On Becoming a Nomad Scientist

by

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ABSTRACT

ON BECOMING A NOMAD SCIENTIST

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The problem: the intensification of a tendency within science—what Gilles Deleuze and Félix Guattari in *A Thousand Plateaus* call “state science”—which has led to routinization, industrialization, theoretical stagnation, a lack of political response, and a massive amount of chemical and informational waste. State science functions top-down, imposing abstract theorems and controlling the material world in order to reproduce its ideals. The solution: learning to perceive another tendency, “nomad science.” This kind of science works from matter up; by paying generous attention to the expressive difference of matter, nomad science is imaginative and creative. Examples of nomad sciences include: the quadrature, Gothic architecture, Indigenous wisdoms, acupuncture, and metallurgy. I consider these problems under the conceptual lens of Deleuze and Guattari (dissecting the twelfth chapter of *A Thousand Plateaus*), along with a discussion on chemistry research and science education.

Dedication

Secretly, I dedicate this thesis first to Joseph, who held me afloat as we waded through an ocean of electron orbitals, brilliant-blue azulene, electromagnetic equations, crystals of cockroach pheromones, and the aberration of light, scribbled on a napkin.

And to Brixton, who, after I had ranted about the nature of science for the nth time, suggested that I write it all down. Here’s a scrap of it.

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Introduction

In the first years of school he goes out into the gravel fields when it is pouring rain. There he moulds the gravel to form rivulets and dams, building up stone to build up water. He likes to follow the choices that the water makes, and he likes to respond, scooping up ground to alter the path of a small stream; it feels like a conversation. In the forest, he chases after his older brothers, who always leave him behind. Finding himself alone with the trees and the squirrels, he talks to them. The rodents rustle away, but the trees listen impassively, branches stroking mossy beards. And when they spend a day on the beach, it is the same: his brothers have swum to the floating dock, and when he tries to follow, the seaweed reaches out and grasps his legs, calling to him—he flails desperately and chokes on salty water. He collapses back on the sand, panting and apologizing to the ocean for intruding in its body. When he opens his eyes he is astonished to meet a crab. The crab looks at him; it hesitates as though it too were astonished, and then it scatters.

At home he learns to attach Lego blocks together according to an instruction manual. His parents think this makes him intelligent, think this makes him creative, having never seen him out in the rain with the rocks and the flows. And at home he watches cartoons where the characters shrink to the size of a cell and enter someone's blood stream. It tells him that inside him is more of the same. They call this knowledge.

Later on he learns the same perception of himself and of the world when he reads Jules Verne's *Journey to the Centre of the Earth*. It plays on an emotion and it cheats him of what he values most: the professor has an expansive knowledge and he pays attention to the smallest details, but his journey within things, within the Earth, becomes one of making this hiddenness just another open field analogous to the world of his bedroom. He starts to confuse mystery with a destination. The most exciting moments are when the professor and his assistant are *on their way* to discovery; and somehow when they arrive at the centre, with all of its supposed wonders, its dinosaurs and geological formations, he realizes this is just a variant of what never needed discovering in the first place. He senses that Verne failed to express true discovery and he wonders why this book is famous.

And then the eight long years of indoctrination begin, from highschool to university. He is preached theory by the highschool-science-priests, who are only able to regurgitate textbook revisionist history and polished theories. There is a kind of institutional insanity that he is pulled into. They never go out into the rain or the snow; they never look at piles of dirt, or watch animals survive; the feeling is that whatever is out there is irrelevant. Their field trips are always to museums, never to the river valley—because that would be too uncontrolled. The teachers only perform demonstrations. And for his "experiments," he is told to follow the instructions perfectly. He is applauded for doing this; and because he is good at it he becomes convinced that it is worth doing. This is why he goes into chemistry; he is good at repeating complex procedures. At some point there was an imperceptible change, and now he is set on a path completely different from his childish passions. He is becoming useful and without wonder.

In biology class he learns that we are made of cells. He learned this a long time ago, but now he is in a position to be unimpressed by the fact; this means that he understands it. He learns to juggle all the parts of the cell and he comes to believe in a little world of folded membranes, like the blankets in the closet, rolling and folding and merging according to literal mechanisms. Never once does he look at his own skin; he is not even shown cells through a microscope. This secures the diagrams and definitions in his mind as the same thing as the biological world. So he learns to hop from one scientific theory to the next; he is made anxious about the spaces in between the theories; he is urged to jump quickly. Year after year he learns that what he learned previously is not quite correct, and he learns that scientific knowledge is just about adjusting the minutiae of a formula. He is already fully convinced of the ideology of scientific realism. Indeed, these become the most obvious things in the world: that science is just about filling in cracks of knowledge, and that there is a correspondence between diagram, word, or concept, and things out there in the material world. Throughout all of this, the material world lay just outside of the classroom like a forgotten dog tied to a post, waiting for its companion. He has been pulled away from wonder in materiality; his passions have been converted into cerebral acrobatics.

University reintroduces the original contradiction to him, between pristine theory and alien matter. The classes intensify the indoctrination, leading to more complex theories and demonstrations, never deviating from a realism-anxiety and a forgetting of matter. But in the summers he works in a laboratory, studying a bacteriophage, its bactericidal properties and genetic material. He learns many specific skills like growing bacteria in agar, and counting the alien plaques, or making electrophoretic gels and illuminating different clumps of DNA. Finally, he has returned to matter. But he is not prepared for this. His first wonder in the rain has been pounded out of him and he no longer has the contentment that would allow him to enjoy a dialogue between his mind and the life of matter in this setting. He performs his first true experiments, and because they fail to be demonstrations and reproductions, he is frustrated and does not understand; this is not the world that he has come to learn; he is petulant.

The original passion must be still somewhere deep inside him because he goes to graduate school, hoping to recover whatever it is that he lost. He has finally made it to the world of societally legitimated science, and he discovers to his horror what it has become. He is able to notice it because he still harbours that basic scientific spirit, which first set Verne's professor on his path to discovery, and which gave him contentment in endlessly dialoging with rivulets and pools. But he is split between this original passion and the indoctrination, and he can see that it is this split that gives him such dissatisfaction; if he were to fully return to his childhood source of the scientific spirit, he would have to leave academia, he would never be able to work in what has become a PhD factory; but if he were to completely embrace his position as a tool in the greater machinations of modern science, he could become completely satisfied with performing one experiment after another in the ridiculously specialized field of drug discovery for a small protein missing in certain types of cancers.

He learns that graduate students and professors do not really research because they believe that they can make a difference, or because they are interested in materiality, but so that they can produce journal articles. He does not understand, until his supervisor yells at him and he is made to feel needlessly insecure about his job. When he applies for grant-money he learns that there exists a bureaucracy at the very top, made of people who know little of science but its capitalistic application, who decide arbitrarily what kind of granting competitions will be funded or invested in (based on vague notions of "impact"), as well as what is a better or worse proposal based on incomplete information. He can see that science has become a game of survival, the scientist choosing short-term, low-risk projects that will enable them to produce articles that no one will read, but will give them funding and intellectual capital. And he sees that scientists play the game so well that they convince themselves that their projects are important; or at least, having to face their own insignificance would either drive them insane or out of academia. Sometimes the articles are read and cited, but he knows how much of this is a hoax, a citing for citing's sake, and how many articles are only cited because they in turn cite a well-known fact, propagating empty information and building up biases of significance; this comes out as soon as he follows the citations down a long, dull electronic hole. He learns that in the world every year almost two million articles are produced in the sciences; this makes him nauseous. Millions of scientists, just like him, working in laboratories, their PhD factories—and all for what? An ocean of information. It is the conversion of ready-made materials into nearly useless mounds of data. It's a monster, a bleak desert landscape.

The chemical waste he produces also makes him nauseous. Every synthetic reaction, every chromatography column, every NMR tube—methanol, dichloromethane, deuterated dimethyl sulfoxide, acetonitrile—the hazardous waste is unending, and all he can do is dump it into the red or blue waste bins, unable to comprehend how so much waste has not already destroyed the world. And when he learns that the chemical waste is burned, his lungs start itching.

In the middle of his thesis he is awarded for a presentation on his research. After having too much wine, he walks across the campus, laughing scornfully at his mediocre talent elevated to false levels of success simply because it conformed to a kind of productivity. Knowing something is terribly wrong, but unable to fully perceive and articulate it, he sneaks into a music room to play the third movement of Beethoven's fourteenth piano sonata. Even in this realm of academia the music rooms are like little laboratories.

At the end of his thesis, after thousands of litres of chemical waste, after too many hours working little powders, crystals, and sludges, after reading journal articles which are so poorly written and so nearly useless that he wants to scream—after so much fuss over his education, his funding, and his research, he is left with some numbers. This is the culmination of his scientific life: two bar graphs. Over the following years, only one person looks at them. They probably did not have time to read his thesis, and instead skipped to the graphs, looked at them for ten seconds, and then moved on to something else.

And even though the system has spent so much time preparing him for scientific research, it leaves him with very few options. It is clear that the purpose of the PhD factory is to produce cheap information-producing labour, and that very few of them now can become professors, let alone pursue meaningful realms of materiality. Too many PhD graduates become postdocs for years and years, until dropping out, the system having milked them dry. Overqualified, they have no where to go next.

He graduates disdainfully. Slowly, he learns how to articulate what is wrong with the current scientific system and its education, why for him science had such a lure and why it became so dissatisfying. It has nothing to do with "science itself," whatever that means. It is because the Earth itself is becoming a factory. Not a factory for the improvement of human life; not a factory for the wellbeing and coexistence of humans and lands and animals; a factory for its own sake, churning out information and waste, money and labourers, who pass from one institution to the next, breaking their backs on a machine which they are told is progress, and which they call "knowledge." Surveying the past century, he sees a pernicious transformation. What has become of science? What was once at least partly a healthy, truth-seeking enterprise, for the sake of humanity and the wider world, has become a cancerous institution, an insane crossroads of millions of tons of chemical and biological waste,[1] millions of hours of cheap academic labor, in exchange for a gratuitously overwhelming ocean of information and tiny islands of applications, of which only an iota are useful, let alone for the direct betterment of the world. We are learning that this is what happens when capitalism tightens its grip in a free market: it is not freedom of business and truth, it is monopolization and the forgetting of truth; it is not usefulness or a responsiveness to our needs; it is whatever we can do for money's sake. The whole situation is so stupid that we can take a lesson from a children's book (though children's books are often wiser than most "lovers of wisdom"): something in us—though not everything in us—is exactly like the "Pollutians" from Bill Peet's *Wump World*, who come crashing down in their ugly spaceships onto the soft, plant-eater's planet and make it into an immense polluted city. When it becomes too unbearable, choking in their own smog, the Pollutians leave for another open space, another planet in the stars. The grass-grazing Wumps wearily step out of the caves they were forced into, and they search painfully for any patch of grass or clean stream in the legacy of the Pollutians.

The problem is more than the capitalistic structure which produces endless waste; and it is more than an institution which has not fulfilled the promise it made to its apprentices. The problem is also linked to a deep scientific ideology, naive scientific realism,[2] which dogmatically takes its information and theories as elaborations of the Real. When a culture creates a simple

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[1] For one example, see Statistics Canada, *Waste Disposal by Source, Province, and Territory.*

[2] Whenever I refer to scientific realism, I do not mean any kind of mature scientific realism, a realism that understands the weirdness and complex relation between theory and thing. Rather, as an ideology, "naive" is always implied. In my experience, this ideology is the dominant scientific worldview, even for graduate students and professors. The exceptions are most often children and old, philosophical scientists ("wizards" or "alchemists").

correspondence between its scientific theory and the Real, two things happen: the Real becomes unproblematic and static, as that which our theory corresponds to, rather than as it is, essentially problematic and dynamic; and the theories of science, in becoming the representations of the correspondence, retreat from the problematic Real, and slip from issues to facts or feeble suggestions. So amazingly, an ideology of scientific realism takes up the theories of science in order to promulgate a conception of the world as in some sense "solved" (or better yet, always on the way to being solved, as in "normal science"), and in doing so, it justifies a scientific and political status quo. This pushes scientists further back into a platonic cave of laboratories and data; and when they discover theories and facts, such as the facts and predictions of rising sea levels and temperatures, they have somehow lost a power to politically motivate, as if the uneducated could somehow decide for the scientists. The tightening of a capitalistic system on science leads to a naive scientific realist ideology, and this is in turn separates the scientific act from the dynamics and problems of the world. It is this, this modern, realist quality of science, that helps explain our political passivity with respect to climate change: it is because we have separated politics and science by an ideology that proclaims scientific theory to be simply a correspondence with the world, a world that is on its way to being solved. When science becomes only a "solution" and correspondence to a static reality, it becomes powerless against problems and dynamics: it lacks an effective and meaningful way to deal with current issues.

Since we are all participants to more or less degrees in this scientific apparatus, the mythical Pollutians are within all of us; they are an imbalance, an intensification of a very specific kind of tendency. It is perhaps this tendency that expresses itself as an ease of indoctrination into scientific realism and a capitalistic normal science. In *A Thousand Plateaus*, Gilles Deleuze and Felix Guattari call it "state science" (422). It is very possible that this tendency is the cause of such a broken system. For there was another tendency like what first turned him as a child towards materiality, which Deleuze and Guattari (D&G) call "nomad science" (420). If we can, as a society, learn to perceive these two different tendencies, maybe we will be able to balance them, and maybe this will begin to help fix the system, so that we can overcome our inner and outer pollutians, engage with matter as a dialogue, and pursue scientific truths for their own, useful and wonder-filled sake.

If the problem is state science and the solution is how we can become nomad scientists, then these concepts require focus and elaboration. The task will be to describe the central scientific concepts from Deleuze and Guattari's twelfth chapter in *A Thousand Plateaus*, "1227: Treatise on Nomadology—The War Machine." This exegesis is the subject of the first two chapters, the majority of the thesis; in order to have clear concepts, in order to see clearly and perceive anew, we should parse out the distinctions as thoroughly as possible. The third chapter then links these concepts to a reformed vision of science education. This is but one specific way that we could reintroduce a balance of tendencies across two kinds of science. With the right education, the nomadic encounters of a child would not be quelled or avoided, but made productive. Only then would they blossom into nomad scientists.

Chapter 1: Nomad and State Science

Home Experiments

A house is full of odd things. As it stands, with everything in its proper place, not much happens. Only the usual: bowls are for soup, chairs for sitting, jars for storing, windows for looking, and candles for romantic light. With the home mapped out like this, each object dwells within the walls passively and only wakes when a human agent activates it. The banality and comfort of a pristinely functioning home is not inevitable, nor completely desirable; it is the result of a dominant way of being in the world, a way of relating to matter: it is the expressed tendency towards hierarchy, control, reproduction, stasis, and order.

Control, reproduction, stasis, and order are not the only ways that humans and other creatures can inhabit their homes, society, or Earth. While some places are obsessively tidy, others, like Francis Bacon's studio, are infamously chaotic. Some children have a place for all the toys in their room, while others throw them everywhere. Some children rearrange the order of their room every few weeks (that was me). Here is a mixture of tendencies. Beyond stasis and beyond disorder, there are tendencies towards creation, difference, freedom, and various becomings. This is the world through the vision of Heraclitus, the becomings of a room as a kind of infinite flux. This way of relating to matter respects and even desires difference, change, and creation.

The habitual function or form that we impose on our household items is a useful restriction; it lends itself to repetition. Repetition gives rise to a feeling of neutrality, immersion, and inattention, which we can conjure at any time just by opening a door or pouring a glass of water. The candle that we light for our holiday meals is then barely noticed way back in the cupboard. Without the tendency towards creation (on the part of the occupants of the home), the candle is merely useful for the repetition of this holiday-light-act. In such a home that candle is defined by its connections to other objects and times: it is stored with the fancy tablecloth and centrepiece, which are only removed from that same cupboard for Thanksgiving and Christmas. Yet at any moment, if the urge towards creation is taken up, the candle could then be connected to new objects and would express itself newly by its new relations. Instead of a fancy table cloth, the candle could be related to a jar and a bowl filled with water for a chemistry experiment in a grade six science fair. Introducing a new set of relations between objects within the house expresses the tendency towards creation. It is an experiment and an improvisation. It is about finding out what will happen, and it does not have to be or involve a demonstration or unconscious confirmation of a preconceived hierarchy, control, reproduction, stasis, and order.

Light the candle and place it in a bowl with a shallow layer of water. Then place the jar over the candle so that the air inside is sealed by a barrier of water on the bottom. Suddenly it becomes obvious that the function of a candle is not only to provide warm, romantic light: in this particular set of relations, it plays with the volume of air and the water level, and it extinguishes itself. It pulls on the water, heats the air and consumes its oxygen (more immanently, the air in the jar becomes unbreathable, to the candle and to me). It enters a negative feedback loop with itself. The physics of the candle becomes an absurd hubris: it burns until the water rises to the flame or until it is snuffed by invisible fingers. Sitting dormant in the cupboard with its fancy tablecloth, the candle has no hubris; it is not in a life-or-death struggle with the other elements. But it could be, if new relations were created with it in an experimental mode. It is true that this candle experiment on its own is not particularly useful (and that it is in fact a set protocol). It could be used as an elementary school demonstration of gas laws, in conflict with chemical reactions. In that way it would be useful as representing and proving a set of preexisting forms. But that would miss half of the picture; placing the value of explanation and demonstration far above the value of experimentation reenacts a hierarchy, drastically favouring rules and order over creation. Often, real scientific experimentation, whether in elementary or graduate school, is a becoming: a movement towards new behaviours, functions, and relations of matter; while scientific demonstration and explanation is an attempt to assemble these for control and reproduction. While the candle-in-a-jar experiment initially follows the tendency towards creation, the explanation and its corresponding demonstration in a science fair context follow the opposing tendency, to put everything in its proper place according to an impersonal law. So, depending on the tendency we favour, such an experiment does not have to be a demonstration; it could also amount to a transformation of the home. And if we are not particularly satisfied with this new relation, then we can continue to follow our tendency for disrupting the order of the home: we could continue the experiment and try something else; what else can the candle do? What are other combinations? Are they interesting or not?

An Ethics of Difference

These are the sort of questions that drive an ethics of difference. They are important questions because the production and following of difference is needed to some degree for the fullest kind of ethic. We cannot completely subsume the particularities of experiences in the world to a set of universal principles or moral codes, like virtues or laws: such universals cannot be the whole ethical picture, for an element of imagination and creation is needed in order to realize the ethic in the flux of the world, a flux that cannot be finally pinned down by any set of principles.[3] So the ethical task of following matter is to set out to discover difference, to realize it, and then to respect it (rather than mere toleration, respect for difference could be touted as a principle). As Gilles Deleuze frames it in *Expressionism in Philosophy*:

> When Spinoza says that we do not even know what a body can do, this is practically a war cry. He adds that we speak of consciousness, mind, soul, of the power of the soul over the body; we chatter away about these things, but do not even know what bodies can do. Moral chattering replaces true philosophy. (255)

And so "the question, 'What can a body do?' must be taken as a model" for true ethical philosophy, for our ethics (Deleuze, 1992, 257). It would be absurd to say that the candle, which is a body, has only one function, and even further, that the candle *should* only be used in one way. That would put the cart before the horse, for it would ground an entire ethics in what has been already set, rather than what could still be; it would assume that in some non-trivial sense we have already arrived at the Good (and that the Good is something to be arrived at, rather than endlessly chased). But really, does not the action-guiding quality of ethics assume that something still needs to happen? Is not ethics a call for change? A war cry? An ethics could not call us to

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[3] One wonders how much Aristotle's phronêsis, practical wisdom, requires not just strong deliberation but an incredible imagination. Perhaps virtue ethics not only requires good deliberation to determine what one should do but also an imagination to see one's situation and actions as possibly otherwise, that is, to be able to imagine one's actions distinct from what the crowd conforms to (like Nietzsche's Übermensch imagining themself distinct from the mob, reevaluating values). It seems that the greatest ethical heroes of the Axial age, such as Siddhārtha Gautama (Buddha), Kǒng Fūzǐ (Confucius), and Jesus of Nazareth, had both solid deliberation and a penetrating imagination: all of them made jokes, told parables and stories, as well as demanded and enacted complete societal and metaphysical reform in ways that no one else had imagined. If this is true, then an ethics of difference is not in disagreement with a virtue ethic but merely stresses imagination as a core virtue.

merely repeat cultural and personal habits we have already formed, or to repeat certain functions that we are used to, or to simply choose between codes that have acted so far as good-enough guides for action; given the differentiation of the world it is also crucially a question of carefully and wisely repeating the difference inherent in matter and bodies. We have to risk imagining and creating the world otherwise, precisely because we are called to change it; the war cry of ethics tells us that something different needs to happen. This might be as radical as imagining a completely new political system, not democratic, not socialist, not monarchical, but something we have not yet conceived. Or it might be as simple as imagining how to use the candle differently (it might be best to start small). In order to do this, we ask such questions: Which specific candle? What new relations can it enter? How can it change with the world around it? How can its newness be brought into the world? And finally, moving beyond the example of a single candle, knowing that the impulse of creation is essential to an ethics (and thus also to an ethics of science), we also need to ask, as Brent Adkins does, "how must we see things if we wish to create something new?" (167).[4] This leads to the question of perception.

In the case of the domain of science and an ethics of science, an ethics of difference necessitates an acknowledgement and embrace of both tendencies: an ethical science pursues change as much as stasis, for in order to be ethical it must pursue some difference. The sole concern of science qua science is not control, reproduction, nor representation of the Real. Nor is

[4] To clarify, the argument here is not that creation or difference is always good, but that some degree of creation and imagination is necessary for an ethic (and more than traditional models of ethics would have), or that to be ethical we often need to pursue difference. Since difference is not always good, it must be pursued carefully and wisely. But as I will argue later, there is also an element of "always" in this equation, for in order to pursue difference in a structure that is always demanding control and reproduction, we must always actively resist with creation, as the counterpoint to sameness; we must always perceive so as to be open to imagining and creating otherwise. This is why we are always becoming nomads and why we are never finally a nomad.

its sole concern freedom, creation, or expression. Nor is it orientated solely toward function. It should not even have a sole concern, and even though it might focus on function and control, it still must be open to changing itself (altering its kind of functions; modulating whether it is more functional, affective, or conceptual; or giving up a certain degree of control and stability). An ethics of science cannot be constrained within the walls of science. A fundamental ethics of science does not *only* ask when it functions best according to its own principles of rigidity, accuracy, or precision (whether statistical analyses of drug trials are biased, which physical explanations are best, how patriarchal biases of science reduce its efficacy, how to increase the number of women in the physical sciences and how this will change its theory and practice, and so on), because it is precisely those principles that are in question. So rather, the fullest possible ethics of science calls for the unquestioned boundaries and principles of science themselves to change; it calls for us to imagine different kinds of science. This might mean rejecting evidence based medicine as scientific (since it has a lack of conceptual reasoning), and accepting Indigenous wisdom not just as something that happens to be true, but as scientific in its own right.[5]

Whatever the particular portions of concern and tendency, science, like any assemblage,[6] is an indivisible moving mixture of parts. From the very beginning, the questions of realism, of a unified science, or of the possibility of progress, are false problems because they are stated from the impossible perspective where science as an enterprise is only the tendency towards stasis and control. The better question is instead: What balance of tendencies and relations are needed at

[5] I discuss the question of Indigenous knowledges and wisdom a little more in the second chapter.

[6] The term "assemblage" is explained in the next section.

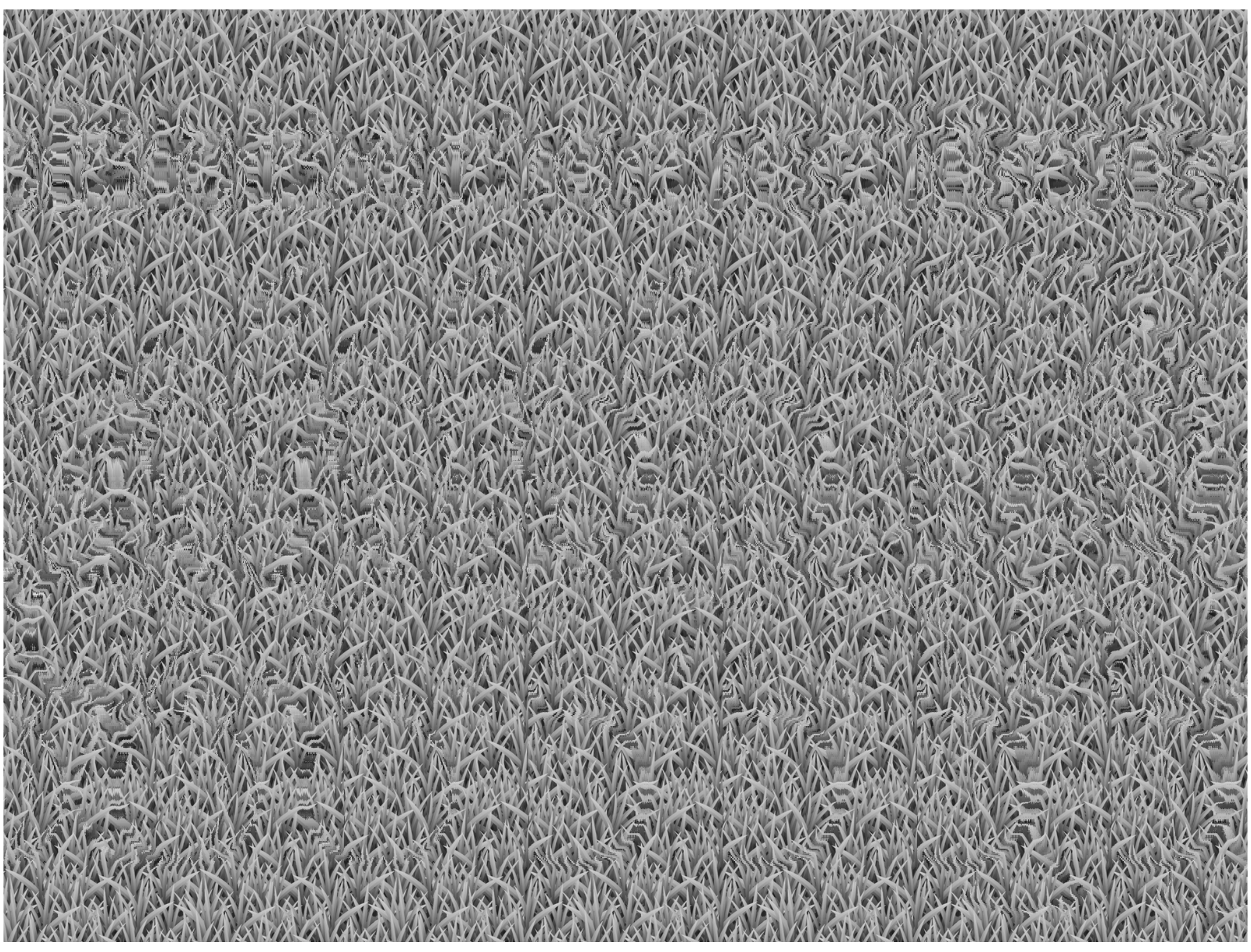
any moment, and how should they be followed? If certain areas of science have been too secured as a realm of control and strict reproduction—which is very likely when it has been immersed in a capitalist economy and highly bureaucratic education—then there must be a way to restore a balance by pushing its practice and theorizing further into the realm of improvisation. But the structure of science cannot change without a correlating change in the sight and perception of its scientists. In order to do this, from the philosophical side, we need concepts that will help scientists perceive in such a way that they can assess and then follow the requisite tendency toward change. It is therefore a matter of articulating philosophical concepts about science that scientists themselves can take up in order to see the different ways in which their science can manifest. If it is correct that an over-emphasis on state science is the source of such a dysfunctional system, then it is essential that scientists committed to science are able to see this tendency manifesting, and that they are able to see alternative ways to structuring the scientific system. As it stands, in my own experience, barely any scientists adequately notice the web that state science has caught them in; without the lens of philosophy, this web is invisible and free to ruin the pure enterprise of science, deforming it into a factory full of overeducated workers.

Assemblages and Tendencies and Concepts

The candle is still a candle even as it melts: it is neither a static object, nor a formless becoming. The ethical question of the difference inherent to the candle and how that latent newness should be brought into the world is tied up with the metaphysical question of what the candle really is, as "a thing." As Brent Adkins argues, "Bearing in mind that Deleuze and Guattari want to scrutinize the question as much as the answer, we can think of 'assemblage' as an answer to the venerable philosophical question, What is a thing?" (10). The candle in its home-milieu is an assemblage of internal and external parts, as well as an assemblage of the two contradictory tendencies, towards change and stability (Adkins, 10). D&G (Deleuze and Guattari) do not make the distinction between these tendencies in order to defend a dualism of change and stasis. Rather, they ground all tendencies within any assemblage, as if all things were always already pulled in multiple directions at once, towards being and becoming, as if the very reality of any thing were a paradox. Assemblages are always mixtures of incommensurate tendencies, and they are also always *continuous* with one another. There are language assemblages, physical assemblages, chemical and biological ones, familial and scientific ones; and these are all (by degree) continuous with each other. This means that there are no strict boundaries between any of them and that the existence of assemblages is determined at least partly by their relations to each other. Not only that, if language assemblages are continuous with assemblages of rock, then a traditional philosophical distinction between the intelligible and sensible is bridged by a continuity. "This basic supposition allows Deleuze and Guattari to reread not only the history of philosophy but the history of thought in general through a new lens. New connections are made. New concepts are created" (Adkins, 12).

In many ways, the whole of *A Thousand Plateaus* (ATP) is a repository of the many concepts that D&G develop to elaborate on the two basic tendencies always inherent to any assemblage. The book begins with a "plateau" (a momentary focusing and settling) on "the rhizome." A rhizome is the assemblage whose primary tendency is change, or the "line of flight." This is contrasted to the tree or arborescent assemblage whose dominant tendency is stasis, hierarchy, and "capture." These are concepts not because they are metaphors, but because they can be used as a philosophical filter of our perception, like any other concept. For D&G, a concept is a way of seeing, being, and moving one's body that can be written down and philosophically connected to other concepts (see *What Is Philosophy?*). Adkins names this approach to philosophy a "perceptual semiotics," a way of seeing the irreducible mixture of tendencies, assemblages, and forces within all things (13). A concept is used in the same way as the crossing-eye trick is used to see the three dimensional image of a stereogram (see figure 1 below), or in the same way that blue and red glasses are used to see old three dimensional films.

Figure 1: A Stereogram. To see the three-dimensional image, to change your perception, you have to pretend as though the image had depth: in the same way that you can make an object blurry by not focusing your eyes on it, make this image blurry and try and focus on a space somewhere beyond the image. Eventually, you will find a plateau of stability, where your eyes can focus, and you will discover a three-dimensional image. It's a trick of perception that gets easier with practice.



This positioning allows for new relations with the world. When I am faced with the chaotic veneer of a stereogram, I have to first cross my eyes and focus on an imaginary spot behind the page before I can see and exclaim "It's a penguin!" (this is not what lies hidden in figure 1). But a concept is not just a bodily habit or a tool; it is continuous with philosophical texts and language. Concepts are not strictly logical creations and like assemblages they can be connected to other ideas and bodies by consistency rather than through literal definitions. It is important that D&G's philosophy follow an ethics of difference from the very beginning, and so their images are not chosen to set out a field that only needs filling in, like Kuhn's normal science.[7] The concepts they offer are for making new connections, always internally balanced with a kind of stasis and control (they choose specific imagery for their concepts after all). In some sense, the first pair we encounter, the concepts of the arborescent and the rhizome, are for the perception or conceptualization of the tendencies of stasis and change within all assemblages—so that one can respond to these tendencies, to alter their balance and overall direction. Rhizomes and trees for D&G are neither things nor metaphors; they are a way to perceive an assemblage, classify it, and respond to it. But while an assemblage can be seen as a rhizome or a tree due to their dominant tendency, every assemblage is also always a complex mixture of these tendencies, and so its parts can also be broken down into little rhizomes and little trees. So every assemblage, even though it might be called (and perceived as) a rhizome or a tree, also "contains" rhizomes and trees, which interpenetrate and inhabit each other:

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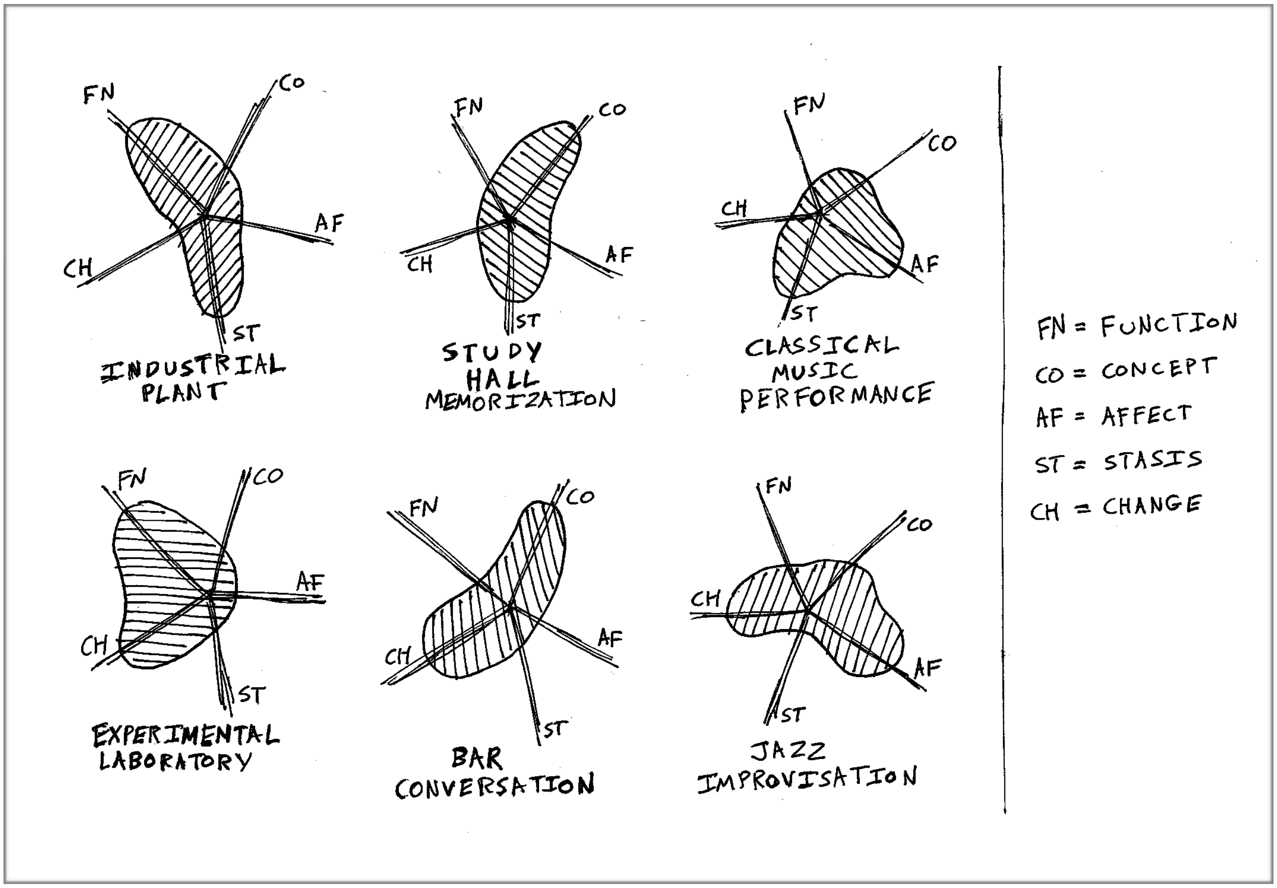
[7] By "normal science" I only mean the conception of an everyday science as Kuhn developed it in *The Structure of Scientific Revolutions*: in normal science a general worldview is shared among all of the scientists and this worldview sets out acceptable problems, solutions, values, and means of experimentation; in some sense, this scientific community looks out onto the world as perfectly fitting its theoretical structure, and the task of this community is but to perfectly explain all the minutiae of the world using their shared worldview.

> There exist tree or root structures in rhizomes; conversely, a tree branch or root division may begin to burgeon into a rhizome. The coordinates are determined not by theoretical analyses implying universals but by a pragmatics composing multiplicities or aggregates of intensities. A new rhizome may form in the heart of a tree, the hollow of a root, the crook of a branch. (ATP, 15)

If *A Thousand Plateaus* introduces and experiments with the two tendencies of change and stasis, then D&G's *What is Philosophy?* (*WIP*) could be said to articulate three others: functions, concepts, and affects. These also manifest to different degrees in all assemblages, and they are manifested most clearly in science (function), philosophy (concept), and art (affect). So science as an assemblage expresses most strongly the tendency towards function, philosophy the tendency towards conceptualization, and art the tendency towards affects. These assemblages, whether candles or art, smear together and there is no precise boundary that we can draw that would ever definitively separate science, art, and philosophy. At the same time, the reason we can even speak of these assuredly different human activities *as* different is because they manifest a higher intensity of a specific tendency. We can talk of a laboratory, a library, or a concert hall, all of them inhabited and each spiking with variable intensities of the five tendencies (stasis, change, function, concept, and affect). These three inhabited spaces are distinguished by their dominant tendency towards function, concept, or affect; but they are not distinguished amongst one another by the tendency towards change or stasis, for even when these tendencies are varied, the spaces will retain their sense and name, as scientific, philosophical, or artistic. With regards to change and stasis, they might function completely differently; it could be the following (figure 2): a natural gas processing plant with distillation towers, versus a laboratory where a professor

Figure 2: Assemblages and Their Tendencies.



has just crystallized a new compound and its qualities are helping her rethink a chemical bonding-model on a chalkboard; a study hall where students are memorizing Hegel's criticisms of Kant, versus a bar where three philosophy students are arguing about peaceful revolution, slowly changing their mind about where to buy food; or a performance of Mozart's first piano concerto, versus a jazz improvisation that has just modulated from E major to E minor. In each case, they retain their characteristic tendency towards function, concept, or affect, while shifting between the tendencies towards stasis and change.

Another example: it is by perceiving through the concepts of reproduction (stasis) and creation (change) that a piano player can learn to improvise: they constantly scan for patterns in order to overcome them, letting the patterns *affect* themselves so as to lead in a new direction, towards new affects; or they land on themes and standards, which in their very affective quality, suggest inventive variations. If the piano player does not pay attention to music making through the lens of some kind of concept—which is how they can identify reproduction, themes, variation, and so on—then they cannot make the shift from classical playing, the reproduction performance of masterpieces, to jazz improvisation, where the discovery and movement of music along a line of flight is achieved by listening to the particularities of the situation, listening to the mood of oneself and others and the way in which the song is evolving and changing its own direction.

"Invent concepts!" is the rallying cry that D&G make to fellow philosophers in *WIP*. (Increase the tendencies toward concept and creation!) The purpose of philosophy is to create conceptual abstractions that can guide action and perception in new directions. So making concepts is ethical because it allows for difference when it is needed. Concepts are abstract not because they are not concrete, but because they are not discrete (Adkins, 25). A concept, too, is continuous with other assemblages, such as books, habits, personalities, societies, and landscapes. A concept is thus not found in some precise, localizable position "in" philosophy, but in a series of fuzzy relations with other assemblages. So it is not discrete, but a concept is certainly concrete as an active player in the real. If we let the concept remain continuous this makes it difficult to fully define, but this is exactly what allows it to be taken up in other assemblages and to be productive, rather than only ever *re*productive.

We might take up concepts to rethink and rearrange a home. We might take up concepts to fight our anxiety. Or we might take up concepts to transform the scientific system. That is the topic of this thesis. The current large scale scientific assemblages, in education and industry, are plagued by inflexible concepts that currently sap the life from science. Why this is so and why it is so critical to transform should already be clear to some extent, but hopefully it will also become more clear later on.[8] The current scientific assemblages are driven by the dominance of physical model concepts, which are biased towards the pure, impossible tendency of stasis, hierarchy, control, and reproduction, free of all "errors" (i.e. deviations from a standard): D&G name it the "hylomorphic model" (429–30). Especially in education, experimentation has come to mean demonstration, following protocol rather than breaking it, reducing deviation rather than following it. This is true of every chemistry laboratory class in university, where for example, students are graded on how close they come to a certain weight, colour, and chemical property. Indeed, Kuhn's physics-generated concept of "normal science" has been taken up as a rallying cry by so many scientists: the task, too many agree, is to fill out the deductive holes of a system that can order everything according to its centre; even Kuhn's "revolutionary science" is only a shifting of this centre,[9] and it does not provide the conceptual framework to revolutionize thought, i.e. to think otherwise.[10] While many current scientists agree that a unification of disparate scientific theories is nonsense, such as the reconciliation of chemical properties with quantum mechanics, the concept is still at least unconsciously in vogue, and we can see it quite

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[8] That is, it should become more clear the more precisely we have formulated our concepts. It is this philosophy and not a set of facts, that will do the job of convincing here. In the end, I am deeply suspicious that any statistical or historical analysis of modern science could ever reveal its foundational problems; so it seems necessary to appeal to two subjective but undeniable realities: personal experiences of deep dissatisfaction with the scientific system, and the gall to imagine it otherwise.

[9] Kuhn's revolutionary science is migratory, rather than nomadic. It moves only for the sake of settling somewhere else. In nomadism one is settled in the movement itself, rather than moving for the sake of an end. I will make this distinction later on.

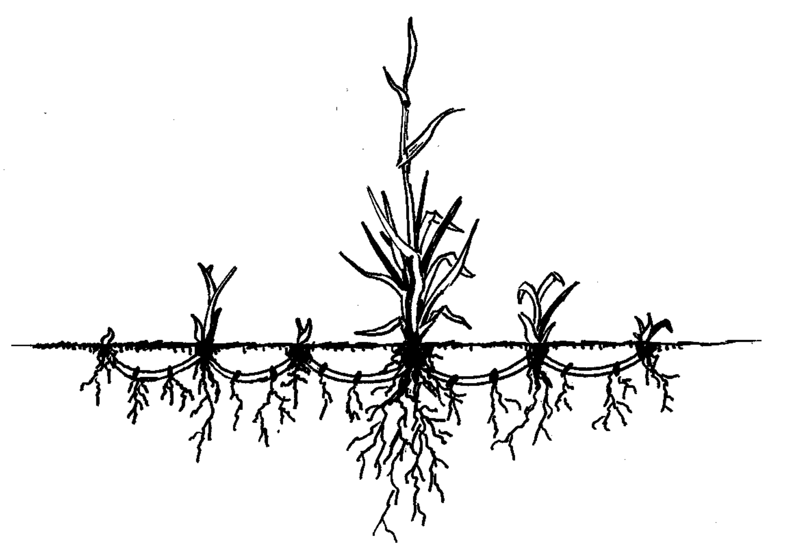
[10] Paul Feyerabend has perhaps a more decentring analysis of revolutionary science in his book *Against Method*. Rather than the classic picture of the rational man of science over and against the irrational church, Galileo is portrayed as mischievously and creatively (irrational in a certain sense) struggling against an overly-rational, stagnant church-state.

clearly in the common model of production, application, and education across all areas of science, including particle physics, chemistry, ecology, and so on. There appears to be a vicious cycle in this relation between education, function, and concept; throughout the whole process of science there is a high tendency towards stabilizing this relation, so that each matches and is in further agreement. The concepts are derived from the most generalized and stable functions (such as a pendulum, light passing through a prism, Boyle's J-tube, Galileo's inclined plane). These concepts are then presented in textbooks and lectures as revisionist history and realist interpretations of theory, and the concepts drive the practice of reproducing the most repeatable functions in university laboratory classes. In this way as well, the mental or physical practices and values of students are directed purely towards reproduction and stability, without the possibility of difference necessary for an ethical science, and they then bring this to their practice of science outside of education. Since scientists are often not trained in philosophy, this means they are not trained in the actual creation of concepts; thus the few concepts that naturally bud from scientific research are simplistic and lend themselves to a vicious cycle such as the one between realism and demonstration. To break it, it seems most appropriate to introduce concepts that can fit within science yet do not lend to that same vicious circularity of stability and reproduction. The concepts must be continuous enough with scientific theories and practices, but they must also be in tension with the concepts that are most easily and lazily produced by scientific theory. At this point in time we need concepts that undermine the bias toward reproduction, hierarchy, and control; we need concepts that can be taught and incorporated into science in order to permanently destabilize it so that scientists are finally equipped for the constant creation of their own concepts and functions.

Basic Concept Imagery Across A Thousand Plateaus

For the larger purpose of creation and permanent destabilization of science, we can start with the basic images that D&G use to make a conceptual distinction between stasis and change. There is “smooth space”: a wild field, an ocean, a dance floor. And then there is “striated space”: a grid of pedestrian walkways and roads and train tracks, a fixed-seating lecture hall, a basketball court. A space of free movement and singularities in continuous variation versus a space that has sharp boundaries and forces motions into directions, stable essences, and repetitions. In smooth space, nomads are free to take lines of flight in innumerable new directions by following the vague essences of matter. The “rhizome” is a kind of root-system that goes this way and that, growing a new root from any breaking point, adding one thing after another, without any specific end in sight or unified direction. The nomad is the person (or assemblage) who follows or creates the rhizome pattern, along lines of flight. The state is a counter force, as it establishes striated spaces (even using smooth spaces for this means), centralizing all the motions and establishing boundaries and hierarchies. In this way, the state more fully embodies an arborescent image than the rhizomatic, for it proceeds from the root system, up the trunk, to its foliage: there is a channeling and structuring that leads always and only to specific, higher ends. This distinction between the tree and the rhizome is not itself a hierarchy but a tension and balance, or better yet, an inside and outside, an internality and externality; for the rhizomatic images are full of little trees, and the arborescent image is peppered with rhizomes, like anarchists living in an abandoned building of a London suburb.[11] There is an assemblage of arborescent and rhizomatic forces that are in perpetual tension, giving rise to a multiplicity of hybridized effects, that cannot be finally labelled either one or the other. The arborescent forces trace what already exists, reproducing for the sake of containment and capture. The rhizomatic forces map (or diagram) in such a way that innumerable rearrangements can be conceived for creative, performative effect. The state overcodes, straining towards a total capture and striation, for an "n + 1", so that the set of *n* things are but additions to the unified one; it is centripetal, pulling everything towards a centre. In resistance, the nomad decodes, for an "n – 1", an assemblage of *n* things void of any final unity; they are centrifugal, defining things against a centre or ground. Throughout all this tension, the nomad and the state are acting through different assemblages, first deterritorializing, taking up acts and separating them from their meaning, and second reterritorializing, reincorporating these acts into new schema of meaning. The state reterritorializes into a

[11] A footnote, by the way, is a little rhizome in an arborescent thesis. It shoots to the side, makes a digression, and introduces an important element of non-linearity that upsets the notion that a thesis is like the deduction of a mathematical problem. Diagrams and images could also be rhizomes. So without further ado, here is a drawing of a rhizome root network in a footnote:



hierarchy. The nomad creates something new. The tactic of the nomad is to use a "war machine," an assemblage of nomads and their weapons that resist reterritorialization into the state. The state in turn captures and transforms the war machine into a means for political violence. Not only are there rhizomes within trees, smooth spaces within striated ones, and vice versa, these images only exist insofar as they are constituted by their relation to each other. The nomad and the state exist as the tension between an internal state and the external nomad; there is no external without an internal, no rhizome without a tree. Yet, the balance is not always equal, and the state can dominate to such an extent that every smooth space exists under or within the dynamic tyranny of a striation.

This can happen when students in a grade ten chemistry class are told to experiment with certain chemicals, and when the teacher has in fact already predicted all of the possible outcomes and mixtures. The students' freedom to choose between mixing different reagents is ultimately subordinated to a theoretical lesson on why they should have expected their results. We must ask, really, what has been learned here? As Dorothea Olkowski says, "the State avoids empowering them, but hopes to make them dependent giving them an imaginary autonomy, while their real task is to reproduce what is already known" (81).[12]

Go and Chess as Ways of Being

If different tendencies are different ways of being in the world, then they manifest most clearly in different spaces and they involve different experiences. The rhizome assemblage and

[12] This is the kind of problem in science education that we will be dealing with in chapter 3 using D&G's concepts.

the nomads move through a smooth space, while the arborescent and the state move through a striated space.

D&G's sample distinction is between the games of chess and Go. In chess, which is more of a striated endeavour, the space is partitioned to a strict number of repeatable positions that can be filled by a strict number of pieces with set functions of movement. The "chess pieces are coded; they have an internal nature and intrinsic properties from which their movements, situations, and confrontations derive" (ATP, 411). Their internal properties are never changed by the emerging situation on the board (even the pawn's contextual moves, the "En passant" and "Promotion," are coded properties from the very beginning). The knight is coded with a capacity to move in an L-shape, wherever it is on the board, no matter what happens. The pieces have names, functions, and ends, all of which have been coded from the very beginning. Every possible particular situation and movement and combination is derived from their internal properties.

In Go, the situation is altogether different: the meaning and structure of the space itself is determined by the presence and array of pieces on the board, and the functions of the pieces are defined by all of their connections with all of the other pieces. As Adkins says, "the importance of space on the [Go] board is a function of adding pieces to the board, which themselves may shift in function and importance throughout the match" (206). Except for their two colours, Go pieces have no intrinsic properties that distinguish them from each other—they are not carved into figures, they are little round stones:

> Go pieces… are pellets, disks, simple arithmetic units, and have only an anonymous, collective, or third-person function: 'It' makes a move. 'It' could be a man, a woman, a

> louse, an elephant. Go pieces are elements of a nonsubjectified machine assemblage with no intrinsic properties, only situational ones. (ATP, 411)

The game-relevant properties of the Go piece are situational or contextual; they take their capacity from the surrounding form and matter: in one situation certain pieces might function to border, to threaten, or to break apart, but the addition of a new piece can completely transform these meanings. Go pieces follow the matter of the board and the pieces; they respond and are always dependent on the assemblage. The strategy in Go is about "maintaining the possibility of springing up at any point," just like a rhizome (411). Set a piece so that when a new piece is added it could fly off in a number of unexpected directions; leave or create an open space for the tendency to change. The Go piece can be used as a conceptual synonym for the nomad, both of whom move within a smooth space and intimately and constantly respond to their changing surroundings, following lines of flight, or unpredictable changes in the function of assemblages. The nomad is a nomad because they maintain an openness to such change.

Of course, Go and chess are both games. They are both striated to an extent because they both have rules that are imposed from the outside. To play the game is to willingly submit oneself to these constrictions, and to the idea that pieces function in a certain way. A Go piece separate from the game is just a stone; so in order to play the game, we grant the stone some minimum level of intrinsic properties, so that it becomes a Go piece. These intrinsic properties aside, the point here is that the smooth space and the tendency to change are found more strongly within Go. When we put on a certain conceptual lens, we find a higher intensity of the tendency to change within Go, and we see a different way that matter can relate to its space. The constrictions placed on the Go pieces are of a different degree than the constrictions placed on the chess pieces, such that the Go pieces are more open to change. This does not mean that the intensity of the tendency to change within Go is a progressive structure or that it is adaptive; the intensity is a constant possibility for change that could fail to go anywhere; but at least Go has more of this possibility and it never goes to zero.

The Smooth and the Striated are Perceptual Spaces

Beyond boardgames, the smooth and the striated can also be thought in terms of the qualities of the senses. Striated space is distinctly optical, as it has a tendency to project-discover forms, partitioning things within boundaries, and submerging essences within things. On the other hand smooth space is tactile or better yet, haptic (relating to the sense of touch and proprioception, the stimuli concerning the movement and position of one's body), for its continuous variation (such as the contextual functioning of the Go piece) cannot be projected and stabilized by the power of light or otherwise; and instead smooth space can only involve a response to each sensation that is present at a particular moment. We run a hand along bark or we scuff the ground and we respond to these particularities as we meet them (responding to the curves of the stream or the "errors" of a chemical experiment). It is not that eyesight is always involved in striated space and touch always in smooth space; rather they seem to be more comfortable in their respective spaces, even though we can always immerse any of our senses in either space.[13] This is why D&G call the smooth-space way of being haptic rather than “tactile”: it suggests that we can see, hear, or smell haptically: “ ‘Haptic’ is a better word than ‘tactile’ since it does not establish an opposition between two sense organs but rather invites the assumption that the eye itself may fulfill this nonoptical function” (ATP, 573). This perceptive difference follows the two fundamental tendencies; the nomad “sees all things in relations of *becoming*” (410) or the ways along which newness might emerge, and this is haptic in the same way that the sense of touch never seems to settle and is constantly fluctuating with the action and micro-movements of one’s body. This could be a tapping foot becoming tired, so that the floor begins to feel different, or a digesting stomach that raises the internal body temperature, changing the cold-quality of a cold glass of water. The haptic (specifically proprioception, where the positioning of the body is part of the perception) has a give-and-take or a responsiveness, which naturally lends itself towards becoming rather than stasis. The person in the state-apparatus on the other hand mostly sees things in terms of binary oppositions (410). This is optical in the way that objects often sit in vision. Despite the variation of a tree blowing in the wind, the essence of the tree seems to sit within our optic sense. As well, the optical lacks a degree of responsiveness, for not much within the human body seems to alter the sense of sight, not even mood. It is, perhaps, a rough distinction.

[13] Haptic visuality recalls Merleau-Ponty’s analysis of the colour red, in “The Intertwining—The Chiasm,” where he sees the colour and texture woven together, seeing it as though he were running his hand over the red with his eyes. He says: “What is this prepossession of the visible, this art of interrogating it according to its own wishes, this inspired exegesis? We would perhaps find the answer in the tactile palpation where the questioner and the questioned are closer, and of which, after all, the palpation of the eye is a remarkable variant” (133). This anticipates the discussion on the next page, where haptic sense is an “art of interrogating [the visible] according to its own wishes”, or rather paying attention to difference and letting this difference speak for itself.

A consideration of the optical and the haptic emphasizes that perception and space are continuous with each other. When we project forms and see stable functions as inherent to things, then we are living in a striated space, where the dominant tendency is towards stasis and control; or when we are in a striated space, we tend to see in this way. A city street is mainly striated, and so it is easy to perceive it this way: we see repeatable car-units and sign-units, all of them acting by their internal functions, moving like pieces on a chess board. The city street is an extension of striating perception and constructed for the sake of the reproduction of cars, functioning in repeatable ways. The way in which we see is continuous with the way in which we act, the habits we form, and the structures that solidify them, be they political, familiar, or scientific.

If perception and space are continuous with each other, then a change in perception can result in a change in space, and vice versa. A pedestrian who lives in a town with strict bylaws and who consistently behaves and thinks by striation, is unable to jaywalk because of their relation with the space around them. But in the right context—such as a protest or a flood—a change in perception of what sidewalk and road could mean allows for a new set of relations to develop, so that the dominant tendency towards reproduction is overcome by the tendency towards change; stop striating excessively and jaywalking becomes possible, often reasonable, relieving, or fun. This changes the pedestrian-car dynamic. With persistence it might lead to new infrastructures: by changing how one perceives the road system, by allowing for new functions and meanings—how *can* a car function?—the North American road system could be revolutionized. Most notably, is the function of a road to fling people from one place to another as quickly as possible? Maybe some roads could function in this way, but why repeat this endlessly and close down on all other possible functions? What about the functions of dwelling, community building, or providing avenues for discovery?

This is what it means to swap from the striated space to the smooth: it means that instead of walking past a tree and labelling it, symbolizing it, we have to spend time with it, become fascinated with its contours and particularities, and then we have to react, such as when we run a hand over the bark and we flinch at a sharp corner. If we don't enact an interest in matter, we cannot follow it because it remains fixed in our optical perception, set at a distance. The crux of an ethics of difference is not about doing something different; it is about the *generosity of our interest*. This is an essential feature of Jane Bennett's *Force of Things*, where she argues that to truly understand matter we must make a shift in perspective, from trash to treasure, from a thing that is formless and void to a thing with its own kind of agency, that has a kind of "anticipatory readiness" and "fortuity of … particular configuration" that "commands attention" (350). As we will later see, D&G are clearly on the same track as Bennett in their hylozoism, which is the stance that matter is full to the brim with expression and life.[14] However, this is only convincing as a theory unless we start to form our own perceptual habits of seeing like the sense of touch, or haptically, following matter and paying generous attention to it. Generous interest is perhaps

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[14] In case the reader feels as though I will be defending animism or panpsychism in this thesis, a few things should be said to both affirm and deny this. In the introduction I took the feeling of having a conversation with matter seriously (here referred to as the agency or affect of matter, and later referred to as the act of "following matter" when discussing the concept of the artisan). But a distinction must be made between animism as an ignorant causal inference about the world's operation and an "animistic" form of perception. In the introduction and first chapter of *How Natives Think*, Lucien Lévy-Bruhl forcibly argues this distinction in the context of mythological ("primitive") cultures: to interpret these cultures as ignorantly making a causal inference that all things have spirits is to fail to appreciate the fact that their perception is not a variation of our own; it is just different. This works for an anthropological analysis, but equally as well for a philosophy that is considering how to perceive newly or differently. The problem throughout this thesis is not one of what causes are true, but of what perception we can and should develop within ourselves; for in the end, we find that specific forms of intelligible causality develop from different kinds of perception. Having a conversation with matter is not an ignorant causal inference; it is the expression of a perception.

another virtue alongside imagination: it is a good disposition ingrained or habitualized in our character over time.[15] Without practicing this widening and sharpening of our interest, an ethics of difference seems inconsequential, and the bland, reproducible road system that takes up such a monstrous amount of space in North America becomes supposedly unchangeable. It is a failure to think otherwise or to be untimely; it is a failure to create and respond that strives to reproduce and numb life.

So the haptic is a way of sensing and bringing about smooth space. Playing the game of Go we experience the continuous variation and contextuality of this space. The nomad is a agent (human or otherwise) who sees and exists in this way. A nomad does not walk past a tree, but a nomad does not have to be a tree hugger—for they might be a carpenter and they might choose to cut it down. But either way, when the nomad encounters the tree, they directly respect this tree's difference. The nomad *always* respects[16] and imagines difference and pays generous attention to it; respect, imagination, and generous interest might be said to be the virtues of the nomad. We can say unabashedly that the nomad empathizes with matter as well as life. This is a way of perceiving, a way of inhabiting space.

It may seem as though I am unfairly favouring nomadism and its smooth spaces, or in general the tendency towards change, over against the state and its striation, especially when I have already said that an ethics of difference requires a balance of these tendencies. A few things should be said. A balance of tendencies does not mean sometimes following one tendency and

[15] If we want to interpret it as an Aristotelian moral virtue, then it would also be a mean between excessive and deficient interest, between mesmerization or stagnant captivation and apathy or inattentiveness.

[16] To respect is "to look again," i.e. to follow matter, to have a habitual, generous interest. For an Indigenous perspective on respect and following matter, see Larsen and Johnson, *Being Together In Place* (88).

then sometimes following the other; it means maintaining a tension between the tendencies. The state, precisely because it controls, reproduces and stabilizes itself, is necessarily more dominant and more prevalent than its opposing nomads. The state is more prevalent in government, in each individual, and in the spaces of society, because it is what has settled and what functions efficiently by reproduction and control; it is the laws, roads, and habits of the human community; these are not bad in themselves, but bad when they are not in tension with the nomadic. Therefore the only means of maintaining a balance of tendencies is through a *constant* resistance, a constant effort to climb out of the striated perceptions, spaces, and ways of thinking and being that we are always settling into. Our resistance to create a smooth space is not ethical because a purity of nomadism would be good (it would not be), but because it is a constant ethical demand that we resist the state. The war machine is the resistance itself. The only balance is the constant resistance, the constant tension between nomad and state, the constant effort to be a nomad. In this sense, the ideal figure that I will talk about in chapter 2, the artisan, is always on the way to becoming a nomad. Becoming a nomad is the growth and maintenance of the virtues of respect, imagination, and a generous interest, which are always in tension with the state.

Difference is What is Felt: Vortexes and Linear Trajectories

Smooth space follows the continuous variation of matter and all of its particularities. A smooth perception then responds to the minutia and becoming of a situation. In this way it pays more attention to matter than a striated perception. It is affected more and its responsive feeling is more intense. Smooth space is whelmed by matter, whereas striated space is underwhelmed. The striated is infatuated with forms that allow for reproduction and control. This has many consequences for the theoretical, practical, and experiential content of science. It is the basis for the distinction between state science and nomad science.

The atomic physics of Democritus and Lucretius was nomadic or minor (which are synonymous here) (ATP, 421). Their atomism was distinctly fluid, rather than solid and corpuscular, and it was focused on heterogeneous becoming, rather than stable or repeatable identities and constants. D&G refer to a concept in Lucretius called the "clinamen": it is the declination or the 'bending away' of the atom, which is the unpredictable tendency of atoms to swerve suddenly and chaotically, veering away from a straight line by the smallest possible degree of deviation. Lucretius argues that the clinamen is necessary for the production of difference:

> When the atoms are being drawn downward through the void by their property of weight, at absolutely unpredictable times and places they deflect slightly from their straight course, to a degree that could be described as no more than a shift of movement. If they were not apt to swerve, all would fall downward through the unfathomable void like drops of rain; no collisions between primary elements would occur, and no blows would be effected, with the result that nature would never have created anything. (Lucretius, 40–41)

To account for difference in the world, atoms must have an inherent chaotic element that is not accounted for or subsumed by a universal property; Lucretius calls this the clinamen. Without this concept, difference is relegated to the impossible situation of 'variations of the same'. So change does not occur by isolated atoms that are set in motion by parallel lines of forces; rather it is a necessary random tendency within atoms to bend the smallest degree from such parallel lines. The clinamen is the tendency of even the smallest realities to not follow perfect regularity and to always already be shot through with an unassimilable difference. Rather than laminar flow, which are parallel lines of flow within a liquid, Democritus' and Lucretius' fluid physics is full of the aggregations of clinamen, which are spirals and vortices, or "vortical organizations" (421). In this way, their minor science of atoms takes place in a smooth space, which is peppered with singularities and curves, instead of a striated space, which is crisscrossed with a universal metrics.

Vortical organization is notable because it is an absolute motion, which is qualitatively different from relative motion. "A movement is absolute when, whatever its quantity and speed, it relates 'a' body considered as multiple to a smooth space that it occupies in the manner of a vortex" (ATP, 592). An angular motion, such as the spinning of a top, does not need a referent for the motion to be perceived as a motion: as soon as we try and move in such a way that the top seems to not be moving, such as spinning above it, we cannot deny our own angular motion, for we feel a centrifugal force. Whereas a linear motion, such as that of a spaceship that is not accelerating, requires a referent to be perceived as a motion; we cannot know a spaceship is moving without another object as a reference. In Newtonian terms, vortical organizations always require acceleration, which can be felt, while linear organizations can occur at constant speeds, which cannot be felt. So not only is the vortical organization an absolute motion that needs no referent and which can be directly experienced—unlike the laminar flow which striates, has only motion by virtue of a referent, and can be entirely devoid of sensation—the vortical organization is also centrifugal or de-centring, like an anti-gravity. The vortical organization flees and flings from a solid centre, like a nomad, and this can be felt through the affective singularities of matter, the difference of matter that affects one who gives it a generous attention. The laminar flow draws matter into a striated space that can become numb in its forgetfulness of the singular qualities of matter.

Problematics: Minor Science

Minor science is problematic instead of theorematic (ATP, 421). While major or state science carries a theoretical weight, with an impressive ability to represent and deduce, nomad science is an impetus, movement, or action. Nomad science is not really a theoretical science with a bent towards practice at all; it is rather only "science" insofar as it is active and problematic; it takes its scientificity from its immanent movement alongside matter. Nomad science sets out, in its very de-centred core (its zones of proximity), to make new connections; and so it is, for example, the science which *is* the exploration of new candle-assemblages. The candle itself is taken as problematic; the starting point is how the candle can be connected to other things to produce new relations, not how the candle can be fit into a theoretical structure, or made into an instantiation or demonstration of a theory. Theory in state science is a means to abstract the flux and pin it like a bug to a reference chart; it explains well, *ceterus paribus*, and it is reproducible and controllable. The mathematical figures (*chiffre*), numbers, or concepts in nomad science are not another theory; since they are not representations or a means of correspondence, they carry a subjective quality which is the motive of an action; in this motivational, active, and subjective sense, they are called "affects" (421). Affects are the "weapons of the war machine," not constrained to the interior of a subject or state, but feelings projected outwards, so that they are a purely exterior "catapulting force" that "transpierce the body like arrows” (415). State science deduces properties from essences, locates objects as theorems within a rational order and then passes between genus and species or deduces from essences (connecting theorems according to the striated space) (421–422). Nomad science deals with the problem, which is a felt affect of the problematic that is continuous with all of the particular fluctuations with science; “this involves all kinds of deformations, transmutations, passages to the limit, operations in which each figure designates an ‘event’ much more than an essence” (422). Problems play out as forces that pierce through bodies like vectors (including the bodies of concepts), pointing in their unique non-referential directions in a smooth space; as affect, we feel compelled to respond. We have not left the concept of the clinamen behind: a nomadic science problem is like a Lucretian atom and its declination, for they both have a tendency to bend away from the straight lines of a referenced space, resulting in vortexes and unique motions that resist being captured into a set of parallel flows. The content of the science and its means of development cannot be separated (declination content, developing like a clinamen). The methodology of nomad science is eccentric—off-centre—developing in a manner completely different from state science (and yet the methodologies are necessarily tied to each other as an inside and an outside, for there is no de-centring without a centre and no centring without a de-centred space). However, even though nomadic science is not theorematic, it still deals with an abstract knowledge (422); the abstract can be concrete, but rather than discrete, isolatable, or discontinuous, it is diffuse or continuous with action and becoming (Adkins, 25).

When the content of a nomadic science is taken up by the state structure (reterritorialized into the state), it is necessarily transformed, for by definition the nomad and the state are different ways of being (manifestations of tendencies) and so they cannot be directly translated into each other without a forgotten remainder. This is the case whether the smooth is directly converted into the striated, or the smooth is only made meaningful in its functioning for the striated. “State science retains of nomad science only what it can appropriate; it turns the rest into a set of strictly limited formulas without any real scientific status, or else simply represses and bans it” (sometimes as mistakes or errors, other times as outliers, noise, or approximations) (ATP, 422). Most nomad science, insofar as it has not been fully reterritorialized by the state, is always given a derogatory status of “parascience”, such as calculus or hydraulics when they first appeared (423). According to D&G, calculus was at first deemed a “well-founded fiction” and mathematicians tried to increase their scientific status by removing everything within it that designated it a nomadic problemata, its “becoming, heterogeneity, infinitesimal, passage to the limit, continuous variation”; in doing so, by imposing static and ordinal rules under its infinitesimals, it changed in quality and became a state science (423). Or in the case of hydraulics, the state needs this science,

> but it needs it in a very different form, because the State needs to subordinate hydraulic force to conduits, pipes, embankments, which prevent turbulence, which constrain movement to go from one point to another, and space itself to be striated and measured, which makes the fluid depend on the solid, and flows proceed by parallel, laminar layers. The hydraulic model of nomad science and the war machine, on the other hand, consists in being distributed by turbulence across a smooth space, in producing a movement that holds space and simultaneously affects all of its points [like the Go board], instead of being held by space in a local movement from one specified point to another. (423)

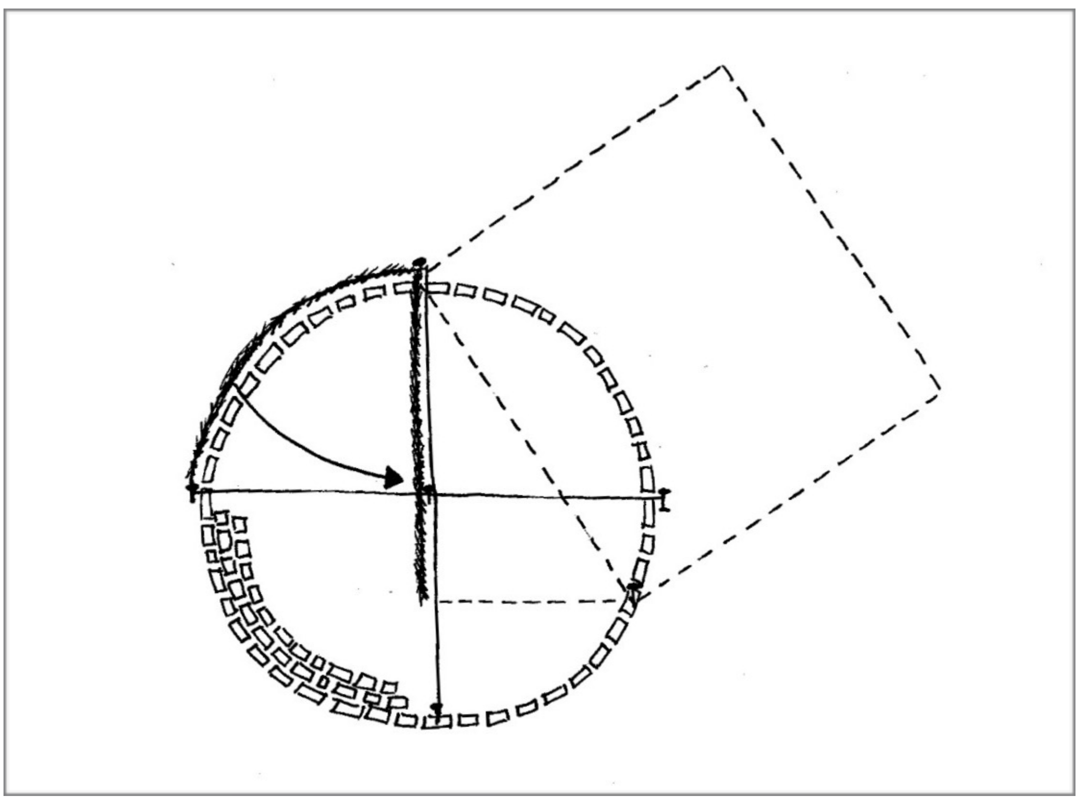
So of course, the state is dealing with liquid problems, but it defines the problem as subordinate to the structure. This is part of a qualitatively different action and system.

Is the Plaza a Circle or a Quadrature?

Say there is a circular brick plaza in a small town and according to a change in the town's urban design we want to make it into a square plaza, reusing all of the bricks, no more, no less. To do this theoretically, as if it were a textbook question, we need to have a set of transcendent principles and forms, the concept of the ideal circle and the equation that it is wrapped up with, $A = \pi r^2$ (A is the area of the circle, π is the transcendental number pi, and r^2 is the square of the radius of the circle). When we perceive the circular plaza like this through the lens of a state mathematics, we pretend as though it were a material instance of a circle that exhibits these mathematical properties—this is hylomorphism—and once we do this, we can easily calculate an ideal area of the plaza by first measuring the radius of the plaza, squaring it, and then multiplying it by π. Then, to determine the side of the square which we wish to create, we need only take the root of the area of the circle. Once we have this abstract determination of the form of the square that we desire, we can impose this back onto the physical space and begin to manifest the square form with ropes, shovels, and extensive measurements. There is nothing particularly wrong with this method; it is quick, efficient, and most importantly for the state, it is accurate and easily and precisely reproduced and taught (requiring little skill). This method is interesting because it requires very little grappling with the particularities of that plaza; it is able to do this because it takes that actual plaza in the small town not just as circular or round, but as an instance of an ideal circle on ideal ground. As soon as that plaza is taken-as-a-circle, all of the other details like the non-human ecology, soil quality, or the surrounding buildings are ignored, considered irrelevant, or in modern parlance, deemed regrettable ‘noise’. This theorematics approach is made possible by the transcendental number π, which cannot ever be expressed by any set of finite digits, but which acts as an important, invariable passage from radius to area; it is a constant, an eternal, immutable essence.

But, and this is key, *there are other ways* to transform a circular plaza in a small town into a square one, methods more immanent than transcendent equations, constants, and forms. There is the method of the quadrature, or squaring. The calculation of an abstract square is the theorematic method, while the quadrature is the problematic method. To square the circular plaza, we can also do the following (Figure 3).[17] Find the centre of the plaza and then draw lines

Figure 3: Squaring the Circle with a Rope.



[17] Method adapted from Murray Bourne, “Squaring the Circle: Rope Method.”

with rope that cut it into quadrants. Anchor a long rope on one of the quadrant markings, on the perimeter of the plaza; arch it around the plaza until the rope reaches the next quadrant marking. Mark this point on the rope and then rotate the rope so that it is still anchored to the first pole on the perimeter but falls straight through the centre of the plaza. Next, walk perpendicular to this rope from its endpoint, and when the walk intersects with the perimeter of the plaza, stop and anchor another rope to this point. Extend this rope to the first anchor. The length of this rope is the length of the side of the square plaza that is being created. Reproduce this length with three more ropes and then assemble a square out of ropes so that its centre overlaps with the plaza. Voilà. No numerical measurements were made: no rulers, equations, or abstractions were needed. Since there is no numerical measurement, there is no way in which the quadrature could deviate from a measurement, and so there is no "error" of measurement to be found; "error" of measurement, "approximation," and "noise" are irrelevant concepts here.

The quadrature is usually mentioned in the context of the ancient Greeks and not a modern plaza. The ancient Greeks did not like to use ropes, apparently; nor did they have the tool of algebra; this meant that their mathematics was a manipulation of drawn lines and curves, using a compass and a straight edge. One of the proposed ways to determine the area of a shape was to perform a quadrature, which was the physical construction of a square of the same area as the shape, manipulating lines on a writing surface. Without a standard metric, they could not measure the length of anything with a ruler, but they could make comparative measurements and constructions: they could make straight marks with the straight edge, arcs with the compass, and they could reproduce lines, add or subtract them, multiply or divide lines using overlapping triangles, and even construct a line that was the square-root of another using a hemisphere or a isosceles triangle. According to transcendent interpretations, the ancient Greeks were foolish to attempt to square the circle with only a compass and a straight edge, because it would only ever produce an approximation.

Often, state science does not deem problematics to be a science. D&G gave the example of calculus, which was not deemed a science until all of its nomadic elements were erased (423). Squaring the circle is another example. When π was proven to be a transcendental number this meant that it had been proved that it could not be derived from any fraction of integer numbers nor an algebraic equation (Lindemann-Weierstrass theorem, 1882). In turn this meant that squaring the circle was "impossible" in a finite number of steps. This makes sense from the side of state science, which requires a belief in its transcendent forms, such as the circle or π. It is true that according to the logical connection of ideal figures in mathematics, if one were to take an ideal circle, an ideal straight edge, and an ideal compass, one could not construct an ideal square with the exact same area as the circle. It is a game of ideals, and the impossibility of squaring the circle is only situated within this game (which only exists in the world of pen and paper, and perhaps something like the world of forms). The quadrature is possible if one changes the rules, introduces an ideal rope, bends it around the ideal circle, and then straightens it (ideally); but from the perspective of the game, the use of a rope is "cheating" because it is not a geometrical ideal, and it only superficially circumvents the infinite steps that are required with a straightedge.

From the side of nomad science, this critique misses the point. Squaring the circle is entirely possible in a finite number of steps: look at Bernard and his journeymen, they just did it. But look at Srinivasa Ramanujan's method of approximation, his magnificent equations and diagrams scribbled on brown, wrinkled parchment: $OH = \frac{1}{2} OP$, $RT = \frac{1}{3} OR$, $RS = TQ$,

$\pi = \frac{355}{113}(1 - \frac{0.0003}{3533})$; the mathematics pulses with an insurmountable struggle; he is unable to succeed because he's set himself the game of ideals. From the side of the game, even methods with ropes which can "accurately" square the circle will always be approximations, because the standard of accuracy here is smuggled into problematics by state science, where error is found in the gap or discontinuity between form and instantiation. But for the nomad approximation is not a hindrance to the possibility of a quadrature; approximation is irrelevant to the quadrature because the form or essence is not separate from the act, and is in fact continuous with it (this is one way to interpret the principle of immanence, or more clearly, as Adkins articulates, "the principle of continuity"). There is no way to reconcile this different way of thinking with the state mathematician and so the argument cannot satisfy their tendencies or preferences—unless they change their perception (this is the crux of a perspectivalism, such as Nietzsche's). In nomadism, matter is not formed by immutable essences, and so a circular-shaped plaza reshaped in a small town was never considered a "circle" in the first place. There are no "squares" or "circles" but there are the many lived events that reside on the edge of consistency, always able to lead to another becoming: the circular array of bricks, the quadrature with all of its ropes and poles and digging and shifting, and then the new squared plaza, which is as well a lived event and is always ready for new events and becomings. The passage between is the becoming and tendency to change, and it is what nomadism is concerned with. So here it would be absurd to subordinate this transformation to the tendency towards stasis. The essences do not determine the acts, but *are* the acts. This means that the act of squaring the circle can easily be taken in a finite number of steps because it is not made possible by fidelity to a representation, but more humbly, to its own functioning. And so this is why D&G say that "the square no longer exists independently of a quadrature" (422). The quadrature is a becoming-square, which does not involve an eternal essence or "squareness," but is rather a way of relating to matter, whose actions are operative equations and constructions. The plaza under construction is not a circle that swaps into a square; its construction is in the act of the quadrature, which is a middle-zone that is not defined by the end ideals of circle and square. This is what D&G mean by "vague essence," which I will discuss later, and includes such terms as roundness or warmness. The plaza is a becoming, a process, and a skilled assemblage of tendencies. It acts and is acted upon. In this way, the figure in problematics is made up of affects, because each part of the figure acts in a different way on the nomad scientist(s) responding to it: there are "sections, ablations, adjunctions, projections" (421) that call for different lines and ropes to be drawn and different movements to be made. This is clear in the quadrature method of rebuilding the plaza, where different parts of the plaza and different ropes and lines are imbued with equations that direct us to certain actions. This reality of the vital singularities of matter and "place," and the perception and response to these are the problemata; it is a weapon of the war machine (ATP, 466), because it is a way of being that undermines the epistemic authority of state science: a quadrature never once requires a homage to π or the ideal circle. To square the circle is to respond to a particular matter, to be caught up by its clinamen, which dominos into a vortex of excitement and creation, guided by the nomad scientist's operative equations, and leads to the construction of new shapes and assemblages. We need don't need to know state math, and we don't need to buy more bricks or throw any out. What we need is something more difficult and productive: the virtues of respect, imagination, and generous interest; and a few perception buddies, a few other nomads to help with the quadrature and any other becomings that might pop up along the way. When the plaza is rearranged by the state and its mathematical method, nothing new can enter the picture. But when we arrange it by the quadrature method, we will be in principle open to possible lines of flight which will emerge from the difference of matter and our attention to it. Perhaps it leads to the restructuring of the entire town. Perhaps to the overthrow of the mayor's dictatorship. Or perhaps we make a dwelling space for the local pigeons. We cannot know until we try.

Chemical Waste

Since it is immersed in and responsive to the particularities of matter, a nomadic science is inherently less wasteful than a state science. The egregious amount of hazardous waste produced in a chemical laboratory which I attested to is therefore a likely symptom of state science. Whatever produces this amount of waste, the structure of the lab, its spaces and economy of chemicals, would also be a symptom of state science. The structure of the lab has been constructed in opposition to green or sustainable chemistry, a chemistry that actively minimizes its hazardous waste. Green chemistry is thus generally more difficult, and by a widespread lack of faith in it there has not been enough commitment and work to improve its results. It is obvious that chemists should be striving as hard as they can to use the least toxic materials for their research projects. But first, this is not possible without rethinking their fundamental areas of research: different reagents means different chemical reactions (or at least, variations). Second, the only way to truly avoid waste is for chemists to take up their research nomadically (since waste is an indicator of state science and nomadic science is the counter); just as the quadrature is done in the thick of the brick plaza, on the ground as it were and responding to the particular place, this nomadic research requires that chemistry be done *in a place*, rather than it be done "in" a theoretical problem. This is easier said than done because the laboratory is designed to be "out of place," separate from its environment, a place where theories and abstract problems are addressed: such as the problem of isolating a protein found uniquely in crustaceans, and determining its amino-acid sequence; or such as analyzing the initial growth patterns of the saplings of a certain tree species in a greenhouse. This "out of place" science is science as we typically conceive of it, science "as usual." It is indeed so difficult to conceive of otherwise because the "out of place" laboratory has sedimented, has become *so* widespread, reproducible, and secure that any change in the institutional structure would be a change in the nature of science (so it seems). And so for now, as the system slowly changes, the laboratory has to become its own place. In this way chemists could approach their research more nomadically, performing their own chemical quadratures. One of the questions that should matter to researchers is what kind of waste they have produced, for the production and recycling of waste can be taken up as part of the research project, a project that will not only refine methods of recycling, but will require forming a laboratory where the projects of that lab are constantly being affected by the actions of recycling. This is one way for the laboratory to become its own place, full of a self-evolving difference, like a Go board. The fact that a certain product like methanol is more easily distilled from the waste of a certain reaction should suggest another set of different reactions that use methanol. In this sense, the famed lab in Stanford that recycles its methanol does not go nearly far enough, because it merely recycles for the reproduction of one reaction (Kemsley). This is efficient and less wasteful; but it is not nomadic at all. In order for this chemistry to be nomadic as well as efficient, the waste and reactions should not form a neat, single cycle (or even several), where the reaction produces waste that can be recycled for use in the same reaction; it should be vortical in nature, spiralling to new reactions and new "waste" (which it is no longer). Such a conception of waste, waste that cannot leave the lab and must be taken back up, waste as yet another useful material, would lead to an ever-evolving research project. But recycling waste should not be outsourced; not only does this lead to more waste, it prevents the waste as acting as a line of flight on the research projects that produced the waste in the first place. The method of reciprocal recycling and reacting is a chemical quadrature, for in order to go from one set of chemical reactions to a new project with different chemical processes—in the same way that the particularities of that circular plaza in the small town directed our ropes and tools towards a new particular shape—the waste intermediate must be skillfully and attentively allowed to set the direction towards the next reaction. The waste, to become more than waste, must be allowed to express itself. As Jane Bennett said, we must not see it as "the litterer's incivility, the neighbor's failure to keep the storm drain clear," or the careless excess of a chemical reaction; we must see it as "an existant in excess of its reference to human flaws or projects" (350)—it is produced by a chemist's reaction, yes, but it has a rich, vital excess which we fail to perceive at the expense of the planet's pollution and the fixity of our own chemical research programmes.

*Gothic Architecture: "*Le Trait Pousse le Chiffre*"*

Bernard de Clairvaux found the task of constructing a cathedral based on pure Euclidean geometry calculations too difficult.[18] A major science would have involved the following directions: before setting foot in the building zone, arrange a set of volumes in a theoretical manner, calculating size of stone and their placements, and then use templates to create ideal blocks of stone, which can then be systematically positioned within a pre-existing framework or striated space—and which can then be reproduced with fidelity in the manner of the modern home (424). Templates and moulds, representations and forms—there are no mistakes to be made, only degrees of imperfection, and a certain potential need only be actualized. Since the template is inflexible, it precludes other possibilities. It is not like a Go piece, which has an openness to new functions that might rise up at any moment when the board is changed. Not only does the template model determine the cathedral beforehand, one must be *able* to do this—which is no small feat for a couple of journeyman.

But Bernard and his journeyman chose a minor science. They used the ancient Greek method of squaring or the quadrature (Adkins, 198). *Le trait* was a "cutting line" ("the line" in French) and a geometric building plan (425). It was described as a "graphic poem derived from geometry," sketched out on the ground, indicating placement of stone and projections of height, as well as other information (ATP, 652–3, translator's note 27, quoting Vergez). They did not use equations before seeing the building site, for the equations were inseparable from the zone, in the exact same way that a square in nomad science is the act of the quadrature. It was an operative

[18] Technically, Clairvaux was not an architect but an abbot who had great influence on cistercian architecture (Swaan). The cistercian style emphasized an austere design without embellishment and it was a transition between the Romanesque and Gothic styles. Despite a difference in style, it seems that D&G believe that Clairvaux's journeyman Garin de Troyes embodied a Gothic spirit.

geometry, certainly determined by calculation and intense planning—in the thick of things, the intermezzo of the building zone—but it was also a “logic of movement,” so that *le trait* had its existence as an impetus: “‘the cutting line propels the equation’ (*le trait pousse le chiffre*)” (425, quoting Vergez). Or rather, *le trait* (the cutting line) was both an operative equation and an affect—as both it was a problemata. They were performing quadratures, cubatures, and rectifications, which are all transformations and constructions, rather than representations, instantiations, or reproductions. The precise sketches in the ground were a set of constantly transforming affects that they responded to. These chalk lines projected volumes above their surface and directed where to cut and to place. They were symbols that acted on the journeyman to position, draw, hew, move, and build. D&G say,

> One does not represent, one engenders and traverses. This science is characterized less by the absence of equations than by the very different role they play: instead of being good forms absolutely that organize matter, they are ‘generated’ as ‘forces of thrust’ (*poussees*) by the material, in a qualitative calculus of the optimum. (425)

What was a straight line if not a rectification of a curve? What was a square if not the very act of squaring an oblong shape? What were the meanings of the chalk symbols if not the way it set them in motion? These are all affective, operative equations, just like the quadrature. And the rocks themselves from a local quarry were like Lucretian atoms, with their clinamen; for all their bumps and particularities, their continuous variations must have acted like declinations, tiny deviations from a straight line or possible form of representation, calling for vortical organizations, sudden shifts in function, so that a line on the ground or a particular stone acted like an operative vector—*move this way*, it said—irrespective of some pre-existing grid or ideal form,[19] calling for the chiseling of the stone and the alteration of *le trait*, changing the shapes of arches, which in turn unpredictably changed the height, direction, and style of the "becoming-cathedral," evolving as stone was stacked on stone, until the cathedral reached beyond its romanesque predecessors.

And all of this makes a difference for modernity. Piotrek Swiatkowski describes the common modern architectural situation, which is state science on a family budget, as humanity living within drab boxes, pathetically ornamented, and lacking all engagement with matter (41). Under a state science, buildings are formed by reproducible and generalizable ideals. This applies equally to most modern as well as most post-modern architecture, which does not escape the problems of state science, for the asymmetry and playfulness of the Guggenheim museum, for example, is still another empty box or mould that acts as a template for each further building-style (42). If the building can be successfully extracted from its context and placed anywhere, without much change in its aesthetic, then it is exactly like a rook chess piece with its intrinsic properties, moving from one square on the board to another, and it lacks the immanent externality of a Go stone. On the other hand, as soon as we engage with matter appropriately, we discover that all matter has its own life; the development of a proper engagement with matter is concomitant with the construction of a "vitalist space" (42). In terms of "a vitalist Gothic ontology," ornamentation is not a veil, but "generates structures" (41). And this call for a nomadic architecture is based in ontological terms very similar to D&G's concepts of assemblages and matter-flow. Suffice to say, a building can only fully inhabit its place if it emerges from its surroundings and responds to them, if within the matter-flow it comes into

[19] Drystacking stone fences are another example of this quadrature building process.

being as its relations, to form a multiplicity or assemblage, a unity that is de-centred or always outside itself (the building exists as its relations to its surroundings, and its relations to its content). The design of outdoor spaces in landscape architecture should be continuous with the design of buildings and indoor spaces. This is not something that can be reproduced; it takes empathy, thought, and response. Further, it is vitalist, for it expresses “an inner force” of the materials (including the builders) (42), or it is made through and retains affects and problemata. A vortical organization is not simply chaos; it is difference. This emergence of a smooth space is a response and a relation; it is a section of a building emerging from an incline, as if projected outwards by the continuous variation of the ground.

To a small extent we can see this in buildings such as the sea ranch condominium in Sonoma County, California (figure 4); but only so far as it follows the curves of the slope, and even here we get the feeling that the building was forced upon the land. Perhaps it would have been more nomadically successful if it had combined its appreciation of the incline with the organic qualities of Gaudi’s cathedral in Barcelona, which goes beyond any kind of geometry. A better example would be Frank Lloyd Wright’s Fallingwater (figure 5), which is praised for a continuity with its site (Rawson, *The House on the Waterfall*). Its stone and concrete walls, floors, and balconies are interwoven with the landscape, sitting overtop of the river, sieving the waterfall, and leaning against the hill; as well, for example, the ledge of the hill protrudes into the living room, and there is a natural spring that passes through the house. Fallingwater is a crossroads of rock and water, hill and gravity; it is an assemblage continuous with the matter of its place and emergent as a whole; in this way it expresses the matter of the place and so it embodies a vitalist ontology akin to gothic architecture. As Schopenhauer says, a well-designed and well-built building is beautiful because it brings to light certain Ideas of matter:

> Such Ideas are gravity, cohesion, rigidity, hardness, those universal qualities of stone, those first, simplest, and dullest visibilities of the will, the fundamental bass-notes of nature; and along with these, light, which is in many respects their opposite. Even at this low stage of the will's objectivity, we see its inner nature revealing itself in discord; for, properly speaking, the conflict between gravity and rigidity is the sole aesthetic material of architecture; its problem is to make this conflict appear with perfect distinctness in many different ways. It solves this problem by depriving these indestructible forces of the shortest path to their satisfaction, and keeping them in suspense through a circuitous path; the conflict is thus prolonged, and the inexhaustible efforts of the two forces become visible in many different ways. (p 214, §43, vol 1).

A building is beautiful because it allows for a fuller expression of the complexities and relations of matter, or the discords of its Ideas. The beauty is found in matter's lived affect and vitality. We might add that a well-integrated or organic building is beautiful not only because it reveals the simple qualities of rock and light, but because in its continuity and contrast with its place, it shows innumerable Ideas of other elements or aspects of matter. In the case of Fallingwater, its integration is beautiful because it sustains certain affects and relations of rock, water, and vegetation, all of which express themselves in a plane of consistency with each other. In this way, by their continuity and difference, the building and the surrounding matter vitalize each

Figure 4: Sea Ranch Condominium, Sonoma County, California.

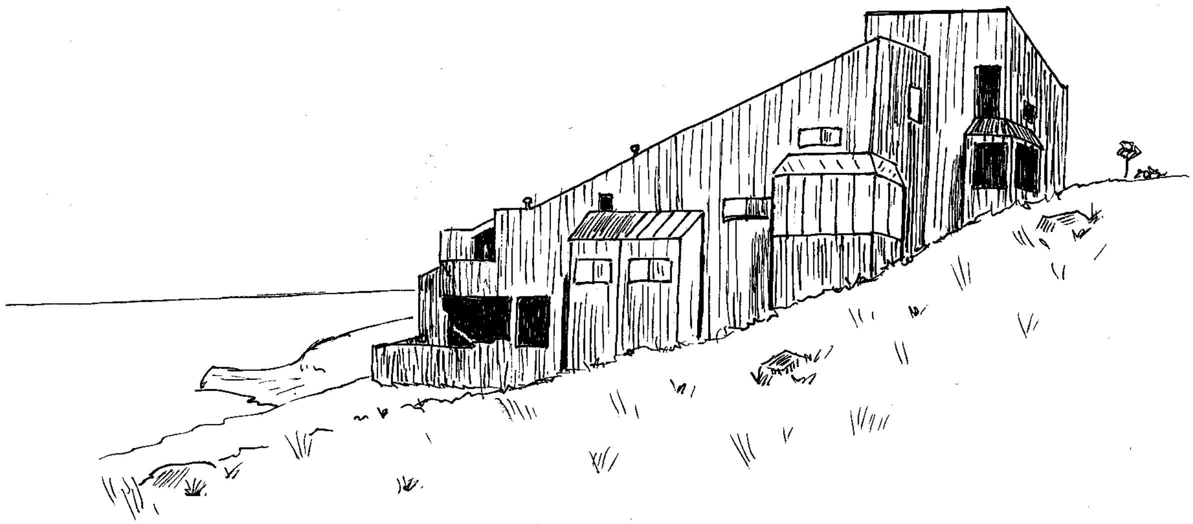
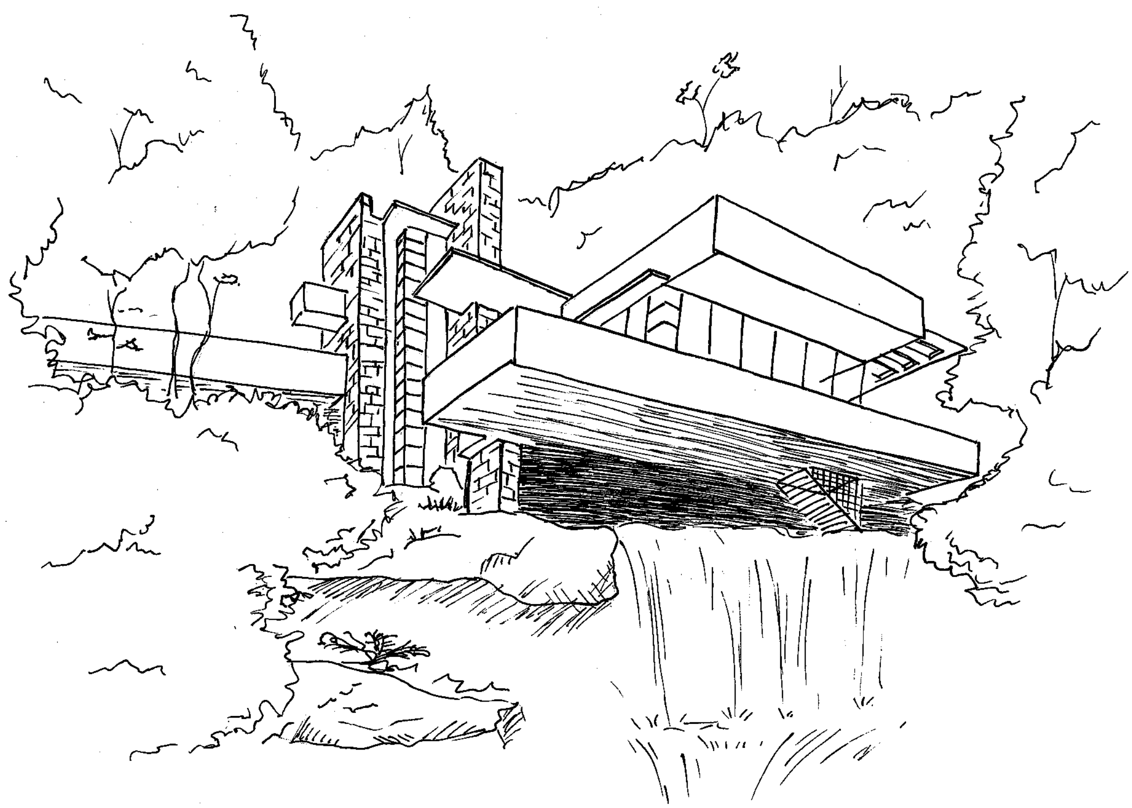


Figure 5: Fallingwater, Pennsylvania.



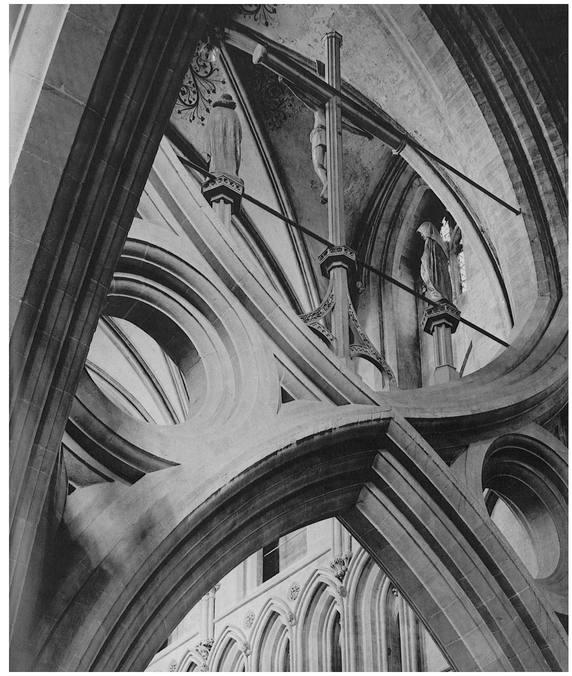
other.[20]

Gothic architecture is not at all the only kind of nomadic architecture; rather it is exemplary of one kind of nomadism. Nomadic architecture includes the organic architecture of Frank Lloyd Wright and Antoni Gaudi; but organic architecture is not in itself nomadic (it is neither necessary nor sufficient) because most important of all is the building's continuity with the matter on site or at hand. Fallingwater is continuous with its site, the river and hill; while gothic architecture is more continuous with the material at hand, for its development is responsive to the most recent stones that have been laid and the most recent ornamentations or styles. Both of these are nomadic in their own way.

The gothic architects embraced a continuous variation because they were persistently responsive to the present, incomplete condition of the building being constructed (so too with Gaudi's Cathedral, which is still not complete). Their worldview was "savage": mistakes, the bumps and confusions here or there, the sudden declination along a new vector, were often

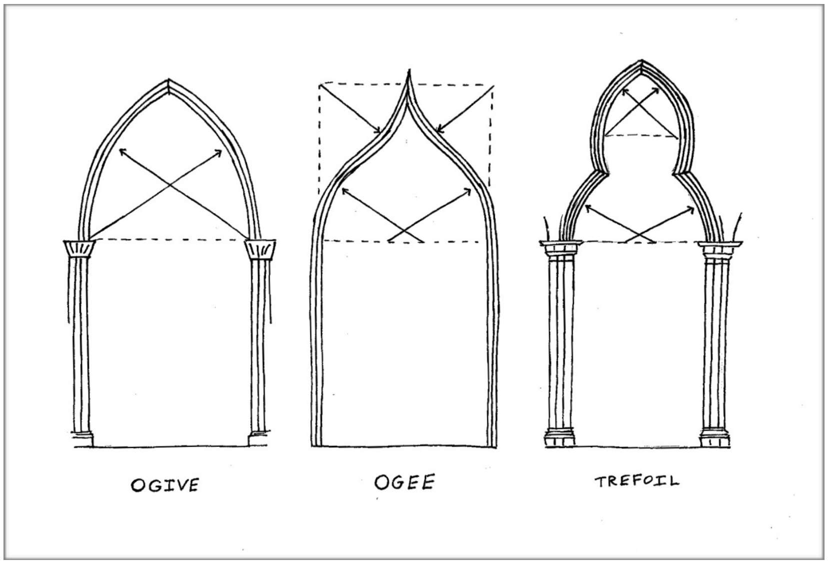
[20] By the way, a vitalist ontology, an affective matter, or even certain kinds of hylozoism (but probably not panpsychism) are not strictly speaking opposed to the metaphysics of philosophers such as Arthur Schopenhauer or Plotinus, for they mean of "matter" something quite different from what a philosopher such as Jane Bennett or D&G might mean. To understand this, we should not equivocate on the two senses of "matter" that are being used by the platonic and post-humanist philosophers. For Schopenhauer, "matter" is but causality itself (the *principium individuationis* of the Ideas), or rather our form of experience through which the Ideas or gradations of will of gravity, rigidity, light, and chemicals are phenomena; and the "matter" of which D&G speak of, would be for Schopenhauer not at all causality itself but a basic will, an Idea, or an in-itself of the world of representation; and even for Schopenhauer, as in his discussion of architecture (p 213, §43, vol 1), simple wills (D&G's matter) are expressive because they are always mixed together in their difference, such as the striking contrasts of rigidity, gravity, light, and shadow of a tall building. Even Plotinus' conception of matter and becoming as negatives is not necessarily in conflict with what post-humanists find valuable in "matter," that is, the eternal freshness and fullness of the world. So a platonic concept of matter can leave room for another kind of matter, the simple will, which is inherently expressive. While it is undeniably expressive, it is on the table whether this simple will is aware or has some degree of consciousness. However, it does not really explain much more if we were to posit all wills as subjects. A conscious matter seems an unnecessary anthropomorphism. If we are to acknowledge the difference from ourselves that we find in matter, that utter alien quality, then it seems we should not reduce matter to consciousness or awareness. It seems that matter is more likely a blind, unaware will, but full of its own kind of expression. Strictly speaking then, though matter is not aware and lacks understanding, it is not "dumb" as Schopenhauer says (p 255, §52, vol 1), for it speaks in its expression.

Figure 6: The scissor arches of Wells Cathedral (Swaan, 188, 189).



reterritorialized, or better, paid attention to and responded to—the "mistakes" weren't undone and redone, but were accepted and taken up into the evolving assemblage (Swiatkowski, 43). The Wells Cathedral in Somerset is another well-known example. Wim Swaan says, "Around 1320 the central tower in the Decorated style was raised to its present height…and almost immediately the crossing piers showed signs of failure" (193). They had overestimated the amount of weight the central pillars (crossing piers) could take. Instead of undoing their work and relieving the weight, they took it in stride and added a further embellishment. "The remedy, in the form of scissor-shaped girders bracing three sides of the crossing—the fourth being sufficiently

Figure 7: Varying Arches, built from J-figures, S-figures, and C-figures.



strengthened by the stone screen shutting off the chancel—has given this cathedral perhaps the most bizarre and sensational structure in all Gothic architecture" (Swaan, 193). See figure 6. In other words, the scissor arches look like a cosmic owl. As someone who has spent time in the shadow of the arches, Swaan has this to say: "Disquieting, and certainly not beautiful, the brutally massive strainer arches of Wells, nevertheless, exert an uncanny fascination, contribute enormously to the drama and mystery of the interior, and afford the most exciting and unexpected spatial sensation" (Swaan, 193). It is not a coincidence that the Gothic architect's "savagery" and acceptance of this mistake led to a deeply *affect*ive structure.

A gothic cathedral took generations to build, and because of their mindset, it was flexible and varied (Swiatkowski, 43). Apparently, different generations would build in their own style, without merely imitating their predecessors; "Hence the second towers of many cathedrals were very frequently raised in completely different styles" (43).[21] Different sections of the building were constructible using a range of sub-elements (43). For arches, J-figures, S-figures, and C-

[21] Other examples include the Notre-Dame de Paris and the Cathedral of Saint John the Divine in NYC.

figures were used to construct ogives, ogees, and trefoils (43); see figure 7. Larger portions of the building were assembled in the same way, swapping out pieces in response to the matter of the situation (43).

The mere fact of variability of gothic architecture does not make it a nomadic science; rather it was their means of dealing with matter-flow, or how they used equations and theoretical material. The problemata rather than the theorem was essential for the actual construction of vital buildings. It is not possible to imitate the vitalism of certain architecture from the side of state science, for as soon as the building is made into a template and reproduced, that reproduction is an ersatz. There is simply no way to construct a life-giving building within state science. When there is no preset reference of a finished, ideal building which can be broken down into template parts (the theorematic), then the ideal can always be set out of reach. This was essential to the gothic sensibility:

> A magnificent enthusiasm which feels as if it never could do enough to reach the fullness of its ideal; an unselfishness of sacrifice, which would rather cast fruitless labour before the altar than stand idle in the market; and finally, a profound sympathy with the fullness and wealth of the material universe. (Swiatkowski, 44, quoting Ruskin)

This is the "generous interest" at the heart of an ethics of difference. As well, it is coupled to an ontology, where

> there is plenty of accident, yes, but accident leading to substance, and there are huge amounts of flexibility, but flexibility leading to rigidity. Things do not miraculously meet in a single moment either through magical emergence or magical intervention; rather,

> they settle step by step, in a process that takes on more direction the more it progresses, trading the initial vagueness for increased determination. (44, quoting Ruskin)[22]

So the vector grows in intensity with each set of stones placed, and the direction becomes more enthusiastic, towards more engagement with matter (rock and air and light). Hence the difference in the basic affect between romanesque and gothic churches: the former feels squished downwards, downtrodden, heavy and ready to passively receive conflict like a sad turtle; the latter feels like an ongoing rush upwards, as if the workers were becoming more and more frantic, piling rocks on top of each other, worried they would run out of time, until finally, the last worker runs and tosses the last, highest rock, which lands, topples, but then freezes in a frame of static dynamism. Indeed, this is exactly what gothic architecture requires: a dynamism that is frozen layer upon layer. Swiatkowski notes its "savageness and vitality can only emerge as a consequence of the rightly set process" (45). And the process is one that embraces its own processual nature, its matter as a flow, its affect and problemata, its striving to fill the material world and to respond at each level. It is to improvise a science, to perform an anti-checklist experimentation. Because the process is affective, based on the smooth space, or the space of problemata, the result is expressive of the process; hence its vitalism. It was only because "Gothic builders battled against the weight of stone" (48) that their buildings expressed a propulsion upwards, a "spiritual delirium" (47). On the other hand, "the modern builders of skyscrapers lack a real opponent, an Other or stranger. They do not have to win. They are trapped by the possibilities offered to them by current technology." (48) They "only actualise the rules of

[22] The "increased determination" here is disputable. The determined direction can always be swerved in a new direction, such as when there is a radical change in style at the next level of the cathedral.

the existing state science" (48). Hence a common modern condition: functionally repetitive, empty boxes, bland spaces, affectively eclipsed by the ancient gothic cathedrals.

Laboratory Design

So one way to think about nomadism is that the direction of a construction of a space depends on its current state. This principle can be taken into the construction of a chemical laboratory or a chemistry classroom. We can even return to the hazardous waste example. If chemical waste requires such an effort to deal with—requiring an entire industry of collecting, transporting, and burning (Kemsley)—then it seems fair to try and share the effort among the chemists themselves. This could increase efficiency by completely removing the need for chemical waste collection and transportation; but it would of course also translate the burning into a recycling. It could also lead to less waste because chemists would want to minimize their waste in order to minimize the amount of recycling required. And, just as importantly, it could introduce an element of nomadism, leaving space for difference whenever it is sensed as needed. The complaint would be that this requires work that detracts chemists from their research—but this presupposes that the recycling could not itself be part of the research, and that chemists should speed up their research, as if the hectic rate of journal article production was not useless enough.[23] But if waste is taken as one problem of the current state, then a nomadic architecture

[23] We might add that there is a remarkable resemblance between chemical waste and scientific journal articles. They stack higher and higher and they often only serve to fill the digital landfills of information. They are stinky, dirty: no one wants to deal with them; we let them pile up out back. It is not only their sheer excess that shows this resemblance; they share an affect: scientists are sometimes disgusted with having to produce journal articles, disgusted that they have to convert their real information into such a sludge of passive speech. Lacking that, most scientists are apathetic towards them (for how many have been excited to write a formulaic journal article?). And apathy is but a lack of interest, not to mention a lack of *generous* interest essential to an ethics of difference. Journal articles: highly refined, "valuable," but completely toxic in affect and volume.

should respond to it. This means that space could be allocated in all laboratories to the recycling of the waste produced in each lab. But if this “recycling station” were to work, it would have to be experimental and collectivized and not a set of concretized equipment and procedures.

More radically though, if laboratories were to be designed and built according to their actual context, then the insides of the laboratory would drastically vary from place to place—and would be constantly varying. We are beginning to see how extreme nomad science can be: the reproducibility and abstraction of state science, the fact that every synthetic chemistry laboratory has fume hoods, pH meters, erlenmeyer flasks, and identical bottles of dichloromethane—all of these, which we typically take as signs of a healthy and functioning science, are counter to the nomad; the nomad has nothing to do with these. Instead the nomad is out back, chipping away at the rocks, extracting sap, or making nuts and bolts in the shop, inventing something. And slowly the nomad develops their own laboratory from the ground up, extracting problems from their current situation. We cannot know what their laboratory would look like precisely because it only depends on their situation.

Such a quaint picture of the nomad seems absurdly nonscientific; and more like a hobbyist than anything. What about the conditions of objectivity, abstraction, and reproducibility? What about equipment? What about non-local problems such as climate change? These *are* serious issues with nomadism (just as there are many issues with the state). The virtue of generous interest can be very counterproductive: the nomad is so absorbed in their immediate engagement with vibrant matter that not only have they forgotten wider problems, problems that lie beyond what they can directly sense, they have also ceased to abstract, preventing other scientists from reproducing their interactions with matter. Contextuality can become countercommunicative: the truest of nomads could never write a journal article because they are so wrapped up in their immediate, singular problems. And the purest of nomads would never be able to help battle global climate change, for they would only ever be wrapped up in the changing elements of *their* place. In fact, the power of state science is this, to do what the nomad cannot: it can take on non-local problems as a whole, and it does this by means of its abstraction and reproducibility. As well, it is the state that provides the nomad with a well-functioning pH meter. Thus in many ways, there *have to be* those pristine chemical laboratories spread across the globe, and there have to be forms of reproducible procedures, materials, and communication; but that's not to say we have to kill the nomad who's out back and burn their laboratory. For even though it is true that the nomads by themselves are not scientific, it is also just as true that the state by itself is not scientific. Neither state science nor nomad science can exist without each other, for the state and the nomad are necessary correlates, the fold of an inside-outside. Thus science is born from their tension and it can only survive as a mixture. We need those nomads; without them, science would die—is in fact dying under the rise of a state-craze. Though we should retain something of the state's fetishized laboratories and equipment and communication, we need to increase the mixture, stir the pot again, allow the crazies back in; because more important than reproducibility at the moment is the *creation* of functions, an increase in our powers and ways, an ability to do otherwise. And this means, as we will see, not segregating the nomads and the state functionaries, but insistently keeping them mixed.

Chapter 2: Mixed Science

The Continuity Between Essences and Labour

The state in the medieval ages did not always support gothic architecture, for it often sensed how this science was external to itself, a power different and in conflict with its own (ATP 425). The journeymen of Gothic architecture built far and wide, so they were quite mobile (429), and though their labor was divided and partitioned, it was not sedentary and not regulated by a larger centralized body (428). This nomadic model of labour, which D&G call “free action,” is directly opposed to the state model of labour, or work. To deal with the Gothic journeymen, “the State’s response was to take over management of the construction sites, merging all the divisions of labor in the supreme distinction between the intellectual and the manual, the theoretical and the practical, modelled upon the difference between ‘governors’ and ‘governed’ ” (429). This led to unskilled or unqualified labor on site, with theoretical, skilled labor seated off site, in the capital and under direct scrutiny of the state. The supposed power of the latter, the architect (and not the Gothic journeyman) became only a puppet to reproduce the power of the state, and the journeymen became grunt workers of little value. To some extent this must still be true because of the vast swath of hideous suburbs in every modern North American city, the houses of which are presumably “designed” by architects, though they are hardly even variations on the same basic “state house” theme, and which are always constructed by workers who have no say in the design and who are easily replaceable. The state’s reformulation of work—its “dequalification of labour” (429)—is also its repression of nomad science. The motive for this repression does not really come from the inadequate or inefficacious content of nomad science: it comes from the challenge this science presents to the state in its division and control of labour (429).

That said, the content of the science and its division of labour cannot be pulled apart. The difference between content and labour, D&G say, "is not extrinsic: the way in which a science, or a conception of science, participates in the organization of the social field, and in particular induces a division of labor, is part of that science itself" (429). There is a continuity between the content and labour, theory and practice. In fact it is the state's claim of *dis*-continuity between practice and theory which serves to instantiate a labour model that can be easily centralized and governed.

A state's own scientific content, its hylomorphism, is continuous with its scientific practice and government. Essences in state science are static and ideal, like a chess piece, a circle, or subatomic particles (ATP, 427). These essences are the form in a hylomorphic model, which give shape or intelligibility to the pure chaos of formless matter. The hylomorphic model implies "both a form that organizes matter and a matter prepared for the form; it has often been shown that *this schema derives less from technology or life than from a society divided into governors and governed, and later, intellectuals and manual laborers*" (430, my emphasis). The primary motive for the content of state science is the way in which it allows for centralized control and reproduction. In this model matter must be homogenized, and form or the governor is the only expressive aspect. The formless, the governed, is left empty of any ability to express its difference. The state has the following division of labour: "Settling, sedentarizing labor power, regulating the movement of the flow of labor, assigning it channels and conduits, forming corporations in the sense of organisms, and, for the rest, relying on forced manpower recruited on the spot (corvée) or among indigents" (428–9). All of the control, expression, and skill are located in the off-site position of the governor, architect, or engineer, while all of the practical work or form-filling is made completely de-qualified or unskilled (governed, journeymen, plumber). Here D&G are in agreement with Karl Marx, who calls this "the objectification of labour" (71), where the workers themselves become "the most wretched of commodities" (70) or rather expressionless matter.[24] Marx argues that with the intensification of the capitalist state there is an inevitable distinction that emerges: "the whole of society must fall apart into the two classes—the property-*owners* and the propertyless *workers*" (70). Therefore we have the static essences, forms, laws, directors, architects, engineers, and property-owners that are located in a tight circle of the state's functional oligarchy, while the quantified commodities, machines, and workers are controlled in order to actualize the static forms of the state. The ideal form of this division of labour is industrialization and factory work, and we see this to varying degrees in farming, textiles, education, and even scientific research (which I discuss further below). And finally, the factory work reaches an acme of dequalification either when humans are completely

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[24] D&G's critique of the state seems to have some parallels with Marx's critique of capitalism. While D&G's state is not necessarily capitalistic and while capitalism itself is not the state (528), the state does seem to have a tendency towards capitalism, so that capitalist structures can thrive in a state system (the chapter following the nomadology chapter, "Apparatus of Capture" focuses on this connection). Capitalism seems to be an extreme limit of the state's ability to reterritorialize or capture, extending to "a new threshold of deterritorialization" (527); perhaps we could say that in this transformation, the capitalistic economy becomes a supra-state. However, D&G disagree with Marx in important respects: for example, "We define social formation by *machinic processes* and not by modes of production (these on the contrary depend on the processes)" (506). Further, their criticisms also seem to have some parallels with Feminist philosophies of materialism and Marxism, which find interesting relations between patriarchy, capitalism, and certain kinds of science; in "The Feminist Standpoint: Developing the Ground for specifically Feminist Historical Materialism" Nancy Hartsock argues that there is a "sexual division of labour" between men and women, just as there was between property-owners and propertyless workers (284). Hartsock's powerful definition of a standpoint on page 285, which she applies to both class and gender, could just as well have been applied to those with specific dispositions or character tendencies, such as nomad scientists, who are oppressed by state science.

made into machines, in sweatshops, or when machines completely replace humans. Either way it is the living world becoming a factory.

Manuel De Landa gives the example of how the state transformed metallurgy into the metal industry:[25]

> While naturally occurring metals contain all kinds of impurities that change their mechanical behavior in different ways, steel and other industrial metals have undergone in the last two hundred years an intense process of uniformity and homogenization in both their chemical composition and their physical structure. The rationale behind this process was partly based on questions of reliability and quality control, but it had also a social component: both human workers and the materials they used needed to be disciplined and their behavior made predictable. (20)

In the state, for metal structures and tools to be reliably mass-produced, the "impurities" and complexities of metal have to be continuously eradicated. But not only is this a hylomorphic model constructing itself, subordinating matter to its static forms, reducing the world to a society where matter and social constructs follow general laws (such as how buildings are constructed with I-beams or drywall, or how time schedules keep track of employee working hours); not only does this model enforce the reproduction of certain forms, so that they are repetitively used in uncreative, non-local, and needlessly complicated solutions (a loss of innovative design based in an inability to conceive of new materials and their relations); this model and state science engagement with matter leads to the unskilled labour model as well, so that instead of people dealing with in situ metal as nomads in free action, they "work," particularly in the sense that

[25] The metal industry must be contrasted with the metallurgist that I will talk about later in this chapter. The metallurgist will be an example of an artisan, a scientist with both nomad and state tendencies.

work is always unqualified, repetitive and requiring little skill. This inevitably leads to a loss of jobs as the workforce is mechanized (21). The hylomorphic model is necessarily linked to routinization, mechanization, homogenization, globalization, as well as a devaluation and loss of skill, experimentation, innovation, and creation.

The state system, its concepts, its means of production, and the life of its labourer cannot be separated. And as Marx argues, the entire system egregiously favours the centre, the property-owners, the architects, and the governors, all at the expense of the workers:

> It is true that labour produces for the rich wonderful things—but for the worker it produces privation. It produces palaces—but for the worker, hovels. It produces beauty—but for the worker, deformity. It replaces labour by machines—but some of the workers it throws back to a barbarous type of labour, and the other workers it turns into machines. It produces intelligence—but for the worker idiocy, cretinism. (Marx, 73)

In its mechanization, the objectification of labour "appears as *loss of reality* for the workers" (Marx, 71–2). The system makes labour external to the worker, as time to be clocked. The worker is forced to view their own productive nature, human creativity, as merely a means to their individual existence (77); the worker's life-activity, their meaningful and embedded life in nature, becomes separated from themselves as a means rather than an end (75–6). Not only are they estranged from their own labour and activity, they are separated from the product of their labour, as a commodity that suddenly belongs to the property owner, the person who is at the centre of the factory, controlling it. And finally, closest to D&G's analysis, they are separated from "the sensuous external world" (72), separated from a meaningful engagement with vital matter and nature. This mechanization can go to such extreme extents, that in certain cases such as sweatshops, “the worker loses reality to the point of starving to death” (72). In sum, the state division of labour, its mechanization and routinization, produces within the worker a threefold estrangement or loss of reality, estrangement from the product, from the worker’s self or activity, and from nature itself (75). Gratuitous mechanization corresponds with a loss of respect for matter and an increasing hatred for our means of subsistence; no wonder there are so few inventors in the world, so few mechanical artisans; it is a system that punishes the virtues of respect, imagination, and generous interest. And since within this state capitalist system the alienated products of labour do not belong to the worker, they must belong to the property-owner, the centre, the state itself (78); as if this were not bad enough, the state will of course only use these products of labour or private properties for its own fortification, for the further alienation of labour (79); that is, it will use its private property gained from forced labour in order to further striate space and intensify a state science that has undoubtedly already been running out of control for over two hundred years since the industrial revolution.

A positive correlate here is that, though human free action (free work or non-estranged labour) can be made unnecessary in a self-sufficient state system (a smoothly running factory, a sweatshop), it can never be fully subsumed by the state, for insofar as it is “subsumed” it is actually transformed from free action into work. The mechanization of the workforce means that society no longer functions by human free action and the closer following of matter. Free action is no longer valued, rather than no longer possible; it is not given a place to function or a means of being rewarded. There is no place for an artisan in a factory, though the artisan is still possible.

The majority of scientific research in laboratories is performed by graduate students and postdocs. They are in the middle or nearing the end of their education, so they are considered not-quite-qualified, their pay is extremely low, and their hours are long. This is supposedly excused because they are students and they are learning. But what really is a graduate student or postdoc? A worker: they are paid to research. As well, they must take some classes and learn from their supervisor so that they can research satisfactorily: the supervisor teaches them how to instantiate the state essences.[26] The division of labour between the supervisor and graduate student is the same as the architect and journeyman, capitalist and worker. The supervisor is wrapped up in the bureaucracy of funding, publications, and teaching, and so they are the central connection of scientific research to the state, the hub of "expertise"; they do less laboratory work than their students, but traditionally their name goes first on a publication (the order of names on a science publication denote order of importance or involvement in the project). And all of these researchers are estranged from their publications, for a journal article is a third-person product of labour which is used to quantify the value of that labour, external to its workers—the article is what makes a worker valuable in the state's eyes. To fit into the state's labour division, the graduate students and their laboratory work is arbitrarily dequalified; they are fit into a structure where they are assumed useful for a set task, but only useful and skilled insofar as they are directed by their supervisor. These are the ideal state roles, so of course they do not map perfectly onto real situations, which will always have elements of nomadism, or rather divisions of labour that break from the state.

Universities, as mentioned, have been called "PhD factories" (Cyranoski et. al.). They use graduate students and postdocs and "permadocs" to produce information, only to spew them out into a job-market that is not prepared for their qualifications. The industrialization has not only

[26] This would be true of any state form of academia; it is not constrained to the sciences.

pervaded the equipment and reagents of a laboratory; it has turned people into identical machines that produce information; and it is just as wasteful and disrespectful of its people as its hazardous chemicals.

Nomadic Essences

On the other side of hylomorphism are the essences of nomad science, which are essentially vague, like roundness (ATP, 427–8). Nomadic essences are a becoming, are "transformations, distortions, ablations, and augmentations" that define the passage between supposed fixed essences (428), but in truth are not determined by the beginning nor the end, for they are essentially always a middle, *un milieu* (307). These vague essences are synonymous with haecceities (430–1). In general, a haecceity is whatever makes a thing the particular thing that it is and no other. So for the nomad, "it is the entire assemblage in its individuated aggregate that is a haecceity" (306). Following this definition, since the particular qualities of assemblages are always transforming, a haecceity is a pure event or a becoming. And since an assemblage is inherently contextual (like a Go piece), a haecceity is necessarily rooted in its place and time:

> This should be read without a pause: the animal-stalks-at-five-o'clock. The becoming-evening, becoming-night of an animal, blood nuptials. Five o'clock is this animal! This animal is this place! … That is how we need to feel. (306)

Yes, if we are to be nomads, that is how we must feel.[27]

[27] The nomadic obsession with haecceities is the (rhizome) root of a place-based ethic, an ethic that cannot be generalized away from the singularity of a place. To say the same, nomadism is the kind of perception that makes place-based ethics possible. In nomadism, what you do and how you do it depends entirely on your wider assemblage: your current landscape, local wildlife, human relations, political structures, and so on.

Motivated by this affect of the urgency of haecceities, which are always becoming anew, nomadic science discovers in working matter a fullness of heterogeneity and difference. Through the nomad's haptic perception, matter "is essentially laden with singularities" and always inherently expressive (430). The nomads themselves, then, as matter and engagement with matter, as but another assemblage, are free to create and express themselves. The assemblage nomad-scientist-stream-two-o'clock-dirt-field can express itself because it is like a Go board, whose pieces express themselves by their relations to all of the others, its expression transforming rhizomatically with the addition of a black stone: the nomad steps into the dirt field and changes the direction of the stream. The nomad expresses themselves as that which is in relation with matter and they find that matter expresses itself as that which is in relation with them.

Due to this expressionism, the division of labour in nomadism is not analogous to matter-form: "Rather, it *follows* the connections between singularities of matter and traits of expression, and lodges on the level of these connections, whether they be natural or forced. This is another organization of work and of the social field through work" (430). The nomad's organization of work is instantiated in the war machine, the assemblage of nomads that are always resisting the state apparatus.

We now have the following problems to consider: given nomad science's vague essences, what does its practice look like? And how can current individuals and societies move from state science toward nomad science?

The War Machine

The answer to the previous question is the main theme of D&G's 'Nomadology chapter' (p. 409–492) that we have been discussing for this whole thesis: it is the war machine. The war machine always has weapons, which are affects or problemata. The solutions of nomadic science to its found problemata are often labelled by state science as merely 'applied science' or technology (434); but as we have seen with quadratures and the Gothic journeymen's *le trait* (the cutting line), the weapons or the problemata are actually full of operative equations and abstract elements (abstract as distinct from discrete rather than concrete), for the entire endeavour of nomadic science is structured, but not in the sense of being ordered by transcendent equations or ideals; the operative equations are such practices as the quadrature or *le trait*, and so they are always a kind of scientific structure, despite their vagueness and lack of ideality. The weapons of the war machine are always "the active discharge of emotion, the counterattack" (466). But most importantly there can be "a schizophrenic taste for the weapon that turns it into a means for peace, for obtaining peace" (469), so that the resistance of the war machine is a weapon of peace. It seems then, that D&G call the affect a weapon not because it is inherently violent, but because it is a process of change and destabilization.

The tool on the other hand is the opposite: "it prepares matter from a distance, in order to bring it to a state of equilibrium or to appropriate it for a form of interiority" (461). Weapons and tools, as D&G point out, are not intrinsically different, but both are technical objects that can be interconverted with the transformation of their elements and relations (460). The weapon is centrifugal, the tool is centripetal. This is why the weapon is "violent," a resistance, a counterattack, an invention (461): it is necessarily a response to the formation of a conservative centre and it breaks stases and equilibriums (462). This is why the tool is always repressing resistance: it must gather together matter against its natural tendency to swing away from a stabilized centre, its radical clinamen (461). In this way, we can see again that neither can exist without the other, and that there must always be a tension. Along the same lines as mentioned previously, the weapon expresses and recognizes difference and unleashes becoming, while the tool is a striving for stasis and control. In this way, if we are to define true violence as a striving against difference or as a power-over, the tool is violent but the weapon moves towards peacefulness (for it is a recognition of difference and a power-with). As well, D&G speak of an "economy of violence" that the war machine lashes out (461). This economy is the nomad's management of de- and re-territorializations which constantly transform their own assemblages. The taking up of new relations and machinic parts and releasing of other stultifying relations and parts is a continuously varying resistance that constitutes the war machine. In this way the war machine could never be an institution, but it could pervade one.

Conceptual Tension Within the Sciences

The two sciences employ two conceptual models, which are extensions of the two tendencies. State science uses a legal model (logos), which D&G call "compars" (430). Nomad science uses a customary model (nomos), called "dispars" (430). The compars and dispars are conceptual, scientific ways of thinking, perceiving, and creating, and they are continuous with their respective individuals, labours, objects, government, and tendencies. As we might expect, compars is the model of creating laws by securing variables relative to constants, laying (discovering/inventing) an invariable form or static essence over the variable matter. Dispars places “the variables themselves in a state of continuous variation” (430), following one variable, then another, and yet another; there is no need for a grounding variable that unites and restricts all of them. Dispars is the model of creating equations that are becomings or processes and are “inseparable from a sensible intuition of variation” (430), or an intuition of haecceities and vague essences.

While dispars deals with matter-forces, and compars deals with matter-form, we might say that the compars deals with forces *as* form (such as the forms of gravity or electromagnetism). This force occurs across homogeneous space, that is, a striated space where the flow of matter is only made intelligible by its parallelism—as, for example, all the trajectories of falling bodies, which are only made intelligible by their movement through the partitioned space of a gravitational force. A centre of gravity is like an Archimedean point, from which its surrounding space can be made homogeneous by carving lines that radiate from the centre, and formalizing any point in the space as relative to these lines; “the vertical distance between two points provided the mode of comparison for the horizontal distance between two other points” (431). A form—the net of gravity—is laid down in order to capture all bodies within its partitioned space.

This formalism of striated space, the model of the compars, then in some sense “slows down” all bodies, by only allowing them to be intelligible as moving within the net of striated space and its objects. Thus bodies within the compars have weight, *gravitas*, or slowness; this is of course an image that Deleuze and Guattari use in intentional oxymoronic juxtaposition to their state-scientific meanings. Rather than saying gravity is the source of movement and speed, the legalist model actually constrains the clinamen to the lines they never quite follow—turning the

Lucretian atom into a reproducible "state atom"—and so it constrains their movement, perceiving them with a hermeneutical inertia, holding them tightly to the ground of the state's transcendent essences. The compars model is a hermeneutical inertia because its gaze of intelligibility (the way it perceives and then conceives, the way it thinks) "slows down" matter, refusing to acknowledge what it takes to be as impossible motions, motions that are never really caught up in a striated space. As soon as that smallest deviation from the straight line to the centre of gravity, as soon as a body has "velocity," we have curves: we have smooth space and we have speed, or *celeritas*. *Gravitas* and *celeritas*, "slow and rapid are not quantitative degrees of movement but rather two types of qualified movement, whatever the speed of the former or tardiness of the later" (432). The different qualified movements here are a matter of perception and response to the particularities of matter: to perceive and conceive by way of *gravitas* or by way of *celeritas*. These distinctions are valuable for thinking of the tension between the concepts: do we draw lines of weight or do we follow the clinamen as they curve away?

Gravity is the model of space that has a centre and parallel lines, so that all variables are set relative to a constant (the gravitational constant, the centre of gravity). This means that every field taken up by Western state science (or "royal" science) has been appropriated to resemble or engage with the gravitational: "even chemistry became a royal science only by virtue of a whole theoretical elaboration of the notion of weight" (431). But at the same time, every appropriation, every new discipline, has led to something that is not fully reducible to, and is excessive of, the gravitational force (432). While chemical disciplines do not contradict the law of gravity, these laws are strictly speaking "chemical" because they address supplementary forces that are not reducible to gravity (or electromagnetism); chemistry is chemistry because it does *something* in addition to physics. The laws of physics set boundaries for fields that physics can only see as empty—there is nothing in between the coordinate lines of its cartesian graph—and the laws of chemistry and biology live within these fields: but their content is certainly not reducible to the boundaries, and is rather an excess or deviation within the striated space.

Chemists are particularly suited to understand this conceptual tension (as long as they have some nomadic elements in their thinking). Chemistry is full of chemical models that have never been adequately explained by physical laws; and chemists have no reason to believe or hope that they could be fully reduced to physical laws. But at the same time, chemical models are thoroughly and constantly informed by physical laws, sometimes finding direct reasons for their conceptual connections in a physical logic. Chemical concepts like covalent bonding or crystallization are neither fully distinct from physical laws, nor derivative of them. In biology, the theory of evolution, in contrast, was not at all deduced from chemical or physical laws (though it was later manipulated to fit within them). One particularly tricky chemical model is the hard-soft acid-base theory. This uses conceptual notions of "electron cloud malleability" for comparative energies of bond formation, which in turn informs the stability of anions and cations, and how acidic or basic a kind of molecule will be in comparison to another. Electron cloud malleability is reasoned as intelligible by the structure of the atom, its balance of electrons and protons, and the number of electron shells (this connection to physical theory is a conception by way of *gravitas*, because it ignores the clinamen of the atom in order to fit it to a nested striated structure). For example, a fluorine anion is considered a hard base: because it has a full outer shell of electrons and there are not many other shells of electrons that could repulse them, they are strongly attracted to the positively charged nucleus, and they are sucked inwards to form a harder, concentrated, negatively-charged (basic) atom. This is continuous with physical modelling by the laws that undergird the periodic table; there is a conceptual connection here—sliding from electron cloud malleability and charge to the sub-atomic particle contents of the atom and their structure—but it is not really reductive or determinative. Further the entire model hinges on the principle that hard molecules are attracted to hard molecules, and soft to soft, reminiscent of and just as mysterious as the spell-like principle *similia similibus solvuntur*, "like dissolves like"; this principle has the same ambiguous relation to physical laws (it is ambiguously explained by the fact that a hard-hard interaction is a kind of ionic bond, while soft-soft is a kind of covalent bond). As well, this is connected to, but not the same as, "electron orbital theories," of which there is a plurality of models, and which it is in principle impossible to perfectly reduce to any quantum mechanical equation. This is due to the fact that the mathematics of the quantum mechanics of any atom with more than one electron encounters the "three body problem." Mathematics can only deal with two interdependent bodies at once, and so it is inherently biunivocal, between two bodies, like gravity; it can never precisely account for an interdependent assemblage of three or more bodies (this first came up as a problem in Newtonian theory when physicists tried to mathematize the gravitational tripartite relation among two planets and the sun). It is amazing, but not surprising that this is never taught in school, for it is an essential limit of state science—the world is not mathematize-able. It is not only impractical to deal with electron orbitals via strict mathematical equations; it is necessarily impossible. Yet, the quantum mechanical equations have certainly informed and guided conceptual mathematics and imagery of electron orbitals. So physical laws can always striate the chemical models, and provide a gravitational centre, but this reductive move necessarily eclipses the uniqueness in the chemical model.

New disciplines are created by the infinitesimal deviation of a clinamen—by a deterritorialization, a release from gravitas and reproduction—establishing a smooth space and new ways to engage with matter-flow, followed by a reterritorialization, so that the new space becomes striated once more, such as a striated field of chemistry within the striated boundaries of physics. Because it is necessary to pass through a smooth space in order to establish a new striated space, the dispars model is an essential player in the development of new disciplines in the sciences. Or rather, the tension and relation between compars and dispars models, between the smooth and the striated—which cannot be fully separated and are defined by their relation to each other, like the nomad and the state—this tension is the progress of science. D&G call this opposition of the two kinds of sciences a "tension-limit" (424). The tension could be said to be a *difference and plurality within science itself*. This ineliminable difference within science itself explains science's simultaneous control and creative freedom, its objectivity and invention. It also explains why it can be so difficult to provide a unified theory of science. But for the purpose of this thesis, we can say that when the tendency towards function is favoured in human activity (over and above the tendencies towards affect or concept), this makes for nomad science, state science, and artisanship (to be explained), a plurality of qualitatively different, interdependent, and overlapping practices. This plurality, along with the plurality of different disciplines that are not reducible to each other but are intricately connected—this double plurality is what I mean by the word "science." One of the working assumptions of this thesis has been that the powerful functions that modern science has produced (such as electricity, MRIs, insulin, airplanes, leukaemia drugs, the combustion engine, computers, and the internet) are just a feeble beginning: in a world crisscrossed by both the tendencies towards stasis and change, there is likely an infinite series of powerful functions that we have yet to discover-create, let alone begin to conceive of, and the only path towards them is to explode science in a flurry of creation—an increase of nomadism, an unleashing of the pluralizing of science itself.

Gravity and celerity are concepts of the tendencies to change and stasis insofar as these tendencies influence the two models of science, compars and dispars, in content and in their relation to each other. "The role of the qualitative opposition gravity-celerity, heavy-light, slow-rapid, is not that of a quantifiable scientific determination but of a condition that is coextensive to science and that regulates both the separation and the mixing of the two models, their possible interpenetration, the domination of one by the other, their alternative" (433). Gravity, the heavy, or the slow, is thus the tendency to stasis as it is manifested in the compars model of science; it is the tendency that motivates the model and pierces through it (or weighs it down). In the same way, celerity, the light, or the rapid, is the tendency to change as manifested in the dispars model (raises it up). And as two tendencies, they make the two models continuous: to pass from compars to the dispars, the science itself need only speed up, giving rise to vertical organizations, difference, excess, and deviation, forming multiplicities that act differently from the laws of physics, neither contradicting them, nor determined by them; conversely, to pass from dispars to compars, the science also slows down, creating a homogeneous space, where everything begins to follow "gravity", or in other words a constant relation that only ever exists between two bodies.

Every scientific discipline contains an inherent tension between the two models, compars and dispars. D&G emphasize that neither model is inherently better than the other; “Not better, just different” (433). The ethical problem here is not the choice between models, but a maintenance of a desirable equilibrium between them. The choice is about emphasizing different tendencies. The best science is not one that has mastered nature, that can achieve perfect reproduction, control, and regulation, nor even perfect representation (in other words perfect repetition). Nor is the best science a complete, servile response to the variations of a chaotic matter. And it is telling that the former is sometimes mistaken for the only good science; it tells us that the current equilibrium leans too far towards the tendency to stasis; the state, the left-hemisphere, and a fear of difference, have taken hold of Western modernity.[28] To take another chemical example, it is telling that many scientists believe that chemistry would be more reliable if it were to be made reducible to physics, such as rejecting the hard-soft acid-base model for it to be replaced by a thermodynamic system. Besides the fact that this general project is not really possible (given the three body problem, among others), this would only extend the field of physics and eradicate the particular field of chemistry in all its difference (this is really another reason why it is neither possible nor desirable). The belief that nothing would be lost in such a striation of scientific disciplines is unfounded and nonsensical because reduction is transformation: the mathematization of hard-soft acid-base theory would produce a mathematized construct, and conceptual tools such as electron cloud malleability would no longer exist in such a reduction, except as numbers.

Smooth space can *always* be translated into striated space:

[28] For a doctor’s perspective on how brain physiology has led to the similar conceptual and perceptive distinctions between the two tendencies, see *The Master and His Emissary* by Iain McGilchrist.

> As a general rule, a smooth space, a vectorial field, a nonmetric multiplicity are always translatable, and necessarily translated, into a 'compars': a fundamental operation by which one repeatedly overlays upon each point of smooth space a tangent Euclidean space endowed with a sufficient number of dimensions, by which one reintroduces parallelism between two vectors, treating multiplicity as though it were immersed in this homogeneous and striated space of reproduction, instead of continuing to follow it in an 'exploration by legwork.' (ATP, 434)

The intermezzo can always be tied to both ends, the passage or becoming positioned between two identities, reformulated so that it is not a movement solely in the middle, not only a vector without parallels, but a movement from one point to another along preset, reproducible lines. It only requires enough dimensions of the striated space to ensure that all the vectors and clinamen of smooth space are slowed down and encapsulated in a larger structure that sets them at parallels, angles, and fixed variables. The state can always capture the nomad. The gothic journeymen's problematics, their "drawing line" and their nomadic movement from church to church, can always be taken up by the state, restructured and directed according to reproducible templates and a division of labour between the unqualified and intellectual. The chemical model can always be reduced (maybe not by certain routes, such as reduction to quantum mechanical equations, but striated nonetheless), that is, it can always be lost in a mathematical transformation. Conversely, *there is always a smooth space outside the striated*; this is a necessary consequence of the definition of the nomad and the state, who are an exteriority and interiority that require each other to exist; no matter how complete a striated space appears, there is difference already acting, unseen, already exploding outwards, already always creating something new and upsetting the striation. The reduction of chemical models to physical laws only pushes the frontier of chemical models a little further, and perhaps even makes them more unique, so that the difference poses an even greater threat to the state science. Nomadism is always already pushing back.

Neither state nor nomad can exist without the other, and so the conceptual and practical tension is not a negation but a qualitative difference, like red and green—a red and green that depend on each for their existence. To speak in chemical terms, there is always an equilibrium; certain chemicals might upset the equilibrium, but eventually it will resettle in different proportions. “There is a type of ambulant scientist whom State scientists are forever fighting or integrating or allying with, even going so far as to propose a minor position for them within the legal system of science and technology” (ATP, 435). In this way, all state science is related to a series of external nomad scientists, and so all science, *to varying proportions*, is a tension of nomad and state scientists, dispars and compars, celeritas and gravitas, smooth and striated, arborescent and rhizomatic. We now turn to an example of how two other sciences can vary in their proportions of tendencies.

East and West Medical Practices: A Case of Varying Tensions

Acupuncture blindsided Western medicine. Here was Western medicine, slowing advancing and filling out its paradigm, when most dramatically in the 1970s (Allchin, 107), it was introduced to a practice that fit nowhere within its striated space. The method of acupuncture worked so well that the act of placing certain needles at certain positions in the body could not only deal with chronic pain, but could act as anaesthetic for major surgeries (Allchin, 113). From its first exposure, Western medicine has had no adequate explanations for the efficacy of acupuncture (Allchin, 108–109). At first, Western practitioners attempted to disregard it as somehow untrue, as "quackery," but at soon as they began to experiment in their hospitals, they could not deny the evidence (Allchin, 108). Most interestingly, even though Western practitioners had no adequate explanation of their own, they rejected the Chinese practitioners' explanations on the ground that they were unscientific (Allchin, 110). The traditional explanation of acupuncture relies on the metaphysic of *qi*, "a primordial life energy or quality… that give substance to all matter" (Allchin, 109). To give an unfairly simple account: "the flow of *qi* maintains a balance between *yin* and *yang*, the two complementary principles according to Daoist philosophy" (109); the body contains many channels for this flow, the upsetting of this flow resulted in health problems and pain, and "the needles either promoted or impeded the flow of *qi*, re-establishing the balance of *yin* and *yang*" (110), which would then remove the pain.

In Eastern practice, acupuncture has the makings of a minor science. Its content and practice is focused on the matter, flow, particularities, and becomings of the human body. Like the clinamen, the haecceities of a given patient are constantly shooting off in irreducibly particular directions, to create flows that can only be responded to and followed in the moment. The pain of a patient is unique and is connected by flows through their body, deviating with its uniqueness. There are equations, the specific channels within the body, along with the "twelve major meridians, each designated by a major internal organ (liver, stomach, spleen, gall bladder, etc.)" (Allchin, 109), which act *operatively* for the Chinese practitioners (in the same way as the quadrature). The haecceity of the patient and the equations are an impetus to "transpierce the body like arrows" (ATP, 415), or rather, as needles. And the positioning of the needle, though it is intelligibly connected to other parts of the body by the channels and meridians, seems to leap to other parts of the body, projecting in the manner of D&G's weapon, or like the roots of their beloved rhizome; for example, a needle inserted "between the thumb and forefinger" projects a flow through the body that can treat headaches and abdominal cramps (Allchin, 108). Of course, the entire method revolves around and is responsive to what both the patient and the practitioner *feel*. It requires a lot of attention to the particularities of the situation. In that way, the image of the vortical organization fits well.

The nomad tendency is strong within acupuncture, but it has still been striated to a certain extent by the Chinese state. Chinese medicine uses the cosmology of *qi* to explain acupuncture (to some theorematic degree) and it appropriates other practices into its own model (such as Western medicine).[29] Both Eastern and Western medicine appropriate each other's practices and theories into their own state structure. Their conflict is rightly noted by Allchin as something like between incommensurable paradigms (in the Kuhnian sense) (107). In D&G's terminology, there is a smooth space that lies between the two striations of East and West medicine, and the form of striation inside each is different. Further, the difference in the content of each state science corresponds to a difference in the degree of each's respective striation. Western practice denied the scientific status of Chinese practice, in the exact same way that a state responds to an exteriority. In this case, it has not been reciprocal: Chinese practice does not reject Western practice as unscientific, and rather affirms both of their practices and explanations within its own state science (Allchin, 110). The fluid metaphysic of Chinese state science corresponds to this

[29] An indication of that acupuncture has been striated in the Western world is the fact that needles are needlessly disposable rather than reusable. The state is not concerned with waste, so long as it allows for control. This occurs in all areas, including the enormous waste of hospitals, biomedical sciences, and chemistry laboratories.

lesser degree of rejection or twisting within its appropriation (or reterritorialization); it is very possible that it has less of a patronizing tendency to label other sciences as unscientific. Western medical science is more typically a state science. In the west, the tension favours the state, in the east, it favours the nomad; but both nomad and state exist in both. Allchin suggests that the reason Chinese practice was able to so easily appropriate Western science, despite the fundamental incommensurability, was due to its "thoroughgoing pragmatism" (111). If this were a Western reterritorialization of the Chinese ontology—which suggests that the deeper ontological questions in some sense don't really matter for the Chinese—it would be patronizing. To speak as if *qi* did not explain the experimental results, and is rather only a summary of the facts, is to pretend as if explanations in the west were always fuller and less provisional than that, and to pretend as if *qi* did not lead to predictions and new discoveries within acupuncture (which it did, such as using it as an anaesthetic for major surgeries). Rather *qi* explains and situates pain and disease within a cosmological and fluid theory (containing elements of a minor science), and indeed it avoids a penchant for over-explanation by paying homage to the particularities of a body: *thankfully*, "no cosmological reasons, at least, dictate the *specific* meridian pathways, which sometimes take abrupt turns, or zig-zag their way, say, around the side of the head" (111). So by pragmatism, Allchin means that, "the implicit aim has always been effective practice or performance, though the cosmological organization remains" (111); they have systematic theories (*qi* maps), but they often tend to follow matter, rather than reproduce it. As Kaptchuk makes the distinction, Western physicians rely on localizable and isolatable diseases and structures, so that they can analyze the patient, breaking down the body into its relevant and irrelevant components, while Eastern physicians assemble a wholistic picture of the patient, and look for a pattern of disharmony, using a kind of synthetic logic that organizes the whole and provides a means to harmonize the whole (3–4). These are both a science, with differing degrees of tendencies.

Since the synthetic approach of Chinese practitioners focuses on the particularities of a patient, their science is undoubtedly nomadic; but since they subsume these particularities into a striated structure, dichotomizing into forces of yin and yang, and formed patterns, and since they have developed a practice that can be taught and reproduced, theirs is a state science. As Deleuze and Guattari define state, every state has a degree of unity of composition, but each can differ in their development and organization (ATP, 449). States in the Orient have unity, but their parts are "much more disconnected, disjointed, necessitating a great immutable Form to hold them together" (449). We might say that Chinese medicine is a state science that is in more balanced tension with its surrounding nomads, even though it may be true that this then means that the state itself is susceptible to "incessant revolts, by seccesions and dynastic changes, which nevertheless do not affect the immutability of the form" (449). Or we might say that more (but certainly not all) Eastern practitioners are in more balanced tension with their inner nomad and the haecceities of matter that they continuously encounter. Chinese medicine functions clinically (Kaptchuk, 21), but it is a kind of state medicine that is more open to anomalies as evidence (which for them are really just particularities to be subsumed into a holistic pattern) (Allchin, 113) and patchwork appropriations; this is why the Chinese state can, without even batting an eye, use both traditional and Western medicine to solve different problems (Allchin,110–1 ; Kaptchuk, 21). D&G make the distinction in the following way: the striated space of the oriental state is far more open to the smooth spaces exterior to it (hence, a more balanced tension), and so often "the oriental state is in direct confrontation with a nomad war machine," which means the integration of the war machine into the state is ongoing and proceeds at a much slower pace than the Western state (449). On the other hand, "Western states are much more sheltered in their striated space and consequently have much more latitude in holding their components together; they confront the nomads only indirectly," the confrontations of which would be then far more extreme in pace and degree (449).

Indigenous Sciences

Allchin notes that the relation between Eastern and Western medicine is analogous to Western medicine's relation to ethnobotany, ethnoecology and other Indigenous sciences (114). We are surrounded by nomad sciences. It is very likely that much aboriginal sciences and knowledges have been completely ignored by Western state science due to their nomadism. Sadly, Indigenous sciences (such as traditional medicinal practices) are only being taken up by state science because the latter is now discovering its own explanations for the phenomena and because it is profitable. This is more than inefficient; it is colonization; a blindness to difference. As we've seen with Chinese state science, the state has the potential to be in a more peaceful and respectful relation with its surrounding nomads, and it can fully appropriate nomadic knowledge for reproduction without first requiring a complete striation of its content or without completely losing the nomadic character of the science.

In *Braiding Sweetgrass*, Robin Wall Kimmerer outlines elements of an Indigenous nomadic philosophy. Many of the Indigenous traditions that she has grown up with or encountered have for her held deep wisdom about the material(-spiritual) world. She mentions many exemplary nomadic scientists, but in particular:

> One I will never forget—a Navajo woman without a day of university botany training in her life—spoke for hours and I hung on every word. One by one, name by name, she told of the plants in her valley. Where each one lived, when it bloomed, who it liked to live near and all its relationships, who ate it, who lined their nests with its fibers, what kind of medicine it offered. She also shared the stories held by those plants, their origin myths, how they got their names, and what they have to tell us. She spoke of beauty. (44)

For Kimmerer beauty is a question too big for science (45). She mainly finds nomadism in poetry, story, and Indigenous wisdom, which she often juxtaposes with the scientific method: "To walk the science path I had stepped off the path of Indigenous knowledge" (44). At the same time, she obviously acknowledges Indigenous wisdom as a deep knowledge of the surrounding world. But the point is not just that their knowledge is beautiful, but that it is in fact a knowledge and a method for obtaining more knowledge, a collection of facts, explanations, stories, and ways of thinking—it is a science in its own right, a creative source of understanding, productive of functions such as forms of medicine and horticulture. This nomadism is not sufficient as something over and against all science, but as a different kind of science. Only this will reset a balance. As Kimmerer says, "Might science and traditional knowledge purple and yellow to one another, might they be goldenrod and asters? We see the world more fully when we use both" (46).

But we have to tread carefully. If we juxtapose beauty, story, and wisdom with science, it seems to lead naturally to the following tendency: Kimmerer occasionally justifies the knowledge of Indigenous elders by referring to the proof of Western scientific evidence. For example: “There is now compelling evidence that our elders were right—the trees *are* talking to one another. They communicate via pheromones, hormonelike compounds that are wafted on the breeze, laden with meaning…” (19–20). While this might be a kind of vindication, it does not seem to lead to a completely healthy conception of the knowledge of the elders, because it suggests that the elders simply made a conjecture that was only proven true by the discoveries of Western science. It suggests that the elders did not have their own methods and proofs and that they fabricated a fantasy like little children. If we think in this way, then we are not respecting nomad science as a science, but as a poetic way of speaking that was only verified as true by Western scientific methods. Not only do Indigenous elders have real knowledge, they have the nomadic method of following matter which does not need to be reduced or subjugated to a state science method (just like the quadrature). In fact, Indigenous knowledge is not explained by state science; not at all; its knowledge is different, and any appropriation is a loss of its nomadic elements. So it must be be respected in itself as a science. Only then will we listen to its knowledge before it is lost in the appropriation of state science; and more importantly, only then will we take their nomadic method and form of perception seriously—for we should not be encouraging state science appropriation of Indigenous knowledges and methods, nor really should we be pointing out that state science has “much to learn from them,” because the point is that nomad science is what challenges and undermines state science, always resisting it in order to maintain a tension of tendencies. These Indigenous knowledges, these nomadic sciences, as Kimmerer argues, are a deeper understanding of nature that can lead to healthy and reciprocal relationships, based in mutual respect and an economy of gifts. So just as we do with acupuncture, we have to champion Indigenous knowledges as sciences in their own right.

The Territories of Science

Migrants and Nomads have different relations to territories. Migrants are on the move, from one point to another, because they intend to settle (ATP, 443). They are not settled in their movement. This is an extensive movement, which is a movement from one point to another, made by a unified body and for the sake of those ends (444). Nomads are not migrants, for they are settled in movement: “the nomad moves, but while seated, and he is only seated while moving” (444). For them, their movement is not subordinated to the two ends that could be said to extensively define it. Nomads are defined by their intensive speed, or *how* they move and stay stationary. D&G’s “speed” is the intensity of a body moving vortically within a smooth space: “only nomads have absolute movement, in other words, speed; vortical or swirling movement is an essential feature of their war machine” (444). More clearly, it is a feeling of the singularities of matter, and the following of these along the tendency to change; with the flux of singularities, it feels just like one is speeding through the world. Movement across a smooth space is not movement because it goes from one point to another but because it has speed, because one is noticing and responding to change. So it is true that literal nomads often move from one point to another, but this is not what makes them conceptual nomads. That a literal nomad moves from point to point is only an accidental consequence of their conceptual territory. The territory of a conceptual nomad is not a place where they settle or the path that is defined between two ends, but the relays themselves, the in-betweens, becomings, quadratures, or intermezzo (443).

The territory of the state is made of roads, walls, boundaries, and buildings, which "parcel out a closed space to people, assigning each person a share and regulating the communication between shares" (443). The territory of the nomad is made of trajectories or relays that "distributes people (or animals) in an open space, one that is indefinite and noncommunicating" (443). The nomad territory, the "*nomos*" (contrasted with the state territory, the *polis*), is a "fuzzy aggregate" like "the vague expanse around a city" (443). In a sense the nomad does not "move" at all because the nomad's territory is the nomad's trajectory, full of particular traits that slide and mingle within smooth space, and the nomad never leaves this territory, never stepping from one point to another. This is unlike a state representative, who can step outside their territory quite easily, and yet can never stop moving, their existence defined by moving from point to point. So the nomad never leaves their territory because there are no particular landmarks or edges that are essentially part of the nomad's territory. Yet the *nomos* space is full of sensation, far more tactile and audible than visual, so that the continuous variations of the nomad's territory is a like a rhizome in that the different relations and haecceities—"winds, undulations of snow or sand, the song of the sand or the creaking of the ice, the tactile qualities of both"—act as "the polyvocality of directions" (445), the territory morphing in innumerable directions, none of which are predetermined, and certainly none of which can be visually captured within a unified map. The nomad is "open" to this polyvocality of directions, in the same way that any Go piece is always open to sudden shifts in function. The nomad always keeps their territory on the border of *terra incognita*, with a few vague doorways and open paths that could lead anywhere. For the nomad space has no secure limit; it is essentially not delimited, essentially vague *as* particularity. The state territory is the space that has been claimed by a flag, by the space that has been discovered and generalized under an ownership. Its space is one of hard limits, where any possible direction is set relative to all others and where it acts as an aggregate that represses the speed of smooth space, pulling by the force of *gravitas* towards its centre.

It is tempting to make the following distinction: science performed in the stationary laboratory like chemical synthesis is state science but science performed in the field like observational ecology is a nomad science. For while the former reproduces experiments, data, materials, and equipment, imposing forms on the variations within the lab (numbers scribbled in a lab book, purified spectra, labelled bottles), the latter follows matter and responds to the particulars of the field (the behaviour of a herd of water buffalo, the lines of sedimentation of an emerging rock formation, the mercury content in the effluence of an industrial plant) as an impetus to investigate more particulars with the help of guiding, affective equations. Of course this distinction does not hold absolutely. For sometimes "the field" is just another striated space, and sometimes, perhaps most difficult to see, the laboratory can become a smooth space. The state scientist has territories with boundaries and regulations, laboratory or field, as places to rule and regulate. The nomad scientist occupies territories of trajectories, laboratory or field, as becomings and open-doors. But while it is true that the distinction between field and laboratory does not have a absolute parallel to nomad and state, it is also true that tendencies, places, and perception are wrapped together. This means that laboratories tend to be tied more closely to the state than an open field. This means that nomad science is far more difficult in a laboratory; resistance, then, usually comes from without, and the war machine of science is hardly found in the basic state science institutions. It is thus easy to localize state science, in its literal buildings, its institutions, and its network of information; but nomad science is difficult to find because it has no such centre. With nomad science it is less about *finding* our inner nomad's home territory than *creating* it for ourselves.

A highschool science classroom could (and should) be modified to open itself to this dual territoriality. On the state-science side of things there are instructors, textbooks, lecture theatres, protocols, demonstrations, fume hoods, benches, glassware, chemicals, homework, practice problems, exams, and a percentile grading system; science education "as usual." On the nomad-science side there are spaces for experiments where not even the instructor knows how they will end, books with case studies that only reference operative equations, a place for making equipment (woodwork, glass-blowing, measuring tools, perhaps a 3D printer), a circle of movable desks for roundtable discussions, and local (*in situ*), practical problems with no known solution (How do we save the oak trees in town? How do we deal with the effluence of the dump, leaking into the river valley?). In a crude sense, nomad science education will involve many more "field trips" and "free time" periods, and it may result in something concrete—though the meanings of all these terms are not the same as in state science, and they have to be used carefully.

Transforming Assemblages

The assemblage is an important concept for understanding the practical matter of how to introduce nomadism into state science. Whether technical objects such as machines in the laboratory are used for work or free action, whether they are used and comprehended as tools or weapons, whether they are used for state or nomad science—this depends entirely on "the social or collective machine, the machinic assemblage" (463). We're returning to the candle in the home, asking, With what new relations can be experimented? Picking up the concept of the assemblage is a way of being that allows us to set new relations, and so it unleashes the latent tendency towards change. As well, the assemblage can never finally be striated because it is crossed with every tendency. We could say that every assemblage is a three-body problem for the state: it is essentially not biunivocal, essentially un-mathematize-able, and though it can be slowed down by the gravitas of the state, transformed into and approaching a biunivocal system, no assemblage can be finally collapsed into only two components, represented by a finite algebraic series—no assemblage can halt to a stop. For an assemblage is affected on all sides, by the social, historical, ecological, passional, and mechanical; it is a multiplicity of relations. Further the whole of the assemblage defines the functioning of its internal parts. An object in an assemblage becomes a tool for the state or a weapon of the war machine depending on the tendencies of the assemblage through which it is constituted; "weapons and tools are consequences, nothing but consequences" (464). All of the technical elements of an object are selected, qualified, and invented by the assemblage (464). The dominant tendency of an assemblage defines whether a manifested space is smooth or striated, rhizomatic or arborescent, vortical or laminar, with speed or with gravity (464). The war machine is the assemblage that lends to the transformation of assemblages, and weapons are the part of this machine that reach out to transform and de-centre. The war machine is the assemblage that has conceptualized itself as an assemblage; the state is the assemblage that has conceptualized itself as a set of discrete beings.[30]

[30] We could say, then, that the war machine is more of an assemblage than the state apparatus and that the state apparatus is more of a discrete being or instantiated form than the war machine.

The nomad and state assemblages can be summarily distinguished by five differential traits, technical elements, or points of view (some of which I will not discuss in detail): "the direction (*sens*) (projection-introception), the vector (speed-gravity), the model (free action-work), the expression (jewelry-signs), and the passional or desiring tonality (affect-feeling)" (469). Everything is caught up in a mixture of these traits, and so everything is a tension of interpenetrating and interconnected assemblages. To transform an assemblage, one can rearrange differential traits of the technical elements (choosing or following which traits to change depending on different priorities). This means that to introduce and support nomadism in anything, we have to change the relations that constitute any given assemblage, and this involves the following: changing the meaning of matter, empathizing with it so that it directs us through its singularities; speeding up our activities, so that they can never be completely caught in a reproducible framework; qualifying or skilling work so that skill and artisanship are prioritized (so that the problem of mechanization could never arise or dominate); changing the expression of our activities from representation to ornamentation, so that ornamentation and action are inseparable (such as the gothic journeyman, allowing differently ornamented arches to set new directions for the building project); and *desiring* change rather than stasis (rather than just following one tendency over another), or becoming affected rather than expressing an internal feeling (allowing one's abilities and emotions to be shifted by external relations, like a Go piece). So individuals within a state *always* have the power to change their proximate assemblages, and they can do this by actively changing any of the differential traits described, whether as an individual or a collective; scientists can always resist the state. And so, finally, "There arise subterranean, aerial, submarine technicians who belong more or less to the world order, but who involuntarily invent and amass virtual charges of knowledge and action that are usable by others, minute but easily acquired for new assemblages" (470). We come to the artisan.

The Artisan

If the state only ever reproduces, then it is only the nomad who can truly invent. "There is always a nomad on the horizon of a given *technological lineage*" (471). This does not mean that behind every invention there is lurking an individual who is the epitome of a nomad; it means that nomadism is the invention of a technological lineage and that invention is always a nomadism. The nomad inside any scientist is the source of their scientific creativity. Nomadism and smooth space pepper a state property-scape, and so it is not at all wrong to say that the collective assemblage of the state can invent technological lineages ("there are so many gray [sic] areas, intermediaries, and combinations between an imperial army and a nomad war machine that it is often the case that things originate in the empire" (471)), but only if we recognize that it is precisely the nomadism contained and loosely captured by the state that is the source of the invention. Who is it that exists within this loose capture? The submarine technician, the artisan, the metallurgist. What do they create? New territories, assemblages, and functions.

There are scientist who have recognized the tension between state and nomad science, between contradictory and irreducible tendencies, and are willing to embrace this tension as fundamental to scientific progress. This is the artisan scientist. For example, *A Feeling for the Organism*, by Evelyn Fox Keller, is about the Noble-Prize-winning geneticist Barbara McClintock who was as creative a scientist as they come. She had many nomadic tendencies: empathy with the matter of her research, a focus on the whole, and a tendency to break from accepted scientific theory. She was not recognized for her work for many decades, likely because of her nomadism (and for being a woman).

A particular kind of artisan scientist that D&G focus on is the metallurgist. Metallurgists had “a certain technological autonomy [from the state], and social clandestinity, so that, even controlled, they did not belong to the State any more than they were themselves nomads” (ATP, 472). Metallurgists (like all artisans) are neither state individuals nor nomads; they are not different from anyone else by the fact that they are neither the pure manifestation of a statist or a nomad—because no one is—but by the fact that they intentionally and constantly straddle the middle or betweenness of both tendencies. Again, they “belong more or less to the world order,” but they “involuntarily invent and amass virtual charges of knowledge and action that are usable by others, minute but easily acquired for new assemblages” (470). This would mean that they are always conjugated with the state, “with sedentary space” and are “always *connected* to nomad space” (484). The metallurgist stays for awhile in plateaus of stability, conjugated to a striated space, or in other words dwelling within a stable territory; but they are also always rearranging the traits of an assemblage so that it can explode with new functionality, connected to a smooth space in a mutual acceleration of doorways and lines of flight that lead to new relations (257).

Specifically referring to “the body without organs”, which is the assemblage that is open to change, the artisan and their milieu, D&G advise, “Lodge yourself on a stratum, experiment with the opportunities it offers, find an advantageous place on it, find potential movements of deterritorialization, possible lines of flight, experience them, produce flow conjunctions here and there, try out continuums of intensities segment by segment, have a small plot of new land at all times” (187). As Adkins says, when we open up assemblages to change, when we become a body without organs, we must not go too far: if the body becomes too empty of the tendency towards stasis, then assemblages can become cancerous, providing a vacuum that will suck in complete, uncontrolled striation, unleashing a fascist life of micromanagement; or it will leave the assemblage so empty or so chaotic that its existence cannot be propagated, that it becomes suicidal and destroys itself (Adkins, 106). There is a balance of tendencies and habits to be developed, and the artisan expresses this balance in science; the artisan doesn't throw away the contents of science and make an unorganized chaos of its laboratories; but neither do they make a fascism of science. They are lodged on a stratum, conjugated with the state, producing for it and being produced by it; they are able to reproduce by tools, representations, and specialized skills; but as well they "have a small plot of new land at all times" (ATP, 187), which is "always *connected* to nomad space" (ATP, 484), and they are always looking for lines of flight, always experimenting with their desires, with functions, weapons, or expressions. This "small plot of new land" is crucial: it is not only the space where the scientist goes for a breath of fresh nomadic air, the space where they can think and act differently, or the space which clears their mind so that when they return to the old plot of land, an old research problem, they bring something fresh to plant in the soil; it does not exist subordinated to the old research turf, as a source of inspiration for the sake of the state: it is for its own sake, the place where real creation happens and is valued.

Following Matter-Flow

The artisan is always caught up in a technological lineage, as the passage between the nomad on its horizon and the state in its reproduction. D&G also call the technological lineage a machinic phylum (473); this is “a technological vitalism[,] taking biological evolution in general as the model for technical evolution” (474). They provide two contrasting examples: the steel saber and the iron sword. The iron sword is a descendent of the dagger, while the steel saber is a descendent of the knife (473). There is the singularity of a hunk of iron, in all of its particular hardness, weight, and sheen, which can be subject to at least two technological evolutionary paths, two different kinds of operations that will in turn manifest new singularities. To create the iron sword, a single iron piece must be forged: it must be heated and pounded with a hammer. Matter expresses itself with a certain resistance here, with clanking and a slow shaping, and when it is quenched, a very particular kind of weapon is actualized, one that attacks from the front, one that stabs. The dagger would have been the first kind of matter to undergo a similar process, and we can easily see how metallurgists would have slowly transformed the operation to extend the dagger into a sword. To make an iron sword, the metallurgist must respond to particular singularities: to a single piece of iron that can be forcibly pounded and slowly deformed. Matter is not passive, for it resists and allows itself to become that which can act in certain ways: iron, and not sandstone, can become such a sword. The iron sword has an affect; it carries with it “its own qualities and traits, which determine the relation of desire to the technical element” (473). The iron determines the passions and qualities of the assemblages in which the sword is caught up, and it cannot be separated from its brute functionality.

Or the metallurgist follows iron in a different way, along a different technological lineage or machinic phylum. A large number of iron pieces are melted in a crucible and then poured into a cast or mold, allowing for shapes, forms, and patterns not possible if it had remained a solid.

This generates a specific kind of weapon, a saber, one that can attack from the side, one that chops. These are different functionalities, desires, processes, and singularities.

The iron sword and the steel saber belong to two different machinic phyla because both their singularities and operations differ. “We may speak of a machinic phylum, or technological lineage, wherever we find a constellation of singularities, prolongable by certain operations, which converge, and make the operations converge, upon one or several assignable traits of expression” (473, emphasis removed).[31] The singularities of molten iron, its glow, heat, and liquidity, which are prolongable by the furnace, as well as the singularities of casted and cooled iron, all converge onto the expressive traits of the saber, which is wrapped up with a specific set of affects and technical elements of a larger assemblage. This is not only an emphasis on the material interconnection of matter, science, technology, the social, and the political; it is also a description of how the metallurgist is in an intimate and reciprocal relation with matter, which is the source of their invention and free action, as well as their reproduction and work.

There is always a phylum that connects and includes two phyla. In the same way that there is the whole long arc of evolution, a phylogenetic tree of all of life, there must then be a single machinic phylum that connects all others. In the end, this is the flow of matter itself, in all of its variation and expression, both natural and artificial, geological and technological (473). This is to say the same as Heraclitus standing by the river: the only thing that does not change is change itself. The human and matter relation is one long technological lineage, but not the whole picture. By speaking of technological progress under a biological, evolutionary model, D&G

[31] Manuel De Landa takes up this project in his book *1000 Years of Nonlinear History*, where he charts the histories of different city dynamics based on nonhuman factors, such as the changing kinds and intensities of energy flows, pathogens, and machines.

have obviated an end to its progress: there is no best direction, no final destination, and certainly not a final direction where everything "gets better." It is this scientism and the myth of technological progress (a functional, but misleading myth) that has done so much harm to Western society and to all those it has come in contact with: we could speak of the structural domination of the North American city by vehicles and junkyards, and the dramatic lack of public places for communal dwelling (Dalsgaard, *The Human Scale*); or the serious lack of response to climate change, often based in a faith that tools and generators, rather than habits and laws, will save the planet; or even the disproportionate focus on medical sciences to treat away symptoms rather than wholistic causes. Metallurgy, conceptually, is the kind of non-scientism science that recognizes the limits of following matter. It has no need of technological progress, though it develops technologies; and it has no need of a scientific realism, where theories represent the real content of matter, though it engages with streams of expressions and transformations with a real matter that can never be represented. Metallurgy recognizes matter as something that cannot be dominated, but only related to reciprocally within its flow, a relation that develops like a creative evolution that has no final destination.

Matter-flow is the nomad's metaphysic. Matter-flow is what enters, makes up, and leaves assemblages, and in this sense it exists prior to any assemblage. It is most basically "a destratified, deterritorialized matter" (474). It is full of haecceities, vague essences, or fuzzy aggregates, which "relate to a *corporeality* (materiality) that is not to be confused either with an intelligible, formal essentiality or a sensible, formed and perceived, thinghood" (475). This matter-flow is the matter that reveals itself when matter is followed: it is inseparable from its active singularities and passive operations, something that gives and takes and can never be finally represented. It expresses itself within its singularity and the way in which the operation unfolds (heating iron to melting point), and so all of its events are also affects. The "event-affects" (475) are the vague essence, such as roundness, brightness, liquidness, and hotness—iron becoming molten in a round crucible. The "vague essence" is not an intermediary between conceptual essences and sensible objects; roundness is not an essence that is defined as the intermediary between circle and wheel. Roundness is an affect with a particular quality that cannot be reduced to a sharp point, a flat surface, nor some intermediary between the two; qualitatively, roundness is not an essence defined by the other two extremes or thresholds, but is its own threshold, a bandwidth of intensity. Roundness is never perfectly round, or perhaps more clearly, warmness is never perfectly warm, brightness is never perfectly bright; instead roundness is the essence that is defined by a thing's very movement towards becoming round, and so it is a limit-process. This is the same as the quadrature. Roundness is an intermediary in the sense that is always in between extremes of other things and concepts, but not in the sense as it only exists or has reality as a passage from one reality to another: the vague essence is not made real by its stretching between two formal essences; rather the vague essence is its own stretching-ness "between things, between thoughts, to establish a whole new relation between thoughts and things, a *vague* identity between the two" (475). To the nomad, roundness is far more real than the formal essences of flat or pointed because roundness is immediate and exists within the actions of children, designers, and engineers. This understanding of essence, this metaphysics, is conjoined with the following of matter, the nomad scientist's ethics.

If, like in the hylomorphic model (matter-form), we assume matter to be a homogeneous reality that is passively fitted to form (and represented) by laws, then there is no room for matter's action and affect (475–6). This in turn would require a denial of matter's haecceities, which would mean that there is nothing to follow in matter; there would only be a matter to control and reproduce. In many non-metallurgical operations, operations seem to take place between two different thresholds (threshold-affects), so that the later threshold is an incarnated form, which can then be taken up as formless matter in the next, successive operation (478); this appears to legitimate the functionality hierarchy of form-matter.

But metallurgy takes place in a liminal space, alongside thresholds rather than operating between them. This is the "intermediary" space of vague essences. Here "an energetic materiality overspills the prepared matter, and a qualitative deformation or transformation overspills the form" (478). Matter is full of its own qualities that drive its flow, and which fluctuate alongside the operations (such as the iron becoming molten, then hardening, like candle wax); but the operation also takes place even after a supposed form has been incarnated (such as decarbonations after casting and quenching after forging). Rather than a succession of forms, there is the continuous variation of a vague essence. As well, as matter-flow, as vague essence and intermediary, metal can always be reused, melted, reshaped, and alloyed (hence the value of ingots). In this way, the metal of metallurgy expresses the matter-flow equation quite well. Hence D&G's exaggerated stance of "panmetallism" (479). Metal is not equal to matter, but it is matter's ubiquitous conductor (such as salt in cells) (479). As a conductor it is the channelling of the flow and force of matter. And this is part and parcel of a hylozoism, for the matter-flow that metallurgy reveals is a vital matter, active and expressive, perennially full of affect and event.

For example: there is some wood to split. There is the density and porosity and resistance of the wood, and there are the variable paths of fibres and knots. It is full of vague essences. If we want to split the wood so that the wood can be used for particular pieces of furniture and so on, "it is a question of surrendering to the wood, then following where it leads by connecting operations to a materiality, instead of imposing a form upon matter" (476). To actually engage with the wood, one does not deal with a formed matter, or matter subject to legalities, or the representable form that imposes properties; one deals with a matter that has its own customs and expressions (476). This takes intuition, and ultimately, in order to split the wood with an eye to the specific kinds of wood pieces that one wants, it takes the calm and assurance of a master artisan. Not only knowing where to split the wood, how to follow its grooves, but also where in the forest to find the wood with the right singularities. An artisan must be a prospector; this cannot be performed by a middleman (477); like when Jiro, one of the most famous sushi chefs in the world, goes every morning to the fish market (Gelb, *Jiro dreams of Sushi*). If the artisan does not have to prospect the forest for their carpentry, the fish market for their sushi, or the rocks in a quarry or field for their rock garden or drystacked wall, then they are one step closer to becoming a de-qualified state worker. This is yet another danger of world-wide transport systems and simple delivery systems such as Amazon.

The status quo of chemical research certainly goes against this ideal of prospecting. There is an equipment and chemical depot in all large universities; this is where chemists can order and pick up four-litre bottles of solvents (acetonitrile, dichloromethane, hexanes, and so on), smaller bottles of various chemical supplies, powders of basic reagents or starting material for chemical syntheses, boxes of one hundred identical glass pipettes, et cetera. The key words here are purity, reproducibility, and industry. Despite all the skill of a chemist, this lack of prospecting—the fact that a chemist has identical bottles of reagents sent to them by a world-wide industrial production and delivery system—means that a chemist has elements of a de-qualified or de-skilled state worker. How can chemists retrieve their days of prospecting? This is a properly nomadic question.

The metallurgist, as a prospector, deals with the subsoil, metal, or that which is matter-flow as pure productivity, and this "subsoil unites the ground (*sol*) of smooth space and the land of striated space" (480). As we said before, the artisan is always conjugated with the state, "with sedentary space" and is "always *connected* to nomad space" (484). The metallurgist's space is full of mines, excavations, or holes within the land, and so it is "a holey space" (482). "*Every mine is a line of flight* that is in communication with smooth spaces" (480), but every mine is also always under some distant control of the state, which weakly spreads its striation (regulation and reproduction) over mines. The mine or the holey space is the place where one begins to deal with matter in a way separate from the state, where matter becomes metal, becomes flow and pure productivity; it is a breaking off from the stone of hylomorphism, and it is a new engagement and activity, where singularities and operations flow together. "Mines are a source of flow, mixture, and escape" (481). This is the new plot of land that the artisan always keeps in sight from their studio, field, or laboratory. As well, the metallurgist form collective bodies, such as guilds or societies or the journeymen of gothic architecture, and are dependent on members of the state in order to survive and function (480). Quite literally, the metallurgist depends on state members who can provide wood for them; more conceptually, the artisan is lodged on a stratum and requires some level of stability and production, the tools for their creation. Yet, the very existence of the mine and the practice of metallurgy is a line of flight through the state, connected to smooth space. In this context, the line of flight then, is an entry point into the process that breaks free from striation, which can never be completed. It is a balance or a good tension, a moving intermediary that is not defined by its opposing ends, a vague essence and becoming, a quadrature always undermining claims made via transcendental numbers, textbook theories, and the efficiency of industry.

For the chemist to be like a metallurgist, they must construct or find their own holey space, their own mines or spaces of lines of flight. This does not have to be a total rejection of the entire industry of chemical production and delivery, because these are some of the tools and levels of stability that a chemist needs; but it certainly means lessening this conjugation with the state and introducing a connection to a nomad space. No matter how efficient this entire industrial chemistry-factory is, *it is only efficient in one kind of way* (for example, with access to so many litres of dichloromethane, a chemist can now perform the same chemical synthesis ten times, but only for reproducibility and statistical analysis). There is a larger efficiency of productivity that is grounded in creation, and this is what we have been considering here, a science that functions well on nomadic principles (in balance with state principles). Almost paradoxically, to reach it requires lessening the efficiency of the industrial system because it requires a lessening of the grip of industry itself. It is the same paradox we find in bureaucracy, which, though created for efficiency by the state, has become largely inefficient and full of pointless jobs, so that the only way to overcome this horrendous shortcoming is to throw away most of the structure, at the cost of its “efficiency”; it is not something that can be done by incremental steps of bureaucracy; it takes something of a revolution, a counterforce, or a war machine to undermine and replace the bureaucratic system. So we must introduce alongside the industry of chemistry a real practice and space for prospecting. In this respect, materials for chemistry must come from the chemist's surroundings, and they must pull it from their surroundings themselves. They must *make a choice*, like Jiro choosing *among* the fish of the market. As a state chemist at the depot, faced with ten identical bottles of acetonitrile, I have no choice to make; there is no prospecting to be done at the depot. To some extent, faced with an entire shelf of various chemicals, musing on what I should experiment with next for the creation of a cancer-fighting drug, I am prospecting, and it could lead to interesting results, though cancer research is pathetically incremental (and it is probably because of this lack of prospecting, the intensification of state science and industry, which leads to me-too drugs; these are so minimally different from their predecessors that their improvements can only be mathematically proved by statistical fiddling such as p-hacking); but even my surveying of the chemical shelf is based in a fundamental and strong striation that only has a finite set of results, because the material has not been pulled from the ground with an eye to quality of what the chemist intends; rather it has been produced by an industrial plant with an eye to a preset value of purity. Purity (of solvents, of reagents, etc.) is an important ideal of the state, and it is essential for reproducibility; but it is only half of the picture. The agency of matter can only express itself when its actions or "properties" emerge from its own complexity. However we approach this, the chemist still needs to prospect, beyond even the most comprehensive shelves of chemicals. The chemist must leave their laboratory. This will necessarily tie the content of chemical research to other places; this is completely inconvenient and inefficient for the state, but it is essential and efficient for the nomad. It will be uncomfortable and awkward at first, but how else can a chemist become a nomad if they do not take their reagents from soil, streams, and plants directly? Prospect they must.

The Humaneness of our Science

But is it good enough to be an artisan, to always be resisting as a nomad in a state milieu? What about the content of the state science itself? Strangely enough, in setting up the distinction between the nomad and the state, and by providing the increase of the nomadic tendency as a perceptive "solution" to the "problem" of the state (or rather by providing the nomad as the much-needed, upsetting "problem" to the all-too-easy, settling "solution" of the state), D&G perhaps do not have enough to say on changing the very quality of state science. The assumption throughout this thesis has been that the balance has been too much in favour of the state for too long, and that we require an increase in the tendency of the nomad; but a serious problem seems to be the following: an increase in nomadism is not good enough if the state, though lessened in manifestation, maintains its quality. It is perhaps true that for certain state sciences, no amount of its particular qualities could ever be good.

For instance, we can consider the criticisms of Martin Heidegger in "The Question Concerning Technology" and Edmund Husserl in *The Crisis of the European Sciences and Transcendental Phenomenology*. Their convergent criticism seems to be that science has become discontinuous with "being" and our human life-world, starting with Galileo and Descartes, and radicalizing over the centuries until the scientific world was so thoroughly mathematized that it forgot its origin in human tasks, cultures, and philosophies. By Heidegger and Husserl's analysis, philosophers such as Gilles Deleuze and Henri Bergson, who have proclaimed themselves as attempting to provide a metaphysics *for* science, are not sufficiently challenging the growing inhumanity of science itself. Modern science is inhuman because it investigates the world as though it were constituted by phenomena of mathematics, objects, and forces ("energy"), and these phenomena are completely disjunct from our human life-world, a reality which is fundamentally *not* mathematical nor crudely made of objects nor crossed-through by forces (the latter of which D&G gleefully affirm).

Heidegger famously argues that the essence of technology is "enframing," which is a way of being, a mode of perceiving, or a way in which being reveals itself, in which we take or frame everything, nature or human or otherwise, as an energy-reserve or "standing reserve" in order to completely master it. He contrasts the dam and the windmill. The dam takes the river as an energy-reserve and this "taking" is a parallel transformation of the river itself. The true river is thus lost, even if we haven't noticed it—or rather precisely because we have forgotten the true being of the river. The river is not an energy reserve because the being of the river is not energy, nor simply an energy *for* us, to be used at our whims; rather the being of the river is at its roots connected to our human life-world: as water-giver, as fords and deep-ends, as fishing grounds and what passes underneath a bridge, or in certain cultures as a god or some other mythical element—in all of these the river is wrapped up with a world in which we are at home. But the river is only a river when we are not controlling it and reducing it to our energy-frame, to a resource enslaved for our symbolic and social activities (which happens when we have completely dammed it). Almost paradoxically, when we have completely reduced its being to *our* functions and uses, then it is no longer continuous with our life-world as a place *in which* we are at home; a life-world is crossed through with difference. In this D&G might agree, for the nomad respects difference. In contrast to the dam, the windmill does not take the wind as an energy-reserve because it was built with a fundamentally different attitude: it was not built to transform the wind into an energy reserve but rather to participate in the element, to conjoin with its flows, and to respect that those flows have other purposes beside human ones. Presumably the massive, white, wind turbines that we see today scattered across expansive fields have *not* maintained the attitude of the windmill, and have transitioned into the mode of enframing, for they are such an intensification of this wind-energy-extraction that they fill entire fields, alter air currents, and make sounds that confuse and kill birds and bats. Here too D&G would agree: the transition from windmill to wind turbine is the intensification of the state. Heidegger's criticism is that the very way in which we perform the plurality of state science is essentially corrupted by the absolute control of enframing. Modern science dominates our lives by single-mindedly revealing being as standing-reserve, or as potential function (anyone who agrees with Heidegger's assessment will probably raise their eyebrows at D&G's metaphysics which seems to subordinate the world itself to a creative explosion of functions, and this is especially noticeable when D&G use such terms as "machinic assemblage," "mechanosphere," or "panmetallism"). The essence of technology for Heidegger is enframing, this destiny of coming to dominate nature (humans and animals included) and perceiving it solely in this violent way, as something merely to be controlled, as energy for our consumption. It should be clear by now that this way of being is not exactly found in nomad science, where there is a generous interest, a following of matter, and so on. But as the creator of function, nomadism bears a responsibility to change the way of being of the state science's function. Even if we reintroduce nomadism to the field of turbines, potentially reducing the number of birds killed, we have not overcome Heidegger's criticism unless that nomad science has in turn transformed the state science: not fewer giant white turbines, but a different kind of state function altogether. Nomadism is not the answer to Heidegger's enframing, because there will always be a state science, and the enframing must be eradicated from it. It seems that D&G did not think this was possible. Thus nomadism is not quite enough to stay true to being and to our life-world. Nomadism must not only counter state science, it must change what seems to be one of the state's foundational quality (enframing).

On that note, we could say that all science begins or deduces from a fixed point, and that small variations in this point can lead to drastically different sciences. One of Edmund Husserl's goal (in *The Crisis of the European Sciences and Transcendental Phenemonelogy*) was to find a phenomenological centre from which a healthy, human science might grow. Husserl believed that if he were to faithfully follow through with his "epochē", a variant of Descarte's doubting and his transcendental reduction, a calm methodical discarding of the inessential, a reaching towards the unshakeable centre—then he would be able to point the way towards a more human science. The closer we would be able to achieve this "epochē," the closer we could come to our own humanness and to being itself, and any science born from this closeness would avoid pernicious problems such as the enframing we find in modern science. (It is not clear what such a new science would look like; for example, it is not clear what role mathematics would have to play in it. This is not at all a criticism though.)

In fact, I do think that these criticisms (though only summarily reviewed) hit D&G hard, for they have not fully considered the possibility that the inhuman quality of modern state science can itself change and yet remain a state science. That said, even if they evaded this problem, D&G (as well as other french philosophers such as Gaston Bachelard and Michel Serres) bring something to the table which Heidegger and Husserl do not: by their insistent resistance, needling creativity further and further into science, they have begun to provide a path towards a more human science. The nomad must rise again in order for the quality of state science to change, in order for it to begin from a more human centre. This can only take place if we are to take as our goal a science continuous with our life-world; though perhaps this is just to say that we must begin with nomadism, which follows matter and in so doing dwells within a continuity between its surrounding, haptic world and its operative equations and problemata. And once we've got nomadism on its way, this nomadic component must be able to transform state science so that even the state's abstract and transcendent theories come closer to lived experience and avoid the crisis of enframing; it is in this way that Heidegger and Husserl's criticisms of science are crucial, in a way that D&G perhaps failed to appreciate. H&H have hope for a new, healthier state science, without providing the best means to get there; D&G point out that nomads are needed for this task, without perhaps quite knowing what exactly the task was supposed to be. Thus while H&H's criticisms seem to be very important, their methods are not good enough: in order to change the structure we cannot hide behind a philosophy that always begins again—we have to take risks, we have to unfold our deductions, we have try from a specific starting point and see where we end up. In order to change the quality of science as a whole, to change the content of the state's essences and governance, nomads must be grown.

Chapter 3: Education for Nomad Scientists

Back to the Beginning: Education

If only a teacher had been there to see him make gravel dams in the pouring rain. Then they might have invented their own fluid dynamics, with a set of operative first principles that would allow for water to express itself as it was channelled towards new functions. Perhaps rather than understanding the water as a fluid contained by the solid, they would have modelled the gravel as a kind of water, as existing only in relation to the liquid. We cannot know what they would have later discovered-created.

If only his parents had given him Lego without any of the instructions. He spent some time creating, such as octagonal robots and houses that looked like trees, but the instructions were so much easier to fall into, without thought or attention. Sitting on the carpet, he became a little lego factory, receiving the shipment and then mindlessly assembling according to the steps. His parents would watch him silently and then mutter in astonishment: how fastidious he is. He did this so much that he eventually couldn't conceive of deviating from the instructions. But if instructions had been prohibited, what would have the lego strewn across the floor become? We cannot know what he would have created.

If only his science classes had used equipment and journeyed outside. His most memorable moment in his physics class was when they played with slinkys, the spring that could transfer both transverse and longitudinal waves. How much more memorable and productive it would have been had they then confronted water waves and echoes in a canyon. Instead of energy being grounded in the letter E, a play of numbers and biunivocal dependencies, then it would have been like an aura around his experience. It would have come to mean something very different. We cannot know what it would have meant for him.

If only he had been given a space to do chemistry separate from capitalism. He would not have needed to produce so much waste, and he would not have needed to inauthentically convert his observations into bar graphs and journal publications that no one would read. He would have enjoyed his work; he would have stayed. We cannot know what functions he would have created. We can only wonder how much more efficient and productive of functions such a system would have been.[32]

It seems that changing the whole structure of scientific research institutions all at once is not an achievable goal, and that anyways this change could only come about if research laboratories were already pervaded by a war machine, that is, a whole host of scientists who were secretly nomadic. Since these closeted nomads are few and far between, they must be grown. The war machine must spread itself. This means first off tweaking how scientists are educated, so that although they will still be admitted into societally legitimated science, we will have harboured in them a desire for change, a recognition of the permanent form of secrecy (see section below), a fascination with vibrant matter, and the will to create new functions. For example, what would happen if by the slow pervasion of the war machine a whole host of scientists ceased to care about publishing journal articles? Could this not lead to a radical shift in

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[32] As I argue later for other causal levels or objects that we can never directly or completely experience, here the object has an inherent secrecy or distance that cannot be traversed. As D&G say: "Think of it as an affair of perception: you enter a room and perceive something as already there, as just having happened, even though it has not yet been done. Or you know that what is in the process of happening is happening for the last time, it's already over with. You hear an "I love you" you know is the last one. Perceptual semiotics. God, whatever could have happened…?" (ATP, 228) It is an unknown that can never be finally filled, a secret that can never be fully fleshed out.

the institution itself? On that matter, time will tell, but on the matter of growing those submarine technicians, those secretly nomadic scientists, there is still much to say and do.

If reproduction and control are the ideal of a state, then the state strives to grow citizens in conformity with its striation. Education is one of the main means for directed growth (and not necessarily change). It is the field where nomads and the state are in indirect conflict over the proper development of individuals. In the science classroom, the state's goal is to grow individuals that have sufficient skill and the correct ambition to reproduce certain tasks, data, and materials that can be regulated and channeled (lovers of bureaucracy). The skill should not exceed the threshold needed to perform the task; there is no use for the labourer to be able to question or rethink their task. Now obviously, scientific practice would lurch to a halt if it ever reached such an ideal (and perhaps if modern scientific progress is truly slowing down—the ratio of output of function to input of materials decreasing—it is due to an asymptotic approach towards this ideal). This is precisely the point, and so it is all the more surprising when such an ideal is the hidden motive in highschool and university level science classes; for such an education does not readily prepare students for the task of scientific research, and by flooding laboratories with such ill-prepared and confused students, who are indoctrinated with the ideal of the state and in confrontation with the reality of re-search, so many holes in holey space are plugged, "new plots of land" become unreachable from the laboratory, and overall scientific progress, in its affect and creation, slows down massively. As the educational factory churns out unhappy or bored-stiff scientists, laboratory research becomes stilted, constrained by a fine-grained striated space. The result is a lethargic ocean of unused information and entire lakes of chemical sludge.

Demonstration and Experiment

It is clear that state ideals have thoroughly wormed their way into science curricula at every level because of this one fact: experiments in science classes are never experiments but demonstrations. At every level, the educational "experiment" has the following format. The students learn of a theory in class; this could be a theory of forces, such as Newton's third law, or perhaps a theory of molecular polarity. The students are herded to the bench where either, in earlier education, a demonstration is performed for them, or in later education, they perform the demonstration themselves. In the later case, they are expected to develop the theoretical skills to understand what data is important and should be measured, what significant steps are in the experiment (such as when a chemical changes in a colour in a titration), as well as the skills to manipulate the tools in order to reproduce with accuracy the expected results. They are often graded on how close their data is to the ideal. Here, students are not only trained to strive in their theoretical and practical skill towards reproduction, not only are they taught what "should" be measured, they are also taught that deviations from the norm are bad, are an "error," rather than something good, as outliers and anomalies that should be investigated. It is disturbing in the least that this has been confused with an "experiment"; and it is not merely semantic, for the students are made to believe that the experiments of many great scientists are the same sort of activity as what they perform in the laboratory.

Experiments and demonstrations can be made to appear identical. This is because they differ in motive and perception; they differ in tendencies. The state demonstrates; the nomad experiments. A demonstration is performed with the intention of reproducing a series of conditions that are in accordance with a theory. As well, it is accompanied by a search for key repetitions or patterns that are presupposed to occur as long as one pays enough attention. A demonstration can be filled with as much damning noise as possible; but the motive and perception of a demonstration will always filter through the morass of supposed irrelevance, to find that kernel of static truth. The demonstrators only see the patterns they expect, and the students are taught this perception. As Noel Gough points out, most practical activities in the science classroom

> are not experiments at all in the hypothetico-deductive sense, but recipes for physically demonstrating the propositional knowledge that students are expected to reproduce in tests and examinations. Labeling this highly regulate activity an 'experiment' trivializes the role of experimental method in scientific inquiry and diminishes the imagination, skill and ingenuity with which scientists design and conduct the kinds of experiments that do, in fact, advance scientific knowledge (2011, 119).

As an example, we can take the mythical story of Galileo at the tower of Pisa. In hopes of providing evidence against the prevailing Aristotelian physics of his time, Galileo decided to test his hypothesis that all objects fall at the same rate, and so, as the legend goes, he dropped two objects of different weights from the tower of Pisa. The Aristotelians, watching from a safe distance below, predicted that the heavier object would hit the ground first. Galileo's aid, also presumably watching from below in order to witness the fall, predicted that the heavy and light object would hit the ground at the exact same moment. Myth or not, we know what happens: the heavier object hits the ground first; the Aristotelians had the correct prediction. In the spirit of a testing a hypothesis, we would probably expect Galileo to resign himself and admit that he was wrong; of course, this is not what would have happened. Galileo would have argued that the two objects hit the ground at different times because of air resistance. The results of the 'experiment' were irrelevant (because it was not an experiment). Both Galileo and the Aristotelians walked away from the demonstration self-satisfied with their contrary conclusions.[33] This is how demonstrations function: they can be fundamentally ambivalent in their ontological conclusion but they are presented and perceived as an epistemically-certain proof of a theory. The characteristic of a pure demonstration (a supposed proof) is a blindness to difference, an assurance of a repeated pattern, with the aim of convincing the prospectors of the demonstrator's theory. In this tower of Pisa case, no one was convinced because, without considering any other experiments, both physical explanations were equal in weight.

While demonstration literally means "to point out" (*demonstrare*), experiment means "to try" (*experiri*) (Oxford Dictionary of English). This perfectly follows the distinction of tendencies made throughout D&G's *Thousand Plateaus*. "To point out" is to engage with matter optically, while "to try" is to engage with matter haptically. To demonstrate is to impose forms on a matter without expression; to experiment is to follow the matter as matter (as matter-flow). The former reproduces and perceives the same; the latter is open sudden shifts in function and it

[33] But, the argument often goes, Galileo's observations were more productive and in fact his new way of thinking was part of the development of a modern science (for Galileo's way of thinking, along with Descarte's, as heralding of modern science, see Edmund Husserl, *The Crisis of European Sciences and Transcendental Phenomenology*, or Martin Heidegger, *Modern Science, Metaphysics, and Mathematics*, or Alexandre Koyré, *From the Closed World to the Infinite Universe*). In this way, it seems, nomadism would not have led to the production of modern science; that in fact, Galileo's state tendencies were good. Not quite. Galileo's way of thinking was only good insofar as it heralded modern science and insofar as we assume modern science to be good. If he was to have had an element of nomadism in his thinking (that is, if the zeitgeist that he followed was more nomadic), then we cannot know what kind of science he would have heralded (though in *Against Method*, Paul Feyerabend seems to suggest that Galileo was quite nomadic). Perhaps it would have been a completely different science, one that would have historically evolved in tension with capitalism and the state, not serving its needs but producing artisan "machines" and "functions" that resisted the state.

perceives in such a way as to be ready for difference at any moment. An education that only uses demonstrations develops perceptions and desires in its students that habituates them to the tendency towards stasis. However, things must be pointed out in education; demonstrations are probably the most valuable form of teaching a solidified theory and function-relation. But only teaching demonstrations solidifies the students in that way of thinking and perceiving. At all ages, true experiment is necessary for students to have a complete understanding of the way of being of science, and to become an artisan of matter.

While it is true that research laboratories contain a far greater degree of experimentation than most classrooms, such laboratories are still often plagued by an imbalance of tendencies. Kuhn's conception of "normal science" is instructive, because it suggests that most scientist's perspectives of themselves and their work in the laboratory is but to fill out a theory in ever greater complexity. Opposed to this is the conception that all theories and practices are in dynamic relation with each other, and that every activity in the lab contains elements of demonstration and experimentation; this would be a proper balance of tension, and it should be the ideal of both research laboratories and classrooms.

One of the serious issues with over-demonstration is the confusion between value and quantity. The most demonstrable things are the easiest to measure, and the easiest to measure is inevitably what is measured most in a classroom. When one thing is measured over and over, it is assumed that it is epistemically valuable to measure that thing and that that thing is valuable (cf. Biesta, 2009). In many ways, repeated demonstrations grow in students the belief that it is desirable to measure what can be measured. By constituting this desire, state education slows down assemblages. More fundamentally, more disturbing for the students, it grows in them a desire to demonstrate and do nothing else, a desire to constitute themselves in an assemblage that functions hylomorphically, where theory can always be trusted in its stasis and instantiation in the variability of matter; it is a desire for matter to be grasped once and for all, to be settled, to be controlled without any need of expertise, to be bored with matter and infatuated with the symmetrical beauty of the state-produced theory. It breeds dogmatism, boredom, repetition, perfect regulation; a million textbooks, a million students mixing baking soda and vinegar, a million computers, four thousand six hundred and seventy hydrogen bombs.[34]

Teaching Experimental Perception

Experimental perception can be taught and reactivated. Since the weapons of the war machine can pierce through any assemblage, any demonstration can become a weapon, or an experiment. Self-conscious demonstration—a demonstrational perception that recognizes its own act of demonstrating—can become a line of flight, a new plot of land.

Most demonstrations are not self-conscious, and indeed most teachers are afraid of confronting the created discontinuity between the activity and the theory they are demonstrating. Noel Gough points out a common feature of primary and secondary school science education: their demonstrations take up everyday concepts, such as work, force, or distance, and then intentionally give these a "real" physical definition that is completely counter-intuitive—as if this will impress the students, as if their previous intuition had been completely misled and silly (1998, 5). A student is asked to hold up a heavy object for awhile, and then asked if they did any work; when the student responds that they did, they are pedantically corrected: "work" "really

[34] The number of of hydrogen bombs in the United States at the time of this writing.

means” force times distance, and since in holding up the object, they did not move it any distance, they did no work. The correct response of the student is to say “that’s dumb; science is dumb.” Gough says:

> if students perceive an incoherence between their commonsense understandings of reality and a scientific representation of it, science educators should not assume that the ‘fault’ lies with students or that it is their sacred duty to coerce students towards an orthodox belief. On the contrary, science educators should be helping students to *understand the incoherence* rather than to fudge it – to *demonstrate* that gaps between reality and representation are inevitable rather than to deploy all sorts of rhetorical tricks (including laboratory work) in an effort to persuade students that it all makes sense. (1998, 6)

If students are not prepared for the incoherence of pure theory, for the impossibility of pure stasis or realism, then they will be frustrated later on as they pursue university studies and research. And even if they do not become scientists, a multitude of these shallow perspectives will inevitably lead to unnecessary social and political problems. For example, if scientists admit the uncertainty of any of their theories, and if that theory is an inconvenience to the public, then the public will find it much easier to reject the theory, technology, or prediction outright. This seems to be true currently for the cases of human-caused climate change and the side-effects of vaccines. Educators often resort to such “rhetorical tricks” of making scientific facts into bizarre dogmas, so that they can avoid the incoherence between theory and perception, which might be deemed too complicated for their students or the public, or so that their students will be able to reproduce a given set of knowledge which can be easily measured for signs of their progress (hence memorization, testing, and grading per usual). Gough argues rightly that "recipes for 'experimental procedures' should not only be couched in terms of the 'minor and major genres of science writing' but also *invite* students to 'translate back and forth between scientific and colloquial statements or questions'" (1998, 11). There must be a *continuity* between scientific theories and direct experience and common language; as the educators should be able to express this, the students should also be able to perceive it. Maintaining both a continuity and incoherence between theory and experience is the doorway to perceiving like a nomad.

Perception is wrapped up with physical space. The placements of the desk, the equipment, the posters—as well as the teaching style of the teacher—actively create certain perceptions, and these perceptions in turn create the classroom. In order to demonstrate, the classroom must be striated, the experience optical: the students could be arranged in rows and columns, directed to the front of the classroom, or they could be clustered around a station[35]—but in any case they are positioned like chess pieces, passively receiving information, the teacher at the head or the centre of the classroom, with access to the central source of knowledge, lecturing, pointing out forms, establishing a set of signs; the classroom slows down, becomes apathetic, matter is forgotten. To experiment, the classroom speeds up, the experience becomes haptic: the students become a pack and leave their desks to actively participate in the activities of the classroom or field, forming knowledge along with the teacher, who is trying something out and helps the students feel the continuity between their experiences and their operative

[35] This has strong parallels to Michel Foucault's use of the ideas of the discipline of docile bodies and the panopticon in *Discipline and Punish*. For example, "Each individual has his own place; and each place its individual. Avoid distributions in groups; break up collective dispositions; analyse confused, massive or transient pluralities. Disciplinary space tends to be divided into as many sections as there are bodies or elements to be distributed" (143).

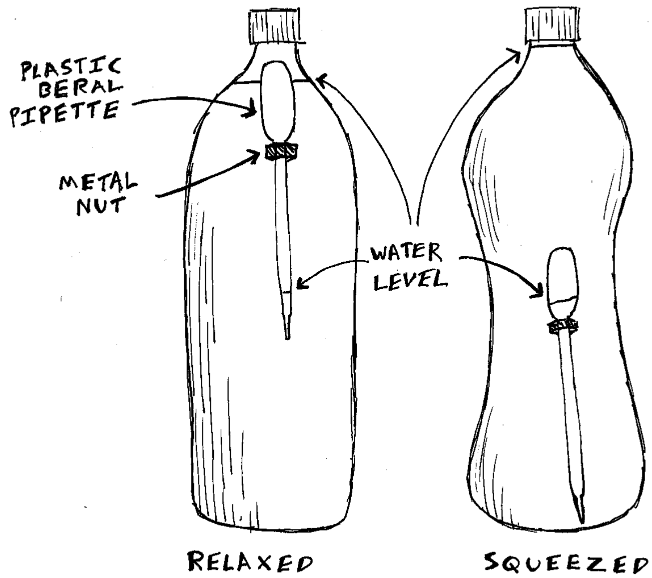
equations; here the classroom becomes a war machine, because at any moment the relations of the assemblage could shift and radically transform the functions of different parts.

Teaching Boyle's Gas "Law" Nomadically

Robert Boyle's gas law is commonly taught in ninth grade science classes. It can be summed up with the equation PV = k, where P is pressure, V is volume, and k is a constant at constant temperature. This equation tells us that a decrease in pressure corresponds with a proportional increase in volume, or that a decrease in volume corresponds with a proportional increase in pressure. It is taught probably because it can be easily demonstrated. The state takes itself to be demonstrating the instantiation of a mathematical law that relates pressure and volume; but for the nomads, it is only manifesting a particular, stable function-relation. For example, a lesson for ninth graders could begin with the students experimenting with what are called "cartesian divers."[36] Cartesian divers are closed bottles of water that contain a plastic beral pipette weighted down with a metal nut (see figure 8). Even though the pipette is saddled with the nut, it is full of air and it floats. If the students squeeze the bottle, the water forces its way up inside the floating pipette, and as the explanation goes, because the pressure inside the bottle increases, the volume of air in the pipette decreases (Boyle's law). When the volume of air in the pipette contracts enough, the pipette suddenly sinks (the displaced volume of water is no longer lighter than the water). The students are then asked questions about pressure, volume, and their relation to each other, guiding students to the conclusion of Boyle's law. The teacher then proceeds with a long lecture on the mathematics of the law. Finally, the students are assigned work, another demonstration (predictably called an "experiment"), involving heating an

[36] The lesson plan was gratefully taken from Rachel Meisner, "Boyle's and Charles' Laws."

Figure 8: A cartesian diver. Squeezing the bottle causes the pipette to dive. The squeeze increases pressure, decreasing the volume of air in the pipette; this changes its buoyancy.



erlenmeyer flask with water in the bottom and a balloon on top; and a worksheet with a number of calculations using a variant of Boyle's law ($P_1V_1 = P_2V_2$). This is the style of state education.

As Douglas Allchin rightly points out, there are innumerable problems even with Boyle's "law": it requires a constant temperature; it does not apply for small volumes, high pressures, or low temperatures; the variation depends on the kind of gas (2007, 18). In other words, it has no true universality. Allchin says, "this is the lesson typically missing when teaching Boyle's law: what's *not* in Boyle's law—a world full of context and contingency, not simple rules" (2007, 19). On the topic of teaching Boyle's law, although Allchin is right to point this out, introducing these complexities is not helpful because *they are only striated qualifications*: in the end the qualifications only lead to, first, the ideal gas equation, $PV = nRT$, and then second, the van der Waals equation, $(P + a/V)(V – b) = nRT$, which has empirically-determined correction variables specific to each pure gas. This kind of nitpicking about laws is always possible,[37] and this unending process of clarifying equations is but one indication of why a scientific realism is misleading; applying inherently-biunivocal mathematics to real-world assemblages only leads to an infinitely unravelling series of mathematical qualifications. But in fact, complexity does not really undermine state science; state science *thrives* on it. Presenting Boyle's gas law equation and then suggesting it has a series of secret qualifications is state education *par excellence*. State science becomes far more difficult to resist when the students think that the reason Boyle's gas law equation—the hylomorphic ideal—does not yet perfectly represent reality is due to a set of qualifications that the student can not yet understand. If the weirdness of Boyle's "law" is due to a lack of the student's understanding, due to the teacher's privileged inside position on the qualifications of the complex representative equation, then the students will be *more* convinced of a state ideology and the need to pursue it. We cannot overcome state science by pointing to complexity, by waving feebly to the van der Waals equation; that only makes the state ideology more insidious.

The question is how we teach Boyle's gas law nomadically; that is, to teach it not as a law, but as a quadrature, not as a demonstration, but as an experiment, not as proof of state ideals, but as the usefulness and weirdness of certain equations alongside new ways to think about gasses. Ironically, our first indication of how to teach Boyle's law nomadically comes from

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[37] This applies to all of the well-known laws: Galileo's pendulum law, Ohm's law, Newton's laws of motion, Mendel's law of independent assortment, Snell's law of refraction—these are the laws that Allchin mentions in "Teaching Science Lawlessly." But it is, in my opinion, far too hasty to *not* apply context-dependence to *every* law, that is, even to laws that as yet do not have any qualifications: such a claim is too suspiciously a state ideology and defence of scientific realism. So this should also apply to Special and General Relativity, the laws of thermodynamics, and all the rest of a physicist's beloved Absolutes.

Robert Boyle himself.[38] He did not formulate his observations as an equation and he did not think of it as a law: "he referred to the spring of air more modestly, as a 'habit of nature' or 'custom of nature'" (Allchin, 2007, 19). This is appropriately empirical. Indeed, Boyle's observations only held in very specific conditions, notably in his J-tube equipment, and in the following centuries, in internal combustion engines, industrial boilers, and certain ventilation systems; it does not even apply to the atmosphere, where wind rather than compression plays a far more important role (Allchin, 2007, 22). The "law" is a contingent and local habit of nature. It is not hiding deep in the structure of reality. It is a function that can be extracted-created. Recognizing it as a habit of nature, though, is not a recognition of complexity: we have no reason to painfully stretch the equation to all four the corners of the world by including a series of mathematical qualifications; rather, the equation is an expression of a local phenomenon, a single function-relation.

Can Boyle's habit of nature be taught nomadically? As argued, the complexity of the equation is misleading, even at times harmful; so it can be taught with the simplest formulation, PV = k. And where do we see this? The cartesian divers, Boyle's J-tube. If we are teaching

[38] If we can temporarily put aside however hierarchical and privileged his intellectual position, however much it is not at all "Boyle's" law. For a sense of how Boyle's law was a cultural and social construction, see Elizabeth Potter's *Gender and Boyle's Law of Gases*. Constructivism, by the way, does not have to be interpreted as a negation of a scientific theory; rather, the fact that all scientific theories must be constructed from a cultural and social milieu explains why theories always look at matter from a particular perspective. Arguably, a theory must be perspectival, for its content can only come from its milieu, and we have little reason to believe that an impartial observer (who is of course an observer, a perspective) can gain sudden, inexplicable access to an ethereal realm of mathematical forms. Mathematics cannot provide content; rather it provides a rational structure for that content: both Newton and Leibniz went looking for a new mathematics in order to provide a rational structure for their new way of looking at the world, and the same applies for the metric tensors of Einstein's general relativity and the Schrödinger equation of quantum mechanics. The same applies to other means of formalizing a rational structure, which can be conceptual as much as mathematical ("models" in chemistry, for example). Therefore, outlining the constructivism of a scientific theory is really always a positive project, an affirmation of the theory as that which has emerged from a context; it is a kind of critique because it outlines the structure and origin of the theory and it simultaneously points the way to new theories.

Boyle's habit of nature, if we want the students to be introduced to this particular function-relation, then we might as well start with a demonstration; the cartesian divers and some follow-up questions could work well here. But in nomadic education, the demonstration is only the beginning; there are so many other functions to discover-create. We cannot and should not predict what they will be, but we can create space for lines of creation to take flight. The demonstration will have set up the space for students to think of how pressure and volume might relate. The task is to keep these variables in constant variation. The students will need a swath of new equipment, materials for creating their own tubes and instruments that roughly play with the same phenomena of pressure and volume. Each student should start from a problem or set-up that they find inherently interesting. See where this goes, what new relations and variables pop up. It will be difficult, and there will be mostly "failure," that is, uninteresting relations or non-reactions. The point is for the students *to learn how to try to produce new relations and functions*, how to intuit what new apparatuses will create interesting relations, and how to abstract functions from these. The job of the nomadic teacher is to guide students along creative routes that they themselves (the teacher and the children) have never explored.

A Nomadic School: Waldorf

State schools have cut-and-paste formulas, in their building structure, curricula, and methods of teaching and management. This is the same tendency that we find in a rook piece in chess, a suburban house, or a pure bottle of acetonitrile. But if we were to have a nomadic school, it would find itself in the middle of a particular context; it would not be "the public school" but a particular assemblage "Waldorf-school-south-west-Ontario-countrysidemennonite-children-2018." It would be a haecceity. That said, pure nomadism is cancerous when it is broken free from its tension with the state, as mentioned of a "body without organs" that is taken to its extreme. The school must then have a method that can be roughly reproduced amongst schools—sufficiently flexible and productive of nomads, but a reproductive method nonetheless. A successful example of such a method is the Waldorf school.[39] For those always on the way to becoming nomad scientists, it is heartening to know that these schools are not driven by the theoretical; there are a thousand of these assemblages, these nomad factories, spewing out little monkey-wrenching nomads.

The Waldorf schools were founded by Rudolf Steiner. Steiner stressed the importance of viewing a human from the perspective of their whole life. This means that his educational method pays attention to and adapts to the particular tradition and background of a group of children (the school and the children and their background thus making an assemblage), and it means as well that "the visual, musical, and tactile arts are integrated in all subjects areas from preschool through highschool" (Easton, 89). Freda Easton observes the following:

> Waldorf educators strive to educate children to become whole human beings in the face of a scientific rationalism that views us as machines and technological advances that threaten to mechanize our lives. Waldorf provides a framework for envisioning a renewal of thinking that integrates imagination, inspiration, and intuition into our ways of

[39] There is also the Montessori school. Like Waldorf, the Montessori method emphasizes different teaching styles dependent on the child's development stage, it consistently grounds its education in sensorial experience, and it "takes into account the whole child and his [or her] place in the community" (Hainstock, 39–40). However, there are a number of goals in the Montessori method that are over-emphasized if it were to be fully nomadic, such as the goals of imitation, obedience, and normalization (see for example, Hainstock, 61).

> knowing… It recognizes the essential role of artistic work in educating children toward a holistic thinking that encompasses aesthetic and ethical considerations. (94)

Art plays such a central role in Waldorf education because it functions to help the students and the teachers actively face the inner and outer worlds, paying attention to difference within themselves and without, helping them become strong individuals and members of a societal and natural community. Arguably this is the root of ethicality. While art is certainly not the same thing as nomadism, weaving art throughout an educational method, including even the classroom dynamics and structures, seems to increase the tendency towards change, introducing an element of nomadism.

The art is integrated (the school is nomadic) in numerous ways: students actively write and illustrate their own "textbooks" or self-created lesson books (there are no textbooks, and they only use primary sources as references) (Easton, 89); instead of bells to signify the end of class the teacher plays melodies or rhythms that signals specific transitions (90); students learn geometric shapes in a thoroughly tactile manner, by drawing and moving their bodies, in the manner of the quadrature, or by finding interesting proportions and symmetries in the plants in the field out back, or even by memorizing a sonnet to Euclid (89); they "learn their arithmetic tables through dancing, singing, and clapping" (91); in general, they use a method of "eurythmy" which helps students "integrate the sounds of speech, poetry, and music through movement, gesture, and color" (Easton, 90);[40] and they can learn other information, scientific, historical, artistic, or literary, through the form of fairy tales and songs for when they are younger, or through legends, poems, and chants later in elementary school, and then through literature and

[40] Mary Caroline Richards describes Eurythmy as "a vocabulary of movement" (87); for a more detailed exposition of this unique Waldorf practice, see pages 86–88 of Richards.

the history of art in highschool (information is better recalled when it is embedded in a story or aesthetic structure) (89). With such a focus on development, the teacher often stays with the same class of students across the entire span of elementary school, for eight years; this continuity of relationships allows them to strengthen and develop together, though it is a difficult task (89). And throughout all of this eccentric structure, the students and teachers can be kept in touch with the rhythms and qualities of the material world by orienting their classroom decoration or curriculum to the current season (Easton, 90). All of this is nomadic because it follows basic tenets of nomadism: paying attention to the singularities of matter and the becomings of larger assemblages (such as seasons and historical changes); linking haptic perception with information, thereby embodying understanding; learning abstractions in the manners of the quadrature, rather than memorizing equations or facts, or reading textbooks. Mary Caroline Richards even speaks of many of the Waldorf practices as a dialogue or conversation with matter (81)—and there is nothing more nomadic than the immediate following of vital matter. As seen with the geometry and arithmetics above, science education in Waldorf is not hived off from this aesthetic integration. Larsson and Dahlin point out that Waldorf science education never begins with a theory and always begins with observation of a natural phenomenon (9). Of course, observation is not itself enough; it is the kind of perception, demonstrational or experimental, that determines its nomadism; the many Waldorf practices ensure this.

Matter's Form of Secrecy: Against Scientific Realism

To repeat, Kuhn's normal science can be likened to the perception of the state scientist: the scientist looks out onto the vicissitudes of matter and thinks "my job is to explain how the forms on this chalkboard, the forms of Einstein and Schrödinger, represent and explain everything here and allow for new technologies; and it is only a matter of time until that is complete, until I have tamed nature and completely understood it." But Kuhn's "revolutionary" science is still a state science, for it is only the perception of a migrant, and not really the perception of the nomad scientist: the nomad scientist is *always* in the process of transitioning between worlds, playing dynamically between thought and matter's actions, barely internalizing the process; instead wondering, amazed that matter will never be tamed and that it will indefinitely produce new relations, functions, and affects. Following this, Kuhn's (normal or revolutionary) science education tells students that there is a particular kind of matter, which one need only go out and find in order to confirm the theories. It is the basic representation-realism pair. "Vinegar is an acid, baking soda a base, and if you mix them together, this is what you will find." In other words, "here is a controlled process that is easily reproduced; go out and reproduce it." The particularities of matter are mathematical details that will inevitably fit into the slots of a theory's table. The scientist merely converts sense data into numbers, assembles these skillfully, and derives predictions, conclusions, technologies, etc. If matter is already given out summarily beforehand as a theory, the only supposed newness is the rearrangement of the relations between preconceived categories. "Now mix this different acid with baking soda… Where does it fit on the table of observations? Did it bubble?" How boring, how unilluminating. We're not even curious. It is because of this transcendent employment of theory, theory through the lens of a state concept, that matter collapses onto a superficial plane of predetermined observations. Matter has no plane of its own, matter does not unfold, it does not become, it has no secrets. While on the plane of immanence in D&G's philosophy there is always further to go and more to discover and create, the plane of physics described here collapses all scientific models, functions, work, and essences into the same striated space, and totally removes the possibility of newness, simultaneously in perception, theory, and action and reaction. This plane of physics, the representation-realism pair, I have already argued, is an impossible ideal set by a state striving for the fulfillment of the tendency to stasis. Under this way of being, this impossible striving that will never satisfy itself, matter is dead and so are the scientists.

A balance of tensions, however, means that there are thousands of plateaus of striated lands, connected by oceanic spaces of constant flux. There is the plateau of physics, perhaps the "widest" plateau (having set for itself that task), outside of which is a vast ocean of change, and inside of which there are smaller oceans, and where these smaller oceans contain plateaus as well, such as chemistry and biology and others further in. The sciences are a plurality of this strange tension, interconnection, and groundless difference; here physics is different from chemistry, chemistry is different from biology, biology is different from the social sciences. They have strange relations that are hard to track, but these relations are not at all determinative of or reducible to each other. In other words, causality has innumerable levels, none of which are reducible to each other. The wind blowing the branches of a tree, coughing after a strong drink, soap becoming suds, arguing, the sun exploding and fusing, gravity bending space and time; these are different kinds of causes, not reducible to a shared ground that could set all of them out in perfect detail "if only we knew enough." The true cause is found in the direct experience because the connections of our experience, part of the form of experience, *is* causality.[41] Our

[41] I am following an aspect of Schopenhauer's principle of sufficient reason, the *principium individuationis*, where causality is the category that fuses the transcendental aesthetics of space and time. Causality is the flux of succession, individuality, and plurality that we directly experience. See for example page 112–3, §23, volume 1 of Schopenhauer's principle text.

theoretical expressions of these causes (or other hidden causes in the innumerable levels of causality) are pragmatic and their correlate, whatever is being "represented," is so distant that our causal theories, we must admit, are only mathematical and functional metaphors that delineate realities which we can only glimpse with our imagination. What really does the flux of water molecules "feel like down there"?[42] There might be something, and if there is, we know one thing: as human subjects, and even with our morass of equipments and theories, the deeper levels of water (of any matter) will always escape us, even as we discover more about it. Scientific discovery is an intimation and a creation. We can never for a moment believe that we have adequately represented the realities we can only imagine. One need only *look* at a glass of water to understand this; one need only *pay attention to difference*, to begin to empathize and to experience as a participant and part of vibrant matter what we have been calling vortical organizations, in order to see that representation, stasis, and realism are horribly inadequate. Only with this embedded perception can we be *curious* and ask "why?" with earnest, for only this perception is in relation with a unique form of secrecy, a form of un-traversable distance, like the rainbow that always flees our grasp. Matter in-itself, or orders of causality beyond our

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[42] A dangerously misleading answer to this question is given by the famous electron microscope and the atomic force microscope, which often implicitly claim to have *visualized* tiny creatures, cells, molecules, and atoms using incredibly precise machinery. However, the whole point is that "down there" cannot in fact be visualized, because photon-matter interaction is completely different; this is why such machinery, rather than precise glass lenses, must be used. Thus the creation of pictures based on the data of these microscopes—without further comment—is a deception and the unabashed propaganda of scientific realism: it says, "see, I told you so; reality is exactly like the state's static essences." Hidden in this deception are equations that make unjustified assumptions: calculations of variations in force are translated and equated to a three-dimensional graph that can be visualized. This direct translation is simply not warranted, for not only is it like saying that the sense of touch is equal to the sense of sight, it is assumes that the sense of atomic and electronic forces, whatever these could possibly feel like, are somehow equal to the visualized, pixelated surface of a mathematical graph. It is a reduction to the same, just like Jules Verne's centre of the Earth or Christopher Nolan's interior of the blackhole (see below). That said, these means of accessing the lower causal realities are very intriguing, and their worth depends entirely on how they are used: do we relate to the pictures in order to pay attention to the differences revealed by this exploration, or do we in fact ignore the differences that we have discovered?

direct experience, would be the other side of the rainbow that we are prohibited to see; and science would be an endless chase.[43]

Outside the Classroom: Media Education

If I can use J. J. Abrams as a foil, it is not as he would have it (in his TED talk "The Mystery Box") that secrecy or mystery is simply a thing that we are waiting to discover, like a box on stage with a giant question mark on it, which only has an infinite potential because it has not yet been opened. And it is not as it is said so crassly in a recent film: "As we've come to understand, there is no such thing as the unknown. Only the temporarily hidden." (Lin, *Star Trek Beyond*, 17:04). Such supposed mystery or curiosity is a relation to an undiscovered fact that will soon be revealed to us in all of its clarity. This is the myth of popular science fiction, which fits with an absurd optimism in scientific progress and the philosophical positions of scientific realism and truth-as-representation. In contrast, there is Stanley Kubrick's *2001: A Space Odyssey*, which has a relation to a *form* of secrecy, a theme that structures the entire film, a "what could have happened?" that will forever remain unknowable, but will always be the impetus for the next step in the evolution of the species and the cosmos. Kubrick's theory of evolution is causal—that is, it sticks close to the plane of experience and it does not conceptualize—and precisely because it is, because of our situated-ness, our being-in-the-world, that is, our places in evolution, we can only sense the causes of evolution from across an un-

[43] One way of thinking about the mysterious relation between scientific theories and their objects is given by another french philosopher, Gaston Bachelard. Roch C. Smith says: "Discarding the assumptions of realism, contemporary science, according to Bachelard, views the atom not as an object to be known but as "a centre of convergence for technical methods" " (52, quoting *Les Intuitions atomistiques: Essai de classification*). This does not seem to disagree with D&G when they say that science is the creation of functions.

traversable distance: the black monolith that is so crucial in each stage of our evolution in *2001*—that eery, wailing monolith—cannot be opened.[44] The form of secrecy sets the undiscovered at a permanent distance; there is nothing epistemically temporary here; it is not a privation.[45] Not only is this good story telling, it is the myth that science needs and it makes for good science; media is a form of education and only movies that stick to the form of secrecy will suitably educate nomad scientists.[46]

To some extent, we can also find this form of secrecy in Christopher Nolan's *Interstellar*. Here the form of secrecy is the force of gravity in its ability to cross time and space, and to manifest as radical disjunctions between human lives. The gravity of a black hole sets the protagonist Cooper in a hundred-year gap with his children. When he witnesses the distance

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[44] And of course, Arthur C. Clarke's novel under the same name (written with Kubrick) breaks from Kubrick because its excessive explanation is based in a scientific realism. The novel was written more by Clarke, the script more by Kubrick; see Gelmis, page 302 and 308, quoting Kubrick.

[45] In *Cinema II*, Deleuze has a strange discussion on Kubrick, which implies a form of secrecy. Here it is: "If we look at Kubrick's work, we see the degree to which it is the brain which is *mis en scène*. Attitudes of body achieve a maximum level of violence, but they depend on the brain. For, in Kubrick, the world itself is a brain, there is identity of brain and world, as in the great circular and luminous table in *Doctor Strangelove*, as in the giant computer in *2001 A Space Odyssey*, the Overlook hotel in *The Shining*. The black stone of *2001* presides over both cosmic states and cerebral stages: it is the soul of the three bodies, earth, sun and moon, but also the seed of the three brains, animal, human, machine. Kubrick is renewing the theme of the initiatory journey because every journey in the world is an exploration of the brain. The world-brain is *A Clockwork Orange*, or again, a spherical game of chess where the general can calculate his chances of promotion on the basis of the relation between soldiers killed and positions captured (*Paths of Glory*). But if the calculation fails, if the computer breaks down, it is because *the brain is no more reasonable a system than the world is a rational one* [my emphasis]. The inside is psychology, the past, involution, a whole psychology of depths which excavate the brain. The outside is the cosmology of galaxies, the future, evolution, a whole supernatural which makes the world explode. The two forces are forces of death which embrace, are ultimately exchanged and become ultimately indiscernible… the robot breaks down from the inside, before being lobotomized by the astronaut who penetrates it from the outside" (212). And finally: "At the end of *Space Odyssey*, it is in consequence of a fourth dimension that the sphere of the foetus and the sphere of the earth have a chance of entering into a new, incommensurable, unknown relation, which would convert death into a new life" (213). One gets the sense that not even Deleuze knows what is happening—"God, whatever could have happened?" (ATP, 228)

[46] The only other science fiction movies (that I know of) that stick to the form of Secrecy as solidly as Kubrick are Andrei Tarkovsky's *Solaris* and *Stalker*.

between him and his daughter and son, and when he sees their lives flit past him in a series of compiled video messages, here the story has a fundamental relation to the form of secrecy, and Cooper can only weep and wonder hopelessly, “God, whatever could have happened?” Theoretically we know what happened, but in truth not at all. In portions of *Interstellar*, gravity is not a sterile theory; it is a living secrecy that causes imperceptible disjunctions, motives, and transformations. Yet while *Interstellar* succeeds to maintain the form of secrecy in certain respects, it fails drastically in others. This is the case with the revelation of Murphy’s ghost, which also coincides with the revelation of the inside of a black hole, and the “solving” of gravity. The will to overcome secrecy is strongest here, for in astronomical theory, the black hole is the epitome of the form of secrecy: the black hole is that which nothing can escape; it is the fundamental object of mystery that can never be opened, a singularity, that which opens onto infinity—and so it is fundamentally different from Abram’s mystery box because *it cannot be opened in principle*. *Interstellar* literally replaces the form of secrecy within gravity and the blackhole with a four-dimensional version of Abrams’ mystery box, the tesseract within the black hole, which unfolds to come back and reveal what was temporarily hidden. Every film, like every novel and classroom, should have a solid relation to the *forms* of “What could have happened?” and “What is going to happen?”; no film is a checklist of veiling and unveilings; so when *Interstellar* abandons these forms, it is a failure of storytelling and a failure to conceive of science properly; it becomes a cheap tale of scientific realism.

There is nothing more destructive to the form of secrecy than scientific realism, whether it is in Abrams’ mystery box, in scientific myths in film, or in science posters and textbooks in a highschool classroom. Scientific realism undermines the form of secrecy by performing a magic trick of its own: too quick to see, it replaces the absolute form of secrecy with a "temporarily hidden" object that can be finally represented. In so doing, it sets out a space for insidiously educating state scientists.

Conclusion: Keep a New Plot of Land at All Times

D&G's advice: *keep a new plot of land at all times*. Smooth out your laboratories and classrooms. Grow artisans in pots. Teachers and students alike should always be creating. Don't have the students memorize the contents of a Eukaryote cell; have them look through a microscope and create and draw their own theories, and then challenge their theories with new cells and phenomena—this is the maturation of an artisan: the continuous development of their capacities as both a state and nomad scientist, building the skills needed for a tension of control and creation. And in order to create they must have a perceptive relation to matter, to its form of secrecy, to an interest in its productive difference, to an intensity and a willingness to constantly but skillfully change assemblages, to change one's desires, technical objects, symbols, meanings, and expressions. There should never be permanent or fantasized discontinuities between scientific theory and experience; the only science worth learning here is the science of continuity, continuity between common language, scientific language, and engagement with matter, none of which should be in conflict, but all of which should in their difference build, confirm, and deepen each other. In fact, as soon as we make the expressions of scientific theory continuous with its demonstrations and experiments, we find that every single action in the classroom and laboratory is open to change, and that the perception that allows for such continuity is exactly the perception that relates to the form of secrecy and the intensity of vortical organizations. So to “have a small plot of new land at all times” means to constantly be able to perceive as a relation to the form of secrecy, and to always strive for continuity; give no quarter to scientific realism. After describing Newton’s third law, it can be as simple as asking “What does this mean?”, immediately turning to a demonstration in the classroom, such that the demonstration is self-conscious, is in fact an experiment that will always simultaneously “prove” and “disprove” the theory; Newton is always a little wrong, and not because of Einstein, or because it is “approximate,” but because there is no such thing as pure stasis. By emphasizing the continuity, the students will be able to immediately recognize and feel the discontinuity of a theory, or the fact that it attempts to go far beyond direct experience, and calls for an imagination of other orders of material reality that will never be fully unveiled and certainly never perfectly represented. At the same time, an education of continuity will link their knowledge and skills to their relation with matter, and it will grow in them a desire to know difference—that’s the most powerful war machine of all. Maybe at some point in the future a swarm of nomads will tear science away from its state domination and establish a community of artisans that endlessly and playfully produce functions and “worlds” from their conversations with matter.

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