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The Ontogenesis of Wind Turbines and the Question of Sustainability

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Chapter 6

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This chapter argues that our ambiguity toward renewable technologies arises from our understanding that the nature of the machine is somehow alien and external to us. Historically, we have thought of the machine as lacking cultural signification. As a result, the machine has been relegated to mere utility rather than having any axiological or human reality. Thinking of the machine as utterly other has exercised a certain xenophobia or misoneism as well as an uncritical technophilia. This ambiguity arises from our acceptance that technology is based on the principle of conservation, a sameness underlying change that is traceable to Aristotle's theory of causality with its implicit ontological distinction between natural and human made objects.

To overcome such teleology, we need a different ontological ground on which to consider the concept of technology. Gilbert Simondon gives us such tools. His work is slowly surfacing with thinkers such as Bernard Stiegler and more recently in the English-speaking academy with thinkers such as Elizabeth Grosz and Andrew Feenberg.[1] This chapter will show how both Aristotle's phenomenology of technology and Simondon's ontogenesis can help to think though the challenges of renewable technologies associated with climate change. It will outline Aristotle's phenomenology of technology and illustrate the intersection and departure of Simondon's ontogenetic epistemology through his three-phase principle of individuation: elemental phase, individual phase, and ensemble phase. For Simondon all objects become whole (*sunolos*) though a process of individuation, which explains the coming into being and the existence of beings of all kinds. There are three phases: the elemental which is the spontaneous excess of being; individuation is the successive multistability of being where being splits becoming both the individual and the many; and finally the ensemble

where the being is concretized becoming more than a unity. At this stage of continuity, and in a spiraling way, the entity enters into the pre-individual stage once again. Using the principle of individuation, we can clearly see the radical rupture between ancient technology and more advanced modern technology while at the same time retaining an evolutionary tension. This tension draws out the ontological and cultural significance of renewable technologies, specifically with regard to the ontogenesis of wind energy. The final section of this chapter appeals to an aesthetic sensibility and its relation to time and space when designing renewable technologies. It argues that artists, as prenoetic creators, must take the lead in designing renewable technologies of the future, a future sensitive to the needs of the earth and human beings.

ELEMENTAL PHASE: MATTER AS PROTOMATTER

The question of genesis preoccupied philosophers in antiquity, culminating in Aristotle's prescient theory of causality explaining the origin and generation of things. And because this chapter is concerned with the emergence of new technologies designed for changes in climate, it will be instructive to revisit Aristotle's production metaphysics as the point of departure to think through the genesis of how a thing is caused or comes into being. For Aristotle, the genesis of being is a becoming, a movement that affects material things.[2] There are three ways something comes into being: through human action (*technē*), self-generation (*poiēsis*), and through chance (*efkairía*). Furthermore, under the theory of causality, beings are subject to change; that is, they undergo prior and posterior time, and because time is the universal form of change, time (or some derivative of time) must exist in the things themselves and cannot be reduced to an epistemological category. This is not apparent to us because the complex interrelatedness of Aristotle's four causes has been systematically overlooked since the late-Scholastic turn to efficient cause as the only ground for any experience whatsoever.[3] However, for Aristotle, our experience of the world first comes to us from sense perception, thereby understanding the things around us in a way in which change cannot be reduced to the invisible action of past forces.

For the most part, when we consider the elemental constitution of a thing, we say that it is made of "matter" or elements. But what does that mean? Perhaps we might say elements are composed of atoms and atoms of subatomic particles. But this is not very helpful, for modern physics does not yet know if fundamental particles even exist. Even if they do, it is not at all clear whether the thing we seek to know can be clarified or distinguished from other things, by knowing that it is composed of some ratio of these fundamental particles.

Yet this is a common way in which the material components of natural things are understood today. The relation between an Aristotelian notion of material cause and the new field of quantum mechanics is still being worked out[4] and will require a further detailed engagement between Aristotelian philosophy and the results of contemporary physics.[5] Yet Aristotle had already realized that one cannot rest content by simply pointing to some material stuff, such as wood or bronze, as the most basic material explanation of natural things. Therefore, material cause must be some sort of principle of conservation that persists or endures through all the natural changes in things. Aristotle called this principle "protomatter" and thought of it as a kind of basic potentiality for existing in various ways.[6] Thus, matter, for Aristotle, is neither some specific material stuff such as water or air nor is it empty space. Rather, it is an indefinite material substratum that embodies the possibility of actualization in some form or other. What then is the substratum of existence? Michael Tkacz, an Aristotle and Albertus Magnus scholar, interprets this as something like the modern concept of energy that is a kind of power the universe has to realize for the various states, properties, and activities of physical reality.[7] Consequently, matter need not, indeed should not, be limited to tangible material stuffs.

Therefore, the generation of an entity at this elemental stage is "potential energy" which exists prior to the being's existence. It is an energy that emerges freely from its own internal tendency, not acted upon from external forces, as a spontaneous act. This is precisely what Simondon calls the *elemental phase* of individuation. Prior to a being coming into existence it undergoes a pre-individual stage. In "The Genesis of the Individual" he describes this pre-individuation arising from a process of differentiation as a "pre-individual" that splits into an individual and a milieu. Milieu refers to an active "becoming" from relative reality to being. It can be understood as the excluded middle to use Aristotle's term. This decoupling during the elemental stage brings into existence that which does not submit to either form or principle. Simondon writes:

> The process of individuation must be considered primordial, for it is this process that at once brings the individual into being and determines all the distinguishing characteristics of its development, organization and modalities. Thus, the individual is to be understood as having a relative reality, occupying only a certain phase of the whole being in question—a phase that therefore carries the implication of a preceding pre-individual state, and that, even after individuation, does not exist in isolation, since individuation does not exhaust in the single act of its appearance all the potentialities embedded in the preindividual state. Individuation, moreover, not only brings the individual to light but also the individual—milieu dyad. In this way, the individual process is only a

> relative existence in two senses: because it does not represent the totality of the being, and because it is merely the result of a phase in the being's development during which it existed neither in the form of an individual nor as the principle of individuation.[8]

So for Simondon, then, the very meaning of "matter" springs up within a complex web of potentialities: form, matter, and energy (or force).[9] Indeed in a note on the milieu dyad, Simondon explicitly points to a tension in force between the two extreme orders of magnitude where the ontogenetic development itself can be considered as *mediation* rather than matter.[10] Thus, the origin of beings cannot be characterized as matter alone. While elements are potentially compoundable in various ways such that, under the right circumstances, their potentiality for acting and reacting in the metabolic process can be effected, this is only ever *relatively* actualized.

Here the individual is always more than itself, it is *supersaturated*, constantly in a process of undergoing further changes, but not in any linear way. The individual constitutes both the individual and the potentialities of the individual. Grosz explains, "Being is at once pre-individual, individuating and individuated; it becomes something, something emerges or erupts, but it leaves in its context or milieu a residue or excess that is the condition for future becomings."[11] According to Feenberg, "The individual is not independent of the world but arises from a process of differentiation in a "pre-individual" medium that splits into individual and milieu."[12] He sees a similar process at play in Bruno Latour's actor-network theory where the social originates in the structure of the network of human and nonhumans. Social groups exist only through their connections, which are sustained by technical artifacts. The human and the nonhuman are tied together, each serving as the milieu of the other in a reciprocal process of individuation.[13] Becomings are the spontaneous potentialities of disparate forces including objects and materials forming a system that preserves many of the object's qualities while transforming them into a cohesive whole.

Thus, for both Aristotle and Simondon the material components that constitute a thing are not solely determinative of it, but merely a relative reality, arising out of a more primordial protomatter which is the result of a phase in the being's development; it is only a partial or relative resolution in a system. Latent in individuation lie potentials and incompatibilities. How do these potentialities form a whole, for Simondon? Can they ever reach their full potency in perfection like they can for Aristotle? Arguably Simondon's objects never reach teleological perfection, even theoretically.[14] Rather, the technical object, while it is finite in its possibilities, tends toward a steady state—from the abstract to a concrete mode in which the system is entirely unified. This process is not a forming as Aristotle would have it, but an unfolding or informing.[15]

INDIVIDUAL PHASE: FROM FORM TO IN-FORMATION

This "unfolding of being" of both human and object means that being is more than a stable unity with a formal structure. As we have shown, materiality in its pre-individual state is neither distinct from being nor intelligible as formed matter. Rather, it is a supersaturation of the individual and its milieu where the subject and environment entangle. Juxtaposing Marx, who argues that the production-line produces standardization, for Simondon standardization is intrinsic to the object, allowing for the production-line to exist in the first place. This entanglement of standardization within the object extends to both artisanal production and industrial production, the former corresponding to the primitive stage of the evolution of the technical object (the abstract stage to which we will return to below) and the latter corresponding to the concrete stage.[16]

One such entanglement is the technology used to harness wind. Wind turbines are used around the world to harvest the kinetic energy of the wind and convert it to electricity usable by human beings. Along with solar and hydro energy, wind is categorized as a sustainable energy source: wind is free, clean, and plentiful, thus wind energy is sustaining and renewable. While this is certainly true, harvesting wind energy requires technology that itself uses fossil fuels, is excessively expensive, is disproportionately big, and is very quickly and effectively reducing land surface.[17] At a first glance, we might think that the genesis of wind energy comes not from modern physics but from ancient sail technology. There is certainly some truth in this idea, but it is a complicated story that we must look at more closely, paying particular attention to the question of ontogenesis. Sails used in the first Polynesian settlement of the South Pacific to early shipping in the Indian Ocean and Persian expeditions on the Mediterranean often originated from the Pandanus tree. In other words, the Pandanus leaf is the prenoetic or preindividual stage of the sail and, thus, has the potentiality of being formed into a sail. For Aristotle, the leaf itself has some actual form: as living tree, as sail, as ropes, as mats, and as spice. Yet, regardless of the form, it remains the leaf with the potentialities of the leaf, one of which is actualized here and now as, say, a sail. The woven sail would have been easy to identify as something composed of the Pandanus leaf. What makes a sail intelligible as sail, however, is not the fact that it is made of woven leaf, but the fact that the potentiality of the leaf is actualized here and now as a sail. In other words, it is the form of the sail that determines the artifact as sail and not, say, a boat. In *Physics* Aristotle writes,

> That which is potentially flesh or bone has not yet gained its own nature, and is not a natural object, until it has acquired the form which enable us to define what the thing is and to define it as flesh or bone.[18]

Here form provides the intelligibility of the subject, and reference to the subject's form provides the subject's definition. For natural subjects that are familiar to us from our sense perception, one can, to some extent, identify the material as a sort of stuff and the form as the shape or configuration of this material. If the tree floats on water it is because the constitution of the wood is such that wood floats on water. On the other hand, that a tree has roots is because of the form of the tree and two requirements that are imposed on the shape of the thing by this form: First, trees are tall, they are vertical, and need to be rooted so they do not blow over. Secondly, trees are living things that require water and nourishment which cannot be easily obtained in air, but can be in soil.[19] This, for Aristotle, is the subject's "substantial form," for it causes the subject to be the kind of substance it is.

This is the core of Aristotle's substance metaphysics. Phenomenologically understood, let us just say that "substance" is the considered word for thing, and one can think of formal cause as the reason for the thingness and *whatness* of the natural substance, such that the substance of a thing is what is given in its definition.[20] Forms like this can be distinguished from those accidental forms that are not only true of the natural subject, but are incidental to its being what it essentially is. Accidental forms vary in presence, absence, or degree without changing the essential character of the substantial subject and are thus directly related to Husserl's method of eidetic variation. They are either attributes or modifications of the substance, but they do not determine its species, even if they are always or normally found in that species.

When human beings intellectually apprehend and define a natural subject, it is the substantial form, *hypokeimenon*, that is apprehended. Hypokeimenon is "what always already lies present."[21] Thus, such apprehension is not the same as sensory apprehension described above, because substantial form is not necessarily immediately revealed in sense perception. Substantial form, of course, is derived from sense experience; one must have some experience of the natural subject to begin the process of learning what it is. Yet, substantial form is more universal and determinative than what is available in sense perception. The defining characteristics of an element or a tree do not just apply to this perceivable piece of each particular tree, for these are what makes them be what they are as a unified whole. Indeed, it is the very fact that substantial form is a reality, that it can disclose the *hypokeimenon* of the substantial form.[22] Aristotle understood the importance of identifying and differentiating the individual things we encounter as individuals of a kind, a process which if left to the senses would not render scientific knowledge. In other words, the fact that simply experiencing a natural subject by means of our senses does not exhaust our knowledge of the subject shows that unless knowledge is simply a function of the imposition of human categories or words onto things, then something like substantial form is a real cause of the nature and intelligibility of the natural subject.

While substantial form accounts for the unity of the natural subject as a subject of a certain species, it also is the source for the subject's various attributes and functions. It is not sufficient to identify the form of a Pandanus tree as a certain shape or size, but to indicate a tree that manifests certain distinguishing operations such as reproducing and growing in a certain way, the long narrow bayonet leaves that halfway up bend sharply at a right angle, its long, narrow spiny fibrous leaves, and so on. Thus, for Aristotle, while part of the causal explanation of the natural subject is identifying its material component, it is also necessary to articulate its formal cause. Indeed, it is the substantial form of the subject that provides its intelligibility, accounting for its species and characteristic operation.

Therefore, Aristotle's hylomorphism insists that pointing to the material cause alone will not adequately account for all that is true of the natural subject. Moreover, one cannot reduce formal cause to material cause. One cannot explain things by simply indicating what they are made of and treating their form as mere shape, configuration, or structure of the matter. This would fail to provide an account of the subject as substance, for it would treat form as simply an accident. For any natural subject to be what it is, it must have both a material cause and a formal cause; the material components with their properties must be brought together in a certain structure in such a way that a substantial unity of a specific kind functions in specific ways: a potentiality for being this kind of thing actualized as being this kind of thing.

While Simondon wants to hold onto Aristotle's refusal to allow form to be reduced to matter and his rejection of matter as inert neutral stuff, he does not accept this formal structure of stability. Being is not a stable state of equilibrium. Rather being is in a constant state of flux and can only be grasped as the activity at the very boundary of the process of formation. This is not the convergence of matter and form but a "resolution taking place in the core of a metastable system rich in potentials: form, matter and energy preexist in the system."[23] What is this resolution of the self and the other, the individual and the milieu, at the threshold of which things come into being? Simondon writes,

> The Being in which individuation comes to fruition is that in which a resolution appears by its division into stages, which implies becoming: becoming is not a framework in which the being exists; it is one of the dimensions of the being, a mode of resolving an initial incompatibility that was rife with potentials. *Individuation corresponds to the appearance of stages in the being, which are the stages of the being.* It is not a mere isolated consequence arising as a by-product of becoming, but this very process itself as it unfolds; it can be understood only by taking into account this initial supersaturation of the being, at first homogeneous and static [*sans devenir*] in which preliminary tensions are resolved but also preserved in the shape of the ensuing structure; in a certain sense, it could be said that the sole principle by which we can be guided is that of the conservation of *being through becoming.*[24]

Here the "resolution" is by no means the process of stability that is meant in the Greek sense. Rather resolution implies a thing's becoming what it was going to be, intrinsic to its being. This anti-reductionist account of causality is the becoming of the individual-milieu dyad. For Aristotle if material cause is a potentiality, then it is a potentiality *for* something. This is not the case for Simondon. Rather, individuation is made possible by the recurrence of causality within a milieu that the technical object creates around itself from out of itself. It is simultaneously a technical and natural milieu.[25] The separation of matter and form that conceives of form as an eminent and transcendent principle privileges the formal conception of being, or as Anne Sauvagnargues puts it, "to the extent that [the Greeks] only conceived of being in a state of equilibrium, they were led to privilege a formal conception of individuation by taking form and matter separately, leaving the operation of individuation itself in the dark."[26] Western philosophy, in particular our orientation toward the rationality of technological thinking, has been framed by such an interpretation. Overcoming the ancient substance metaphysics required from Simondon a transformation in ontology itself, an ontology of becoming, what he would come to call an *ontogenesis*. What are the implications for this?

In line with our modern thinking, Simondon drops the metaphysical term "substantial" reality and the inductive logic upon which it is grounded, toward "relative reality." This means that form is no longer the fundamental structure of reality; rather, it is replaced by an *in-forming*. Informing is a transitive verb, which fits into his schema of the logic of transduction: a horizontal and vertical theory of generation. Information forms the noun, which is an "act of," a "state of," or "result of." In other words, the technical being retains the essence of its evolution as *in*-formation. For example, the movement from a Pandanus leaf to a sail means the sail retains or conserves a trace of the material form of the tree. The sail, however, takes on a relative reality that transforms the Pandanus leaf to a sail. As Grosz articulates, this transformation generates "a creative leap" from the past and present to an unknown future.[27]

Unlike the spontaneity of the elemental phase, this phase expresses a successive linear character. In the case of wind energy, the sail undergoes change simultaneously with human beings as technologies become more efficient, lighter, and versatile. This process of individuation persists through the evolution of the first recorded wind-powered device in Persia (present-day Iran) in the Middle East in AD 644. The Persians used a vertical shaft with several sails built from bundled reed and straw also known as *panemone* presumably from the Pandanus tree. Sails were used to drive a mill stone for the grinding of grain, irrigation, and wood cutting from the seventh to twelfth century.[28] By AD 1000, as sails developed, wind-powered devices became more powerful. The difference between this design and earlier designs is that the sails

are shaped more efficiently to capture the wind and they spin vertically. But windmill technology evolved slowly from 1300 to 1850, maintaining its function of milling grain and occasionally pumping water. The function of the sail based on the early weavings of the Pandanus tree, endured for one thousand years. The wind turbine, however, is not the same. Theoretically, it is designed to harvest enough wind energy to replace fossil fuels. Such technology is what Simondon calls industrial technology and corresponds to the *concrete stage* of production. But can such technology be said to retain a trace of the modest windmill and hence its sustaining character?

ENSEMBLE PHASE: ONTOGENESIS OF WIND TURBINES

According to Simondon, there would be little analogy between a wind turbine and a windmill, yet the technical being retains the essence of its past evolution in the form of its technicity.[29] Windmills reached a resolution or stable state in thirteenth-century Europe, as a technology to grind grain or to irrigate the land. In Simondon's language it can be understood as an *ensemble*. The ensemble tends toward a steady state in a system that is entirely coherent within itself and entirely unified. But this is other than Aristotle's stable equilibrium. Simondon calls it a "metastable equilibrium," "*the conservation of being through becoming*."[30] This movement itself is what Simondon calls transduction. Transduction is

> characterized by the fact that the result of this process is a concrete network including all the original terms. [It] is characterized by the conservation of information, whereas induction requires a loss of information . . . transduction does not presuppose the existence of a previous time period to act as a framework in which the genesis unfolds, time itself being the solution and dimension of the discovered systematic: time comes from the preindividual just like the other dimensions that determine individuation.[31]

Here again we see that we do not have to adopt the metaphysical implications of Aristotle's notion of teleology. By embedding things or objects within an environment and assigning time as the basic structure of existence, Simondon avoids the Aristotelian problem of defining limits, which ultimately end in nonbeing, and consequently avoids the problem of teleology in the strict sense, more broadly associated with determinism. While the core idea of determinism is closely related to causality, what we find in Simondon is causality without determinism, in particular "soft causality" that allows for an event that is not predictable from prior events.

So, on what grounds should we reject the modern notion of causal determinism as we now experience it? Well, we have the outlines of a project for doing so in Aristotle and Simondon who point us to the ways certain kinds of matter can be informed in certain kinds of stable ways so that things can engage in their characteristic functionings. However, while we can learn a great deal from the Aristotelian challenge to the modern reduction of reality to efficient causality and inert materiality, we also want to avoid the temptation toward a reduction to notions of a preordained intelligibility and remember that the ontogenesis by which these things come into being can emerge as multistabilities within an open-ended process of becoming. Understanding ontogenesis as an interweaving of materiality and form gives us the ontological ground for beginning a conversation about wind turbines that is much less restrictive than the one with which we are familiar. Instead, beyond thinking of climate sustainability as an engineering problem, we need to address it in terms of a social and cultural practice which is aesthetically informed. The next section will apply pre-individuation to the prenoetic phase of humanity, which includes, paradigmatically, the artist.

In terms of the human condition, pre-individuation is the neonoetic or pre-reflective stage of humanity, characteristically revealing the work of artistic production. Artists, as creators, are the kinds of beings that are marked by an excess of reality. Artworks emerge spontaneously creating new beings. This is not a *renewal* of something bygone. Thus, the very notion of *renewable* technology is already redundant. Of course the emergence of renewable technologies is the result of a rapidly warming climate primarily caused by burning fossil fuels. The American Wind and Wildlife Institute released their White Paper, "Bats and Wind Energy: Impacts, Mitigation, and Tradeoffs" (November 15, 2018), stating that only 6 percent of energy in the United States is generated by wind, and 17 percent is generated by all renewable sources combined.[32] We know that the pace and scale of such renewable technologies needs to accelerate to keep temperature increases below 1.5 C by 2050. Thus, the need for the shift from fossil fuels to non-carbon-emitting sources is undisputable. However, I would argue our inability to think through appropriate technologies to achieve this goal is due to our reliance on engineers and technicians to "fix" the climate problem. But the weather does not need fixing; it is not an engineering problem. Ontogenetically, thinking about harvesting wind capable of powering local and urban communities must begin at the pre-reflective stage. This means that artists and not engineers are the ontogenerators capable of breathing new life into technological design. For the sake of brevity, let me point to two artists working *with* nature toward a sustainable way of living.

Sculptor Lyman Whitaker has focused on gracefully capturing the spirit of the wind through his kinetic art. Lyman dedicates his work to the wind

and weather. The sculptures are made of the highest quality stainless steel and copper. Similar to the windmill, it uses wind to harness energy. Similar to the wind turbine, these are engineer-tested to winds of 90 mph and can withstand hurricane-force winds. Uniquely, Lyman's designs have perfect balance and aerospace-grade stainless steel sealed bearings, insuring little or no maintenance. Furthermore, they do as Lyman writes "inspire love for our earth's thin, moving layer of air—it warms us, gives us breath and sustains our being."[33] Titles such as "Element Air," "Double Helix Sail," and "Lotus" indicate the interweaving or entanglement of technology and nature. This spontaneous eruption and decoupling of artist and technology informs the natural environment. "Element of Air" is a 2' 6" stainless steel blade twisted into a semi-mobius. As the wind catches it, the blade moves around like a ballet dancer in tune with the wind. The artist and art work, no longer in the process of creation, individuate into the object and the milieu; phenomenologically humanity and nature come into view. Wind sculptures not only are aesthetically appealing, but are designed to utilize wind capacity to supply energy for individual homes. Furthermore, they maintain the integrity of the natural world without the disruptive power of wind turbines. For example, bats are one of the many fatalities of wind turbines. The "Bats and Wind Energy" White Paper suggests the decline in bats is due to anthropogenic activity, with wind turbines considered one of the greatest threats to bat populations in North America and Europe, citing approximately 190,000 to nearly 400,000 fatalities in the United States and Canada in 2012 alone. These numbers have increased steadily over the last six years.[34]

Ideally, it would seem that replacing wind turbines with wind sculptures would avoid the negative consequences of modern renewables, but while this technology may be feasible for suburban and rural households, it may not be adequate for high-density urban life. For proposals of a larger scale we can turn to architect and visionary, David Fisher, who conceived the "Da Vinci Tower," which is currently planned for construction in the city Dubai, UAE. Each of the sixty-eight floors will rotate independently, and there is a space between each floor for wind turbines.[35] The rotating building will use its central horizontal axis for harvesting and storing energy created by the rotating floors. Theoretically, this is a building that will produce its own energy.[36] Fisher sees architecture as "part of nature," buildings that "adjust to life, to our needs, to our moods." His buildings reflect time and motion. This is still at the conceptual or elemental stage and is not planned for production until 2020. Prenoetically informed, the rotating building has the potential to create a living space that moves with the rhythm of nature and to produce an excess of energy for the urban region. Given more time, we could investigate other ways that wind energy could be harvested using the resources already available to us. However, it is enough to point out that wind turbine technology

is at the elemental stage of development. As such we should think carefully about how to integrate both inductive and deductive logic into the genesis of the entity such that the machine is not external to humanity but built into the fabric of living.

CONCLUDING REMARKS

The present chapter has shown the ontogeneis of the windmill emerging from unpredictable protomatter; from Pandanus leaf to sail, from sail to windmill. Windmill technology endured for more than a thousand years. It was, in short, sustaining. Wind turbines, on the other hand, are undergoing a process of ontogenesis in a radically new context and, as such, remain at an early stage of development. They are at the pre-individual stage. This is not a progressive linear structure of problem solving by way of which any given technology gets more efficient over time while remaining substantially the same. Indeed, thinking of technology and technical solutions as evolutionarily determined fails to account for the radically different needs of time and place.

The excess of human creativity by the artist, can individuate a thing into a quasi or metastable reality. The resulting object enters into a second phase of individuation where the world of technical and social actors informs the object socially, culturally, and politically. The more creative the process at the elemental stage, the more scope we will have for thoughtful engagement as the technology becomes concretized. Today, it seems we have no options for reflection; either we accept the massive wind farms or we reject them. Their form seems predetermined and, therefore, outside the realm of the discussion. To break free from such enframing, we need to open up the design process of harvesting natural resources to artists—they are the creative thinkers who can imagine new designs beyond the limits of technicians and engineers Artists are attuned to the elemental stage where things remain devoid of form or content.

Because wind turbines carry the trace of their evolutionary past, that does not mean they evolve naturally from the windmill. Indeed, this kind of inductive causal connection is fallacious. If wind turbines are based on the logic of transduction, as is suggested in this chapter, then the artists and designers, in their excess of technics, can create possibilities for thinking creative ways to harvest wind. But until we understand the temporal character of our technologies, we will continue to merely "improve" on older technology (a self-fulfilling prophecy of determinism), foreclosing the possibility of designing energy-harvesting technologies that are truly sustaining for our own time and place.

NOTES

1. Other writers influenced by Simondon include Jean Baudrillard, Paolo Virno, Giorgio Agamben, Alberto Toscano, Bruno Latour, and Isabelle Stengers but will not be addressed here.

2. In *Heidegger on Being and Acting*, Schürmann refers to this as the "kinetic paradigm of origin" which constitutes both an inception and domination. He argues that "once it is understood that phenomena as a whole are knowable from the viewpoint of causality, then it can be said that a true cause is only that which begins its action "and never ceases to being it," that is, a cause that also commands." 99.

3. Indeed scholars debate about whether the four causes are really causes at all. For a useful overview of some of the various contemporary approaches, see Beebee et al. (2007). On contemporary approaches to the relation between causation and explanation, see Psillos (2002). And for a discussion on the four causes see Moravscik (1974), Freeland (1991), Lewis (1991).

4. See Peter Hoenen, *Cosmologia*, 5th ed. (1956); Hoenen, *De Noetica Geometriae* (1954); Hoenen, *The Philosophy of Inorganic Compounds* (Indiana: West Baden College, 1960); S. J. Philip Soccorsi, *De Physica Quantica* (1956), William A. Wallace, *Modelling Nature: The Philosophy of Science and the Philosophy of Nature in Synthesis* (Catholic University of America Press, 1996).

5. As modern chemistry improved on the ancient Greek theory of the four elements by developing the periodic table of the basic building-blocks of the universe, modern physicists continued to investigate the notion of conservation as an even more basic characteristic of nature.

6. Aristotle, in Chapters 7–9 of the 1st Book of *Physics*, refers to matter as "underlying nature" (191a8) and form as "the natural form" (192b1).

7. Albert Magnus, *Opera Omnia*, edited by E. Borgnet (Paris: Vives, 1890–99), Volume 6: Metaphysicorum Libri XIII. Also, Michael Tkacz's essay, "Albert the Great and the Revival of Aristotle's Zoological Research Program," *Vivarium* 45, no. 1 (2007): 30–68.

8. Gilbert Simondon, "The Genesis of the Individual," in *Incorporations*, eds. Johnathan Crary and Sandford Kwinter (New York: Zone Books, 1992), 297–319, 300.

9. Ibid., 304.

10. Ibid., Note 1, 317.

11. Elizabeth Grosz, "Identity and Individuation: Some Feminist Reflections," in *Gilbert Simondon Being and Technology*, eds., Arne De Boever, Alex Murray, Jon Roffe, and Ashley Woodward (Cheshire: Edinburgh University Press, 2013), chap. 3, doc. 840–1245, 869. Kindle.

12. Andrew Feenberg, *Technosystems: The Social Life of Reason* (Cambridge, MA, London: Harvard University Press, 2017), 73.

13. Ibid., 74.

14. This is a controversial point, as it can be said that Aristotle has three different concepts of telos, which is not identified by Simondon.

15. Gilbert Simondon, *On the Mode of Existence of Technical Objects*, trans. Cecile Malaspina and John Rogove (Minneapolis, MN: Univocal Publishing, 2017), 29.

16. Ibid., 29.

17. *Institute of Political Economy in Utah State University Report.* https://connecticuthistory.org/halladays-revolutionary--today-in-history-august-29/ Downloaded 10/15/2017. Investigators Randy T Simmons, Ray M. Yonk, and Megan E. Hansen put together a forty-page report outlining the true cost of producing electricity from wind power. The report claims that wind energy is indefensible. It outlines in detail the true cost of wind energy that is often overlooked, leading to a dramatic underestimation of the true costs of producing electricity from wind. In the interest of time let me point to two of the above: Government Subsidies and Transmission Costs.

18. Aristotle, *Physics,* trans. Robin Waterfield (New York: Oxford University Press, 1996), 193a30–b3.

19. Ibid., xxii.

20. Ibid., 239.

21. *Being and Time,* 35/30.

22. In more Husserlian language, this is why adumbrations that are not immediately present to consciousness are nonetheless co-present in the unity of intentional object.

23. Simondon, "The Genesis of the Individual," 303.

24. Ibid., 301.

25. Simondon, *On the Mode of Technical Objects*, 59.

26. Anne Sauvagnargues, "Crystals and Membranes: Individuation and Temporality," trans. Jon Roffe in *Gilbert Simondon Being and Technology,* eds., Arne De Boever, Alex Murray, Jon Roffe, and Ashley Woodward (Cheshire: Edinburgh University Press, 2013), chap. 4, doc. 1258–534, 1277. Kindle.

27. Grosz, "Identity and Individuation," 947.

28. Anindita Roy and Santanu Bandyopadhyay, *Wind Power Based Isolated Energy Systems* (Springer International Publishing, 2018), 17.

29. In a note, Simondon refers to the technical being as "analectic," that is, the barer of the technicity can be the object of adequate knowledge, "only if the latter grasps the temporal sense of tits evolution: this adequate knowledge is a culture of technics, distinct from technical knowledge, which is limited to the actuality of isolated schemas of operation." See Simondon, OMETO, Note 1, 26.

30. Simondon, "The Genesis of the Individual," 301.

31. Simondon, *Being and Technology,* 315.

32. American Wind and Wildlife Institute released their White Paper, "Bats and Wind Energy: Impacts, Mitigation, and Tradeoffs" (November 15, 2018), 3. See also IPCC, 2018: Global warming of 1.5 °C. An IPCC special report on the impacts of global warming of 1.5 °C above preindustrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty (V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, Y. Chen, S. Connors, M. Gomis, E. Lonnoy, J. B. R. Matthews, W. Moufouma-Okia,

C. Péan, R. Pidcock, N. Reay, M. Tignor, T. Waterfield, X. Zhou [eds.]). file:///C:/Users/home/AppData/Local/Microsoft/Windows/INetCache/IE/PRLDWK38/AWWI-Bats-and-Wind-Energy-White-Paper-FINAL.pdf.

33. Lyman Whitaker, Worthington Gallery Art for Life, https://worthingtongallery.com/ Downloaded 10/15/2017.

34. American Wind Wildlife Institute (AWWI), "Bats and Wind Energy: Impacts, Mitigation, and Tradeoffs" (Washington, DC, 2018), 11.

35. Chad Randl, *Revolving Architecture: A History of Buildings that Rotate, Swivel, and Pivot* (New York: Princeton Architectural Press, 2008), 188.

36. Paul Goldberger, "Shape-Shifter," *The New Yorker*, July 21, 2008, https://www.newyorker.com/magazine/2008/07/21/shape-shifter-paul-goldberger, Retrieved, January 21, 2019.

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