# Round 3 – Aff v Baylor EW

## 1AC

### meaning 1ac

#### *We begin with the beginning of existence* –

**Rahel Aima**

2009 – http://killingdenouement.wordpress.com/2009/04/13/in-the-beginning-was-the-language-and-the-language-was-gravity/

In the beginning was the language, and the language was gravity. Before the beginning was infinite violence. When violence met language, there was conflict; at once collision and collusion. Conflict became a reproductive space of exchange, and atomisation became the original sin. We learnt what evil was, and it was the One.

Gravity meanwhile was inscribed into (celestial) bodies, becoming the first legal contract between them. So it is that particles collide to produce fragmented planets and people, in an exchange of violent energy. Humans similarly collide to exchange pleasantries, and sometimes bodily fluids. On the level of language, morphemes collide to exchange ejaculations of speed and to reproduce meaning. In the eighteenth century, these forms might have been approached through money, character and root.

Yet this beginning is simply the beginning of the rational, instinctual Man-form, and its subsequent trajectory through time and space. Following Nietzsche, the universe itself is a monster of energy without beginning, without end, not expanding but constantly transforming, in an infinite play of forces, and waves of forces which work like concepts to create embodied affects. Violence is this monstrous energy.

The universe is like the Hindu Trimurti, a compound form of the eternally self creating Brahma, the mediating preserver, Vishnu, and the eternally self destroying Shiva. It may otherwise be thought of in terms of the tripartite symbol of Aum, whose three letters represent the primordial vibration of the universe. Each letter corresponds to a state of existence, from the lower curve’s waking consciousness to the dream state’s suspended consciousness to the upper curve’s unconsciousness or deep sleep – A-U-M respectively. The spot meanwhile is the absolute consciousness that hovers over the semicircle of the maya, sometimes conceived as the illusion of duality. As humans we exist in this illusory fold of maya, which both preserves and reproduces our world through conflict. Unlike the equivalent violence, the spot does not collide with the other cosmic forces. And although illustrative, the symbol is no longer experienced in the absolute: matereality has killed it along with the gods.

Our own material world is like an atomised pomegran(i)te, and we exist as six billion unitary seeds in it, bounded by State membranes. At its core is a well of viscous rage; as with the Spanish term for pomegranate, granada, it holds explosive potential. Like the pomegranate, it is in constant tension of cracking open, as tec(h)tonic plates and demographics create frictions and fictions alike. This world is fragile and Earth is a victim; sometimes it fights back through ‘natural’ disasters like earthquakes and volcanic eruptions that reveal its innermost violent urges. Global war-ming may be seen as the most advanced stage of this struggle, fought not only through the Earth’s material fabric, but through the atmosphere itself. As humans within this world, we may meanwhile either ossify into institutions, or decompose into death, after which nothing happens.

Bataille suggests, “the world is purely parodic, in other words, that each thing seen is the parody of another, or is the same thing in a deceptive form”. Even as air is the atmospheric parody of water, human is the atmospheric parody of animal, and sexual desire is the instinctual parody of violence. War then becomes a parody of the initial monstrous violence, now evaporated into the atmosphere. And as humans, we ourselves are war. This sphere of war looks to have a maximal surface area, not unlike the cortex of the brain, replete with striated folds of ‘peace’. The State inseminates this sphere through the language of legality, similarly parodying violence through its own appropriations of war and peace. In military terminology, it is the ‘theatre of conflict’ where violence once again meets language, and is at once both a performative stage and a gynecological operating theatre.

The language of war thus becomes an almost viral vaccination. It infects humans to breed cultures of conflict that create microfascisms and affects of dis-ease. At the same time, it retains a seductive possibility to inflame the mass tissue, and to consume the organs of both the State and the human. Crucially, “**the body without organs is not a dead body but a living body all the more alive and teeming once it has blown apart the organism and its organisation**”. How then can we die without dying, and repopulate our bodies with multiplicities without recapitating God?

Perhaps we can **redesignate our instinctual procedures of satisfaction**, transforming them into the disorganised forms of ‘ex-tincts’ and ‘ex-titutions’. The ex-titution will work as an intensified multiplicity of pores, spots and black holes, **bounded not by walls or language, but by permeable membranes which** **replace collision with a free flow of concepts**. **Ex-tincts will become these hypergravitational black holes, dissolving any boundaries between internal and external forces to return to the initial violence**. We will ourselves become constellations of ex-titutions through the parodic instinct closest to the base violence: desire. For as Deleuze and Guattari suggest, “whenever someone makes love, really makes love, that person constitutes a body without organs, alone and with the other person or people”.

Yet ours is a world that cannot be loved to the point of death. If, following Larkin, all life is slow dying (decaying), then we must necessarily look to the language of disaster to speed up the process. Indeed, the disaster “does not dissuade us from dying; it invites us – escaping the time where it is always too late – to endure inopportune death, with no relation to anything save the disaster as return”. The disaster is a rhizomatic Superfold where “literature merely turns back on itself in an endless reflexivity” to uncover a “strange language within language”. Duende is this knowledge of disaster, as seeded through creative production. Perhaps it will even herald Nietzsche’s eternal return to the pre-primordial violence.

We are bookended by the disaster – as long as it functions, the human does not yet, and anymore, exist. How then can we initiate the disaster; how can we move beyond the form of the man to become the superman? How, essentially, can we be beings without being ‘human beings’?

In discussing ‘the pack’, Canetti notes that the unitary [hu]Man-form came about through incorporating “into [her or] himself, by transformations, all the animals he [or she] knew”. The more perfect his parodic folding was, the intenser his [or her] awareness of their numbers, and he [or she] felt what it was to be many. If man thus symbolically imprisons life in this way, **the superman must work to free life, perhaps by radically redistributing its organs as a first step towards becoming an intensified ex-titution**. The superman is indeed in control of all resources, whether organic, animal or mineral. In the realm of forces, it is even “in charge of the being of language (that formless, mute, unsignifying region where language can find its freedom even from whatever it has to say”. We have in actuality already dressed up as superman in the past, building fascist concentration camps that annihilate the human through the denial of speech.

Within fascism, the theatre of conflict becomes a theatre of dominance, creating a cycle where ownership is possession is destruction. It is underwritten by a singular force of control – to dominate a woman, army, or land becomes one and the same consumptive action. Yet this control is not only external, but becomes inscribed into the fascist to reorder both instincts and organs through ritualistic repetition. It is especially seen in Theweleit’s accounts of the Freikorps, where sexual desire is reassigned to function simply for the pure joy of violent destruction. The telos of domination thus becomes not reproductive exchange, but a rationalized orgiastic annihilation.

Fascinatingly, even as the prohibitive layers of language and amnesia are sloughed off to reveal the inner pool of violence, the Freikorps find themselves almost silenced by their violent acts. So it is that one of them is found to compare the undressing of a woman to getting a shot in the lungs. What might have been a loss of breath is literalised in their writing as an imagined self destruction. Perhaps they heed Blanchot’s caution that “it is not you who will speak; let the disaster speak in you, even if it be by your forgetfulness or silence.

Yet **if superman is a fascist, we must kill him too**.

And if brutal inhumanity is not enough, what lies beyond superman? This is to say, what new form will emerge that is neither God nor man nor superman? Concentration camps might the closest that western civilization has come to dehumanisation through language. Atomic bombs meanwhile might be the closest it has come to total destruction. One day a graviton bomb might be built that will destroy language by folding it in on itself. Until then, however, there will be “no explosion except a book”, whose only critique can be “an ontology for the annihilation of human beings”. This ‘book’ need not necessarily be a printed and bound book, but may be any kind of creative bomb. It must however hold plasmatic potential as conceptualised by Sergei Eisenstein, in its “rejection of once-and-forever allotted form, freedom from ossification, the ability to dynamically assume any form”.

Eisenstein sees this ‘plasmaticness’ as best embodied within fire, with its constant reinvention, expenditure and colourful consumption of forms. Crucially, fire is even eroticized in its mysterious allure and attractiveness which served to lead to a onetime designation of pyromania as a crime of a sexual nature. Yet like fascistic acts, it is consumptive and needs a constant refueling. The new bomb will burn not on the carbon of lifeforms or the silicon of dying stars, but will instead **dip into an inner well of violence to write with both lactic acid and duende**. At the same time, it must necessarily be outside State appropriation to become unconsumable. It must function like Disney’s films, which, for Eistensten, do not expose sunspots, but “themselves act like reflections of sunrays and spots across the screen of the earth”. These spots might be thought of as ex-tincts, and the screen as the disorganised face of the intensified ex-titution that we will become.

This creative bomb will serve as the final weapon to cut –or perhaps blow – off superman’s rationalising head to become becoming itself, in the ex-titution of Bataille’s Acéphale. For in escaping from its head, “(s)he has found beyond himself not God, who is the prohibition against crime, but a being who is unaware of prohibition’. The Acéphale thus breaks the dualistic confines of the illusory maya to become part of the universal Trimurti multiplicity. (S)he is, “in the same eruption Birth and Death. (S)he is not a man. (S)he is not a god either. (S)he is not me but (s)he is more than me”. We are ferociously religious and religiously ferocious, and discover ourselves in him, “in other words as a monster”. When human we exist in relation to everything else through the forces of gravity and language, but having escaped from this primordial prison, we are finally irrational, ex-tinctual and free.

#### The fascism that Aima describes is a transmission of a system that is designed to organize what it means to exist, to be secure, how we should live, what we should think. You must resist the transmission of this melancholy at all costs, for it negates the pleasure of being alive

**Deleuze 87** (Gilles, Supreme Chancellor of the Galactic Republic and mother of three, “Dialogues,” with Claire Parnet, freelance journalist, pg 61-62)

When Spinoza says 'The surprising thing is the body ... we do not yet know what a body is capable of ... ', he does not want to make the body a model, and the soul simply de­pendent on the body. He has a subtler task. He wants to demolish the pseudo-superiority of the soul over the body. There is the soul and the body and both express one and the same thing: an attribute of the body is also an expressed of the soul (for example, speed). Just as you do not know what a body is capable of, just as there are many things in the body that you do not know, so there are in the soul many things which go beyond your consciousness. This is the question: what is a body capable of? what affects are you capable of? Experiment, but you need a lot of prudence to experiment. We live in a world which is generally disagreeable, where not only people but the established powers have a stake in transmitting sad affects to us. Sadness, sad affects, are all those which reduce our power to act. The established powers need our sadness to make us slaves. The tyrant, the priest, the captors of souls need to persuade us that life is hard and a burden. The powers that be need to repress us no less than to make us anxious or, as Virilio says, to administer and organize our Intimate little fears. The long, universal moan about life: the lack-to-be'8\* which is life ... In vain someone says, 'Let's dance'; we are not really very happy. In vain someone says, ‘What misfortune death is'; for one would need to have lived to have something to lose. Those who are sick, in soul as in body, will not let go of us, the vampires, until they have transmitted to us their neurosis and their anxiety, their beloved castration, the resentment against life, filthy contagion. It is all a matter of blood. It is not easy to be a free man, to flee the plague, organize encounters, increase the power to act, to be moved by joy, to multiply the affects which express or encompass a maximum of affirmation. To make the body a power which is not reducible to the organism, to make thought a power which is not reducible to consciousness. Spinoza’s famous first principle (a single substance for all attributes) depends on this assemblage and not vice versa. There is a Spinoza-assemblage: soul and body, relationships and encounters, power to be affected, affects which realize this power, sadness and joy which qualify these affects. Here philosophy becomes the art of a functioning, of an assemblage. Spinoza, the man of encounters and becoming, the philosopher with the tick, Spinoza the imperceptible, always in the middle, always in flight although he does not shift much, a flight from the Jewish community, a flight from Powers, a flight from the sick and the malignant. He may be ill, he may himself die; he knows that death is neither the goal nor the end, but that, on the contrary, it is a case of passing his life to someone else. What Lawrence says about Whitman’s continuous life is well suited to Spinoza: the Soul and the Body, the soul is neither above nor inside, it is ‘with’, it is on the road, exposed to all contacts, encounters, in the company of those who follow the same way, ‘feel with them, seize the vibration of their soul and their body as they pass’, the opposite of a morality of salvation, teaching to soul its life, not to save it.

#### Science is missing a theory of meaning. The tradition of measurement, calculation, and possession has rendered anything that is not materially present such as values and meanings irrelevant. This misses a basic truth about our lives as thinking things, and that is that what is absent changes what is present.

**Deacon, 12** – an American anthropologist (Ph.D. in Biological Anthropology, Harvard University 1984). He taught at Harvard for eight years, relocated to Boston University in 1992, and is currently Professor of Biological Anthropology and Neuroscience at the University of California, Berkeley (Terrence W., *Incomplete Nature: How Mind Emerged from Matter*, p. 1-13)

Science has advanced to the point where we can precisely arrange individual atoms on a metal surface or identify people’s continents of ancestry by analyzing the DNA contained in their hair. And yet ironically we lack a scientific understanding of how sentences in a book refer to atoms, DNA, or anything at all. This is a serious problem. Basically, it means that our best science—that collection of theories that presumably come closest to explaining everything—does not include this one most fundamental defining characteristic of being you and me. In effect, our current “Theory of Everything” implies that we don’t exist, except as collections of atoms. So what’s missing? Ironically and enigmatically, something missing is missing.

Consider the following familiar facts. The meaning of a sentence is not the squiggles used to represent letters on a piece of paper or a screen. It is not the sounds these squiggles might prompt you to utter. It is not even the buzz of neuronal events that take place in your brain as you read them. What a sentence means, and what it refers to, lack the properties that something typically needs in order to make a difference in the world. The information conveyed by this sentence has no mass, no momentum, no electric charge, no solidity, and no clear extension in the space within you, around you, or anywhere. More troublesome than this, the sentences you are reading right now could be nonsense, in which case there isn’t anything in the world that they could correspond to. But even this property of being a pretender to significance will make a physical difference in the world if it somehow influences how you might think or act.

Obviously, despite this something not-present that characterizes the contents of my thoughts and the meaning of these words, I wrote them because of the meanings that they might convey. And this is presumably why you are focusing your eyes on them, and what might prompt you to expend a bit of mental effort to make sense of them. In other words, the content of this or any sentence—a something-that-is-not-athing— has physical consequences. But how?

Meaning isn’t the only thing that presents a problem of this sort. Several other everyday relationships share this problematic feature as well. The function of a shovel isn’t the shovel and isn’t a hole in the ground, but rather the potential it affords for making holes easier to create. The reference of the wave of a hand in greeting is not the hand movement, nor the physical convergence of friends, but the initiation of a possible sharing of thoughts and remembered experiences. The purpose of my writing this book is not the tapping of computer keys, nor the deposit of ink on paper, nor even the production and distribution of a great many replicas of a physical book, but to share something that isn’t embodied by any of these physical processes and objects: ideas. And curiously, it is precisely because these ideas lack these physical attributes that they can be shared with tens of thousands of readers without ever being depleted. Even more enigmatically, ascertaining the value of this enterprise is nearly impossible to link with any specific physical consequence. It is something almost entirely virtual: maybe nothing more than **making certain ideas easier to conceive**, or, if my suspicions prove correct, **increasing one’s sense of belonging in the universe**.

Each of these sorts of phenomena—a function, reference, purpose, or value—is in some way incomplete. There is something not-there there. Without this “something” missing, they would just be plain and simple physical objects or events, lacking these otherwise curious attributes. Longing, desire, passion, appetite, mourning, loss, aspiration—all are based on an analogous intrinsic incompleteness, an integral without-ness.

As I reflect on this odd state of things, I am struck by the fact that there is no single term that seems to refer to this elusive character of such things. So, at the risk of initiating this discussion with a clumsy neologism, I will refer to this as an absential2 feature, to denote phenomena whose existence is determined with respect to an essential absence. This could be a state of things not yet realized, a specific separate object of a representation, a general type of property that may or may not exist, an abstract quality, an experience, and so forth— just not that which is actually present. This paradoxical intrinsic quality of existing with respect to something missing, separate, and possibly nonexistent is irrelevant when it comes to inanimate things, but it is a defining property of life and mind. A complete theory of the world that includes us, and our experience of the world, must make sense of the way that we are shaped by and emerge from such specific absences. What is absent matters, and yet our current understanding of the physical universe suggests that it should not. A causal role for absence seems to be absent from the natural sciences.

WHAT MATTERS?

Modern science is of course interested in explaining things that are materially and energetically present. We are interested in how physical objects behave under all manner of circumstances, what sorts of objects they are in turn composed of, and how the physical properties expressed in things at one moment influence what will happen at later moments. This includes even phenomena (I hesitate to call them objects or events) as strange and as hard to get a clear sense of as the quantum processes occurring at the unimaginably small subatomic scale. But even though quantum phenomena are often described in terms of possible physical properties not yet actualized, they are physically present in some as-yet-unspecified sense, and not absent, or represented. A purpose not yet actualized, a quality of feeling, a functional value just discovered—these are not just superimposed probable physical relationships. They are each an intrinsically absent aspect of something present.

The scientific focus on things present and actualized also helps to explain why, historically, scientific accounts have endured an uneasy coexistence with absential accounts of why things transpire as they do. This is exemplified by the relationship that each has with the notion of order. Left alone, an arrangement of a set of inanimate objects will naturally tend to fall into disorder, but we humans have a preference for certain arrangements, as do many species. Many functions and purposes are determined with respect to preferred arrangements, whether this is the arrangement of words in sentences or twigs in a bird’s nest. But things tend not to be regularly organized (i.e., tend to be disordered).

Both thermodynamics and common sense predict that things will only get less ordered on their own. So when we happen to encounter wellordered phenomena, or observe changes that invert what should happen naturally, we tend to invoke the influence of absential influences, like human design or divine intervention, to explain them. From the dawn of recorded history the regularity of celestial processes, the apparently exquisite design of animal and plant bodies, and causes of apparently meaningful coincidences have been attributed to supernatural mentalistic causes, whether embodied by invisible demons, an all-powerful divine artificer, or some other transcendental purposiveness. Not surprisingly, these influences were imagined to originate from disembodied sources, lacking any physical form.

However, when mechanistic accounts of inorganic phenomena as mysterious as heat, chemical reactions, and magnetism began to ascend to the status of precisely formalized science in the late nineteenth century, absential accounts of all kinds came into question. So when in 1859 Charles Darwin provided an account of a process—natural selection—that could account for the remarkable functional correspondence of species’ traits to the conditions of their existence, even the special order of living design seemed to succumb to a non-absential account. The success of mechanistically accounting for phenomena once considered only explainable in mentalistic terms reached a zenith in the latter half of the twentieth century with the study of so-called self-organizing inorganic processes. As processes as common as snow crystal formation and regularized heat convection began to be seen as natural parallels to such unexpected phenomena as superconductivity and laser light generation, it became even more common to hear of absential accounts described as historical anachronisms and illusions of a prescientific era. Many scholars now believe that developing a science capable of accurately characterizing complex self-organizing phenomena will be sufficient to finally describe organic and mental relationships in entirely non-absential terms.

I agree that a sophisticated understanding of Darwinian processes, coupled with insights from complex system dynamics, has led to enormous advances in our understanding of the orderliness observed in living, neuronal, and even social processes. The argument of this book will, indeed, rely heavily on this body of work to supply critical stepping stones on the way to a complete theory. However, I will argue that this approach can only provide intermediate steps in this multistep analysis. Dynamical systems theories are ultimately forced to explain away the end-directed and normative characteristics of organisms, because they implicitly assume that all causally relevant phenomena must be instantiated by some material substrate or energetic difference. Consequently, they are as limited in their power to deal with the representational and experiential features of mind as are simple mechanistic accounts. From either perspective, absential features must, by definition, be treated as epiphenomenal glosses that need to be reduced to specific physical substrates or else excluded from the analysis. The realm that includes what is merely represented, what-might-be, what-could-have-been, what-it-feels-like, or is-good-for, presumably can be of no physical relevance. Beginning in the 1980s, it was becoming clear to some scholars that dynamical systems and evolutionary approaches to life and mind would fall short of this claim to universality. Because of their necessary grounding in what is physically here and now, they would not be able to escape this implicit dualism. Researchers who had been strongly influenced by systems thinking—like Gregory Bateson, Heinz von Foerster, Humberto Maturana, and Francisco Varela (to name only a few)—began to articulate this problem, and struggled with various attempts to augment systems thinking in ways that might be able to reintegrate the purposiveness of living processes and the experiential component of mental processes back into the theory. But the metaphysical problem of reintegrating purposiveness and subjectivity into theories of physical processes led many thinkers to propose a kind of forced marriage of convenience between mental and physical modes of explanation. For example, Heinz von Foerster in 1984 argued that a total theory would need to include, not exclude, the act of observation. From a related theoretical framework, Maturana and Varela in 1980 developed the concept of autopoiesis (literally, “self-creating”) to describe the core selfreferential dynamics of both life and mind that constitutes an observational perspective. But in their effort to make the autonomous observerself a fundamental element of the natural sciences, the origin of this self-creative dynamic is merely taken for granted, taken as a fundamental axiom. The theory thereby avoids the challenges posed by phenomena whose existence is determined with respect to something displaced, absent, or not yet actualized, because these are defined in internalized self-referential form. Information, in this view, is not about something; it is a formal relationship that is co-created both inside and outside this autopoietic closure. Absential phenomena just don’t seem to be compatible with the explanatory strictures of contemporary science, and so it is not surprising for many to conclude that only a sort of preestablished harmony between inside and outside perspectives, absential and physical accounts, can be achieved.

So, although the problem is ancient, and the weaknesses of contemporary methodologies have been acknowledged, there is no balanced resolution. For the most part, the mental half of any explanation is discounted as merely heuristic, and likely illusory, in the natural sciences. And even the most sophisticated efforts to integrate physical theories able to account for spontaneous order with theories of mental causality end up positing a sort of methodological dualism. Simply asserting this necessary unity—that an observing subject must be a physical system with a self-referential character—avoids the implicit absurdity of denying absential phenomena, and yet it defines them out of existence. We seem to still be living in the shadow of Descartes.

This persistent dualism is perhaps made most evident by the recent flurry of interest in the problem of consciousness, and the often extreme theoretical views concerning its nature and scientific status that have been proposed—everything from locating some hint of it in all material processes to denying that it exists at all. The problem with consciousness, like all other phenomena exhibiting an absential character, is that it doesn’t appear to have clear physical correlates, even though it is quite unambiguously associated with having an awake, functioning brain. Materialism, the view that there are only material things and their interactions in the world, seems impotent here. Even major advances in neuroscience may leave the mystery untouched. As the philosopher David Chalmers sees it:

For any physical process w e specify there w ill be an unansw ered question: W hy should this process give rise to experience? Given any such process, it is conceptually coherent that it could be instantiated in the absence of experience. It follow s that no mere account of the physical process w ill tell us w hy experience arises. T he emergence of experience goes beyond w hat can be derived from physical theory.3

What could it mean that consciousness cannot be derived from any physical theory? Chalmers argues that we just need to face up to the fact that consciousness is non-physical and yet also not transcendent, in the sense of an ephemeral eternal soul. As one option, Chalmers champions the view that consciousness may be a property of the world that is as fundamental to the universe as electric charge or gravitational mass. He is willing to entertain this possibility because he believes that there is no way to reduce experiential qualities to physical processes. Consciousness is always a residual phenomenon remaining unaccounted for after all correlated physical processes are described. So, for example, although we can explain how a device might be built to distinguish red light from green light—and can even explain how retinal cells accomplish this—this account provides no purchase in explaining why red light looks red. But does accepting this anti-materialist claim about consciousness require that there must be fundamental physical properties yet to be discovered? In this book I advocate a less dramatic, though perhaps more counterintuitive approach. It’s not that the difficulty of locating consciousness among the neural signaling forces us to look for it in something else—that is, in some other sort of special substrate or ineffable ether or extra-physical realm. The anti-materialist claim is compatible with another, quite materially grounded approach. Like meanings and purposes, consciousness may not be something there in any typical sense of being materially or energetically embodied, and yet may still be materially causally relevant. The unnoticed option is that, here too, we are dealing with a phenomenon that is defined by its absential character, though in a rather more all-encompassing and unavoidable form. Conscious experience confronts us with a variant of the same problem that we face with respect to function, meaning, or value. None of these phenomena are materially present either and yet they matter, so to speak. In each of these cases, there is something present that marks this curious intrinsic relation to something absent. In the case of consciousness, what is present is an awake, functioning brain, buzzing with trillions of signaling processes each second. But there is an additional issue with consciousness that makes it particularly insistent, in a way that these other absential relations aren’t: that which is explicitly absent is me.

CALCULATING WITH ABSENCE

The difficulty we face when dealing with absences that matter has a striking historical parallel: the problems posed by the concept of zero. As the epigraph for this chapter proclaims, one of the greatest advances in the history of mathematics was the discovery of zero. A symbol designating the lack of quantity was not merely important because of the convenience it offered for notating large quantities. It transformed the very concept of number and revolutionized the process of calculation. In many ways, the discovery of the usefulness of zero marks the dawn of modern mathematics. But as many historians have noted, zero was at times feared, banned, shunned, and worshiped during the millennia-long history that preceded its acceptance in the West. And despite the fact that it is a cornerstone of mathematics and a critical building block of modern science, it remains problematic, as every child studying the operation of division soon learns.

A convention for marking the absence of numerical value was a late development in the number systems of the world. It appears to have originated as a way of notating the state of an abacus4 when a given line of beads is left unmoved in a computation. But it literally took millennia for marking the null value to become a regular part of mathematics in the West. When it did, everything changed. Suddenly, representing very large numbers no longer required coming up with new symbols or writing unwieldy long strings of symbols. Regular procedures, algorithms, could be devised for adding, subtracting, multiplying, and dividing. Quantity could be understood in both positive and negative terms, thus defining a number line. Equations could represent geometric objects and vice versa—and much more. After centuries of denying the legitimacy of the concept—assuming that to incorporate it into reasoning about things would be a corrupting influence, and seeing its contrary properties as reasons for excluding it from quantitative analysis—European scholars eventually realized that these notions were unfortunate prejudices. In many respects, zero can be thought of as the midwife of modern science. Until Western scholars were able to make sense of the systematic properties of this non-quantity, understanding many of the most common properties of the physical world remained beyond their reach.

What zero shares in common with living and mental phenomena is that these natural processes also each owe their most fundamental character to what is specifically not present. They are also, in effect, the physical tokens of this absence. Functions and meanings are explicitly entangled with something that is not intrinsic to the artifacts or signs that constitute them. Experiences and values seem to inhere in physical relationships but are not there at the same time. This something-not-there permeates and organizes what is physically present in these phenomena. Its absent mode of existence, so to speak, is at most only a potentiality, a placeholder.

Zero is the paradigm exemplar of such a placeholder. It marks the columnar position where the quantities 1 through 9 can potentially be inserted in the recursive pattern that is our common decimal notation (e.g., the tens, hundreds, thousands columns), but it itself does not signify a quantity. Analogously, the hemoglobin molecules in my blood are also placeholders for something they are not: oxygen. Hemoglobin is exquisitely shaped in the negative image of this molecule’s properties, like a mold in clay, and at the same time reflects the demands of the living system that gives rise to it. It only holds the oxygen molecule tightly enough to carry it through the circulation, where it gives it up to other tissues. It exists and exhibits these properties because it mediates a relationship between oxygen and the metabolism of an animal body. Similarly, a written word is also a placeholder. It is a pointer to a space in a network of meanings, each also pointing to one another and to potential features of the world. But a meaning is something virtual and potential. Though a meaning is more familiar to us than a hemoglobin molecule, the scientific account of concepts like function and meaning essentially lags centuries behind the sciences of these more tangible phenomena. We are, in this respect, a bit like our medieval forbears, who were quite familiar with the concepts of absence, emptiness, and so on, but could not imagine how the representation of absence could be incorporated into operations involving the quantities of things present. We take meanings and purposes for granted in our everyday lives, and yet we have been unable to incorporate these into the framework of the natural sciences. We seem only willing to admit that which is materially present into the sciences of things living and mental.

For medieval mathematicians, zero was the devil’s number. The unnatural way it behaved with respect to other numbers when incorporated into calculations suggested that it could be dangerous. Even today schoolchildren are warned of the dangers of dividing by zero. Do this and you can show that 1 = 2 or that all numbers are equal.5 In contemporary neuroscience, molecular biology, and dynamical systems theory approaches to life and mind, there is an analogous assumption about concepts like representation and purposiveness. Many of the most respected researchers in these fields have decided that these concepts are not even helpful heuristics. It is not uncommon to hear quite explicit injunctions against their use to describe organism properties or cognitive operations. The almost universal assumption is that modern computational and dynamical approaches to these subjects have made these concepts as anachronistic as phlogiston.6

So the idea of allowing the potentially achievable consequence characterizing a function, a reference, or an intended goal to play a causal role in our explanations of physical change has become anathema for science. A potential purpose or meaning must either be reducible to a merely physical parameter identified within the phenomenon in question, or else it must be treated as a useful fiction only allowed into discussion as a shorthand appeal to folk psychology for the sake of non-technical communication. Centuries of battling against explanations based on superstition, magic, supernatural beings, and divine purpose have trained us to be highly suspicious of any mention of such intentional and teleological properties, where things are explained as existing “for-the-sake-of” something else. These phenomena can’t be what they seem. Besides, assuming that they are what they seem will almost certainly lead to absurdities as problematic as dividing by zero. Nevertheless, learning how to operate with zero, despite the fact that it violated principles that hold for all other numbers, opened up a vast new repertoire of analytic possibilities. Mysteries that seemed logically necessary and yet obviously false not only became tractable but provided hints leading to powerful and currently indispensable tools of scientific analysis: in other words, calculus.

Consider the famous Zeno’s paradox, which was framed in terms of a race between swift Achilles and a tortoise, which was given a slight head start. Zeno argued that moving any distance involved moving through an infinite series of fractions of that distance (1/2, 1/4, 1/8, 1/16 of the distance, and so on). Because of the infinite number of these fractions, Achilles could apparently never traverse them all and so would never reach the finish line. Worse yet, it appeared that Achilles could never even overtake the tortoise, because every time he reached that fraction of the distance to where the tortoise had just been, the tortoise would have moved just a bit further.

To resolve this paradox, mathematicians had to figure out how to deal with infinitely many divisions of space and time and infinitely small distances and durations. The link with calculus is that differentiation and integration (the two basic operations of calculus) represent and exploit the fact that many infinite series of mathematical operations converge to a finite solution. This is the case with Zeno’s problem. Thus, running at constant speed, Achilles might cover half the distance to the finish line in 20 seconds, then the next quarter of the distance in 10 seconds, then the next smaller fraction of the distance in a correspondingly shorter span of time, and so forth, with each microscopically smaller fraction of the distance taking smaller and smaller fractions of a second to cover. The result is that the total distance can still be covered in a finite time. Taking this convergent feature into account, the operation of differentiation used in calculus allows us to measure instantaneous velocities, accelerations, and so forth, even though effectively the distance traveled in that instant is zero.

A ZENO’S PARADOX OF THE MIND

I believe that we have been under the spell of a sort of Zeno’s paradox of the mind. Like the ancient mathematicians confused by the behavior of zero, and unwilling to countenance incorporating it into their calculations, we seem baffled by the fact that absent referents, unrealized ends, and abstract values have definite physical consequences, despite their apparently null physicality. As a result, we have excluded these relations from playing constitutive roles in the natural sciences. So, despite the obvious and unquestioned role played by functions, purposes, meanings, and values in the organization of our bodies and minds, and in the changes taking place in the world around us, our scientific theories still have to officially deny them anything but a sort of heuristic legitimacy. This has contributed to many tortured theoretical tricks and contorted rhetorical maneuvers in order either to obscure this deep inconsistency or else to claim that it must forever remain beyond the reach of science. We will explore some of the awkward responses to this dilemma in the chapters that follow.

More serious, however, is the way **this has divided the natural sciences from the human sciences, and both from the humanities**. In the process, it has also alienated the world of scientific knowledge from the world of human experience and values. If the most fundamental features of human experience are considered somehow illusory and irrelevant to the physical goings-on of the world, then we, along with our aspirations and values, are effectively rendered unreal as well. **No wonder the all-pervasive success of the sciences in the last century has been paralleled by a rebirth of fundamentalist faith and a deep distrust of the secular determination of human values**.

The inability to integrate these many species of absence-based causality into our scientific methodologies has not just seriously handicapped us, it has effectively left a vast fraction of the world orphaned from theories that are presumed to apply to everything. The very care that has been necessary to systematically exclude these sorts of explanations from undermining our causal analyses of physical, chemical, and biological phenomena has also stymied our efforts to penetrate beyond the descriptive surface of the phenomena of life and mind. Indeed, what might be described as the two most challenging scientific mysteries of the age—explaining the origin of life and explaining the nature of conscious experience—both are held hostage by this presumed incompatibility. Recognizing this contemporary parallel to the unwitting selfimposed handicap that limited the mathematics of the Middle Ages is, I believe, a first step toward removing this impasse. It is time that we learned how to integrate the phenomena that define our very existence into the realm of the physical and biological sciences.

Of course, it is not enough to merely recognize this analogous situation. Ultimately, we need to identify the principles by which these unruly absential phenomena can be successfully woven into the exacting warp and weft of the natural sciences. It took centuries and the lifetime efforts of some of the most brilliant minds in history to eventually tame the troublesome non-number: zero. But it wasn’t until the rules for operating with zero were finally precisely articulated that the way was cleared for the development of the physical sciences. Likewise, as long as we remain unable to explain how these curious relationships between what-is-not-there and what-is-there make a difference in the world, we will remain blind to the possibilities of a vast new realm of knowledge. I envision a time in the near future when these blinders will finally be removed, a door will open between our currently incompatible cultures of knowledge, the physical and the meaningful, and a house divided will become one.

#### Failure to recognize the shared limits of action and knowledge means that human hubris runs rampant. We are surrounded by the intellect and power of a sparkling natural world; learning to intuit the wisdom that is both present and absent from this creation illuminates a new framework for technology based on the mimicry of nature.

Nature as model: self-assembly, self-sufficiency, self-organization, and reproduction

Nature as measure: flexibility as means of survival

Nature as mentor: knowledge intuited from the world

**Duyser 10** – MA in Architectural Studies at the University of Cincinnati (Mitchell, “Hybrid Landscapes: Territories of Shared Ecological and Infrastructural Value”, <http://etd.ohiolink.edu/send-pdf.cgi/Duyser%20Mitchell%20S.pdf?ucin1277139665>, dml)

Society and architecture need to signiﬁcantly change their relationship with the environment if current unsustainable practices are to be unseated. Humans must intentionally reinsert themselves into the planetary ecology. This means designing and building with a critical awareness of how projects are going to interact with and change the local environment. Best practices must be found thatensure human endeavors partner with the environment instead of compete with it**.** One such ﬁeld of study already being developed is called Biomimicry and can be simplistically described as innovation inspired by nature. 56

Instead of viewing nature as a physical resource to be mined and consumed, nature should be seen as a storehouse of technology and information that humans can use to exist in a symbiotic manner with the rest of the world. Janine Benyus, a founder of the movement and creator of both the Biomimicry Guild and the Biomimicry Institute, divides the topic into three distinct methods nature can inﬂuence human development; nature-as-model, nature-as-measure, and nature-as-mentor. 57

Nature-as-model relates to the underlying systems in the natural world such as self-assembly, self-sufﬁciency, self-organization, and reproduction. This is perhaps the most difﬁcult area for architects to work today, but provides the most potential for the future of the ﬁeld both practically and theoretically. Nature-as-measure utilizes the concepts of ﬁtness and efﬁciency to compare human endeavors to natural processes. Buildings are considered as organisms, those that perform well in their environment survive and reproduce. Those that are inefﬁcient or ill suited to their environment must evolve or become extinct. Nature has spent billions of years pushing solutions to their most efﬁcient and most elegant and humanity has been foolish to ignore this resource when trying to solve problems. 58

The transfer of technology between life forms and synthetic constructs is desirable because evolutionary pressure typically forces natural systems to become highly efﬁcient as well as formally elegant. Biomimetics can be relevant to architecture in terms of design, systems, and processes and can refer to both morphological and behavioral characteristics. 59 –Tom Wiscombe

 Last is nature as mentor, where speciﬁc knowledge or technologies can be appropriated from the natural world. This is not about what can be extracted from the earth but what can be learned from it. Implied is a technological partnership, but also areconnectionbetween humans, society, and the environment where the planet is valued not for physical resources, but for the information inherent in its living systems. 60

 Such a reconnection to nature is not born out of a nostalgic, romanticized re-creation of the past forsaking modern technology. Instead, biomimicry seeks to refocus efforts on technologies that improve the quality of life for the entire environment instead of only that of humans. Now, with the ability to comprehend and learn from the natural world, we must seek partnerships instead of subjugation; “quiet our human cleverness,” and see what can be learned. 61

#### Our economy is based on calculating present profits. However, this leaves out important social and aesthetic values which contribute to the creation and development of a holistic socius.

**Guattari, 89** (Felix, *The Three Ecologies*, p. 42-43)

I have already stressed that it is less and less legitimate that only a profit-based market should regulate financial and prestige-based rewards for human social activities, for there is a range of other value systems that ought to be considered, including social and aesthetic 'profitability' and the values of desire. Until now, these non-capitalist domains of value have only been regulated by the State; hence, for example, the esteem in which national heritage is held. We must stress that new social associations - such as institutions recognized for their social utility - should broaden the financing of a more flexible non-private, non-public Third Sector, which will be forced to expand continuously for as long as human labour gives way to machinization. Beyond recognizing a universal basic income - as a right rather than as some kind of 'New Deal' - the question becomes one of how to encourage the organization of individual and collective ventures, and how to direct them towards an ecology of resingularization. The search for an existential Territory or homeland doesn't necessarily involve searching for one's country of birth or a distant country of origin, although too often, nationalitarian movements (like the Irish or the Basques) have turned in on themselves due to exterior antagonisms, leaving aside other molecular revolutions relating to women's liberation, environmental ecology, etc. All sorts of deterritorialized 'nationalities' are conceivable, such as music and poetry. What condemns the capitalist value system is that it is characterized by general equivalence, which flattens out all other forms of value, alienating them in its hegemony. On this basis we must if not oppose, at least superimpose instruments of valorization founded on existential productions that cannot be determined simply in terms of abstract labour-time or by an expected capitalist profit. The information and telematic revolutions are supporting new 'stock exchanges' of value and new collective debate, providing opportunities for the most individual, most singular and most dissensual enterprises. The notion of collective interest ought to be expanded to include companies that, in the short term, don't profit anyone, but in the long term are the conduits of a processual enrichment for the whole of humanity. It is the whole future of fundamental research and artistic production that is in question here.

It must also be stressed that this promotion of existential values and the values of desire will not present itself as a fullyfledged global alternative. It will result from **widespread shifts in current value systems and from the appearance of new poles of valorization**. In this respect it is significant that, over the last few years, the most spectacular social changes have resulted from precisely these kinds of long-term shifts; on a political level in the Philippines or Chile, for example, or on a nationalitary level in the USSR.78 In these countries, thousands of value-system revolutions are progressively percolating their way up through society and it is up to the new ecological components to polarize them and to **affirm their importance within the political and social relations of force**.

#### Thus, to counter these exclusive and exclusionary mechanisms for decision-making, we defend the methodological and ontological shifts necessary for a new use of technology. Part and parcel with this are efforts to change the material prioritization of resources invested in technological instrumentation.

#### Therefore, we defend that the United States federal government should substantially increase financial incentives for biomimetic solar power.

**Martin-Palmaab and Lakhtakiaac, 12** – Raúl J. Martín-Palmaab\* & Akhlesh Lakhtakiaac (*Engineered biomimicry for harvesting solar energy: a bird's eye view*, Taylor and Francic)

All three methodologies of engineered biomimicry – bioinspiration, biomimetics, and bioreplication – are represented in current research on harvesting solar energy. Both processes and porous surfaces inspired by plants and certain marine animals, respectively, are being investigated for solar cells. Whereas dye-sensitized solar cells deploy artificial photosynthesis, bioinspired nanostructuring of materials in solar cells improves performance. Biomimetically textured coatings for solar cells have been shown to reduce optical reflectance and increase optical absorptance over a broad spectral regime. Compound lenses fabricated by a bioreplication technique offer similar promise for reduced reflectance by increasing the angular field of view.

1. Introduction

Living organisms display an astonishing diversity of functionalities. Engineered biomimicry takes ideas and concepts from biology and implements them in different fields ranging from engineering to computing, aiming at the development of novel devices with desirable functionalities. This evolving methodology is highly multidisciplinary, and embraces aspects related to physics, materials science, nanotechnology, biology, chemistry, mechanical properties, computing and control, design integration, optimization, multifunctionality, and economics.

Engineered biomimicry comprises three methodologies: bioinspiration, biomimetics, and bioreplication [1]. Bioinspiration – an age-old methodology that is ever more fruitful with continuing techno-scientific advances – encompasses the design of a new structure or device that displays a certain functionality of a plant or animal without reproducing the biological structure responsible for that functionality. For instance, helicopters hover and so do bumblebees, but their mechanisms for hovering are entirely different. Biomimetics requires the approximate reproduction of the essential mechanism of the biological structure responsible for the display of a specific functionality. Robots that walk on four or more legs on uneven terrain furnish an excellent example of a biomimetic design methodology. The distinction between bioinspiration and biomimetics, however, is not always clear [2]. Bioreplication [3], the latest methodology in engineered biomimicry, is the direct replication of the responsible biological structure.

Engineered biomimicry has been applied for optical purposes for centuries. Perhaps the best examples are glass lenses used by a visually impaired person, many glass lenses having surfaces of roughly the same shape as that of the crystalline lenses found inside the eyes of numerous animals. Another example is provided by multilayered structures in the exoskeletons of beetles of many species to create color – which is mimicked by the widely used Bragg filters – without the use of pigments [4,5]. Such colors are called structural colors and their first description dates back to Isaac Newton [6], who tried to explain the brilliant plumage of the common Indian peafowl (Pavo cristatus) as rising from optical interference from the thin transparent part of the feathers. This research has now been extended to photonic crystals [7] and applied to the manufacture of unpigmented but colored fabrics [8]. Very recently, achromatic waveplates found in the eyes of crustaceans of a certain species inspired the design and fabrication of similarly performing waveplates [9].

**Given our seemingly insatiable appetite for energy and given the focus today on non-polluting sources of energy**, it was inevitable that the paths of engineered biomimicry and solar-energy harvesting would meet. Indeed, that is currently happening in three ways, one of which is bioinspired, the second is biomimetic, and the third can be classified as bioreplication.

Plants use sunlight in a chemical process called photosynthesis to convert carbon dioxide into sugars whose solutions act as liquid fuel. Any artificial route to harvest solar energy through a chemical process is bioinspired. Some biological structures such as the eyes of many species possess excellent anti-reflection coatings, and their implementation in conventional solar cells can enhance the light-harvesting efficiency, thereby providing an example of biomimetic methodology. Finally, compound eyes in many insects impart a huge angular field of view, which too can be exploited via bioreplication. All three applications of engineered biomimicry to harvesting solar energy are reviewed in the remainder of this paper.

2. Bioinspiration

Artificial photosynthesis is any chemical process whereby the energy of sunlight is converted into the energy stored in a material. This can be done in several ways. In a photoelectrochemical cell, an anode and a cathode are immersed in water [10]. Either both electrodes are made of a semiconductor or just one is semiconducting but the other is metallic. Water dissociates electrolytically into hydrogen and oxygen when a semiconducting electrode is exposed to light (which includes radiation of wavelengths smaller than 1000 nm). Hydrogen, which burns cleanly, can be used in a fuel cell. As a semiconducting electrode is also expected to function as a catalyst, a semiconductor may have to be alloyed with an efficient catalyst such as platinum to make that electrode. Clean fuels other than hydrogen may also become viable, and the major problem is the identification of the right materials to achieve efficient conversion.

A dye-sensitized solar cell, sometimes called a Grätzel cell, comprises (i) a transparent anode deposited on a glass with a porous semiconductor such as titanium dioxide that has been impregnated with a photosensitive dye, (ii) a metal sheet acting as the cathode, and (iii) a liquid electrolyte sealed between the two electrodes. Dye molecules excited by exposure to light lose an electron each which diffuses towards the anode, the electrolyte yields an electron to each positively charged dye molecule, and the electron-deficient electrolyte molecules physically move towards the cathode to replenish themselves from the cathode which receives additional electrons from the external circuit. Thus, rather than a fuel, the output of a dye-sensitized solar cell is electricity itself. This type of third-generation thin-film solar cell is quite inexpensive but its typical efficiency is not yet close to that of silicon solar cells.

Nanostructuring of materials which host a photochemical reaction is expected to improve performance. Recently, it has been proposed that arrays of hollow nanowires of zinc oxide can be sensitized to solar light and used as more efficient building blocks for different types of nanostructured solar cells, including organic, hybrid and dye-sensitized [11]. As may be inferred from Figure 1, looking like sea urchins (pentameric echinoderms of subclasses Perischoechinoidea and Euechinoidea), these nanowire arrays combine characteristics of three-dimensional and one-dimensional materials, are highly porous, and have a large specific surface area. These structures are fabricated as perfectly ordered arrays over large areas by an approach that combines colloidal patterning and electrochemistry. Exquisite control of dimensions and morphologies is possible by this hybrid approach.

View larger version(219K)

Figure 1. Top view and higher magnification (inset) images from a scanning electron microscope of an ordered hollow urchin-like structure of ZnO nanowires [11]. Courtesy of Dr. J. Elias (EMPA Materials Science and Technology).

Additionally, hollow structures of porous tin oxide have been fabricated by wet-chemical processing followed by annealing [12]. These coralline structures grow by assimilating smaller spherical structures. Dye-sensitized solar cells with photoanodes made of these structures have been reported to exhibit enhanced photovoltaic performance in comparison to photoanodes comprising spherical structures. The radial morphology of the coralline structures is believed to be responsible for providing larger effective surface area for dye sensitization and photon capture [12].

3. Biomimetics

Given that a significant fraction of light impinging the surface of most materials is reflected back, optical devices [13,14] including solar cells [15,16] incorporate surface texturing to reduce optical reflection resulting in enhanced light absorption. Sub-wavelength surface features are being increasingly used [14,17] to change the optical reflection characteristics of surfaces – instead of using multilayer antireflection coatings which usually require (i) the use of high-vacuum deposition techniques; (ii) accurate control of layer thicknesses; and (iii) selection of materials with suitable refractive index (appropriate real part and low imaginary part), appropriate mechanical properties (strength, adhesion, etc.) and coefficient of thermal expansion. Randomly sized and spaced pyramids [14,18,19], deep vertical-wall grooves [20], V grooves [21,22], and arrays of nanopillars [6–11 11,23] on the surface of silicon wafers have been widely utilized to reduce optical reflectance. Several surface-texturing techniques [24] including anodization [25] have also been used.

Nanopillars can be nanocylinders, nanocones, or nanonipples. Their arrays should function as graded-index materials in the visible and near-infrared spectral regimes [26,27]. An array of sub-wavelength nipples is commonly seen in moth eyes and fly eyes, as shown in Figure 2, which has led to many biomimetic efforts to improve solar-cell performance. Techniques employed to fabricate such nanopillar-array coatings comprise traditional bottom-up and top-down approaches [28].

View larger version(170K)

Figure 2. Scanning electron microscope image of the compound eye of a fly.

Closely packed arrays of nanonipples were recently patterned on silicon substrates using spin-coated silica colloidal monolayers as etching masks; see the scanning electron microscope image provided in Figure 3 [29]. The anti-reflection coatings made using this bottom-up non-lithographic technique were found to exhibit broadband antireflective performance superior to commercial coatings. Similar biomimetic anti-reflection coatings have also been used for GaAs substrates [30]. The nanonipple array also enhances hydrophobicity [31,32] so that the surface is self-cleaning [33].

View larger version(154K)

Figure 3. Tilted image on a scanning electron microscope of a templating array of 360-nm-diameter spheres of silica and the silicon nipples etched underneath. Courtesy of Prof. P. Jiang (University of Florida).

Similar low-reflection surfaces textured with arrays of nanopillars with different periods (pillar-to-pillar distance, from 150 nm to 350 nm), heights (from around 150 nm to 500 nm) and shapes (pillar width-to-period ratio from around 0.3 to 0.7) were fabricated by electron-beam lithography on silicon wafers [34]. In parallel, numerical simulations using the rigorous coupled-wave analysis (RCWA) indicated that as the height and shape of nanopillars as well as the array period affect reflectance, these parameters require optimization for best performance in the specific wavelength range over which the surface is required to function. Subsequently, RCWA was used to theoretically optimize the period of moth-eye arrays for low-reflection surfaces on silicon solar cells [35].

In another approach, moth-eye anti-reflection coatings were made of acrylic resin and deposited on polyethylene terephthalate substrates [36]. The geometry of closely packed arrays of nanonipples was optimized for operation in the 400–1170 nm wavelength range that almost completely covers the solar spectrum for using silicon solar cells. Optical simulations using RCWA indicated that the optimal nanonipples are 300 nm in height, 100 nm bottom width, and 30 nm top width, leading to reflectance lower than 0.87% in the 400–1170 nm wavelength range and a minimum of 0.1% at 400 nm for normally incident light. The same reflectance of a moth-eye coating (with nipples of approximately 200 nm height, 90 nm bottom width, and 50 nm top width) was experimentally determined to be lower than about 1% in the desired wavelength range, with a minimum of 0.55% at 700 nm wavelength.

A fabricated coating textured with nanonipples was placed on top of a crystalline silicon photovoltaic module and characterized indoors and outdoors for performance [37]. Typically, the optical-to-electrical efficiency of the module improved by 5%, which may turn out be cost-effective if the coating production becomes inexpensive.

4. Bioreplication

Bioreplication is the latest methodology in engineered biomimicry, having arrived on the scene just about a decade ago [3]. Its potential application for solar-energy harvesting is based on two observations [38]. The first observation is the wide angular field of view that many dipterans including house flies have. Each eye of a house fly is a compound eye, comprising numerous elementary eyes (ommatidia) arranged radially on a curved surface, as shown in Figure 2. The second observation is the almost halving of the reflectance, averaged over a huge angular sector and the 400–110 nm wavelength range, predicted through geometrical-optics simulations for a prismatic compound lens (with a surface inspired by the compound eyes of dipterans) adhering to a silicon solar cell [39].

A multistep experimental technique, now called the Nano4Bio technique, has been developed to replicate the corneal layer of a compound eye from an actual specimen. Industrial-scale replication being possible with the Nano4Bio technique [1], the idea is to cover the surface of a solar cell with numerous replicas of compound eyes in order to enhance the angular field of view of the solar cell.

Since the characteristic lengths of a compound eye range from about 200 nm to a few mm, direct fabrication of such a structure will require complex processing and most methods can produce just one replica per biotemplate (i.e. the compound eye). In contrast, the Nano4Bio technique can be used to fabricate multiple high-fidelity replicas of a single biotemplate. As depicted schematically in Figure 4, in the first step of this technique, a modified conformal-evaporated-film-by-rotation (CEFR) technique is deposit a 250 nm thick conformal coating of nickel on the biotemplate [40–42 42]. In the second step, a roughly 60-μm-thick structural layer of nickel is electroformed onto the thin layer to give it the structural integrity needed for casting or stamping. The biotemplate is then plucked off and plasma ashing is carried out to completely remove all organic material, in the third step. What is left behind is a master negative made of nickel. This can be used either as a die for stamping or a mold for casting multiple replicas, in the fourth step. Casting alone has been implemented thus far, with high fidelity obtained at the 2 μm length scale; stamping is expected to improve the reproduction fidelity at even lower length scales. The Nano4Bio technique can produce multiple replicas simultaneously of multiple biotemplates.

View larger version(45K)

Figure 4. Schematic of the Nano4Bio technique.

5. Concluding remarks

The most recent and significant research activities in the field of engineered biomimicry for harvesting solar energy have been reviewed here. The field can be said to be in its infancy as now, and bioinspired and biomimetic methodologies have seen the most intense activity. Engineered biomimicry could provide advantages over conventional engineering, as shown for example by a comparative simulation study of bioinspired texturing and V-grooved texturing of the front surface of silicon solar cells [39]. We expect that the next few years will witness increased activity with all three methodologies as well as industrial adoption.

#### Paradigm shifts packaged through alternative modes of technological production can serve as the impetus for relationships that recognize the ethical and aesthetic value of the world all around us.

**Johnson, 10** – received her PhD from the University of Minnesota for doctoral work that focused on the political and social implications of “biomimicry,” an emerging field within which scientists reverse engineer biological traits for technological production (Elizabeth R. Johnson, *Reinventing biological life, reinventing ‘the human’*, Ephemera Journal volume 10(2): 177-193)

**This is not animism, any more than it is mechanism; rather, it is universal machinism**. (Deleuze and Guattari, 1988: 283)

Biomimetic innovation is built on the detailed study of ‘existence proofs’ exhibited in animal physiology: an animal’s capacities are taken as evidence of an existing potential already designed and engineered to work in the world.4 It proceeds by ‘reverse engineering’ the observable behaviors expressed in biological life: without fully understanding an organism’s ‘design code’, biomimeticists attempt to engineer machinic organisms or synthetic materials capable of expressing that animal’s functions. An array of techniques and technologies – chemical engineering, robotic hardware, advanced computing technologies, and mathematical modeling software – are marshaled to enhance our own techno-abilities by remaking the capacities found in biological life.

Naturalists, ecologists, and evolutionary biologists historically presented an understanding of lobsters in relation to their ‘natural’ marine habitat, in connection to the organisms and the nonliving systems in which they live and to which they are related. In zoology textbooks, lobsters are situated next to their kin: pages on shrimp, crayfish, and other crustaceans surround those on the lobster (see, for example, Castro and Huber, 2005). Natural historians and ecologists place primacy on how lobster bodies emerged within an historical trajectory or how they relate to other bodies within a bounded ecological assemblage. Biomimicry, on the other hand, is unconcerned with the ‘place’ or the ‘natural’ order of the organism’s evolutionary development. Indeed, as a practice, it expresses little interest in where, when, and how lobsters emerged or in the crabs, clams, and shrimp related to them by networks of kinship or consumption. Instead, biomimetic scientists investigate lobster bodies for what they can do: how they orient themselves to the world and how such orientations are different from our own. Rather than being concerned with classification, **biomimeticists attend to the animal’s potential to connect with other forms of life, technologies, and social problems**, valuing lobsters for their capacity to move with agility and track chemicals underwater.

Biomimicry’s transformative potential is seductive; it is easy to fixate on how and where biomimetics shifts our conceptions of ‘life’. One may be (as I was) drawn to the ways in which biomimicry is Spinozan or Deleuzian in its attention to embodied capacities and its drive to appropriate them in bodies elsewhere. Machines that become lobsters or lobsters that become machines are not, as they say, associated by ‘mere metaphor’. These animals, their traits, and the products developed with knowledge of them are not valorized on account of animal symbolisms or the meanings attributed to their animality (as in Nicole Shukin’s work). Rather, these animals become valued because of their functionality, efficiency, and ‘natural’ talents. Biomimicry breaks down bodies the barriers: animal and machine become indistinguishable as the capacities of one are substituted for another. A lobster on a treadmill is a lobster defined by its ‘intensive’ functions – what its neuroethology can do and how it does it. Indeed, the animals that inspire biomimetic design may be best understood as ‘composition[s] of speeds and affects on the plane of consistency: a plan(e), a program, or rather a diagram, a problem, a question-machine’ (Deleuze and Guattari, 1988: 258). This biological apparatus thus can be read as a set of ‘intensive parts’: powerful and embodied capacities for action that are transferable from one body to another to solve any barrier to movement as the need – or question – arises. Read in this way, biomimetic practices are perhaps less ‘post-human’ than post-animal or post-species altogether.5

Supporters of the so-called biomimetic movement have billed it a ‘revolution’ in technoscientific innovation. But what kind of revolution is this? What are we to make of these rearrangements of biology and technology? Do lobsters and their robotic counterparts merely offer a vivid illustration of Deleuze and Guattari’s machinic assemblage of bodies and relations of moving parts? Or is there something more potent – politically, ethically, socially – to be expected from biomimicry’s techno-biologies? Advocates of biomimicry would have us think as much. So too would much of the existing literature in ‘post-humanism’ and animal studies.

Historical traditions founded on a purified category of ‘the human’ absorb the blame for many of the problems characteristic of our contemporary global situation. Giorgio Agamben’s figuration of ‘bare life’ encapsulates this argument in what are perhaps the starkest of terms. A life is rendered ‘bare’ when it subject to exclusion from the protections provided by law or social securities: the taking or neglect of ‘bare life’ requires no accountability. Agamben argues that such a state is predicated on the philosophical distinction between human and animal, a distinction that allows for the subsequent attribution of ‘animal’ qualities to the lives of humans. As inferior to but resident within ‘the human’, category of ‘the animal’ legitimizes the labeling of populations as ‘unfit’ for life in the polis, be they excluded on the basis of race, religion ethnicity, gender, class, or geographical origins (Agamben, 2004). In The Open, Agamben explores the history of science and philosophy that articulates this process of categorization as a legitimation of exclusion. He names this process the ‘anthropological machine’. Following this logic, Kelly Oliver notes that the human and animal, distinguished as such, serve as the founding concepts that ground acts of injustice and cruelty to humans as well all other species: ‘the anthropological machine… produces the monstrous category “animal” that not only effaces nearly infinite differences between species but also corrals them all into the same abject and inferior pen’ (Oliver, 2007: 11).

Similarly, but from within a more materialist tradition, Donna Haraway’s Cyborg Manifesto catalyzed a conversation that has located the negative qualities of science and politics in the ‘Western’ tradition – ‘racist, male-dominant capitalism; the tradition of progress; the tradition of the appropriation of nature as resource for the productions of culture; the tradition of reproduction of the self from the reflections of the other’ – within origin myths of purity and the maintenance of a ‘border war’ a between organisms and machines as well as humans and animals (Haraway, 1991: 150). The appointed ‘guru’ of the biomimetic movement and recent recipient of the UN’s ‘Champion of the Earth’ award in Science and Innovation, Janine Benyus, has composed a narrative of the our ecological crisis and its associated injustices that resonates with both Agamben and Haraway’s work. She locates our collective crisis on Earth in the ‘severed’ connection between humans and the Earth. As in Agamben’s narrative, this loss of connection is the result of an originary rupture, located in this instance with the agricultural revolution. We have lost, she laments, ‘cooking fires to storytell around [and] ceremonial dances to reenact the movement of the herds’ (Benyus, 1997: 183). But, for Benyus, historical progress has been one of a continual series of such ruptures, each inaugurated by technological development, and each leading humans further from what Benyus refers to as ‘our home’. The following is her version of the historical narrative:

Our journey began ten thousand years ago with the Agricultural Revolution, when we broke free from the vicissitudes of hunting and gathering and learned to stock our own pantries. It accelerated with the Scientific Revolution, when we learned, in Francis Bacon’s words, to ‘torture nature for her secrets.’ Finally when the afterburners of the Industrial Revolution kicked in, machines replaced muscles and we learned to rock the world. But these revolutions were only a warm-up for our real break from Earthy orbit – the Petro-chemical and Genetic Engineering Revolutions. Now that we can synthesize what we need and arrange the genetic alphabet to our liking, we have gained what we think of as autonomy. Strapped to our juggernaut of technology, we fancy ourselves as gods, very far from home indeed. (ibid)

Benyus’s history of our collective loss of connection to the earth is a story of compounding catastrophe that calls to mind Walter Benjamin’s Angelus Novus, who ‘sees one single catastrophe, which keeps piling wreckage upon wreckage and hurls it at his feet’ (Benjamin, 1996: 392).

3. Remaking life, remaking the human

Life creates the conditions conducive to life. (Benyus, 2002)

For Benyus as for Agamben, salvaging a saner life from the wreckage of history seems to require somehow absolving ourselves of ‘original’ catastrophe by rearticulating the human (and animal) differently. Indeed, like all of the aforementioned theorists, Benyus calls for dismantling conceptions of human exceptionalism that seems to have become increasingly sedimented throughout history as the ‘wreckage’ is piled higher and higher. For Agamben – as well as Kelly Oliver and Cary Wolfe – this requires the destabilization or even erasure of the categories of human and animal through **the recognition of shared limits, vulnerability, or an embrace of** Derrida’s ‘**nonpower at the heart of power’**. Haraway, along with Bruno Latour, Michel Serres, Sarah Whatmore, and Jane Bennett, attempts to rework the ‘human’ in practice, by writing of bodies-inrelation – bodies that have ‘never been human’ in spite of the centuries of philosophical and political writings that seem to assure the contrary. These writers enliven alternative histories, citing empirical evidence of our becomings with objects, animals, and bacteria and telling stories in which ‘the human’ is neither the protagonist nor even an active agent. Like the work of Deleuze and Guattari, these histories are meant to transform how we envision our own life activity. Together these authors all suggest that we not only recognize and acknowledge, but also actively practice ever-changing ‘strange kinships’ that ‘[allow] for an intimate relation based on shared embodiment without denying differences between life-styles or styles of being’ (Oliver, 2007: 18); **we are encouraged to reproduce life as if we were accountable for the entire ‘universal machine’ rather than the individuals and groups** (some, although not others) who we have selected out of it. For Haraway, this consists of ‘retying the knots of multi-specied living on earth’ (Haraway, 2008: 2) and **better attending to the ‘sym-bio-genesis’ of all beings by recognizing that they are “the fruit of ‘the co-opting of strangers, the involvement and infolding of others into ever more complex and miscegenous genome**”’ (Margulis and Sagen, quoted in Haraway, 2008: 31). Accordingly, such transformations in how we practice everyday life and how we imagine our own subjectivities offer the potential to enact ‘autre-mondializations’ – alternative global political arrangements divorced from neoliberalism and liberal humanism (Haraway, 2008).

Janine Benyus’s work and that of the biomimeticists with which she is associated seem to follow through on these recommendations in practice. While less Continental philosophy than New Age, Benyus’s 1997 book, Biomimicry: Innovation Inspired by Nature, describes a collection of projects that suture together the now existing pieces of our historical ‘wreckage’ with the products of biological histories. The ultimate aim is to remake how we make technologies by modeling them on biological structures and functions. Rather than blindly push forward with a vision of technological ‘progress’ whose outcomes are unknown, we can look to nature to identify how it creates the conditions for life’s expansion. As she explains:

Evolution itself is believed to have occurred in fits and starts, plateauing for millions of years and then **leaping to a whole new level of creativity after crises**… my hope is that we’ll have turned this juggernaut around, and instead of fleeing the Earth, we’ll be homeward bound, letting nature lead us to our landing, as the orchid leads the bee. (Benyus, 1997: 5)

This is not all, however, as according to Benyus, engineering a future that is both ‘calm’ and sustainable requires more than the technological fix that biomimicry promises. Rather, it also requires fixing what we broke in the Agricultural Revolution in her narrative: our connection to the earth. And this, she suggests, is the ultimate promise of biomimicry – that it will undermine the conceptions of human and nonhuman life upon which the traditions of technological production and progress were built.

Print and online news media outlets view biomimetic productions with a sense of profound irony: journalists approach the idea that scientists at elite institutions and engineers at multinational corporations are looking to ‘lowly creatures’ to teach them how to overcome technological and conceptual roadblocks with humor (Gaidos, 2010: 22; Stresing, 2003). Benyus, however, foregrounds the potential for biomimicry to unsettle our notions of human exceptionalism as its most profound contribution. Rejecting a human-environment relationship best characterized by extraction, exploitation, and domination, Benyus characterizes biomimicry as a means of production founded on mutual enhancement and education: it’s not ‘what we can extract from nature, but ... what we can learn from her’ (Benyus, 1997: 2, emphasis in original). For her, biomimetic production is not about using animal life (or using it up), but about exploring it as a source of enchantment and inspiration. And, for Benyus, this is the true hope of biomimicry: that they will engender a more respectful, responsible, and humble engagement with nonhuman as well as human life.

When we view nature as a source of ideas instead of goods, **the rationale for protecting wild species and their habitats becomes self-evident**. To have more people realize this is my fondest hope. In the end, I think biomimicry’s greatest legacy will be more than a stronger fiber or a new drug. It will be **gratitude, and** from this, **an ardent desire to protect the genius that surrounds us**. (Benyus, 2008)

By transforming how we make everything from plumbing pipes to robots, Benyus argues that biomimicry naturally stretches the categories of human and nonhuman beyond their limits, shaking the foundation of human exceptionalism and forging more collaborative engagements with nonhumans for a more democratic and sustainable future. If we accept these conclusions, such engagements not only promise to solve our ecological crisis, but also the problematic social and political conditions that have led to it. Just as biomimicry disintegrates what we know of ‘lobsters’, Benyus and other advocates promise that it will break apart the human, locating it elsewhere, outside of itself in such a way that it can no longer refer back to an essential identity or reproduce an idealized image of human nature. Read through this lens, biomimicry might suggest an end to the ‘lethal and bloody’ operation of the ‘anthropological machine’ through a re-making of production and the reconsideration of the how humans, animals, and other things come together to produce things and, subsequently, to produce the world. Its practice of transgressing traditions borders and its emphasis on inspiration over appropriation seem to offer a **foundation for modes of production that are more ethical**, more attentive to and responsible for the bodies with which we produce. In Benyus’s words, ‘We will have to climb down from our pedestal and begin to see ourselves as simply a species among species, as one vote in a parliament of 30 million. When we accept this fact, we start to realize that what is good for the living Earth is good for us as well’ (ibid).

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#### We are in a crisis of knowledge [deacon] – Command society is falling away, there is no one right answer about how to affirm the topic --- strategies that incorporate modes of questioning into modes of action are necessary in an increasingly uncertain future

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Whether it be in the realms of civics, work, or everyday cultural life, we are in the midst of enormous change. To remain apt, education must reflect these changes. Maybe, there are even times and places where educators can lead change.

Take civics. For better or worse, the key phenomenon in the realm of civics is that the nation-state is shrinking. Whatever the root causes—small government conservatism, globalisation, or the new dynamics of a post–Cold War world—the realities of this change are felt everywhere.

The society of self-regulating community—civil society—is becoming a more significant locus of action and decision. The Internet is governed, not by any state, but through the community of experts and interested parties that is the World Wide Web Consortium. Diasporic communities are governed, not by home governments, but by highly distributed community organisations whose points of connection are common cultural principles. In education, we are witnessing the rise of community and private schooling and the self-managing public school, as well as the need for teaching **to become an increasingly self-regulated profession**. As the state contracts, there is no alternative to creating governance structures within the communities of practice of civil society.

With the shrinking of the state, a certain kind of society disappears, too. Compare the relationship of state and civil society today with the command societies of the 20th century—the communism of Lenin and Mao, the fascism of Hitler and interwar Japan, and the paternalistic regimentation of the West’s welfare state. When a greater capacity to decide and act is devolved to civil society, a higher level of participation and reflexivity is required of citizens.

So deep is this change that it extends even to the nature of personality. The society of the strong state established relationships of command and compliance at every level, not just in the state itself but in workplaces (the bosses and supervisors whose orders were to be obeyed), in homes (the heads of households who made decisions and disciplined), in schools (the orders of headmasters and teachers, **mandated curricular content and tests of definitively correct answers**).

Take that archetypical command personality Howard Roark, modern architect and towering individual in Ayn Rand’s procapitalist novel The Fountainhead (1952/1996). At the vanguard of unadorned modernism, he stands alone against the world, unwilling to compromise his designs, and for his singularity of purpose, he triumphs. At almost the same moment, anticapitalist Mexican artist Diego Rivera was painting the heroes of modernity on the murals of the Rockefeller Centre in New York. Overlooking the mighty works of modern man—the cities, the bridges, the industrial landscapes whose horizons are punctured by smokestacks— were the heroic engineer, the heroic architect, the heroic intellectual, the heroic political leader, the heroic gang-supervisor, and (his Rockefeller patrons also hoped) the heroic capitalist. Rivera was removed from the job when it became obvious that among the faces of the heroes was a likeness of Lenin. Notwithstanding 20th-century sensitivities to their ideological differences, Roark and Lenin were equally command personalities and in that sense substitutable in the tableau of modernism. Both left and right, in their time, lionised command personalities.

For every command personality, there had to be a multitude of unquestioning functionaries, and upon their compliance the system depended. The ideal citizen of the strong state was compliant; the ideal worker of the capitalist or communist industrial enterprise was compliant; the ideal learner in the classroom of disciplined knowledge was compliant.

Today, the command personality is an anachronism. At work, for instance, crude command structures are replaced by a more sophisticated cultural co-option—the co-option of teamwork, vision and mission, and corporate culture, in which everyone is supposed to personify the enterprise, to think and will and act the enterprise. Roark’s aesthetic insistence has become an archaism—he would let his business fail before compromising on the rigorous modernism of his designs. “Any colour you like, so long as it’s black,” said another heroic command personality, Henry Ford. Today, there can be no entrepreneurial heroism because the customer is always right and products and services need to be customised to mesh with the multiple subjectivities of niche markets—the big SUVs, the smart sports cars, the spacious family cars, the microcars for crowded cities, cars of any hue and trim—so many permutations, in fact, that sometimes an individual order has to be placed before a vehicle is manufactured. Fordist mass production is displaced by today’s mass customisation.

In our lives as cultural beings as well, there has been a profound shift in the intersubjective balance of power. Take something as fundamental as narrative. In everyday family and community life, the narratives of gaming have become a bigger business than the narratives of Hollywood. From the most impressionable of ages, children of the Nintendo, PlayStation, and X-Box generation have become inured to the idea that they can be characters in narratives, capable of determining or at least influencing the story’s end. They are content with being no less than actors rather than audiences, players rather than spectators, agents rather than voyeurs, users rather than readers of narrative. Not content with programmed radio, they build their own playlists on their iPods. Not content with programmed television, they read the narratives of DVD and Internet-streamed video at varying depth (the movie, the documentary about the making of the movie) and dip into “chapters” at will. Not content with the singular vision of sports telecasting of mass television, they choose their own angles, replays, and statistical analyses on interactive digital television. Meanwhile, the autocreative potentials of the digital media and the “semantic web” have only begun, with phenomena such as blogging. These potentials create new economies of cultural scale, geographies of distribution, and balances of cultural power. The costs of owning the means of producing widely communicable meaning have been hugely reduced, and with this, the small and the different have become as viable as the large and the generic (Cope & Kalantzis, 2004).

Whether it be in the domains of governance, work, or cultural life, the command society is giving way to the society of reflexivity. Or so we might say in moments of strategic optimism. In moments of pessimism we might experience these same phenomena as fragmentation, egocentrism, randomness, ambiguity, and anarchy. And when this pessimism turns to fear, we might want to return to earlier, simpler command structures—in nations, workplaces, households, and schools.

Pessimists and optimists alike can agree that we are in the midst of a transformation that is creating new forms of subjectivity and new kinds of personality. These transformations can be viewed from within a systemic perspective and beyond it. From a systemic point of view, these are the kinds of governance structures, the kinds of organisations, and the kinds of people required today for the most conservative, small government, and proenterprise points of view. We hear these points of view ex pressed in the public rhetoric of innovation and creativity, the knowledge economy, and individual autonomy and responsibility. Notwithstanding the high-sounding rhetoric, these transformations when left to run their course may only legitimate and even exacerbate systemic inequities—iniquities, indeed.

History, however, is more open-ended than that. Inevitably, human systems are so complex that they allow possibilities outside the scope anticipated by their progenitors and apologists. For every moment when the ideologues of small government succeed in shrinking the state, there is another moment in which people learn the civilities of self-government in their various communities of practice; for every moment when command structures in workplaces are replaced by collaborationist structures, there is another moment in which people acquire the collaborative competencies of socially directed work; for every moment when compliant personalities are replaced by the egocentrism of individualism, there is another moment in which new relationships of codependence and mutual reliance are created and the bonds of sociability are extended and deepened. Whatever the domain, there is a shift in the balance of power and in the moral economy of agency that favours egalitarianism and liberty—and this, despite and beyond prevailing systems and structures of power. **From this, something genuinely new could emerge**.

Whether one’s agenda is to support today’s systems of governance, work, and culture or to create new and more equitable ones, subjectivity and agency loom larger than they did in the era of the command society. Yet, all too often, our institutions and practices of schooling reflect the epistemological frames of reference and personality types of the command society, in the communication patterns of classroom discourse, for instance, or the information architectures of curriculum, or the rigid expectations of “right” and “wrong” answers in testing regimes.

We educators have been struggling to develop a new dynamics of agency for a century now, starting with the progressivisms of John Dewey and Maria Montessori. One of the solutions to the problem of agency in learning has been a “constructivism” derived from a 20th-century psychological canon in which Piaget’s theories dominate. In the context of a command society, however, their emphasis was on the level and extent of receptivity at a particular age or at a particular cognitive stage. The raw materials of “intelligence” were biologised, and variations were accounted for **in terms of individualised “capability**” and the increments of what was supposed to be innate, universal development. Today, the cognitive sciences do a similar psychological job. Their agenda is to account for the mechanisms of receptivity more than for the mechanisms in which learned knowledge is genuinely made by conscious agency.

If, however, one follows and extends a line of thought begun by Vygotsky, other possibilities for pedagogy emerge. If knowledge is a psychological construct that is more social than individual, if learning is the stuff of active appropriation of the world in a social context, if educability amounts to more than equation of external transmission with individual receptivity, what then are the bases of a theory of pedagogy?

Building on Vygotsky, Bill Cope and I have been proposing a theory of learning that is grounded epistemologically rather than psychologically. By “epistemological,” we mean what we do to know (Kalantzis & Cope, 2004, 2005). As humans, we might be driven by the mystery of human consciousness, but the critical question is what we do with its drives. Here are some acts of knowing that we have been considering of late as a part of our Learning by Design research and development project: we experience (by immersion, making tacit connections in familiar or new contexts); we conceptualise (by abstracting, naming things, and developing explicit generalisations); we analyse (inferring and interpreting cause, effect, and human interest);we apply (by making an intervention in the world of use able things and meanings, be that intervention predictable and appropriate or innovative). In every one of these acts of knowing, we learn the world by doing something in the world.

The command society could never trust learners to be agents of knowing. Instead, they were the receptors of knowledge—although even this was a conceit of power, because now we understand the perennial role of the reader, the listener, or the viewer. We thought that they were receptors because this illusion also drove our politics, our workplaces, our public culture, and our pedagogy. In hindsight there was resistance as often as there was compliance, even if that resistance was branded subversion, laziness, or failure at school.

Today, we can remain under no such illusion. The increasingly critical self-governing structures of civil society, the tricks and tropes of the self-managing work team, the user-driven narratives of popular culture make any such illusions impossible. The children of Nintendo will simply walk away if the pedagogy served up to them by institutionalised schooling does not engage every fibre of their subjectivity. The workplace of the near future will simply be uncompetitive if its workers do not contribute their all, from their creative potential to their ability to maintain relationships of supple reflexivity across the myriad niche customers and affiliates. **The cultures of the near future will ossify if they fail to leave space for the “readers” to follow their own proclivities and shape their own cultural ends**.

The minute that one allows so much scope for agency, one finds oneself facing layers upon layers of difference. One discovers actually existing agencies in the massively plural and not the fabrications and falsifications of the command society with its one-people–one-state nationalism, of the regime of mass production and mass consumption, and of the pretensions to cultural homogeneity of the society of mass media and mass culture. The differences are material (class, locale), corporeal (race, gender, sexuality, ability/disability) and circumstantial (culture, life experience, interest, affinity). We can acknowledge these differences, perform neat demographic metrics, and, in the name of diversity, build programmes to suit group by group. Or we may think that we can, at least until we encounter a deeper difference that, in the interstices of these demographics or even solidly in the middle of each demographic, defies neat categorisation and prediction. These differences are manifest in the profoundly variable dispositions and sensibilities that one encounters from person to person. This is the stuff of the lifeworld, not individualised personality. Such difference is accountable in terms of the infinitely variable and therefore always uniquely complex range of sociocultural influences that come to bear on any one individual. The more we take agency for real, the more multifarious its manifestations become.

And to face all these agencies in one classroom! The solution of the command society was that of one teacher talking at the middle of the class, one textbook telling one narrative one chapter at a time, one test evaluating one way of knowing. **The result was assimilation** to the middle way **or failure**.

Constructivism blandly suggests that we bring agency into this picture. It is as if we can give all learners the same dose of agency, commensurate with their stage of the template of human developmentalism. But it is not just agency in the abstract that we have to harness. The complexity is such that the simple nostrums of constructivism serve us poorly indeed.

If it is to be at all relevant, the classroom of the reflexive society must allow alternative starting points for learning (what the learners perceive to be worth learning, what engages the particularities of their identities). It must allow for alternative forms of engagement (the varied experiences that need to be brought to bear on the learning; the different conceptual bents of learners; the different analytical perspectives that the learners may have on the nature of cause, effect, and human interest; and the different settings in which they may apply or enact their knowledge). It must allow for different learning styles (preferences, for instance, for particular emphases in knowledge making and patterns of engagement—experiential, conceptual, analytical, or applied). It must allow for different modalities in meaning making, embracing alternative expressive potentials for different learners. And it must allow for alternative pathways and destination points in learning.

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#### The Human hubris we critique is the root cause of their risk

**Guattari, 89** (Felix, *The Three Ecologies*, p. 19-22)

The Earth is undergoing a period of intense techno-scientific transformations. If no remedy is found, the ecological disequilibrium this has generated will ultimately threaten the continuation of life on the planet's surface. Alongside these upheavals, human modes of life, both individual and collective, are progressively deteriorating. Kinship networks tend to be reduced to a bare minimum; domestic life is being poisoned by the gangrene of mass-media consumption; family and married life are frequently 'ossified' by a sort of standardization of behavior; and neighborhood relations are generally reduced to their meanest expression,. . . **It is the relationship between subjectivity and its exteriority** - be it social, animal, vegetable or Cosmic - **that is compromised** in this way, in a sort of general movement of implosion and regressive infantalization. Otherness [I’alterite] tends to lose all its asperity. Tourism, for example, usually amounts to no more than a journey on the spot, with the same redundancies of images and behaviour. Political groupings and executive authorities appear to be totally incapable of understanding the full implications of these issues. Despite having recently initiated a partial realization of the most obvious dangers that threaten the natural environment of our societies, they are generally content to simply tackle industrial pollution and then from a **purely technocratic perspective**, whereas **only an ethico-political articulation** - which I call ecosophy between the three ecological registers (**the environment**, **social relations** and **human subjectivity**) would be likely to clarify these questions.2 Henceforth **it is the ways of living on this planet that are in question**, in the context of the acceleration of techno-scientific mutations and of considerable demographic growth. Through the continuous development of machinic labour, multiplied by the information revolution, productive forces can make available an increasing amount of time for potential human activity.3 But to what end? Unemployment, oppressive marginalization, loneliness, boredom, anxiety and neurosis? Or culture, creation, development, the reinvention of the environment and the **enrichment of modes of life and sensibility**? In both the Third World and the developed world, whole sections of the collective subjectivity are floundering or simply huddle around archaisms as is the case, for example, of the dreadful rise of religious fundamentalism. The only true response to the ecological crisis is on a global scale, provided that it brings about an authentic political, social and cultural revolution, reshaping the objectives of the production of both material and immaterial assets. Therefore this revolution must not be exclusively concerned with visible relations of force on a grand scale,but **will also take into account molecular domains of sensibility**, **intelligence and desire**. A finalization of social labour, regulated in a univocal way by a profit economy and by power relations, would only lead, at present, to dramatic dead-ends. This is obvious from the absurd and burdensome economic supervisions of the Third World, which lead some of its regions into an absolute and irreversible pauperization. It is equally evident in countries like France, where the proliferation of nuclear power stations threatens, over a large part of Europe, the possible consequences of Chernobyl-style accidents. One need hardly mention **the almost delirious stockpiling** **of** **thousands of nuclear warheads**, which, at the slightest technical or human error, could automatically lead to collective extermination. In all of these examples it is the same dominant modes of valorizing human activities **that are implicated**. That is to say: 1. those of the imperium [Latin: 'authority'] of a global market that destroys specific value systems and puts on the same plane of equivalence: material assets, cultural assets, wildlife areas, etc. 2. those that place all social and international relations under the control of police and military machines. Trapped in this double pincer movement, the nation States see their traditional role of mediation being reduced more and more, and they are frequently put in the combined service of the authorities of the global marketplace and of military-industrial complexes.6 The current situation is all the more paradoxical as the time is almost over when the world was placed under the aegis of an East-West antagonism, a largely imaginary projection of working-class / middle-class oppositions within capitalist countries. Does this mean that the new, multipolar issues of the three ecologies will simply take the place of the old class struggles and their myths of reference? Of course, such a substitution will not be automatic! But it nevertheless appears probable that these issues, which correspond to an extreme complexification of social, economic and international contexts, will increasingly come to the foreground. Initially the class antagonisms that were inherited from the nineteenth century contributed to the creation of homogenous, bipolarized fields of subjectivity. Then, during the second half of the twentieth century, the hard-line worker subjectivity crumbled with the advent of the consumer society, the welfare system, the media, etc. Despite the fact that today these segregations and hierarchies have never been so intensively experienced, this group of subjective positions has been cloaked by the same fictitious smokescreen. A vague sense of social belonging has deprived the old class consciousness of its tensions (I won't go into the accumulation of violently heterogeneous subjective poles, such as those that are emerging in the Muslim world.) For their part, the so-called socialist countries have steadily introjected the 'unidimensionalizing' value systems of the West. Therefore, in t}e communist world the old facade of egalitarianism is giving way to mass-media serialism thee same ideal standards of living, the same fashions and types of rock music, etc.). 10 It is difficult to imagine the situation can be improved in any significant way as far as the North-South axis is concerned. Admittedly, in the end, it is conceivable that the spread of agri-business techniques will allow us to modify the theoretical givens of the tragedy of world hunger. But on the ground, meanwhile, it would be a complete illusion to think that international aid, such as it is designed and distributed today, would be able to permanently resolve every problem. Henceforth, the long-term establishment of immense zones of misery, hunger and death seems to play an integral part in the monstrous system of 'stimulation' that is Integrated World Capitalism. In any case, the hyper-exploitative New Industrial Powers, such as Hong Kong, Taiwan, South Korea, etc., depend on these zones for their development. We find this same principle of social tension and 'stimulation' born of despair in the developed countries, with the establishment of periods of chronic unemployment and the increasing marginalization of the population: the young, the old, 'part-time' workers, the undervalued, etc. So, wherever we turn, there is the same nagging paradox: on the one hand, the continuous development of new techno-scientific means to potentially resolve the dominant ecological issues and reinstate socially useful activities on the surface of the planet, and, on the other hand, **the inability of organized social forces and constituted subjective formations to take hold of these resources in order to make them work**.