiffel Tower, which was built in 1889 by replicating the structure of the femur bone, and Clément Ader, whose 1897 *Avion III* was inspired by the fruit bat (Wanieck *et al.* 2017).

1. Avion III (1897) by Clément Ader based on the observation of bat flights

From the work of Leonardo da Vinci to current Airbus research on the falcon and the manufacture of drones with wings, there is a long filiation between biomimicry and aeronautics.
Musée des Arts et Métiers, Paris. CC by SA

3 The recurring reference to wonder in standard discourses about biomimicry emphasizes the fact that humans have very different motivations when they seek to imitate nature. Games, rites, art, science, and engineering all adopt very different perspectives on the natural world when they seek to objectivize its salient traits. Playing at walking like an animal, imitating the dance of a bird during a wedding rite, or creating a work of art "based on nature" are all biomimetic practices, just like the flagship projects usually highlighted in discussions of biomimicry. Anthropologically, instead of studying biomimicry in the singular, we would do better to catalogue the different biomimicries at work in different socio-technological contexts. In this way, we can understand how imitation brings beings together by establishing highly variable relations and attachments between humans and non-humans, without reducing imitation to the representational logic of mimesis, which is based on a dichotomy between original and copy.

2. Automaton flute player and Vaucanson duck

These artefacts illustrate the paradoxical beliefs in the eighteenth century: "on the one hand, life and intelligence could be understood by reproducing them, and on the other hand, life and intelligence were precisely defined by the impossibility of reproducing them" (Riskin 2003: 633).

BnF, estampe v. 1749-1750, collection Michel Hennin, public domain

Epistemological reflection on a social phenomenon

The success of biomimicry can be explained by the fact that it presents imitating nature as a way of breaking with productivist practices. In addition to the abundant literature on the subject, the biomimetic approach has been institutionalized in various domains within engineering and scientific research,[1] as well as in education and public policy. Thus, in many European countries, the international enthusiasm for biomimicry has permeated the worlds of higher education and research. This is especially true in Germany, where in 2017 Ceebios[2] counted a total of 15 university degree-granting programs in biomimicry. Beginning in the fall of 2020, France will also have two university training programs specializing in biomimicry. The approach is also mentioned as a catalyst in the French Biodiversity Law of August 8, 2016, sponsored by Minister of Ecology Ségolène Royal, and today is an integral part of the national strategy for ecological transition promoted by the Ministry for the Ecological and Inclusive Transition of France. Finally, this approach is at the heart of numerous exhibitions[3] and experiments by citizen-scientists.[4] Biomimicry is thus a social fact that must be studied not for the purposes of “doing” biomimicry but in order to better understand the relations that humans establish with their natural environments through this type of technical activity.

4 In this issue, we do not wish to sing the praises of biomimicry; our intention is to stimulate thought and reflection around this notion, building on the work we began

during a conference organized at the Collège de France in 2014 (Pitrou, Dalsuet & Hurand 2016). The objectives pursued by biomimicry are so noble—protecting the environment, creating new forms of co-operation within human societies—that it might seem discordant to probe the coherence and solidity of the set of propositions and experimentations associated with it. But are we certain that there are no drawbacks to imitating nature and living systems? Have we properly measured the consequences that raising nature up as a model to be imitated will have on the organization of human societies? At a time when sustainable development and green growth are being critically assessed, how can we make sure that the biomimetic option leads to effective changes in the technical processes that characterize industrial societies? The attraction exerted by a field as diverse as biomimicry—which is part a history of civilization, part an inventory of processes, and part an encyclopedia of forms, materials, structures, and so on—does not cancel out the need to question its empirical foundations and its theoretical coherence. The immediate support it engenders should, in fact, encourage us toward epistemological prudence.

A diversity of biomimetic techniques

As anthropologists carrying out ethnographical research on conceptions of life in very diverse socio-technical contexts (Amerindian societies in Mexico, scientific companies and laboratories in France, the Biosphere 2 project in Arizona, hospitals in France and in India), it seemed useful to us to bring together articles that describe a wide range of practices, in order to spur collective reflection on the basis of concrete empirical data. In contrast to philosophical approaches, which can often be abstract and textual and which focus on defining what biomimicry *is* or *should be* (Matthews 2011; Dicks 2016), the descriptive process has the advantage of explaining what human beings *do* when they imitate nature or declare the desire to do so. Rather than considering imitation to be a universal mechanism, or seeking at all cost to distinguish between "biomimicry" and "bioinspiration," and thus to establish and set their meaning from a strictly semantic point of view, it is better to inspect the diversity of techniques involved when humans seek to reproduce living systems: body techniques; cognitive techniques (measurements, records, surveys, etc.); making and using artifacts and machines; creating artificial environments. Opening this black box to reconstruct the operational chains at work in imitation makes it possible to shed light on hybrid processes that combine observation, conceptualization, calculation, visual representation, schematization, fabrication, experimentation, and so on.

5 The subtitle we have chosen for this issue of *Techniques&Culture*—"imitating living beings and modelling life"—refers to the two poles between which these kinds of technical operations can be classified. We may distinguish two complementary aspects of biomimetic projects: humans may focus on organisms and select characteristics of their morphology and behavior to replicate, or they may examine the systems of ecological relations that take shape around organisms. We propose referring to this latter as "modeling life," an undertaking that should not be confused with "imitating living beings," which applies to the former. In this context, "life" is defined as a set of causes that produces "living beings": biological units that are "alive."

6 Imitation involves reproducing the signs (sounds, colors, odors, etc.), behaviors, and functions that humans observe in living beings. From ceremonies (dances, masks, body

ornaments) to robotics, by way of agricultural or therapeutic practices or camouflage used for hunting, a wide variety of body techniques and material elements involve selecting and replicating the morphological, physiological, and functional characteristics observed in organisms. As for modeling life, it involves reproducing, within artificial systems and for experimental purposes, the conditions that allow living beings to exist. From ritual miniaturizations in the Andes and Mesoamerica to systems such as the Biosphere 2, by way of Achuar (Descola 1996) or Mayan (Ford & Nigh 2015) gardens and microforests, there exists a wide array of such practices to be studied and documented.

7 This issue brings together case studies that were carried out in very different socio-technical contexts and that demonstrate very different "theories of life" (Pitrou 2019) within different social organizations. One group of texts draws on ethnographical material from traditional societies in Oceania (Florence Brunois-Pasina), East Africa (Jean-Baptiste Eczet), Central Asia (Roberte Hamayon), and Mesoamerica (Perig Pitrou) to examine various ways of imitating living beings or modeling life. These authors' analyses show that these practices, often carried out as part of rites, have distinct purposes: they may be agricultural or hunting techniques, or involve the construction of the body or the person; they may be part of social organization (age groups, initiation, alliances, etc.) or of systems of collaboration and exchange with non-humans. Studies that focus on scientific laboratories showcase a range of projects that take inspiration from living systems in order to perform experiments: cataloging the potentials of micro-organisms at the French National Museum of Natural History (Mathilde Gallay-Keller); creating a work of art that reproduces fish songs (Lia Giraud et al); using microfluidics to make proto-cells (Cyrille Jeancolas); a bio-designer's creation of a bioluminescent lamp (Lauren Kamili); the discovery of "molecular machines" in a chemistry lab (Sacha Loeve); the construction of robots that imitate the movement of ants (Stéphane Viollet) or crabs (Elizabeth Johnson). We shall see that in all these experiments, the same problematics can be found. Studies of farmaculture in Japan (Yoann Moreau & Masumi Oyodomari) and of the restoration of a river in France (Marie Lusson) emphasize the coexistence of ecological practices and the techniques of the naturalist West within the same project.

8 Comparing data gathered from such diverse sociotechnical contexts confirms the heuristic value of the comparative approach. Of course, we could ascribe a recent origin to the notion of biomimicry as it has developed in the West.[5] But anthropology takes a larger view. Far from being brand-new phenomena, the imitation of living beings and the modeling of life are found in many societies, involving practices that are sometimes quite ancient and are much more complex than they might appear at first glance. There are thousands of ways to imitate a living being. Even the "mimetic rites" of the Aborigenes, which Émile Durkheim presented as primitive forms of religious organization, are sophisticated systems that objectivize very distinct orders of facts (forms, processes, behaviors, etc.) by drawing on a vast repertory of technical processes (Durkheim 2008 [1912]). Jessica Riskin's work (2003) on Vaucanson's automatons emphasizes how the problems contemporary science encounters when it seeks to imitate living systems were already at the heart of artisanal practices. Without anthropology and history, we risk missing the fact that the most recent version of biomimicry is but one particular case—a variant—of a broader phenomenon, and must be understood within a larger framework.

3.

The similarities observed between the organization of the Achuar gardens and that of the Ecuadorian Amazon forest invite us to reflect on the imitation of ecosystems from a broader perspective. If gardens can be seen as micro-forests, it is because forests are conceived as macro-gardens shaped by non-human entities. (Descola 2016)

9 There are two possible options here. We could choose to reserve the term biomimicry for the meaning the word has taken on over the past few decades, distinguishing it from forms of imitation and modeling found in traditional societies, on the grounds that for the sake of rigor, different terms should be used to designate each of these forms. Or, we could decide to develop an anthropological concept of biomimicry on the basis of the wealth of empirical data anthropologists have gathered from very different societies. We have chosen this second option, maintaining that there are different ways of practicing and understanding biomimicry, all of which are complex and worthy of respect. This is why we have chosen to speak of biomimicries in the plural.

Technical innovation and the diversity of relations to nature

This issue of *Techniques&Culture* represents an epistemological experiment that seeks to formulate new problematics for studying biomimicry (see Provost, Pitrou, Kamili 2020). One of our goals is to determine the conceptions of nature that correspond to the "technological choices" (Lemonnier 1993) made in biomimetic projects.

10 Many pages could be dedicated to unpacking the foundations and theoretical implications of Benyus's propositions mentioned earlier, for their axiomatic and axiological value is quite debatable. To summarize our argument: while Benyus and her followers hope to guide humans toward a new regime of interactions with nature, in reality they simply invert a hierarchical relation, without really reshaping the

fundamental conceptions of Western naturalism (Descola 2014). In comparison to the Cartesian project of mastering nature, the biomimetic or bioinspired ideal does indeed call for more humility, but it is content to replicate its hierarchy: it is nature that is put in the position of an engineer who has carried out experiments for millennia, while humans must symmetrically take a subordinate position to it. However, it is doubtful that this role reversal is helpful in grasping the complexity of natural systems or the wealth of human experiments carried out to interact with them.

4. In the territory of the Huichol people of Mexico on the ninth day of the Naxiwyéri ceremony or Taurus Day

The man who embodies the bull during the ten days of the ceremony rolls in the blood of one or more sacrificed bulls. This festival, which relates the Huichol's resistance to the Conquest, takes place the week before Shrove Tuesday.

Tuxpan de Bolaños, 2012 © Ivan Alechine

11 First of all, the scientific conception of nature as an engineer is debatable. Yes, we may be fascinated by the end results of physio-chemical or biological process when we see things like glass structures produced by diatoms, or snail shells. But it would be a mistake to think that nature, in its totality, does more than achieve local optimums, which often are in tension with one another. It may be instructive to observe natural phenomena, but claiming that they behave like engineers is more problematic. The metaphor risks legitimizing finalist forms of reasoning and even theological representations (Chansigaud 2011). As for us, we are committed to the understanding of evolution summarized by François Jacob in his article "Evolution and Tinkering" (1977). Against a view of nature as following a plan like an engineer, the French biologist draws on the work of Lévi-Strauss (1966) and mobilizes the notion of bricolage to describe the randomness of natural phenomena. To us, it is a conceptual error to see nature as perfection or as the manifestation of a series of trials and errors when, from

the molecular to the eco-systemic level, it displays chance and necessity above all. Such play of possibilities is also found within human societies, in the inventiveness that characterizes human techniques for interacting with natural systems. In *Beyond Nature and Culture*, Descola (2014) establishes that, like technical innovation, the forms of the collectives that humans construct with non-humans depend on the ontological regimes within which they develop. It is not only the comparison between nature and an engineer that is debatable: the very idea of a uniform domain, objectivized in the same way across all societies, is erroneous. Even if Benyus's understanding of nature reverses the traditional hierarchy, it expresses a Western naturalist view that must be compared to other ontologies. What does it mean to imitate living beings or to model life within an animistic, totemic, or analogist regime? Doesn't the valorization of a process such as imitation—which is analogical by nature—within the naturalist procedures of Western science and engineering express an ontological upheaval underway?[6] It is crucial to at least formulate these questions in order to gain some perspective on biomimicry.

12 Concentrating on what humans actually do when they imitate nature—rather than merely exhorting them to do so—means looking at the evolving nature of natural systems and human inventiveness. Biomimicry's praise of nature sees evolution as a quest whose results are final—as if different evolutions were no longer imaginable. This is undoubtedly why biomimicry's most standard images and discourses sometimes seem to reduce the richness of natural configurations to stereotypes. As a result, the same stories and images are repeated: rather than illustrating the fecundity of nature, what is expressed are above all the technicist and functionalist frameworks used to observe living beings. Paying attention to functions alone obscures the fact that the nature biomimics refer to is itself a construction, including within the natural sciences: "we have to remember that what we observe is not nature in itself but nature exposed to our method of questioning" (Heisenberg 1958: 25).

The biomimetic dynamic beyond static forms and functionalism

The dynamic inherent in the continuous dialogue between techniques and natures requires us to go beyond static points of view that establish term-to-term correspondences between natural and technical phenomena. The website *AskNature*[7] is an example of this type of view, which examines natural beings as part of a quest for solutions to technical problems. Over 1700 "biological strategies" are referenced there, with nearly 200 "ideas inspired" by nature. In comparison to the billions of living beings that exist on Earth, these figures indicate that we are far from generating a biomimetic encyclopedia that would mirror the great book of nature. The presentation and comparison of side-by-side images from nature and from biology makes clear the analogical aspect of biomimicry, which involves drawing correspondences between entities from the natural world and artificial objects.

13 Although such associations are convincing, we ought to examine the motivations behind projects to establish these analogies. The chiasmus between a nature that is already seen as a technician and a humanity that should naturalize its practices must be evaluated. Developing an anthropological concept of biomimicry means not only reconstituting the understandings of nature and techniques that are dominant in human societies: it also means reflecting on the non-utilitarian objectives pursued in

the imitation of living beings. Roberte Hamayon's work, which she discusses in her interview in in this issue, reminds us that understanding metaphors is essential for grasping the complexity of the relations humans create with their environments. Rites as well as games—and, ultimately, all the technical and social constructions that mobilize symbolic thought—remind us that the domain of techniques contains worlds of meanings that are much vaster and richer than the quest for function, the identification of problems, and the search for solutions.

14 In order to open ourselves up to this richness, we must not be content with seeing imitation of the world solely in terms of the logic of correspondence: the connections that are established through imitation must be demonstrated. This is why it is beneficial to approach biomimicry from a pragmatic and interactional point of view. Let us take the example of interspecies communication, during which a human being adapts his or her movements and gestures to an animal. Here, imitation does not mean copying what animals do into the human register; rather, it constitutes a common ground on which attachments and community can be created. Analyses of rituals by various authors show just how much human societies draw from the potentials contained in imitation. Imitation, whether it allows one to adopt the point of view and subjectivity of the other or aims to co-ordinate interactions between beings who remain separate, is ultimately a polyvalent mode of action for constructing a multiplicity of relations both between different humans and between humans and non-humans.

15 We speak of biomimicry in the plural not only in order to defend the idea of cultural diversity, but also to show that even within the same society, there are multiple ways of observing and imitating phenomena. Thus, let us reserve a place within our analyses for an entire swath of less-noted biomimicries—ludic, ritual, artistic, empathetic, etc.—even if these are less organized or structured than those emphasized in contemporary discourses. Our hope here is to forge a more solid concept of biomimicry by reflecting on the types of collectives that humans establish when they imitate their natural environment and the beings who live there.

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NOTES

1. For a presentation of the state of the art, see: Molina & Raskin 2018; Chayaamor-Heil, Guéna & Hannachi-Belkadi 2018; Wanieck, Fayemi, Zollfrank *et al.* 2017; Pawlyn 2011. For a mass-audience presentation, see Chapelle & Decoust 2015. On engineering, see Roth 1983; Coineau & Kresling 1987; Vogel 1988; Vincent *et al.* 2006. On green chemistry, see Anastas & Warner 1998.
2. Ceebios stands for Centre européen d'excellence en biomimétisme de Senlis (Senlis European Center for Excellence in Biomimicry).
3. In addition to the major annual exhibition Biomim'Expo organized at the Cité des sciences et de l'Industrie, let us note the exhibits "Biomimétisme. Quand la nature inspire l'innovation" ("Biomimicry: When nature inspires innovation") at the Nîmes Museum of Natural History

(2019); “S’inspirer du vivant: le biomimétisme de Léonard de Vinci à nos jours” (“Inspired by living beings: Biomimicry from Leonardo da Vinci to the present”) at the Musée de Sologne in Romorantin-Lanthenay (2019); “La fabrique du vivant” (“The Factory for Living Beings”) at the Centre Georges Pompidou (2019); and “En vie: Au frontières du design” (“Alive: At the frontiers of design”) at the Espace foundation EDF (2013). In April 2020, an exhibit on the imitation of the living was held at the Cité des sciences et de l’industrie.

4. For example, the Biotope project led by Helena Amalric at Terre Vivante (Isère), and the Low-tech Lab, an association located in Concarneau (Finistère).

5. The biophysician Otto Schmitt (1969) was the first to use the term “biomimetic.”

6. We are grateful to Pierre-Olivier Dittmar for this suggestion.

7. https://asknature.org