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#### Let’s begin with the story of Professor Challenger.

**Pindar and Sutton, 2k** (Ian and Paul, *Introduction to The Three Ecologies*, p. 1-5)

When he gave the world Professor Challenger, Conan Doyle was already justly famous for creating Sherlock Holmes. He wrote his two Challenger collections - early examples of a new genre that eventually would be called 'science fiction' at the turn of the last century , The Lost World n 1912 and The Poison Belt the following year. Unlike Sherlock Holmes, however, Challenger is almost completely forgotten, although the stereotype he embodied continues to subsist in books, television and film. He is rational, scientific man at the dawn of a new century, confident of his superiority over nature, which is ably demonstrated in the story to which Guattari and Deleuze allude: 'When the Earth Screamed'. Challenger has all the arrogance of Sherlock Holmes but none of his charm. He takes an almost sadistic delight in experimenting on the natural world and despises his much abused, Watson-like stooge Edward Malone and anyone else who dares to question his superior intelligence ('Clearly a typical victim of the Jehovah complex,' observes one of his critics).2 He is a caricature, of course, but it would not be far-fetched to say that the twentieth century was the century of ~~men~~ like Challenger. In 'When the Earth Screamed' Challenger argues that the Earth is an organism, much like a sea-urchin, hard on the outside but soft inside. Human beings are a fungal growth of which the planet is completely unaware. Surrounded by sceptics, he proposes to prove his point by vigorously stimulating the creature's sensory cortex, that is, driving a shaft into the centre of the Earth, thereby gaining its attention (for his experiments are always little more than outlets for his insufferable egotism;. Having, he supposes, proven his superiority over the rest of a.nimal- and humankind, the Earth is his final and finest challenge: 'I propose to let the Earth know that there is at least one person, George Edward Challenger, who calls for attention - who, indeed, insists upon attention.' After a brief lecture to a restless audience, Challenger presses the 'electric button' that sends an enorrnous iron dart into 'the nerve ganglion of old Mother Earth'. There is the most horrible yell that ever was heard . . . a howl in which pain, anger, menace, and the outraged majesty of Nature all blended into one hideous shriek. For a full minute it lasted, a thousand sirens in one, paralysing all the great multitude with its fierce insistence, and floating away through the still surnmer air until it went echoing along the whole south coast and even reached our French neighbours across the Channel. No sound in history has ever equalled the cry of the injured Earth. Much to Challenger's satisfaction, an 'enormous spout of a vile treacly substance of the consistency of tar' erupts from the ground to soak the assembled Press, and then the excavation is buried by a SO-foot pyramid of earth. The story ends with Challenger's transformation from lunatic to genius - 'Challenger the super scientist, Challenger the arch-pioneer, Challenger t}e first man of all men whom Mother Earth had been compelled to recognize' - although it remains unclear what practical benefit the experiment had other than to gratify his terrifying ego or to demonstrate that nothing can 'defend Mother Earth from intrusive Challengers'. In The Three Ecologies Guattari objects that **we have challenged the Earth enough and** are **now** on the brink of ecocide. After a century of unparalleled scientific and technological progress we have made our presence known to the planet in the most dramatic and self-defeating fashion. Had the Earth's response to man's 'stimulation' been as localized as it is in Conan Doyle's story - a retaliatory spurt of black tar - we would be safe; but instead we are faced with a very different kind of 'feedback': a bewilderingly complex array of interrelated and unpredictably erratic fluctuations over which we have little or no control and which remind us that the whole world is a giant ecosystem with a sensitive biosphere that has taken 4.5 billion years to evolve. Our Challenger-like contempt for nature has driven thousands of species to extinction already, insects, other invertebrates and micro-organisms in the main, although birds and larger mammals such as the elephant and the tiger are also at risk, and it is not fanciful to suppose that eventually we might deprive even ourselves of an ecological niche.3 The Earth's environment is composed of a multiplicity of such niches, each of which is a potential home for life forms. (As Guattari reminds us, the etymology of 'eco' is the Greek word oikos, meaning 'home'.) We have upset the delicate symbiosis between ourselves and nature, with largely unforeseeable results. In the oceans, for instance, overfishing, increased pollution, and rising temperatures as a result of human activity have resulted in the spread of unknown or unidentified infectious 'agents' that have led to the mass mortality of fish, sea mammals, tropical corals and sea-water plants. The biodiversity of the oceans is seriously threatened by mysterious pathogens - viruses, bacteria, fungi and other parasites - that wipe out whole populations. These pathogens are making crossspecies leaps of the sort that the Professor Challenger of ,{ Thousand Plateaus would be better able to explain, and have exploded the popular belief that the Earth's oceans are so vast they would remain relatively immune from mankind's influence. Whereas Nietzsche could still find comfort in the analogy of the world as a 'sea of forces' that never expends itself, 'eternally flooding back' ('the sea will cast it up again'), we can have no such faith in our diseased and toxic oceans with their oil slicls and giant algae blooms visible from space.a There can be little doubt that around the world increased pollution, global warming, deforestation, desertification and the loss of biodiversity are anthropogenic, or that the motor of this generalized impoverishment of the biosphere is capitalism. The latter half of the twentieth century was a period of intense globalization. With the end of the Cold War and the collapse of the Soviet Union, the dominant mode of economic interaction and transaction was the capitalist system, with its emphasis on the free market. This ideology of unrestricted competition has resulted in the widespread plunder of natural resources, particularly fossil fuels such as oil or coal, but it isn't just the natural environment that is threatened. Poorer countries are forced to sell their labour extremely cheaply in order to enter the global marketplace, and have exploited their natural resources without a thought for sustainability. Meanwhile in the pollution-choked cities of the developed world the most vulnerable in society are living increasingly insecure and alienated lives. Globalization has given rise to 'exploitative practices that perpetuate a quiet violence on low-income labour and other vulnerable groups such as the poor, women and children. New technological and scientific advances that could be used to liberate human potential remain instead in the service of a capitalist drive for profitability. A third of the world's population continues to suffer from massive poverty and malnutrition, while at the same time there has been an increase in global wealth unprecedented in the history of humankind. The increasing globalization of all areas of our lives is not being directed by one particular capitalist organization, party or country - not even the USA, despite the fact that the model which most of the world is confronted with is the American Way of Life. Post-industrial capitalism - which Guattari calls Integrated World Capitalism (IWC) - is delocalized and deterritorialized to such an extent that it is impossible to locate the source of its power.6 IWC's most potent weapon for achieving social control without violence is the mass media. For instance, everyone nowadays has a television set. Many people in the Third World will have televisions long before they have proper irrigation. With the worldwide domination of capitalism came a parallel expansion in communications technology. Instant global communication became a reality leading to the creation of a 'global village': the world as a single community linked by telecommunications. The mass media is involved in the creation of demand, so there will always be a market for capital investment. A new type of individual is being shaped and moulded by the unseen pressure of market forces. In The Three Ecologies Guattari argues that we are being 'mentally manipulated through the production of a collective, mass-media subjectivity'. That there might be a need for a mental ecologiests one of the most profound ideas in this short book. Guattari's contention is that IWC is not only destroying the natural environment and eroding social relations, but is also engaged in a far more insidious and invisible **'penetration of people's attitudes, sensibility and minds'** (Guattari and Negri, 1990: 53). Human subjectivity, in all its uniqueness what Guattari calls its 'singularity' - is as endangered as those rare species that are disappearing from the planet every day. It is up to us to resist this mass-media homogenization, which is both desingularizing and infantalizing, and instead invent new ways to achieve the resingularization of existence. It is not enough to take to the streets and wave placards, an entire mental ecology is necessary in order not to give IWC our unconscious assent. But to illustrate how IWC infiltrates and saturates the unconscious, let us return briefly to its effect on the environment. It might have been better for us if the Earth had screamed, as it did for Professor Challenger. Instead it has gone eerily silent. Take, for example, the population of songbirds in the British countryside. In 1972 there were an estimated,7.72 million skylarks in Britain. By 1996 there were only about 3.09 million. In a short space of time almost 60 per cent had disappeared.s It is very rare to hear a skylark today, as it is to hear other once common songbirds such as the song thrush or the blackbird. Their ecological niches or homes hedgerows, heaths, ponds, meadows, moors and marshes have been eroded by the intensive use of agri-chemicals and pesticides which have decimated their food supply. Birds sing to mark out their territory (Deleuze and Guattari, 1988: 312), so it is only to be expected that the singing has stopped.

#### Arrogance is an intoxicant---the Challengers of the 20th century greedily ate up all available resources. By creating a society based around fossil fuel consumption, we have shut out considerations of alternatives and normalized a belief in our ability to separate ourselves from natural limitations.

**Scheer 7 –** Member of the German Parliament, President of the European Association for Renewable Energy EUROSOLAR, Chairman of the World Council for Renewable Energy WCRE

(Hermann, *Energy Autonomy: The economic, social, and technological case for renewable energy* pg 204-206, dml)

Ecological thinking needs to be holistic so that its impact can be understood in context. Ignoring these contexts – proceeding from that particularistic concept of science that has become dominant in modern natural science – is a profound cause of the ruthless way that industrial growth societies have dealt with natural goods**.** Specializing in the particular has been carried forward from the natural and technical sciences onto an evergrowing number of scholarly fields. A particularistic understanding of science shapes teaching and occupational training, and it promotes the increasingly frayed specialization of professions. Weighing trade-offs between a number of factors is becoming harder, as is the evaluation of their relative significance. By contrast, the capacity for a holistic view of strategy against environmental crises is indispensable. Yet it is a tortuous path from these imperatives of thinking and acting to heeding what they tell us to do.

‘Any new interpretation of nature’, according to the physicist, philosopher and historian of science Thomas S. Kuhn in his book The Structure of Scientific Revolutions:25

emerges first in the mind of one or a few individuals. It is they who first learn to see science and the world differently, and their ability to make the transition is facilitated by two circumstances that are not common to most other members of their profession. Invariably their attention has been intensely concentrated upon the crisis-provoking problems; usually, in addition, they are men so young or so new to the crisis-ridden field that practice has committed them less deeply than most of their contemporaries to the world view and rules determined by the old paradigm… [At first] a new candidate for paradigm may have few supporters (and the motives of the supporters may be suspect). If the supporters are competent, they will improve the paradigm, explore its possibilities, and show what it would be like to belong to the community guided by it. For the paradigm destined to win, the number and strength of the persuasive arguments in its favour will increase. As more and more scientists are converted, exploration increases. The number of experiments, instruments, articles, and books based on the paradigm will multiply. More scientists, convinced of the new view’s fruitfulness, will adopt the new mode of practising normal science, until only a few elderly holdouts remain.

So far, however, the scientific revolution leading to a holistic ecological approach has remained bogged down. Renewable energy, which is the natural linchpin of the new paradigm from a holistic perspective, has hardly gone beyond the candidate role, in spite of enormous interest on the part of younger scientists. Specialized disciplines dominate the world of science so much that they have succeeded in subordinating holistic efforts. There are quite normal reasons for this, having to do with inertia inside the world of science itself, a system that is not eager to rewrite its textbooks, and whose exam regimens and careers are oriented around specialized disciplines. Instead of a new holistic approach, often nothing more is ventured than a summation of specialized perspectives that empty out into a sea of ‘complexity’. This goes along with a refusal to recognize just one parameter – in our case, renewable energy – as the key factor, and not just for overcoming a single problem, but for overcoming several. To the representatives of the particularistic scientific establishment, this seems too monocausal, although it cannot be disputed that the central cause of most environmental problems is fossil energy consumption, which is why the central solution – which will enable many other problems to be solved simultaneously – can only lie in a shift to renewable energy. But the moments of inertia in today’s specialized culture of science are not the only impediments to a holistic perspective; equally obstructive are the economic interests and dependence relations of scientific training institutes.

Even environmental policy, although it is a classic case of a problem that cries out for a comprehensive approach, became enmeshed in a political decision-making operation that was also organized in a particularistic way; environmental policy became just one department among many. This started with the installation of environmental ministries. Their job, to be sure, is championing the environmental cause, but as a rule they do not have authority to attack the problem of energy crises at their roots and to press ahead immediately with the necessary shift in resources. One of the few exceptions is Germany’s Environment Ministry, which was authorized to deal with renewable energy in 2002. This led to tensions inside the Ministry, whose classic assignment was to alleviate the consequences of resource consumption, meaning that it was attacking the problem at the end of the resource chain rather than at the beginning. This inevitably leads to sideshow battles. The more environmental policy deals with pollutant particles instead of the sources of pollution, the more extensive is the growth in the number and scope of environmental laws accompanying the number of recognized particle dangers – rather like that well-known criticism of criminal law practice whereby the little guys go to the gallows and the big fish get off scot-free. Particle-oriented environmental protection is also directed against renewable energy. When the environmental authorities cannot find a single hair in the renewable energy soup, they shake their heads until a hair falls in.

#### We are not superhuman – presuming a rational, objective starting point from which we can prescribe so-called necessary plans and policies can never deal with anything outside its paradigm – the status quo exemplifies a dangerous logic of separation that is unsuitable for dealing with the existential crises it created.

**Peat, 08 –** theoretical physicist, Ph.D., founder of the Pari Centre for New Learning (F. David, “Gentle Action: Surviving Chaos and Change”, http://www.gentleaction.org/library/paper2.php)

Many rapid changes that are taking place around us. These include globalization, developments in technology; fears of terrorism, the instability of the Third World; the rise of the Pacific Rim and a United Europe; the breakdown of inner cities; economics that appear to be out of control with the consequent challenges of inflation, recession and unemployment; spiraling health costs; revolutions in communication technology and information processing; the demands of consumers and special interest groups; threatened species and ecologies; the dangers of global warming and ozone depletion; increasing rates of teenage suicide and drugs use; the transformation of management and the breakdown of conventional institutions. Governments, institutions, organizations and individuals experience considerable anxiety in the face of such rapid change and **feel powerless to ameliorate the problems** that surround them. Indeed, it sometimes appears as if their plans and policies, as well as the traditional structures of their institutions, **are themselves part of the problem**. In so many cases policies, plans, interventions and other actions, all taken in good faith, have not only failed to resolve an existing situation but in many cases **have acted to magnify and render the problem even more intractable**. In other cases, the attempt to impose a solution in one location or context **has had the effect of creating an even larger problem elsewhere**. Organizations and individuals feel control slipping from their grasp and their natural reaction is to become even more intransigent in their attempt to clamp down on events and exert ever more control. **The result is a spiral of control that has literally gone out of control!** The realization that plans and policies are ineffective leads to a sense of depression and hopelessness. Faced with the insecurities and flux of the modern world many institutions fall into a state that, where it to be detected in an individual, would be diagnosed as manic-depression! How did this cycle of anxiety, hopelessness, panic and the desire for ever more control arise? I would argue that it is a paradigm of thought and behavior that originates in our particular view of reality, a view, moreover, that modern science had now demonstrated to be fundamentally erroneous. Thus, when our perception of the world around us is astigmatic, the actions we take become increasingly inappropriate and incongruous. It is only by entering into new modes of perception and acknowledging a new paradigm of reality that more appropriate forms of action can be taken. The Myth of Control One of the great themes of Western civilization, a theme of virtually mythic proportions, involves the way in which nature has been tamed and controlled over the course of the last few thousand years. Other cultures and civilizations have, for example, developed the techniques of farming but it appears that only the civilizations that expanded from their Neolithic birthplace in Northern Europe and the Fertile Crescent of the near East possessed the hubris necessary to impose themselves to such a marked extent upon the landscape. Thus, even in prehistoric times, European forests were cleared, marshes drained, vast tracts of land converted to farming, and tracks and walkways established as human beings sought to recreate the landscape according to their own needs. And, as ever more powerful technologies and social control became available, this path of domination continued. Within our own time, social critics have pointed out that this desire to exert control has led to our distancing ourselves from the natural world. The effect has been for us to place an **increasing faith in human reason, science, technology and the effectiveness of plans**, directives **and policies** while, at the same time, to decrease our sensitivity for the complex and subtle nature of the world around us. In short, **we tend to stand outside the world**, like observers, **indulging in constant analysis,** **making predictions and exerting corrective control** when situations do not move in the direction we desire. When human society and its associated technology were relatively simple and localized, and the resources that it called upon were unlimited, then this pattern of control was relatively successful. But as societies attempt to deal with ever more complicated issues, their boundaries became more open, their resources are found to be finite, the environment fragile, and technologies and world economics become increasingly complex then these conventional approaches simply fail. Ultimately, by virtue of its early success, the desire to dominate grew to the point where **it began to subvert itself and**, in the process, **endangered the whole planet**. And increasingly actions taken in one sphere **have unintended consequences in another**. Engaging complexity Over the last decades, however, there have been indications of a remarkable transformation within this traditional vision; a revolution in the perception of ourselves, our culture and the nature of reality that is truly Copernican in its implications. Just as in the 16th century astronomical observations were to dethrone the human race from a central place in the universe, so too in our own century relativity, quantum theory, chaos theory and systems theory, along with new insights in psychology, ecology and economics, have demonstrated the fundamental fallacy of our belief in definitive control. At the same time they are affirming our basic connectedness to the whole of creation. These scientific insights happen to have come at a time when the world has been experiencing rapid revolutionary change. States have risen and fallen. The notion of government is being transformed. Institutions are questioning their effectiveness. Businesses are desperately searching for new ways of operating. Technologies have developed so rapidly that people are unable to keep up with their implications. The overall effect has been to create **a profound sense of anxiety**, a fear that things are out of control, that the future is increasingly uncertain and that we have been left with nothing to hang on to. Yet what if this anxiety actually **points to an essential truth about the world**, that ultimately control and definitive prediction are strictly limited and that we must discover new ways of being and acting? Our current economic, social, ecological, environmental and institutional systems are now enormously complex to the extent that **we may never have complete knowledge** **about the inner dynamics of** such **systems**, nor the ability to predict exactly or exert total control. In this we can draw on metaphors from the new sciences of quantum theory, chaos theory, systems theory, and so on which also indicate essential limits to prediction, description and control. It is for such reason that so many of our plans and policies have been unable to meet the complexities of the modern world and why some supposed "solutions" have created even deeper problems and more intractable situations. The myth of eternal progress and control that has lain behind Western civilization can no longer sustain itself. The island of order and certainty on which we have been living has turned out to be not solid land but a rapidly melting iceberg, and we have no alternative but to **plunge into the boiling sea of flux, uncertainty and change that surrounds us**. The Dilemma of Action These are the dilemmas that many organizations find themselves in today, dilemmas that translate into the anxieties and uncertainties faced by many individuals. Programmed by their goals and mission statements, as well as by their very structures, many organizations inevitably seek ways of exerting control and believe that they must always take positive action in the face of uncertainty. Yet increasingly they discover that these actions are inappropriate. And so organizations, institutions, governments, groups and individuals retrench, break apart or in some other way get trapped into a spiral of ineffective decision making, paralysis and anxiety. These organizations, governments and institutions have been created according to our traditional image of reality; that is, of **a world that is external to us, predictable, relatively mechanical, and whose dynamics can be controlled** by the application of directed force. As a result, organizations are themselves relatively rigid in their nature, operating from fixed plans, policies and mission statements. Their internal structures are often hierarchical in nature, their lines of communication are limited rather than being flexible and dynamic, and their response to challenge and change is often predictable. In other words, most organizations are far less subtle and complex than the very systems they are attempting to address. **The basic problem** facing our modern world **is:** **How can society respond to the flux and challenge of the modern world** when all its institutions are inflexible and over-simplistic? When situations move more rapidly than an organization is capable of responding, policies and programs are outdated even before they are put into operation. Rather than acting to render organizations and policies more flexible, the apparatus of modern technology tends to **rigidify and entrench the problems** and rigidities that already exist within an organization. Organizations are composed of individuals and here too the conditioning of our society tends to inhibit natural creativity and abilities. Just as organizations have areas of rigidity, limitations also apply to the psychology of the individual. The issue becomes, therefore, one of freeing and fostering the natural intelligence and creativity of individuals and allowing them to operate fully within society, governments and institutions. In other words, how can organizations and individuals transform themselves so that they can become as subtle, sensitive, intelligent and fast-responding as the world around them? How can institutions heal their separation from society; society from the individual; and the individual from the natural world? Creative Suspension Paradoxically it is the very effort to change that establishes an internal resistance and rigidity that sustains the blocks that are to be removed. The first step towards transformation lies in an act of "**creative suspension**" and "alert watchfulness". This is an action that has the effect of relevating and making manifest the internal dynamics, rigidities, **fixed positions**, **unexamined paradigms**, **interconnections** and **lines and levels of communication** within the organization and the individual. A form of "creative suspension" is taught to paramedics and rescue workers who have to deal with serious accidents. While a layperson may wish to rush in an "help", a professional will suspend immediate response in order to make a careful assessment of the whole situation and determine how to use resources most effectively. Likewise doctors and paramedics made a visual examination of the wounded before carefully touching and then determining what medical action should be taken. The nature of this creative suspension is related to other approaches and techniques whereby unexamined assumptions and rigidities are brought into conscious awareness. For example, Sigmund Freud's notion of "non-judgmental listening" as well as various meditative practices. Artists, composers, scientists and other creative people often describe how their work unfolds from a form of creative "listening". These acts of listening and watchfulness have the effect of dissolving rigidities and **rendering a system more flexible**. Of course the lights will begin to flash and the alarm bells ring. Like Pavlov's dog an organization is conditioned to react and respond. But what if it does nothing--but it a very watchful way, and this applies not only to organizations but to individuals as well? **The first stage will be one of panic and chaos**, a flow of commands and information. All of this is not **being generated by** any external threat but through **the** internal **structure of the organization** itself. By remaining sensitive to what it going on it may be possible to become aware of the whole nature of the organization, of its values, the way its information flows, its internal relationships, dynamics and, in particular, its fixed and inflexible responses-- the organizational neuroses and psychoses if you like. Arthur Koestler suggested that a scientific revolution is born out of the chaos as a paradigm breaks down. It is possible that **something** **new and more flexible could be born out of the** break-down of fixed patterns in an organization, policy group or individual. Through a very active watchfulness it may be possible to detect its unexamined presuppositions, fixed values and conditioned responses and in this way allow them to dissolve by no longer giving energy to support them. The idea would be to permit the full human potential for creativity within each individual to flower, it would enable people to relate together in a more harmonious way and human needs and values to be acknowledged. In this fashion the organization or group dies and is reborn. In its new form it becomes at least as flexible and sensitive as the situation it faces. Now, using science, human creativity and the art of working with complex systems it may be possible to perceive a complex system correctly and model it within the organization. This new understanding would be the basis for a novel sort of action, **one that** **harmonizes with nature and society**, that does not desire to dominate and control and but **seeks balance and good order** and is based on respect for nature and society. Gentle Action explores images of new organizations and institutions that would be able to sustain this watchfulness. In place of relatively mechanical, hierarchical and rule-bound organizations there would exist something more organic in nature. In place of relatively mechanical, hierarchical and rule-bound organizations there would exist something more organic in nature. By way of illustrate one could draw upon ideas and concepts in systems theory, Prigogine's dissipative structures, cooperative and coherent structures in biology, neural networks, quantum interconnectedness and non-locality. In such a way organizations will be able to reach a condition in which they are as sensitive, subtle and as intelligent as the systems and situations that surround them. New Organizations, New Dynamics With this increased flexibility, organizations will now be able to internalize and model the complex dynamics of the systems that surround them. Rather than seeking to predict and control, they will now be able to enter the flux of change and engage in those actions that are appropriate to each new situation.

#### Our whole aff is a plan, but to say this requires distinguishing between policy and planning – policy begins from an assertion of a privileged position from which to hand down objectively determined solutions—whereas, planning involves an awareness of our situatedness in the processes that produce problems---this allows deeper solutions to the issues we face---we will not reduce our insight down to a static vision, we will however defend the revolutionary moments we create.

**Moten and Harney, 10** – (Fred Moten and Stefano Harney, *Policy and Planning*, http://www.darkmatter101.org/site/2010/04/19/policy-and-planning/)

The hope that Cornel West wrote about in Social Text in 1984[1] was not destined to become policy in 2008. The ones who practiced it, within and against the grain of every imposed contingency, always had a plan. In and out of the depths of Reaganism, against the backdrop and by way of a resuscitory irruption into politics that Jesse Jackson could be said both to have symbolized and quelled, something West indexes as black radicalism, which “hopes against hope…in order to survive in the deplorable present” (p.10-11), asserts a metapolitical surrealism that sees and sees through the evidence of mass incapacity, cutting the despair it breeds. Exuberantly metacritical hope has always exceeded every immediate circumstance in its incalculably varied everyday enactments of the fugitive art of the impossible. This art is practiced on and over the edge of politics, beneath its ground, in animative and improvisatory decomposition of its inert body. It emerges as an ensemblic stand, a kinetic set of positions, but also takes the form of embodied notation, study, score. Its encoded noise is hidden in plain sight from the ones who refuse to see and hear—even while placing under constant surveillance—the thing whose repressive imitation they call for and are. Now, a quarter century after West’s analysis, after an intervening iteration that had the nerve to call hope home while serially disavowing it and helping to extend and prepare its almost total eclipse, the remains of American politics exudes hope once again. Having seemingly lost its redoubled edge while settling in and for the carceral techniques of the possible, having thereby unwittingly become the privileged mode of expression of a kind of despair, hope appears now simply to be a matter of policy. Policy, on the other hand, now comes into view as no simple matter.

By policy we mean not a particular policy, as in company policy or public policy, but rather policy as something in contradistinction to planning. By policy we mean **a resistance to the commons from above, arrayed in the exclusive and exclusionary uniform/ity of imposed consensus**, that both denies and at the very same time seeks to destroy the ongoing plans, the fugitive initiations, the black operations of the multitude.[2] As a resistance from above, policy is a class phenomenon because it is the means to advantage in the post-fordist economy, a means that takes on the character of politics in an economy dominated structurally by immaterial labour. This economy is powered by the constant insistence on a radical contingency producing a steady risk for all organic and non-organic forms, a risk that allows work against risk to be harvested indefinitely.

Policy is the form that opportunism takes in this environment. It is a demonstration of willingness to be made contingent and to make contingent all around you by demonstrating an embrace of the radically extra-economic, political character of command today.[3] It is a demonstration designed to separate you from others, in the interest of a universality reduced to private property that is not yours, for your own survival, for your own advantage in this environment. Opportunism sees no other way, has no alternative, but separates itself by its own vision, its ability to see the future of its own survival in this turmoil against those who cannot imagine surviving in this turmoil (even if they must all the time) and are thus said by policy to lack vision, and in the most extreme cases to be without interests, on the one hand, and in capable of disinterestedness, on the other.[4] Every utterance of policy, no matter its intention or content, is first and foremost a demonstration of one’s ability to be close to the top in the hierarchy of the post-fordist economy. (Thus every utterance of policy on the radical Left is immediately contradiction.)

As an operation from above designed to make the multitude productive for capital, policy must first deal with the fact that the multitude is already productive for itself. **This productive imagination is its genius, it’s impossible, and nevertheless material, collective head**. And this is a problem because plans are afoot, black operations are in effect, and in the undercommons, all the organizing is done. The multitude uses every quiet moment, every peace, every security, every front porch and sundown to plan, to launch, to improvise an operation. It is difficult for policy to deny these plans directly, to ignore these operations, to pretend that those already in motion need to stop and get a vision, to contend that base communities for escape need to believe in escape. And if this is difficult for policy then so too is the next and crucial step, teaching the value of radical contingency, teaching how to participate in change from above. Of course, some plans can be dismissed – plans hatched darker than blue, on the criminal side, out of love. But most will instead require another approach.

So what is left for those who want to dwell in policy? Obviously the most salient and consistent aspect of policy – help and correction. Policy will help. Policy will help with the plan, and even more policy will correct the planners. Policy will discover what is not yet theorized, what is not yet fully contingent, and most importantly what is not yet legible. Policy is correction. Policy distinguishes itself from planning by distinguishing those who dwell in policy and fix things, from those who dwell in planning and must be fixed. This is the first rule of policy. It fixes others. In an extension of Foucault we might say of this first rule that it remains concerned with how to be governed just right, how to fix others in a position of equilibrium, even if this today requires constant recalibration. But the objects of this constant adjustment provoke this attention because they just don’t want to govern at all.

And because such policy emerges materially from post-fordist opportunism, policy must optimally for each policy-maker fix others as others, as those who have not just made an error in planning (or indeed an error by planning) but who are themselves in error. And from the perspective of policy, of this post-fordist opportunism, there is indeed something wrong with the multitude. They are out of joint – instead of constantly positing their position in contingency, they seek solidity, a place from which to plan, some ground on which to imagine, some love on which to count. Nor is this just a political problem from the point of view of policy, but an ontological one. **Seeking fixity, finding a steady place from which to launch a plan, hatch an escape signals a problem of essentialism**, of beings who think and act like they are something in particular, like they are somebody, although at the same time that something is, from the perspective of policy, whatever you say I am.

To get these planners out of this problem of essentialism, this fixity and repose, this security and base, they have to come to imagine they can be more, they can do more, they can change, they can be changed. Because right now, there is something wrong with them. We know there is something wrong with them because they keep making plans. And plans fail. Plans fail because that is policy. Plans must fail because planners must fail. **Planners are static, essential, just surviving**. **They do not see clearly**. **They hear things.** **They lack perspective. They fail to see the complexity**. Planners have no vision, no real hope for the future, just a plan here and now, an actually existing plan.

They need hope. They need vision. They need to have their sights lifted above the furtive plans and night launches of their despairing lives. Vision. Because from the perspective of policy it is too dark in there to see, in the black heart of the multitude. You can hear something, you can feel something, feel people going about their own business in there, feel them present at their own making. But hope can lift them above ground into the light, out of the shadows, away from these dark senses.

Whether the hope is Fanonian redemption or Arendtian revaluation, policy will fix these humans. Whether they lack consciousness or politics, utopianism or common sense, hope has arrived. With new vision, planners will become participants. And participants will be taught to reject essence for contingency, as if planning and improvisation, flexibility and fixity, and complexity and simplicity were opposed within an imposed composition there is no choice but to inhabit, as some exilic home. All that could not be seen in the dark heart of the multitude will be supposed absent as policy checks its own imagination. But most of all they will participate. Policy is a mass effort. Left intellectuals will write articles in the newspapers. Philosophers will hold conferences on new utopias. Bloggers will debate. Politicians will surf. Change is the only constant here, the only constant of policy. Participating in change is the second rule of policy.

Now hope is an orientation toward this participation in change, this participation as change. This is the hope policy gives to the multitude, a chance to stop digging, and start circulating. Policy not only offers this hope, but enacts it. Those who dwell in policy do so not just by invoking contingency but riding it, by in a sense, proving it.

Those who dwell in policy are prepared. They are legible to change, liable to change, lendable to change. Policy is not so much a position as a disposition, a disposition toward display. This is why policy’s chief manifestation is governance.

Governance should not be confused with government or governmentality. Governance is the new form of expropriation. It is the provocation of a certain kind of display, a display of interests as disinterestedness, a display of convertibility, a display of legibility. Governance offers a forum for policy, for bidding oneself, auctioning oneself, to post-fordist production. Governance is harvesting of immaterial labour but a willing harvest, a death drive of labour. As capital cannot know directly affect, thought, sociality, imagination, it must instead prospect for these in order to extract and abstract them as labour. This is the real bio-prospecting. Governance, the voluntary but dissociative offering up of interests, willing participation in the general privacy and privation, grants capital this knowledge, this wealth-making capacity. Who is more keen on governance than the dweller in policy? On the new governance of universities, hospitals, corporations, governments and prisoners, on the governance of NGO’s, of Africa, of peace processes? Policy offers to help by offering its own interests, and if it really seeks to be valuable, provoking others to offer up their own interests too.

But governance despite its own hopes to universality, is for the initiated, for those who know how to articulate interests disinterestedly, who know why they vote (not because someone is black or female but because he or she is smart), who have opinions and want to be taken seriously by serious people. In the mean time, policy also orders the quotidian sphere of aborted plans. Policy posits curriculum against study, child development against play, careers against jobs. It posits voice against voices, and gregariousness against friendship. Policy posits the public sphere, and the counter-public sphere, and the black public sphere against the illegal occupation of the illegitimately privatized.

Policy is not the one against the many, the cynical against the romantic, or the pragmatic against the principled. It is simply baseless vision. It is against all conservation, all rest, all gathering, cooking, drinking and smoking if they lead to marronage. Policy’s vision is to break it up, move along, get ambition and give to your children. Policy’s hope is that there will be more policy, more participation, more change. However, there is also a danger in all this participation, a danger of crisis.

When the multitude participates in policy without first being fixed, this leads to crisis. Participation without fully entering the enlightenment, without fully functioning families, without financial responsibility, without respect for the rule of law, without distance and irony, participation that is too loud, too fat, too loving, too full, too flowing, too dread. This leads to crisis. People are in crisis. Economies are in crisis. We are facing an unprecedented crisis, a crisis of participation, a crisis of faith. Is there any hope? Yes, there is, if we can pull together, if we can share a vision of change. For policy, any crisis in the productivity of radical contingency is a crisis in participation, which is to say, a crisis provoked by the wrong participation of the multitude. This is the third rule of policy.

The crisis of the credit crunch cause by sub-prime debtors, the crisis of race in the U.S. elections produced by Reverend Wright and Bernie Mac, the crisis in the Middle East produced by Hamas, the crisis of obesity produced by unhealthy eaters, the crisis of the environment produced by Chinese and Indians, are all instances of uncorrected, unmanaged participation. If the multitude is to stop its sneaky plans only to participate in this way, crisis is inevitable. But policy diagnoses the problem: participation must be hopeful, it must have vision, it must embrace change. Participants must be fashioned who are hopeful, visionary, change agents. Those who dwell in policy will lead the way, toward concrete changes in the face of the crisis.

Be smart. Believe in change. This is what we have been waiting for. It’s time for the Left to offer solutions. Now’s the time, before its night again, and you start hearing D.O.C. They got a secret plan of their own and they won’t be corrected. Before you get stopped by KRS One and asked for your plan, before Storm says ‘holla if you understand my plan ladies.’ Before you start singing another half-illiterate fantasy. Before you are in the ongoing amplification at the dark heart of the multitude, the operations in its soft centre. Before someone says let’s get together and get some land, where we’ll still plan to be communist about communism, still plan to be unreconstructed about reconstruction and still plan to be absolute about abolition. Policy can’t see it, policy can’t read it, but it’s intelligible if you got a plan.

#### Life is constantly fighting against the force of entropy---the channeling of parts into wholes involves cooperation to overcome competition. Life and vibrancy will not be sustained with inflexible attitudes that straightjacket us into spiraling cycles of failed control—we should instead embrace the flexibility afforded to us through sustainable ways of thinking about flows of energy in our human-influenced ecosystem --- we will defend reliance upon the earth’s current solar input

**Guattari, 89** (Felix, *The Three Ecologies*, p. 43-45)

There is a principle specific to environmental ecology: it states that anything is possible - **the worst disasters or the most flexible evolutions** [ev olutionse n souplessel. Natural Equilibriums will be increasingly reliant upon human intervention, and a time will come when vast programmes will need to be set up in order to regulate the relationship between oxygen, ozone and carbon dioxide in the Earth's atmosphere. We might just as well rename environmental ecology machinic ecology, because Cosmic and human praxis has only ever been a question of machines, even, dare I say it, of war machines.8o From time immemorial 'nature' has been at war with life! The pursuit of mastery over the mechanosphere will have to begin immediately if the acceleration of techno-scientific progress and the pressure of huge population increases are to be dealt with. In the future much more than the simple defence of nature will be required; we will have to launch an initiative if we are to repair the Amazonian 'lung', for example, or bring vegetation back to the Sahara. The creation of new living species – animal and vegetable - looms inevitably on the horizon, and the adoption of an ecosophical ethics adapted to this terrifying and fascinating situation is equally as urgent as the invention of a politics focused on the destiny of humanity. As new stories of the permanent recreation of the world replace the narrative of biblical genesis, we can do no better than cite Walter Benjamin, condemning the reductionism that accompanies the primacy of information: When information supplants the old form, storytelling, and when it itself gives way to sensation, this double process reflects an imaginary degradation of experience. Each of these forms is in its own way an offshoot of storytelling. Storytelling . . does not aim to convey the pure essence of a thing, like information or a report. It sinks the thing into the life of the storyteller, in order to bring it out of him again. Thus traces of the storyteller cling to the story the way the handprints of the potter cling to the clay vessel.sr To bring into being other worlds beyond those of purely abstract information, to engender Universes of reference and existential Territories where singularity and finitude are taken into consideration by the multivalent logic of mental ecologies and by the group Eros principle of social ecology; to dare to confront the vertiginous Cosmos so as to make it inhabitable; these are the tangled paths of the tri-ecological vision. A new ecosophy, at once applied and theoretical, ethico-political and aesthetic, would have to move away from the old forms of political, religious and associative commitment Rather than being a discipline of refolding on interiority, or a simple renewal of earlier forms of 'militancy', it will be a multifaceted movement, deploying agencies [instances] and dispositives that will simultaneously analyse and produce subjectivity. A collective and individual subjectivity that completely exceeds the limits of individualization, stagnation, identificatory closure, and will instead open itself up on all sides to the socius, but also to the machinic Phylum, to techno-scientific Universes of reference, to aesthetic worlds, as well as to a new 'pre-personal' understanding of time, of the body, of sexuality. A subjectivity of resingularization that can meet head-on the encounter with the finitude of desire, pain and death. However, rumour would have it that none of this is self-evident! All sorts of neuroleptic cloaks [chapes] enshroud this subjectivity, concealing it from any intrusive singularity.82 Do we have to invoke History yet again? There is at least a risk that there will be no more human history unless humanity undertakes a radical reconsideration of itself. We must ward off, by every means possible, the entropic rise of a dominant subjectivity. Rather than remaining subject, in perpetuity, to the seductive efficiency of economic competition, we must reappropriate Universes of value, so that processes of singularization can rediscover their consistency. We need new social and aesthetic practices, new practices of the Self in relation to the other, to the foreign, the strange – a whole programme that seems far removed from current concerns. And yet, ultimately, we will only escape from the major crises of our era through the articulation of:

-a nascent subjectivity

-a constantly mutating socius

-an environment in the process of being reinvented,

In conclusion, it should be understood that the three ecologies originate from a common ethico-aesthetic discipline, and are also distinct from the point of view of the practices that characterize them. Their different styles are produced by what I call heterogenesisi,n other words, processes of continuous resingularization. **Individuals must become both more united and increasingly different**. The same is true for the resingularization of schools, town councils, urban planning, etc. By means of these transversal tools [c1e;6], subjectivity is able to install itself simultaneously in the realms of the environment, in the major social and institutional assemblages, and asymmetrically in the landscapes and fantasies of the most intimate spheres of the individual. The reconquest of a degree of creative autonomy in one particular domain encourages conquests in other domains - the catalyst for a gradual reforging and renewal of humanity's confidence in itself starting at the most miniscule level. Hence this essay, which sets out, in its own way, to counter the pervasive atmosphere of dullness and passivity.s3

#### Any analysis that confines itself to a particular means of parsing out knowledge is inadequate to act in the world. Synthesizing a meta-model out of the insights from policy, philosophy, and ecology gives ontological grounding to a new vision of the world.

Tinnell, 11 – Department of English, University of Florida (John, The Fibreculture Journal, issue 18 2011, *FCJ-121 Transversalising the Ecological Turn: Four Components of Felix Guattari’s Ecosophical Perspective*, http://eighteen.fibreculturejournal.org/2011/10/09/fcj-121-transversalising-the-ecological-turn-four-components-of-felix-guattari%E2%80%99s-ecosophical-perspective/)

Transversality, as can be surmised Watson’s insightful work on Guattari, moves hand in glove with the activity of metamodeling. Models such as the Oedipal triangle purport a representational, standardised map of the psyche designed for the clinical evaluation and diagnosis of individual patients. [5]Metamodels, on the other hand, adopt a more playful and constructivist stance towards modeling; here the ultimate aim is singularity rather than standardisation, and this entails appropriation from a multitude of models in order to avoid being “stuck” within the entropy of a dominant model (Watson, 2008). As Guattari writes of schizoanalysis, transversal thinking ‘does not choose one modelisation to the exclusion of another’; rather, transversality is about creating lines of flight among various models, ‘making them…operative within modified assemblages, more open, more processual, more deterritorialised’ (Guattari, 1995: 61). As such, transversality is a radically ecological concept in that it pushes us to constantly (re)articulate things at the relational level of their interactions. With Guattari, then, we are not enlarging the selfhood model—we are developing the metamodels and practices of emergent subjectivities. Inspired by Guattari instead of Naess, we would become less interested in the representational paradigms of nineteenth century realism (which are often celebrated by leading ecocritics) and more interested in modernist and contemporary aesthetics of collage and montage; rhetorical acts of aesthetic invention would become as important, if not more important, than pseudoscientific methods of literary hermeneutics. 6 Though Naess coined the term “ecosophy”, he does not think through the semiotic implications of the word as fully as Guattari does. Ecosophy is not the same thing as eco-philosophy; it is not simply the redirection of the philosophical tradition towards ecological concerns. To think ecosophically is to rethink philosophy in our contemporary moment defined by the convergence of nature and culture, ecological crises, globalisation, and the Internet. Born of his transversal conception of subjectivity, Guattari’s ecosophical perspective suggests for (eco)humanities scholars a unique constellation of concepts adequate to these emergent situations; it offers an alternative to the standard “normal science” approach by which critics apply old ideas to the same type of texts, only now in the spirit of environmentalism. By analogy, then, the proper aim of ecosophy (and a properly transversal eco-humanities) is not to produce a more energy-efficient light bulb or a hybrid car, but to reconfigure subjectivity and to remake academic and/or social practices altogether. While scientist and social scientists rightfully pursue advancements in green technology and debate environmental policy issues, humanities scholars should aim to further our understanding of ecological problems in ways that are unavailable to the technocratic perspective. Guattari’s ecosophy suggests that humanities scholars should concern themselves first with ontological advancements. Thus, in addition to green buildings, hybrid vehicles, environmental legislation, etc., we need to rethink traditional notions of selfhood and, at the same time, invent practices designed to facilitate an ontology consummate to contemporary ecological concerns, as well as the emergent relational modes proliferating with the expansion of global capitalism and digital media. Of profound importance to these latter issues is Guattari’s notion of the “post-media era”—his ecosophical vision of the potentialities afforded by emergent media technologies—which I expound upon later in this essay. 7 While much work in ecocriticism tends to avoid poststructuralist theory in favor of deep ecology, leading Guattari scholars have begun to survey the ecological implications of the philosopher’s notoriously complicated writings. Readers new to Guattari should be cognisant of three basic ways in which the tenets of his ecosophy conflicts with more popular appropriations of ecology. First, affirming his belief in the inseparability of nature and culture, Guattari contents throughout his later writings that what we call the ecological crisis is not simply an environmental disaster, and that ecology is not limited to the natural environment. For Guattari, ‘The ecological crisis can be traced to a more general crisis of the social, political and existential’, which ‘involve[s] changes in production, ways of living and axes of value’ (Guattari, 1995: 119/134). Furthermore, Guattari differs from the early leaders of ecocriticism who tended to work from the popular belief that ecological thought is simply an idealistic, utopian project committed to preserving Nature’s pure, harmonious, and delicate balance. In Guattari’s radical ecology, the ecological point of view beholds the world as a dance between chaos and complexity—a multitude of productive syntheses between nomadic parts that exist independent of any fixed structure or transcendental whole. There is no larger “natural” order, no transcendent grand scheme according to which beings manifest. The ecology of ecosophy is neither that of popular environmentalism nor environmental science. Whereas environmentalism (like Naess) attempts to strengthen the bond between humans and the natural environment, which are articulated as two discrete and relatively stable categories, Guattari’s ecosophy rethinks this relationship in terms of dynamic assemblages of enunciation without assigning humans, nature, or culture a fixed role or place in the production of subjectivity. In this way, we might think of ecosophy as performing a metamodeling with respect to environmental models such as the ecosystem. While the model of the ecosystem was first drawn by environmental scientists, a generalised ecology extends relational modes of thinking implied by this model across disciplinary boundaries with hopes **to** enrich the study of any number of paradigmatic problems—most notably the production of subjectivity in Guattari’s case. 8 Moreover, in metamodeling environmental ecosystems, by bringing them into contact with mental and social ecologies, one can rethink the ethos of management and regulation that has pervaded the largely scientific discourse of environmental ecology. Indeed, the challenge of Guattari’s ecosophy is not to regulate the forces of the world into some idealised, harmonious balance, but rather to engender institutional and ontological conditions that encourage people to encounter the world as a series of open and ongoing syntheses between partial objects (as opposed to regarding phenomena as objects-in-themselves, complete and isolatable). This challenge informs and is informed by passages in The Three Ecologies and Chaosmosis where Guattari discusses nascent subjectivity and machines (see below). Guattari’s view of ecology is especially unique in that he claims to be working from an “ethico-aesthetic paradigm” rather than from scientific or pseudo-scientific paradigms. For Guattari, ethico-aesthetic paradigms do not necessarily deal with art as we traditionally conceive it, but seek to incorporate an aesthetic order—an artist’s ‘way of assuming their existence’—into the existential territories of everyday life, within and beyond the studio or the museum. [6] He insists that the decision to engage subjectivity on a scientific basis or an aesthetic basis carries important ethical implications; Guattari of course asserts that attempts to “scientifise” subjectivity lead to its reification, while ethico-aesthetic approaches mobilise subjectivity ‘in its dimension of processual creativity’ (Guattari, 1996: 198). To be clear, Guattari’s turn towards ethico-aesthetic paradigms does not constitute a rejection of science so much as a pointed critique of the ‘use of reductive models and general laws, at the expense of singularity and complexity’ (Watson, 2009: 97). Ultimately, I will suggest that it is this autopoetic node of Guattari’s ecosophy that most powerfully distinguishes his approach to ecology. 9 Though recent scholarship on Guattari is quick to mention his notion of ecosophy, only a few of these books and essays contain elaborations of Guattari’s ecosophy that are specific to the larger ensemble of concepts quintessential to his philosophical outlook. Genosko and Watson stand out of course as two scholars who have taken immense steps towards recognising the (potential) impact of Guattari’s contributions on the contemporary study of ecology, subjectivity, and media. More typically, however, humanities scholars commenting on Guattari’s engagement with ecology rarely venture beyond his most explicitly ecological book, The Three Ecologies, and are therefore likely to miss the transversal connections among the otherwise disparate domains of ecology, subjectivity, and media that he developed throughout his later writings. While it is accurate in some sense to summarise Guattari’s ecosophy by mentioning his three interrelated ecologies (i.e., mental, social, and environmental), such summaries do not convey the full potential of Guattari’s ecosophical perspective, which he seemed to regard as the crowning accomplishment of his philosophical career. To appreciate the theoretical weight of The Three Ecologies, one must explore the ways in which this short book intersects with Guattari’s larger body of work. In what follows, I offer an exploration of ecosophy in the context of The Three Ecologies and Guattari’s other writings such as Chaosmosis and selected essays from The Guattari Reader, as well as the collaborative works Anti-Oedipus and What is Philosophy?. Indeed, Guattari’s ecosophy is a concept that, like all concepts, configures the ‘constellation of an event yet to come’ and ‘renders components inseparable within itself’ (Deleuze and Guattari, 1994: 19/33). But given its (unfinished) state at the time of Guattari’s sudden death, ecosophy remains a concept whose components need to be rendered further. The four sections below strive to construct a “zone of neighborhood” or “threshold of indiscernability” wherein these four components (i.e., nascent subjectivity, machines, post-media, and autopoiesis) become seen as the vital constituents of ecosophy’s conceptual consistency. Only then can we mobilise ecosophy towards the invention of the event yet to come, the people yet to come, or at least, the eco-humanities yet to come.

#### Solar power need not eat up finite resources --- technology can dialogue with nature

**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.

#### Sustainable lifestyles require sustainable technologies – biomimetic solar power prioritizes coexistence with nature over separation and rigidity.

**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 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).

## 2ac

### clean coal da

**Multiple tech and cost barriers bar the effective deployment of clean coal**

**Brown 12** – Associate Professor of Environmental Ethics, Science and Law at Penn State University (Donald, "The Ethics of 'Clean Coal' Propaganda" Think Progress, <http://thinkprogress.org/climate/2012/06/03/494130/the-ethics-of-clean-coal-propaganda/?mobile=nc>)

**Defenders of** the **clean coal** campaign **will** sometimes **argue that the clean coal campaign is simply an exercise of the coal industry’s right to free speech.** Although free speech is to be strongly protected, **speech which tells untruths about very harmful behavior is morally odious.** This is the moral basis for the understanding that people are not free to yell fire in a crowded theater. In fact, the clean coal campaign is more like someone in a theater shouting that there is no fire who has no factual basis for claiming that no fire exists when smoke first appears in the theater.

And so, **the clean coal campaigns cannot be understood as a responsible exercise of free speech but as deeply deceptive disinformation**. It is deceptive for two reasons as we have seen.

First, **the implied claim that coal combustion is environmentally clean is not true. It is also not true that new technologies** capable of sequestering CO2 from coal fired power plants **will likely be in widespread operation in the near future** according to a recent article in the New York Times that explained that **coal combustion that relies upon carbon sequestration may not be economically viable given competition from other fuel sources and additional costs of geologic carbon sequestration** (Wald, 2012) .

Second, the failure to disclose who the real parties in interest are behind front groups, AstroTurf campaigns, and those who show up at public events claiming that coal is clean are tactics meant to deceive.

Given what is at stake with climate change, these are deceptions about potentially very, very harmful human activities.

There would be no problem with coal industry calls for public support for research that could make coal combustion environmentally acceptable, yet even **such campaigns should reveal that there are open questions about whether these technologies if developed can economically compete with other fuel options.**

From the standpoint of climate change, new technologies that would allow coal combustion without greenhouse gas emissions would be an important positive step to achieve urgently needed greenhouse gas emissions reductions. However, as we have seen, **there are very open questions about whether these technologies will be technically and economically feasible at commercial scale.** There are no doubt places in the world that geologic carbon sequestration that traps heat-trapping gases will work, yet **there are serious questions about whether these technologies are technically feasible** **in many places of the world that do not have the right geology** needed to seal in the CO2 and prevent if from escaping into the atmosphere nor the large spaces needed to bury the huge volumes of CO2 that are created in coal combustion. However, **probably a bigger barrier to widespread deployment of this technology is whether these technologies can be deployed at acceptable cost.**

**Clean coal isn’t clean – still emits two million tons of c02 annually**

**Conniff 8** – 2007 Guggenheim Fellow, is at work on a book about the discovery of species. He is a National Magazine Award-winning writer, and his articles have appeared in Time, Smithsonian, The Atlantic, The New York Times Magazine, National Geographic, and other publications (Richard, "The Myth of Clean Coal" Yale Environment 360, <http://e360.yale.edu/feature/the_myth_of_clean_coal/2014/>)

And the commitment to clean? The scale of the problem suggests that it needs to be big. **Coal-fired power plants** generate about 50 percent of the electricity in the United States. **In 2006**, they also **produced 2 billion metric tons of carbon dioxide** — 36 percent of total U.S. emissions. For a remedy, the industry was banking on a proposed pilot plant called FutureGen, which would have used coal gasification technology to separate out the carbon dioxide, allowing it to be pumped into underground storage. But in January, the federal government canceled that project because of runaway costs. At last count, FutureGen was budgeted at $1.8 billion — with about $400 million of that coming from corporate partners over ten years. That is, the “commitment to clean” would have cost roughly as much per year as the industry is now spending on lobbying and “Clean Coal” advertising.

The business logic of this spending pattern is clear: **Promoting the illusion that coal is clean**, or maybe could be, **helps to justify building new coal-fired power plants now.** The tactic is at times transparent: In Michigan recently, a utility didn’t promise that a proposed $2 billion plant would have carbon-control technology — merely that it would set aside acreage for such technology. **The proponents of a new power plant** in Maine **talked about capturing and storing** 25 percent of the carbon dioxide emissions, **but didn’t say how, and even if they figure that out, the plant would still produce two million tons of CO2 annually.**