Animal Ensembles, **Robotic** Affects
Bees, Milieus, and Individuation

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> That they are able to fly by an indirect route and yet reconstruct the true direction without the aid of ruler, protractor, or drawing-board is one of the most wonderful accomplishments in the life of the bee and indeed in all creation.
>
> — Karl von Frisch, *The Dancing Bees*

Quite often the Second World War is represented as the dividing line between two worlds: the industrial era of modernization and the postindustrial era of computers, network technologies, and "postmodernization." The concerted planning, funding, and building of intelligent information systems from signal engineering to computing and social systems took off during that postwar period branded by the Macy Conferences in Cybernetics (1946-1953), officially titled Cybernetics: Circular Causal and Feedback Mechanisms in **Biological** and Social Systems. The conferences synthesized much of the interest in research into *animal* worlds, affects, and technological systems and represented a peculiar social institution in themselves—something that has not escaped the interest of cultural theorists and historians. John Johnston offers, to my mind, the best and most refined analysis of the significance of that cybernetic period as a rethinking of the various complex ties among actual **machinery** such as computers, information and control sciences, and the refashioning of living systems as information entities instead of heat engines.[1] The coinvestigation into computing and how life is fundamentally conceived is defined by "the regulation of passage of information," which incidentally pointed out for writers such as Norbert Wiener not only the importance of Gibbsian statistical mechanics but also the crucial context of "Bergsonian time," which both living organisms and modern automata shared.

However, most often the critical focus has been on the theoretical and practical discourses surrounding human-**machine** interaction. The talk about "giant brains" and "thinking **machines**" was only the popular cultural tip of the iceberg in a much more complex field of translations among informatics, psychology,

1 John Johnston, *The Allure of Machinic Life, and the New AI* (Cambridge, Mass.: MIT Press, 2008), 25–27.

sciences of the brain, and other disciplines in which work on formalizing the functions of thought was taking place. The research surrounding computers was focused on the specific faculty of thinking, and the human **being** was seen as the ultimate behavioral and architectural model. Physiology fed into design of computer systems that remediated organs and memory as if in the human "system."[2] Popular representations of science embraced these references to similarities in **machine** and human brains,[3] and indeed the scientific discourse used a lot of **biological** metaphors as well: John von Neumann's pioneer research relied much on such metaphoric uses, in which the radically *nonhuman* wirings of computer architecture were made familiar with the help of ideas relating to the human measure and phenomenology. Quite strikingly, technical media that had not much to do with the human dimensions were mapped onto the human body plan that had structured politics and models of thought for centuries. For example, the McCulloch-Pitts model of the brain neuron provided a bridge between fleshy embodied brains and logical patterning that could be used to build computer "brains." Despite attempts of this type, using the human **being** as a model of **intelligence** to cover the material reality of the world, the problem was far from resolved, as N. Katherine Hayles has remarked. Continuously haunting the scientists was the task of "how to move from this stripped-down neural model to such complex issues as universals in thought, gestalts in perception, and representations of what a system cannot represent."[4] No matter how well thought, there always remained a fringe of unrepresentable stuff in/of the body.

As Hayles notes, Warren McCulloch was continuously interested in the importance of embodiment for calculations. The drive was toward seeing how human **beings** and computers could share a similar ontological background in flows of binary codes. This could be seen as part of a very pragmatic "management task" of controlling the temporality of *animal* bodies in terms of informational events. Hayles continues that McCulloch was continuously interested in signal processing, where the signal is always a very material one. What interests Hayles is how concepts such as the McCulloch-Pitts neuron stood as "liminal object(s)"[5] that helped to translate between interests in mathematics and concrete embodied constructions. To paraphrase Hayles, the embodied constructions provided an effective way to value cybernetics "in-action." Indeed, a whole cybernetic zoo emerged after the Second World War, ranging from William Grey Walter's **robot** tortoises to Norbert Wiener's moth automata that reacted to light (the moth working toward light, the bug running away from light) and from Claude Shannon's maze-solving rat devices to the interest in ant and bee communication that emerged in the midst of the Macy conferences.[6] *Animals* were at the core of the cybernetic interest and the turn toward the informatic biopower of network society. As Johnston has recently demonstrated, the postwar period can be characterized as one of a systematic rethinking of the relations between physical processes (life) and information (computers as the symptomatic **machine**). Such transactions between discourses provided a new ontology for rethinking "computational organisms," as in the case of cyberneticist W. Ross Ashby's

2 See David F. Channell, *The Vital* **Machine**: *A Study of Technology and Organic Life* (New York: Oxford University Press, 1991), 120–21.

3 William H. Laurence, "Science in Review: Cybernetics, a New Science, Seeks the Common Elements in Human and Mechanical Brains," *New York Times*, December 19, 1948.

4 N. Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago: University of Chicago Press 1999), 57.

5 Ibid., 62.

6 Ibid., 62–63.

suggestion that any system that is sufficiently complex and dynamic will produce a group of organisms specific to it.[7]

This chapter focuses on the zoology of communication and cybernetics. Embodied forms of life became of crucial interest for the emerging technologies and discourses of control. Dealing not only with disembodied logics and a Platonist dualism of body versus matter, they more closely suggested translations between different spheres in terms of pragmatics: what works, what does not. Experiments along these lines emphasized the contrast to the post-1956 **artificial intelligence** research that focused more on disembodied logic and cognitive psychology; cybernetic zoology relied on the embodied and contextual *animality* of both **machines** and nature.[8] This insistence on embodiment inherent in the new regimes of cybernetics, informatics, and their **machines** and **robots** can be further connected to the themes and arguments I have suggested concerning biopower and the capturing of *animal* affects in the culture of technical modernity. In addition, in this latter context we see the theme of technology or media emerging as an *animal* or even an insect. Naturally insects were not the only *animals* discussed, but they represent one particular example that was of interest in terms of their less brainy but complex modes of action, behavior, perception, and, not least, communication.

Communication was of special interest in the postwar situation. As Charlotte Sleigh argues, the communication was well recognized in terms of the funding and attention it received in the United States. *Animals* provided examples of "effective orientation and meaningful communication"[9] in a manner that was to be directly translated into military and social tools. From ants to bees, fish to various other examples that could be turned into cybernetic circuits, communication was seen not only in technological terms. Or, to be more accurate, the technological interest in communication and perception was broadened to also encompass living entities such as insects.[10] If the nineteenth-century era of early technical media was intimately tied to experimental psychology and the measuring of the reaction times and perception thresholds of the body, the post-World War II rise of the digital media culture was embedded in a new valorization of experimental biology. As Warren Weaver has noted, experimental biology was seen as a priority research area that could feed solutions to social registers as well.[11] From Karl von Frisch's communicating bees to William Grey Walter's tortoise **robotics**, the question of the perception of the *environment* and orientation in space and time became key themes for the development of sensing technologies. These can be framed in the theoretical innovations of Gilbert Simondon, writing around the 1960s, on notions of information that tried to evade the age-old hylomorphic schemes of "matter-form." Hylomorphism can be seen as characterizing the cybernetic models of communication as well. Instead, with Simondon, information came to be understood as intensive relations with the *environment*, something that was pragmatically understood in research on matters from problem-solving **robotics** to bees' *food* excavation trips. With Simondon and his ideas on "individuation," we gained a strong theory that the relation between an entity and its *environment* is not to be understood in terms of structure, a priori forms, or stability. Instead the individuating

7 Johnston, *The Allure of* **Machinic** *Life*, 8–9.

8 Ibid., 58–60.

9 Charlotte Sleigh, *Six Legs Better: A Cultural History of Myrmecology* (Baltimore, Md.: Johns Hopkins University Press, 2007), 170.

10 John Lubbock had already experimented on bees' sense of direction and faculties of communication at the end of the nineteenth century. See John Lubbock, *On the Senses, Instincts, and* **Intelligence** *of Animals, with Special Reference to Insects* (Boston: Elibron/Adamant Media, 2004). The book originally came out in 1888.

11 Sleigh, *Six Legs Better*, 174–74.

entity is a temporal becoming that works by creating topological solutions (instead of "having" geometrical presolutions) to problems encountered. Instabilities are organized into metastabilities.[12] This is where a link with the temporal dynamics of the ethological relations of *animals*, analyzed in earlier chapters, connects with the cyberneticdiscourses of 1950s and 1960s and where Simondon offered a materially situated way of evaluating and appreciating information — not as a pattern that is beyond or outside its material expressions but as an intervention between entities and milieus to be understood through notions such as individuation and transduction. We will return to these complex notions later.

The adoption of ants and bees as problem-solving **machines** has been a key theme in information sciences since the early analysis of ant trails and bee hives around the 1950s. Researchers such as Adrian Wenner suggested approaching the hive as a Markov process that was to be analyzed according to population-level probabilities.[13] In recent years research into social insects (especially ants) as "optimization **machines**" has risen to be a whole research field of its own.[14] Ant colony optimization algorithms have been used to find ideal ways of managing networks and other distributed systems. The idea is basically to adopt an ant way of solving the *food* problem by randomly scanning the *environment* and enhancing the good solutions found. The positive feedback patterns then reinforce certain solutions over others and prove, it is claimed, nature's way of solving complex mathematical problems.

Random evolution of solutions through environmental perceptivity is related to other informational solutions that seem to take their cue from the effective calculative processes of nature. For example, take genetic algorithms that were hailed in the new millennium's popular science literature as a key innovation in harnessing nature's **powers**. The early experimenter John Holland's idea was to let solutions to algorithmic problems rise from a predefined "genetic pool" that worked as if according to a Darwinian principle of evolution.[15] Different solutions were tried, but only the "strongest" survived. As we saw in the second chapter, this is where the early insect discourse on the innate mathematics of nature and bees seemed to be of interest to the network-minded scientists and enthusiasts of the turn of the millennium. However, another question will be whether this neo-Darwinian model is the most accurate and interesting in terms of understanding the insect turn in media design and theory. Is addressing insect colonies, emergence, and self-organization as a form of random selection the most accurate description? Or is the suggested environmental relation of ants and bees, as already argued during the early research, a more complex description that involves instinctual systems that extract much of the information needed from the intensive encounter with the insects' milieus? This would lead us to another way of understanding the harnessing of nature and toward a nature-culture continuum[16] instead of just another version of a hylomorphic scheme (ideal genotypes vs. material phenotypes). Next, through bees and milieu-bound **robots**, we are going to address this question concerning relations, intensity, and individuation as a key theme of the early interfacing of *animals* and technological entities.

12 Gilbert Simondon, *L'individuation psychique et collective* (Paris: Aubier, 1989, 2007), 125–26. As Alberto Toscano notes, what is missing in the mathematical notions of information is a focus on ontogenesis: the intensive (in)formations of individuation. Alberto Toscano, *The Theatre of Production: Philosophy and Individuation between Kant and Deleuze* (New York: Palgrave 2006), 144.

13 Adrian Wenner, "Division of Labor in a Honey Bee Colony—A Markov Process?" *Journal of Theoretical Biology* 1 (1961): 324–27.

14 For a good example, see the Web page Ant Colony Optimization, http://www.aco-metaheuristic.org/ (accessed April 6, 2009).

15 Steven Johnson, Emergence: *The Connected Lives of Ants, Brains, Cities, and Software* (London: Penguin, 2001), 59–60.

16 See Parisi, "For a Schizogenesis of Sexual Difference." For Parisi, this continuum extends to a schizogenetic analysis of gender as well.

It is rarely mentioned that Norbert Wiener's first published paper was on ants. As Sleigh explains, this suggests that the history of cybernetics was not "only engineering and neurophysiology but also natural historical," involving the study of other *animals* and their ecological relations.[17] After the Second World War, communication was seen as a crucial catalyst of social and technological relations, from the micro levels of dealing with computers in human-**machine** *environments* to the macro levels of cold war and social development.[18] This was the period when bees were analyzed as communication *animals*, as in the much-hailed Karl von Frisch's studies on bee language. Von Frisch himself could not hear without being wired. The Graz, Austria-based professor's 1940s trip to the United States was shadowed by his being half-deaf and dependent on **machines** (a hearing aid and a personal assistant) that amplified the noise of the world into something significant for him.[19] He responded by wiring bees into a perspective of knowledge that introduced them as communicating through dance.

The *animals* of Von Frisch's 1953 book *Aus dem Leben der Bienen*, translated a year later into English as *The Dancing Bees*, were much more perceptive. The book was based on research that Von Frisch had performed since the 1910s, and already in the 1940s it had earned him an international reputation, with theorists far outside the **biological** sciences, such as Jacques Lacan, drawing on his findings.[20] The book covered a wide range of bee behavior in a reader-friendly fashion, continuing the popular literature of the insect genre that had been successful since the nineteenth century. As we learned from earlier chapters on insects, bee life was filled with their astonishing capacities to build, live, and sense the world. One of the curiosities that Von Frisch emphasized was the bees' ability to express complex navigational instructions through dancing.

The discovery that bees have a language was a spin-off from Von Frisch's other experiments. Already around 1917–1919 his observations regarding bees' sense of color led him to the activity of the bee dance, which seemed to communicate information about nearby *food* resources.[21] Later his emphasis changed, but in any case Von Frisch was looking into the perceptive qualities of bees with the help of different tests that provided surprising results on how single bees attracted to honey treasures were later followed by several others from the same hive. This involved meticulous tracking of the bee in ethnographical fieldwork fashion: constructing an observation hive, painting the visitors for differentiation purposes, and then following the interactions with other bees. What followed for the scientific spectators was the "round dance": "On the part of the comb where she is sitting, she starts whirling around in a narrow circle, constantly changing her direction, turning now right, now left, dancing clockwise and anti-clockwise in quick succession, describing between one and two circles in each direction."[22] As a form of crowd behavior that was a key issue for modern sociologists and city planners, the dance "infects" the other bees, which start to follow the first bee's movements. This train of dancers continues for some seconds or even half a minute to disgorge honey she has brought with her.

17 Sleigh, *Six Legs Better*, 163.

18 The suggestions offered concerning the "ethnicities" of bees resonated with the European linguistic-political situation in the midst of unification after the Second World War, where Austrians and Italians could perhaps work together but communication was the problem. Again, talking about bees: "When the Austrian and Italian varieties are put together in a colony, they work together peacefully. But confusion arises when they communicate. The Austrian bee aroused by the wagging dance of an Italian bee will search for the feeding place too far away." William Laurence, "Bee Language: Study of Different Kinds of Bees Reveals Communication 'Dialectics,'" *New York Times*, August 12, 1962.

19 Sleigh, *Six Legs Better*, 168.

20 "Reading the Language of Bees," *New York Times*, January 12, 1947; "Bee Language Topic of Talk," Washington Post, April 10, 1949; Jacques Lacan, *Écrits* I (Paris: Éditions du Seuil, 1999), 295–96.

21 Tania Munz, "The Bee Battles: Karl von Frisch, Adrian Wenner, and the Honey Bee Dance Language Controversy," *Journal of the History of Biology* 38 (2005): 543.

22 Karl von Frisch, *The Dancing Bees: An Account of the Life and Senses of the Honey Bee*, trans. Dora Ilse (London: Country Book Club, 1955), 100–101, quote on 101.

Not too surprisingly, using the word dance made Von Frisch susceptible to accusations of anthropomorphism. His work was debated from the 1930s with constant accusations that he was conflating human superiority with the more affective *animal* communication.[23] In fact, as Eileen Crist argues, the use of the word dance was a much more figural way of addressing the interest of the reader, whereas the idea of this bee movement as a "language" was to be taken literally.[24] What Von Frisch suggested was that the movements were related to the source of *food* and that the dance communicated both the direction and the distance of the find. With shorter turns in the dance, the bees signal a distance of a hundred yards, but longer intervals signal a greater distance, something that Von Frisch was able to demonstrate with a stopwatch and a mathematical graph. The bees' movement is directly related to distances, which led Von Frisch to suggest that the bees "must possess a very acute sense of time, enabling the dancer to move in the rhythm appropriate to the occasion, and her companions to comprehend and interpret her movements" — even more astonishing to the observers because the bees " do not carry watches."[25]

Here we discover again the theme of insect bodies as relational entities whose technics are inseparable from the bodies themselves. As Henri Bergson claimed approximately fifty years earlier, the way insects solve the problems of life is intimately tied to the technics of their bodies immanent to their surroundings. The spatializing forms of knowledge that enable the projections into the future that characterize intelligent humans differ from the lived relations of insects, for example. Bergson reminded us that instinct does not have to be resolved either as a form of pre-**intelligence** or a mechanism, but it can be seen as a potentiality of relations that does not reside outside the terms. Caterpillars are not just systems of spatially definable nerves and nervous centers but modes of relating. Consider Bergson: "The Ammophila, no doubt, discerns but a very little of that force, just what concerns itself; but at least it discerns it from within, quite otherwise than by a process of knowledge — by an intuition (lived rather than represented)."[26]

This relates to the idea of technology as machinology addressed in chapter 3. In the machinological context, Samuel Butler's nineteenth century fabulations of the machinology of technology sidesteps the general understanding of the origins of technology à la Kapp or McLuhan. More recently Luciana Parisi has taken up this **machinic** ontology and argued, with the help of Deleuze, Guattari, and Simondon, that it helps us to bypass the dualist division of the given and the constructed, nature and culture, and see creation in terms of an ontogenesis of **machinic** relations.[27] **Machines** are mixtures of heterogeneous components (from **biological** to social), and **machinic** assemblages are the processes through which organizations of the body are constructed by cutting from flows of intensive elements of the world.[28] Such a perspective assumes that technologies are also **machinic** in the sense of relational enterprises that organize bodies. As part of a certain Spinozan ontology, the focus is on bodies concerting with other bodies and the **powers** to connect and disconnect. This intensive layer of **machinics** is then an analysis of the continuous orders of couplings from which stratified organizations emerge and are spatialized, for exam-

23 Munz, "The Bee Battles," 547. See also the very interesting debate on *animal* communication with a special focus on Von Frisch at the Eighth Macy Foundation Cybernetics Meeting in 1951. Herbert G. Birch, "Communication between *Animals*," in *Cybernetics: Circular Causal and Feedback* Mechanisms *in* **Biological** *and Social Systems: Transactions of the Eight Conference, March 15–16, 1951, New York*, ed. Heinz von Foerster, Margaret Mead, and Hanks Lukas Teuber (New York: Josiah Macy Jr. Foundation, 1952), 134–72. Birch signals from the beginning his reluctance to address *animal communication* and indicates that he feels more comfortable if talking about *animal* interrelations. For him, communication is an issue of functions such as feeding, mating, migration, and so on (134). Despite the early reservations, the questions of anthropomorphism and differences with human communications are vividly addressed in the discussions.

24 Eileen Crist, "Can an Insect Speak? The Case of the Honeybee Dance Language," *Social Studies of Science* 34, no. 1 (February 2004): 12.

25 Von Frisch, *The Dancing Bees*, 119.

26 Henry Bergson, *Creative Evolution*, trans. Arthur Mitchell (Mineola, N.Y.: Dover, 1998) 175.

27 Luciana Parisi, *Abstract Sex: Philosophy, Bio-Technology, and the Mutations of Desire* (London: Continuum, 2004),

28 Ibid., 15.

ple, through scientific analysis.[29] Instead of the focus being on single elements interacting (such bees and flowers), it is on the systematic relationality of the elements where the relations are primary. As elements of relatedness (as Morgan named it), the terms connected emerge only as part of a wider system of environmental referentiality, which is to be judged in terms not of passive adaptation but of active becoming. This is of course a peculiar and perhaps a stretched way of looking at nature in terms of technics or machinology. However, it provides a way out of the impasse of seeing nature as oppositional to cultural terms, which is reflected, for example, in the difficulty of understanding what Von Frisch meant when he referred to bee communication as language. What I would like to argue is that the bees he is referring to are not representational entities but machinological becomings, to be contextualized in terms of their capabilities of perceiving and grasping the environmental fluctuations as part of their organizational structures. The hive, then, extends itself as part of the *environment* through the social probings that individual bees enact where the **intelligence** of the interaction is not located in any one bee, or even a collective of bees as a stable unit, but in the "in-between" space of becoming: bees relating to the mattering milieu, which becomes articulated as a continuum to the social behavior of the insect community. This community is not based on representational content, then, but on distributed organization of the society of *nonhuman* actors.

What is curious is that this environing extends as a parallel to the early trends in **robotics** and the crucial recognition that perhaps an effective technological system works not through **intelligence** input into the **machine** but through creating various affective modes of relating and responding to the fluctuations of the *environment* as a "naturing nature" in process. The way research on bee communication worked toward intensive environmental relations can in fact be connected to the way pioneering work on responsive systems had to come up with ways of maneuvering in concrete space. Despite the epistemological distance, these movements are parallel in constituting the emerging interest in context-sensitive ways of understanding *nonhuman* actors and how this knowledge stretches from "intelligent" perception-action sequences into dumb but interconnected emergent "**intelligence**"—or what would have been called an instinctual approach some fifty years ago. This tracking distances itself from approaches that stick to the ontology and epistemology of cybernetics and their view concerning language and informatics. Instead, as we will see later, the alternative notions concerning information, entities, and environments developed by the French philosopher Gilbert Simondon around the same time provide a much more fruitful way to think of bodies in action. With Simondon, concepts of individuation, transduction, and intensive environmental relations are more accurate and complex ways to understand natural or technical processes. First, however, we turn to another example of a zoology of cybernetics, W. Grey Walter's **robotic** tortoises.

Machine *Animals*

Technological zoology is not only a recent trend. During the earlier phases of modernity, automata introduced slightly

29 Ibid.,38.

different but no less revolutionary ideas concerning the nature of (technological) life. Then an **artificial** duck was a celebrity. The Vaucanson creation demonstrated, as Jessica Riskin argues, a threshold **machine** in the **simulation** of natural beings.[30] It not only resembled a duck in appearance and habits but simulated the internal workings of the *animal* as well. Living processes were incorporated into the experimental creations that produced knowledge about the *animal* world but also about the interfaces of humans, nature, and technology. Here two phenomena acted as watersheds for the distinction, explains Riskin: movement and speech. What can move itself is, according to the much-embraced Aristotelian idea, a living being, and what can respond in terms of speech is an intelligent living being. Of course speaking **machines** existed, and they seemed to question this division. Julien Offray de la Mettrie believed in speaking **machines**, and in 1791 Wolfgang von Kempelen from Hungary explained the workings of such a **machine**. In this kind of **machine**, speech was the physical result of the movement of air through the imitations of lungs and other human organs. Nevertheless, it provided important lessons on the question of what is reproducible and what seems to be unique to the intelligent human being. Such an interest in mechanical ducks and the like fed into very pragmatic goals in terms of the emerging factory system and the redistribution of **labor** from humans to **machines**. *Animals* and **machines** could do several types of repetitious and nonintelligent work, such as weaving, and hence could amplify the production of all those goods needed for the emergence of the modern world.

Is it a bee, then, instead of a duck that stands at the beginning of the postmodern era of communication and cybernetics? For some, like Steven Shaviro, it is the insect that is the "totem *animal*" of postmodernity owing to its refashioning of the inside and the outside, its radical becomings evident in the transmutations that its goes through.[31] Certainly the 1950s were filled with gigantic bugs that threatened the organized society of the United States — hence it was a figure overladen with fears of communism, disorder, and environmental pollution. The film *Them!* introduced gigantic nuclear ants in 1954, and only a year later *Tarantula* applied a similar logic to spiders. There were plenty of similar examples for years to come.[32] However, in terms of communication and the optimization of efficiency, movement and language were marked as threshold questions in new technologies that were to brand the emerging network world. Much as in the case of the automata of the eighteenth century, the fields of knowledge concerning nature and experimental engineering of technological objects guided the analysis by reproducing examples of life. Paraphrasing Riskin's argument, such experiments simultaneously functioned as the organizing division of what remains beyond **artificial** reproduction in life and hence drew or reinforced differences between **artificiality** and nature. However, in the field we address in this chapter we encounter various fabrications of **artificial** objects, and the natural talking bees are also "**artificial** constructions," as I will argue.

W. Grey Walter's cybernetic tortoises are a good example of more concrete **robot** *animals* of the 1950s. Walter was a pioneer of different physiological measurements of the human

30 Jessinca Riskin, "The Defecating Duck."

31 Steven Shaviro, Doom Patrols.

32 See William M. Tsutsui, "Looking Straight at Them! Understanding the Big Bug Movies of the 1950s," *Environmental History* 12 (April 2007): 237–53. In 1965 Susan Sontag published her key essay "The Imagination of Disaster," which set the agenda for understanding the monster insects as a trauma of the nuclear age. However, Tsutsui argues that the fear was much more mundane and had to do with the fear of uncontrollable insect swarms and infestation in the 1950s.

body and one of the early developers of the electroencephalograph **machine** that mapped the electrical activity of the brain. Brains were his primary interest not only as organs but as transmission and crossroad points of living organisms. Nerve-knots define life from its simple forms such as ants and bees on, which fascinated Walter: "Who would call brainless a creature which can return from a long flight and report to its community, to within a few yards, where it has discovered honey supplies?"[33] Indeed, Walter seemed to be aware of the research into bee communication, which he saw in terms of nerving with the world: "Appraised by results, the bee is a highly developed mobile unit of a sedentary brain."[34] Bees were an early form of mobile communication in this 1950s influential take on the centrality of the brain.

Walter thought that evolution is to be read in terms of brain development, which itself is a function of nerve complexity. The brain is conceptualized as a communication system in its own terms, a mediation point between external and internal communications. Nervous systems are networks for receiving, correlating, storing, and generating signals,[35] which emphasizes their status as media systems but ones grounded in living bodies.

In order to tap into the complexity of the brain, Walter built experimental objects, cybernetic tortoises, that were designed to illustrate what complex wiring even a simple orientation in space demands. Of course the Vaucanson duck was already a cybernetic unit of a kind based on feedback mechanisms, but the cybernetic tortoises were designed to take into account environmental variations. The "Machina Speculatrix," as explained in the book *The Living Brain* in 1953, was to practically investigate the question of whether brainpower works through the number of units in the brain or through the "*richness of their interconnection*."[36] Thus it worked as an experimental object that implicitly maneuvered between the nature-technology division and looked into the brain as a complex network that interacted with its outside. Walter's idea was to build a very simple **machine** equipped with goal-seeking and scanning abilities together with movement. The electronically wired "*animal*" was speculative in its push toward exploration of its *environment* instead of waiting for impulses.[37] It was not only a reactionary entity but was equipped with a certain spontaneity bound, however, by "positive" and "negative" tropism. In other words, it was tightly coupled to certain environmental attractions, as Walter called them, through simple sensors. Positive tropism referred to its push toward light, negative tropism to a pull away from "very bright lights, material obstacles, and steep gradients."[38]

The tortoises (which looked more like toasters on wheels than actual *animals*) were hence ecological units of a kind equipped with a **simulation** of a nervous system of a very simple *animal*. Yet the obstacle to a complex environmental relationship was that the **machines** could not be taught to learn. Learning to learn was still the stumbling block for the tortoises, which did not have extensive memories that could help them to summate their experiences.[39]

What was remarkable according to Walter was the tortoises' recognition of their surroundings, which seemed to present unforeseen results. The **machines** worked through specific but

33 W. Grey Walter, *The Living Brain* (London: Gerald Duckworth, 1953), 3.

34 Ibid.

35 Ibid., 36.

36 Ibid., 77. Italics in original.

37 Ibid., 83.

38 Ibid.

39 Ibid., 94. This simple form of learning was also evident in Claude Shannon's maze-solving **machine** rat. It learned by trial and error but was able to remember the path through the maze on subsequent attempts. Claude Shannon, "Presentation of a Maze-Solving **Machine**," in *Cybernetics: Circular Causal and Feedback* Mechanisms, 173–80.

simple thresholds of perception of their surroundings, maneuvering past objects and toward lights. In addition, they showed traits of "self-recognition" in front of a mirror surface, where responsive photo cells responded to their own headlamps. This led Walter to claim that this behavior was signaling their similarity to some higher *animals* that were able to understand that a mirror image was an image of themselves instead of other *animals*. Furthermore, two **machines** could be seen exhibiting mutual recognition that according to Walter was a form of community building of sorts; the stimulus to community and communication was recognition of the light from the other **machine**. However, this banality of community, reducible to response to a bright light from another Machina Speculatrix, resulted in surprising behavior:

> Some of these patterns of performance were calculable, though only as types of behaviour, in advance; some were quite unforeseen. The faculties of self-recognition and mutual recognition were obtained accidentally, since the pilot-light was inserted originally simply to indicate when the steering-servo was in operation. It may be objected that they are only "tricks," but the behaviour in these modes is such that, were the models real *animals*, a biologist could quite legitimately claim it as evidence of true recognition of self and others as a class. The important feature of the effect is the establishment of a feedback loop in which the *environment* is a component. This again illustrates an important general principle in the study of *animal* behaviour—that any psychological or ecological situation in which such a reflexive mechanism exists, may result in behaviour which will seem, at least, to suggest self-consciousness or social consciousness.[40]

Hence, looping the *environment* into a component of the emerging system or a community of **machines** was the early phase of "**intelligence** building," so to speak. Here the banal mode of communication was far from communication of content in terms of abstracted symbols; it was rather a mode of embodied interaction in a shared space. This stance implies that communication is actually based in perception, and perception is furthermore conceptualized as an environmental being and a perceptiveness that Walter tried to hardwire into the speculating **machines**. Building **machines** included a simultaneous building of milieus for the **machines**. Environments were to be incorporated as part of the plans of any circuit, *animal* or **machine**, as Uexküll had already argued.[41] A contemporary example of such "**machine species**" might be the **robotic** spiders of Ken Rinaldo, which resemble the tortoises to a slight degree but are more chimeratic **robots** that interact in real time with their viewers: "The Auto telematic Spider Bots installation is an **artificial** life chimera; a **robotic** spider, eating and finding its *food* like an ant, seeing like a bat with the voice of an electronic twittering bird."[42]

The ethological task of the speculating **machines** was to provide the needed links among notions of the environment, perception, and communication, all key themes in the context of cybernetics, which was working toward more embodied models of automata and communication. This is also the

40 Walter, *The Living Brain*, 85–86.

41 Uexküll, *Theoretische Biologie*, 153.

42 See Ken Rinaldo's Web site, http://kenrinaldo.com/ (accessed April 23, 2009).

context in which the research agenda started to move from classical **artificial intelligence** (AI), with **intelligence** as the information processing of an intelligent **machine**, to **intelligence** as a result of numerous simple parts' interacting. Emergence was no longer an event of the insects but a mathematical way of understanding how several simple bits can produce complex, heterogeneous wholes. This was an engineering problem because the older models of AI were not able to produce efficient **robots** or embodied **intelligences**. Instead, models such as the perceptron, a form of **artificial** neural network designed by Frank Rosenblatt, introduced ways to conceptualize more brainlike actants. The perceptron idea could be seen working in a certain radical empiricist tradition in which the potential novelty of connections should be accounted for. Instead of spatialized models of memory and nerve systems, Rosenblatt suggested the primacy of connections and associations. Information is never only a passive recording in the brain matter of a living **being** or a **machine** but rather works as a "preference for a particular response" and hence lives in the connections that are not modeled as recognitions or representations.[43] In other words, the perceptron **machines** lived through temporal relations in which networked nerve relations were continuously renewed.

Walter's **machines** fit into that concept of networked actors, as well as Herbert Simon's realization, also from the 1960s: an agent such as an ant is only as intelligent as its environment. The ant is intimately coupled with its outside much as any artifact can be understood as an interfacing of its inner *environment* and its outer surroundings. Simon sees it as a meeting place, a relay, and through this intensive environmental relation its capacities for living and functioning are determined through an unfolding in time.[44] Environmental variation is temporal unfolding. Simon thinks that the ant works as a "**machine**" similar to Walter's creations. An ant is an adaptation **machine**, a speculatory vector that "deals with each obstacle as he comes to it; he probes for ways around or over it, without much thought for future obstacles."[45] Here the turtle can be transformed into an ant, a supposition Simon makes, suggesting that we turn the turtle's dimensions into those of an ant as well as the means of locomotion and "comparable sensory acuity."[46] Simon thinks that the electromechanical turtle is parallel to the adaptive ant; both entities owe their complexity of behavior to the interfacing of the **machine**/insect/turtle with the environment. Far from reflexive communicators, the agents are more akin to the Bergsonian instinctual **machines**/insects that extend their bodies as part of the intensive, varying milieu that opens up only through time.

Perception as Communication: Bee Lessons in Dealing with The Environment

Turning back to the 1950s context, the so-called bee language can also be understood through similar considerations of environmental relations. Here communication becomes less a matter of abstract conveyance of symbols and more a matter of embodied interactions in intensive spatial environments. However, this is where Lacan, and following him Friedrich Kittler, pointed out the difference between Von Frisch's dancing bees and the cybernetic zoo (including computers). They think

43 To quote Rosenblatt: "The 'coded memory theorists' are forced to conclude that recognition of any stimulus involves the matching or systematic comparison of the contents of storage with incoming sensory patterns, in order to determine whether the current stimulus has been seen before, and to determine the appropriate response from the organism. The theorists in the empiricist tradition, on the other hand, have essentially combined the answer to the third question with their answer to the second: since the stored information takes the form of new connections, or transmission channels in the nervous system (or the creation of conditions which are functionally equivalent to new connections), it follows that the new stimuli will make use of these new pathways which have been created, automatically activating the appropriate response without requiring any separate processes for recognition or identification." F. Rosenblatt, "The Perceptron: A Probabilistic Model for Information Storage and Organization in the Brain," *Psychological Review* 65, no. 6 (1958): 387. See also Sherry Turkle, Life *on the Screen: Identity in the Age of the Internet* (London: Phoenix, 1997), 130–31.

44 See Herbert Simon, *The Sciences of the* **Artificial** (Cambridge, Mass.: MIT Press, 1969), 6–7, 14. However, alternative accounts were expressed as well. Earlier, in 1792, François Huber wrote in his *Nouvelles observations sur les abeilles* of the innateness of **intelligence** in bees: "If the worker does not have a model to work to, if the pattern according to which she cuts every cell is not something outside herself and Nature which directs her senses, then we have to admit that such work is directed by some kind of **intelligence**." Huber, quoted in Ramírez, *The Beehive Metaphor*, 27.

45 Simon, *The Sciences of the* **Artificial**, 24.

46 Ibid.

that *animal* codes are not language because their signs have a fixed correlation with reality. Symbolic language and subjectivity are in contrast, defined by the discourse of the other, which leads Kittler to state in his idiomatic style: "Bees are projectiles, and humans, cruise missiles."[47] This refers to how the natural communication of bees and the like consists of "objective data on angles and distances," where as both humans and computers are more tuned to the if/then modulation that takes account of environmental factors. This is the point at which, according to Kittler, computers can become **subjects** but not bees: "IF a preprogrammed condition is missing, data processing continues according to the conventions of numbered commands, but IF somewhere an intermediate result fulfills the condition, THEN the program itself determines successive commands, that is, its future."[48] In other words, *animals* do not have a (sense of) future, but **machines** do. However, as we will see later, this dualism gains its momentum from a Heideggerian tradition that fails to understand the *animal* environments as dynamic and works toward a continuous analytics of why humans, *animals*, and **machines** differ from each other.

Von Frisch and his bees stand in an interesting interzone in which different interpretations try to fix him and the communicating bees as part of different traditions and possibilities of agency. The focus on bee language as an abstract processing of symbols is one that remains in the classical model of AI and in notions of language as disembodied symbol processing. The other path, opened around the 1950s and 1960s, started to emphasize the embodied environmental relations of any cybernetic relation. Hence, communication could also be seen as moving from **being** a mere informational pattern to a more nonrepresentational account of capabilities of agents, whether we are talking about perception or communication.[49] In a way, the language was not about "containing" information, an idea that was used around the 1960s when discussing the patterns. In contrast, language enacted perceptions, movement, and actions in which the division between "intelligent" self-guiding users of language and instinctual, passive, mechanistic followers of signals was bridged.

In fact, revisiting Von Frisch's text clarifies the ties between bee language and bee modes of perception. Throughout his scholarly career, Von Frisch was interested in sensory physiology; he was also a student of his uncle, the experimental physiologist Sigmund Exner.[50] As explained earlier, Von Frisch's research in itself was carefully framed for scientific observation, involving the setting up of an observation hive that transformed the insect habitat into a theater for the scientists. This disclosed visibility of the hive, then, led to an understanding of the sense organs and capacities of bees that was the crucial prerequisite for any discourse concerning bee language. The sections on communication were contextualized in a much wider discussion regarding the bee eye and its workings Von Frisch argued that the bee eye is especially well tuned to perception of movement. The panoramic visual perception of the insect is composed of "eight to ten thousand little eyes" coordinated to take in rapidly changing impressions.[51] In addition, the bee eye is capable of perceiving polarized light that remains imperceptible to humans. In fact, insects can even "distinguish the direction of [the light's]

47 Friedrich Kittler, *Gramophone, Film, Typewriter*, trans. Geoffrey Winthrop-Young and Michael Wutz (Stanford, Calif.: Stanford University Press, 1999), 259.

48 Kittler, Gramophone, 258; Lacan, Écrits, 295–96. Lacan's ideas reinstate the hylomorphic idea of a fixed reality versus dynamic language. The language of human **beings** is based on the discourse of the other, where symbols work through their internal, dynamic relations —not through referring to reality. This implies a stagnant conception of the **material** and reality, which the neomaterialist mode of cultural analysis is trying to be rid of.

49 See Hayles, *How We Became Posthuman*.

50 Munz, "The Bee Battles," 539–40.

51 Von Frisch, *The Dancing Bees*, 80. Hence, "cinema in the bee state" (80) would be about hundreds of single pictures a second, according to Von Frisch.

vibrations, which they use to help them in their orientation."[52] The bee as a coordination device is tuned to such frequencies and phenomena of its milieu, which it can contract to help in its placement and individuation. In this context, the physiological nature of the compound eye proved to be an "ideal kind of analyzer"[53] and hence a focal point for the perception of polarized light. Thus the eye stood for Von Frisch at the center of this intensive environmental relation as a relay of a kind that could be **artificially** modeled by six units of Polaroid glass.[54]

Furthermore, Von Frisch reminded us that the bee language that is visual for us is in fact sensed by other bees through feeling and smell due to the normally dark hive. Hence, we move from the abstracting capacities of vision to the murkier regimes of tactility and olfactory senses. Of course the major criticism targeted at Von Frisch since the 1960s was actually that he had neglected the world of smells. Adrian Wenner's argument was that bee communication happened not on the level of bodies but in terms of sounds and smells (i.e., chemicals).[55]

In the book *The Dancing Bees*, the section on bee language frames the movement of the dancing bee in terms of distances and directions, which actually correspond more closely to a coordinate system than to a symbolic language. A dance works through indicating the spatial and temporal relations among the body of the dancing bee, the *food* source, the other bees, and the hive, enveloping them all into a **machinic** assemblage of language as an ordering of reality into a very functional entity. This is underlined by the fact that the bee dance works differently depending on whether it takes place "inside the hive on the vertical comb or outside on the horizontal platform."[56] In case the bees can see the sky, according to Von Frisch, the sun can act as their compass, which the bees can use to tune the dancing body to a right angle: "The bees who follow after the dancer notice their own position with respect to the sun while following the wagging dance; by maintaining the same position on their flight, they obtain the direction of the feeding-source."[57] Inside the comb, things are different due to the lack of visibility and the different positioning of the upright-standing comb surfaces. Here, explained Von Frisch, the bees use a different mode of getting the message through:

> Instead of using the horizontal angle with the sun, which they followed during their flight to the feeding place, they indicate direction by means of gravity, in the following way: upward wagging runs mean that the feeding-place lies towards the sun; downward wagging runs indicate the opposite direction; upward wagging runs 60° to the left of the vertical point to a source of *food* 60° to the left of the direction of the sun... and so on.[58]

Von Frisch argued that a process of transference takes place: the bees' "delicate sense of feeling for gravity is transferred to a bearing on the sun."[59] In fact, I would extend this notion of transference and suggest that this is the much more interesting aspect Von Frisch is trying to elucidate. A process of transference between bodies and environments is the key force of this dance language that acts as an embodied tool or

52 Ibid., 82. See also Birch, "Communication between *Animals*," 142–43.

53 Birch, "Communication between *Animals*," 153.

54 Ibid. In the Macy conference discussions following the presentation in 1951, Birch posed the key question as follows: "How in the world does the bee translate this kind of orientation, based upon the polarization features of light, into the gravitational field itself?" Birch, "Communication between *Animals*," 153.

55 Munz, "The Bee Battles," 557–59. Wenner also planned to build an **artificial** bee in the 1960s but soon discarded the idea (554–55).

56 Von Frisch, The Dancing Bees, 121.

57 Ibid., 122.

58 Ibid., 122–23.

59 Ibid., 123.

an indicator, not a patterning that could be extrapolated outside the topological surroundings and bodies of the bees. In other words, perhaps Von Frisch could be read in the context of a whole different mode of understanding language and information than the hegemonic cybernetic view of patterns.

This context draws from nonrepresentational approaches to the *environment* and the milieu of the individuation of agents. In the earlier chapter on ethology, I argued that Uexküll's theories of the *Umwelt* functioned through a more pragmatic coupling with the environment; the aforementioned Herbert Simon's approach similarly takes into account an interactional becoming with the *environment* much more than a mentalist conception of perception and action; Humberto Maturana and Francisco Varela's work from the 1960s has indicated that they took a similar direction. As part of the second wave of cybernetics, Maturana and Varela point toward an ethological realization of how crucial the work of construction is in the act of perception. Instead of there being a direct correlation between the world and perception, all environmental relations are constructed in a comovement of the milieu and the sense system of an *animal*. Perceptions are specified according to capacities of **species**. This is evident, for example, in the case of the cybernetically wired frog that Maturana and Varela used to analyze its specific capacities for perception of fast movements, like that of the fly.[60] This assemblage approach suggests why Deleuze and Guattari were also fond of Maturana and Varela, because this viewpoint seemed to be in line with Bergson and Uexküll: perception is not only a registering of reality but a much more complex and embodied relation in which the eye is coordinated with the rest of the body and these coordinations also extend outside the body to the world. In fact, some of Von Frisch's critics, such as Wenner, suggested that we need a hypothesis that takes into account the dynamics of population as part of an *animal*'s environment. Instead of symbolic language, argued Wenner, bee orientation is a population-level process that suggests that the hive, its surroundings, and their history are "part of a dynamic system."[61] Instead of individual behavior producing intelligent-seeming results, the workings of the bee system stemmed from probabilistic patterns, argued Wenner in his attempt to dodge the dangers in detaching the individual from the environment.

However, writers such as Simon had already suggested a midway solution to the problem of the individual versus the population when he argued that the individual is already in any case structured and afforded by its *environment* (without suggesting complete adaptation). In a similar vein, we can appreciate the possibility of approaching Von Frisch's ideas relating to complex processes of environmental individuation. This way we can perhaps move from a disembodied view concerning communication, as promoted by Wenner and the wider cybernetic-influenced research fields, toward a **materially** grounded but dynamic understanding of communication as inherently part of perception and individuation as part of the milieu.

60 Hayles, *How We Became Posthuman*, 134–37.

61 Wenner, quoted in Munz, "The Bee Battles," 557. According to Munz (559–64), the debate between Von Frisch and Wenner was settled with the synthesis offered by James Gould: both modes of communication (the dance language and the olfactory sense) were to be taken into account.

In addition to the thinkers mentioned earlier, Gilbert Simondon approached similar conclusions in his distinctive take on information, milieus, and perception. Through Simondon's work from the 1950s and 1960s, which remains to a large extent not translated into English,[62] we can gain a better understanding of the intensive environmental relations of agencies from bees to speculating machines.

Simondon was aware of Von Frisch's bee research and contributed some words on bees, perception, and communication in his course on perception, taught between 1964 and 1965 at the Sorbonne in Paris. Simondon is interested in how bees are able to transform the measurement of distance into body movements that Von Frisch referred to as the communicating language. Simondon refers here not only to Von Frisch but also to Viaud's *Cours de Psychologie Animale* to explain the diminishing logarithmic relation between the amount and the nature of dancing and the number of possible voyages in a determined time frame. In other words, he explains that the "semantics" of this language are about correspondences between the distance, or the milieu, and the bee's body movements, which stand in a certain more or less fixed proportion to that milieu (although different dialects exist among bee species). Perception turns into body movements, which then turn into a collective perception that informs space and changes its dynamics because of its effects on the relations of bodies and milieu. Space turns into an active milieu of relations instead of only a backdrop for events and communication. Furthermore, the relation is not only that of spatiality, continues Simondon, but that of temporality and duration.[63] Another name for the process of unfolding through metastability is individuation.

With Simondon we are able to understand the intensive individuation that always takes place in the shifting boundaries of an entity and its milieu. Milieu is far from a stable background of individuation and is "characterized by a tension in force between two extreme orders of magnitude that mediatize the individual when it comes into being."[64] Thus we receive an account of the dynamic relationship between an individual embedded in a milieu of potential in which information becomes less a stable object to be transmitted than an indicator of change. Hence the notions of abstract information and language that characterized the understanding of communication in the cybernetic context can be reevaluated in the light of a more embodied notion.[65] Yet this embodiment is one that works through dynamics and the primacy of movement.

In his critique of hylomorphic notions of form and content, Simondon challenges the formalist ideas in information theories. Information is too often seen through conceptual dualisms of form and content, which brands communication as a stable process of transmitting content already in place. For example, the idea of bee communication is too easily formalized as a functionalist account of transmitting abstract symbols about the world rather than as an active becoming of *animals* within a milieu that is itself also an active part of the individuation. What Simondon proposes is to start with the individuation instead of the individuated entities and look at information

62 Translations of *L'individuation psychique et collective* and *L'individu et sa genèse physico-biologique* are both forthcoming from the University of Minnesota Press.

63 Gilbert Simondon, *Cours sur la Perception* (1964–1965) (Chatou, France: Les Éditions de La Transparence, 2006), 307.

64 Gilbert Simondon, "The Genesis of the Individual," trans. Mark Cohen and Sanford Kwinter, in Incorporations, ed. Jonathan Crary and Sanford Kwinter (New York: Zone, 1992), 317 n. 1.

65 In fact, this has been on the primary agenda of much of research into cybernetic culture and network society, from N. Katherine Hayles to Mark B. N. Hansen. See Hayles, *How We Became Posthuman*; Mark B. N. Hansen, New Philosophy for New Media (Cambridge, Mass.: MIT Press, 2004). Hayles and Hansen acknowledge the work by Donald MacKay as an early rethinking of the importance of embedded cybernetics. Hansen (76–85) draws in addition from the early work by Raymond Ruyer in his attempt to look for alternatives to Shannon-and Weaver-inspired perspectives, including that of Friedrich Kittler.

as the intensive process of change at the border of different magnitudes. Information is not quantifiable in the way Shannon and Weaver and cybernetics proposed it to be but should be seen as an effectuating operation. In other words, information effects changes.[66] In another passage of his book *L'individuation psychique et collective*, Simondon argues that information is a dynamic notion that functions to "situate the subject in the world."[67] Information informs and guides as an intensive ongoing process, not as a stable form. It assembles agencies into positions in a parallel move as language shifts from a representational signification to a gathering in terms of relations, collectives, and transindividuals — a project of connection.[68] Instead of stable positions communicating — subjects talking (or dancing) about objects that are quantified as information — a focus on information and communication as individuation proposes a transductive notion of communication. The perceptions and orientations in the world of entities are about individuations, but similarly the second-order communications of those perceptions are individuations that gather up collectivities.

In this context, a key notion is that of "metastability," as Adrian Mackenzie explains. Ontogenetical metastability is the essence of transduction as a process of intensive encounters. The transductive nature of life owes to its temporal and topological characteristics, Mackenzie continues, pointing out that the transductive encountering of information is about responsiveness to problems. Living beings respond to problems of their milieu "through constant temporal and spatial restructuring."[69] Mackenzie uses the concept throughout his book-length analysis of technical culture, and we can similarly use it to understand the event of bee communication. Mackenzie argues that Simondon believes that the living beings' transduction also happens through interior milieus in which the body of the living can provide itself information and hence be characterized as metastable. This highlights the way the body of the living is a milieu, a medium in its own way, and also a collectivity instead of an individual. The processes of perception, movement, nutrition, excretion, communication, and dying are intensive processes of transductive nature that Mackenzie articulates as pertaining to the complex fields of biology and technicity. In other words, the body of a living being, or the life of a body, is defined by the metastability that signals a collectivity in place and manifests itself through individuation, change, and continuous foldings of various natures (perceptual, alimentary, semiotic, energetic, symbiotic).[70] As Matthew Fuller underlines, Simondon's way to bypass form-matter hylomorphism affords a way to understand the material process of individuation and "allows accounts of technicity and media to escape from a merely semiological reading of the world into an expanded involvement with and of it."[71]

Again we encounter the theme of the insect as a medium in itself. According to Simondon, "The living being can be considered to be a node of information that is being transmitted inside itself — it is a system within a system, containing within itself a mediation between two different orders of magnitude."[72] The body of the living being is thus an intensive carrier of change, which resonates with its environment. The transductive body of the living being works, then, not according to a

66 Gilbert Simondon, *L'individuation psychique et collective* (Paris: Aubier, 2007), 234.

67 Ibid., 88.

68 Ibid., 200.

69 Adrian Mackenzie, *Transductions: Bodies and Machines at Speed* (London: Continuum 2002), 17. Mackenzie notes that the notion of transduction was also actively used in 1950s cell biology: "It named a specific event in which a virus carries new genetic material over into the DNA of bacteria" (17).

70 Ibid., 174.

71 Matthew Fuller, *Media Ecologies: Materialist Energies in Art and Technoculture* (Cambridge, MA: MIT Press, 2005), 18–19.

72 Simondon, "The Genesis of the Individual," 306. Italics in original.

predefined principle (whether termed instinct, **intelligence**, or whatever) but through drawing the solutions to problems from the process itself. In this sense, it is opposed to deduction, which operates with ready-made positions.[73] In the section on bees, Simondon notes that we should understand the bees' behavior through the register of perception. However, this perception works through a perception of distance that posits the perceiver as well.[74] The distances fix and inform positions for the perceiver in temporal terms of duration and bodies in duration so that Simondon seems to be also drawing from the bee lessons ideas regarding the temporal forces of situating the milieu; when the bees waggle and dance, so does the milieu through the medium of the bee in a double movement. The milieu is also a rhythmic refrain of a kind.

What Simondon and related perspectives provide, then, are ways to understand the fundamental and constitutive work of perception and individuation. Perception and communication seen as individuation are not separate modes of being in the world but processes constituting living beings as afforded by their milieus.[75]

But why this focus on bees and all the trouble finding an alternative explanatory context for those 1950s research objects, often framed in contexts of cybernetics and information theory? In order to provide an insight into nonrepresentational and intensive environmental relations that connect bees framed in scientific contexts, **artificial** *animals* like the environment-sensitive turtles of Walter and the potentials for using the bee bodies as philosophical tools to develop ways of understanding language less as information transmission and more, in a way loyal to Von Frisch's initial metaphors, as an embodied dancing that takes the world as its stage.

So far, the way Simondon paves an alternative way to understand the events of the living, information, and the intensive exchanges in fields of milieus (external and internal) has received little attention from scholars of media. Mackenzie's *Transductions* remains a pioneer work in this regard and offers an insight into the relevance of Simondon for media studies of technical culture embedded in discourses of biology. Contra mathematical theories à la Shannon and Weaver and cybernetics, Simondon focuses on the "genesis of the systems of relations,"[76] as Toscano writes. Individuation does not measure information, but information points to an orientation with it. All of this happens in the intensive environmental relation in which any "senders" and "receivers" are enveloped in the individuation taking place. To specify this point in terms of communication research, we are dealing with information as an arrangement and a creative relation between different states of reality. The pre-individual intensity affords a creation of dimensions "where in the individual can come to exist and function, a dimension taking over from the scalar heterogeneity or energetic tension that precedes it."[77]

My intention has been to highlight, through this specific example of the communicative bees from the 1950s, the question of how to tap into a similar context of individuation and the milieu. Once again, tiny *animals* offer insight relevant not only to entomology and biology in general but also to the cultural theory of the cybernetic era as well as contexts of communication

73 Simondon, *L'individuation psychique et collective*, 27.

74 See Simondon, *Cours sur la Perception*, 309–10.

75 My suggestions resonate strongly with J. J. Gibson's ecological and nonrepresentational analysis of perception, which he has initiated since the 1950s. Gibson's later ecological theories, which offer a more material understanding of perception and being-in-the-world than does, for example, *The Perception of the Visual World* (1950), are about the mutuality of the *animal* and its environment. In this sense it works on several similar premises as, for instance, Uexküll's ethology. Consider the illuminating opening of Gibson's *The Ecological Approach to Visual Perception*: "We are told that vision depends on the eye, which is connected to the brain. I shall suggest that natural vision depends on the eyes in the head on a body supported by the ground, the brain being only the central organ of a complete visual system." J. J. Gibson, *The Ecological Approach to Visual Perception* (Hillsdale, N.J.: Lawrence Erlbaum Associates, 1986), 1.

76 Toscano, *The Theatre of Production*, 144.

77 Ibid., 146. Toscano's recommendable reading of individuation highlights the importance of Simondon in thinking individuals and intensities—and also of the critique of code enacted by Simondon. In this passage, Toscano (142–47) explains the pre-individual tension of information, which is, contra mathematical information theory, unquantifiable. In other words, the receivers are not known in advance. This is an approach of potentials and relations in which the terms formed are secondary to individuation. As mathematical theories of communication systems suggest, there are systems between which messages travel, but Toscano outlines how Simondon sees this "between" as the primary (in)forming of the relational systems. A similar radical empiricist stance is also part of Deleuze and Guattari's philosophy and resonates, for example, with the work of William James.

and media. Similarly, the new sciences of **artificial** life arising since the 1980s were much keener on emphasizing the connections with the embodied and less **intelligence**-oriented constructions of cybernetics than was the post-1956 AI research. For scientists such as Christopher Langton, the new **machines** of distributed nature paradoxically afforded much more than models of **intelligence**; they were closer to the simple but more effective processes of living organisms.[78] Indeed, next we will reconvene around the theme of non representational approaches to perception and work through the digital insects that infiltrated 1980s visual culture. We focus less on the representations of insects in the cinema of the 1980s (where, for example, David Cronenberg's films or Dario Argento's *Phenomena* would be obvious choices) than on the ways that neo-Darwinism and the emerging field of **artificial** life transposed insect life as an optimization of movements and perception and how this was framed through a reconsideration of the visual and perception in the algorithmic sphere.

78 See Johnston, *The Allure of* **Machinic** Life, 173; Christopher G. Langton, "Artificial Life," in **Artificial** Life: *The Proceedings of an Interdisciplinary Workshop on the Synthesis and* **Simulation** *of* Living *Systems Held September 1987 in Los Alamos, New Mexico*, ed. Christopher G. Langton (Redwood, Calif.: Addison-Wesley, 1989), 38–40.

This text was first published in Jussi Parikka, *Insect Media: An Archaeology of Animals and Technology* (Minnesota UP, 2010).