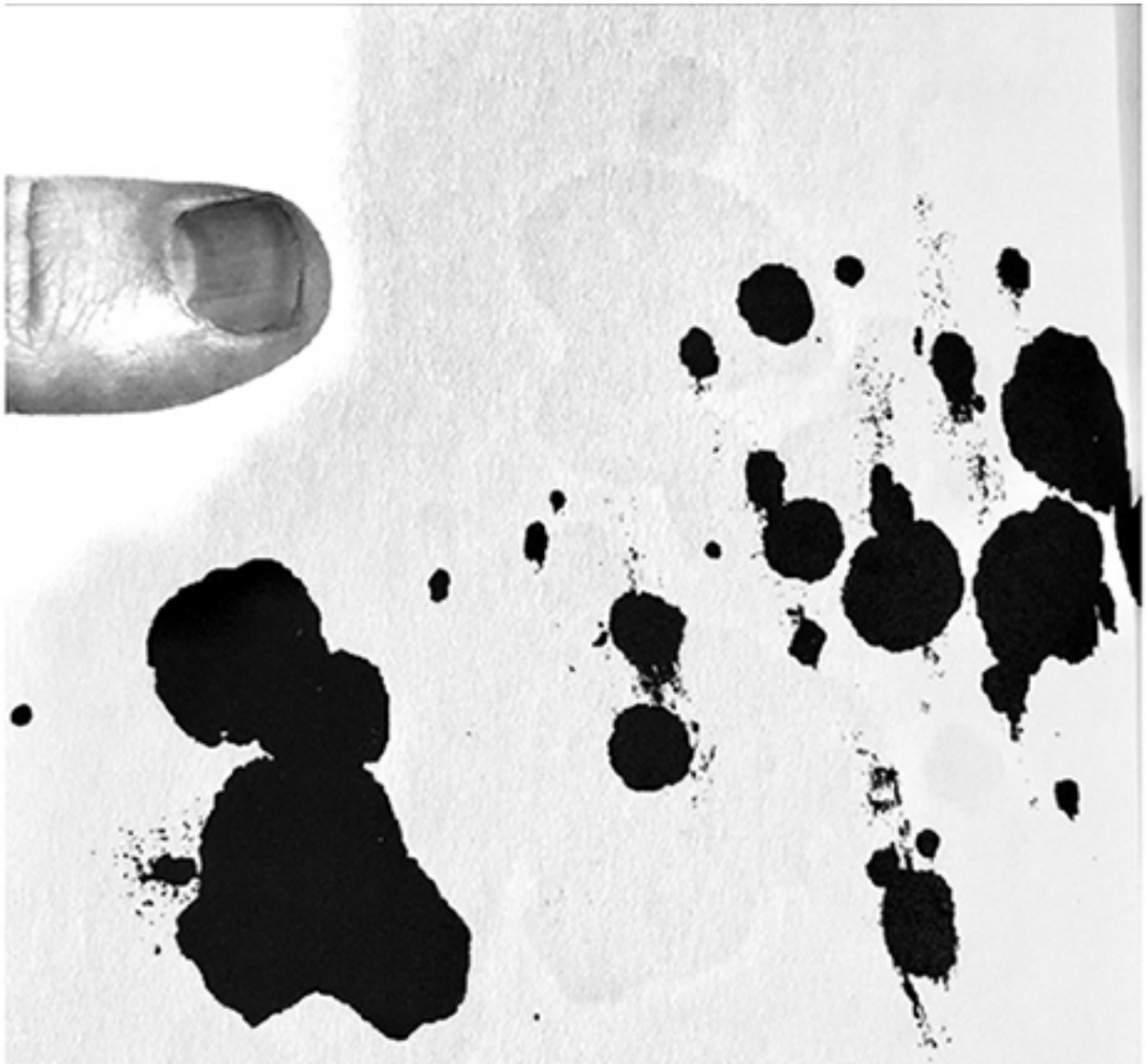
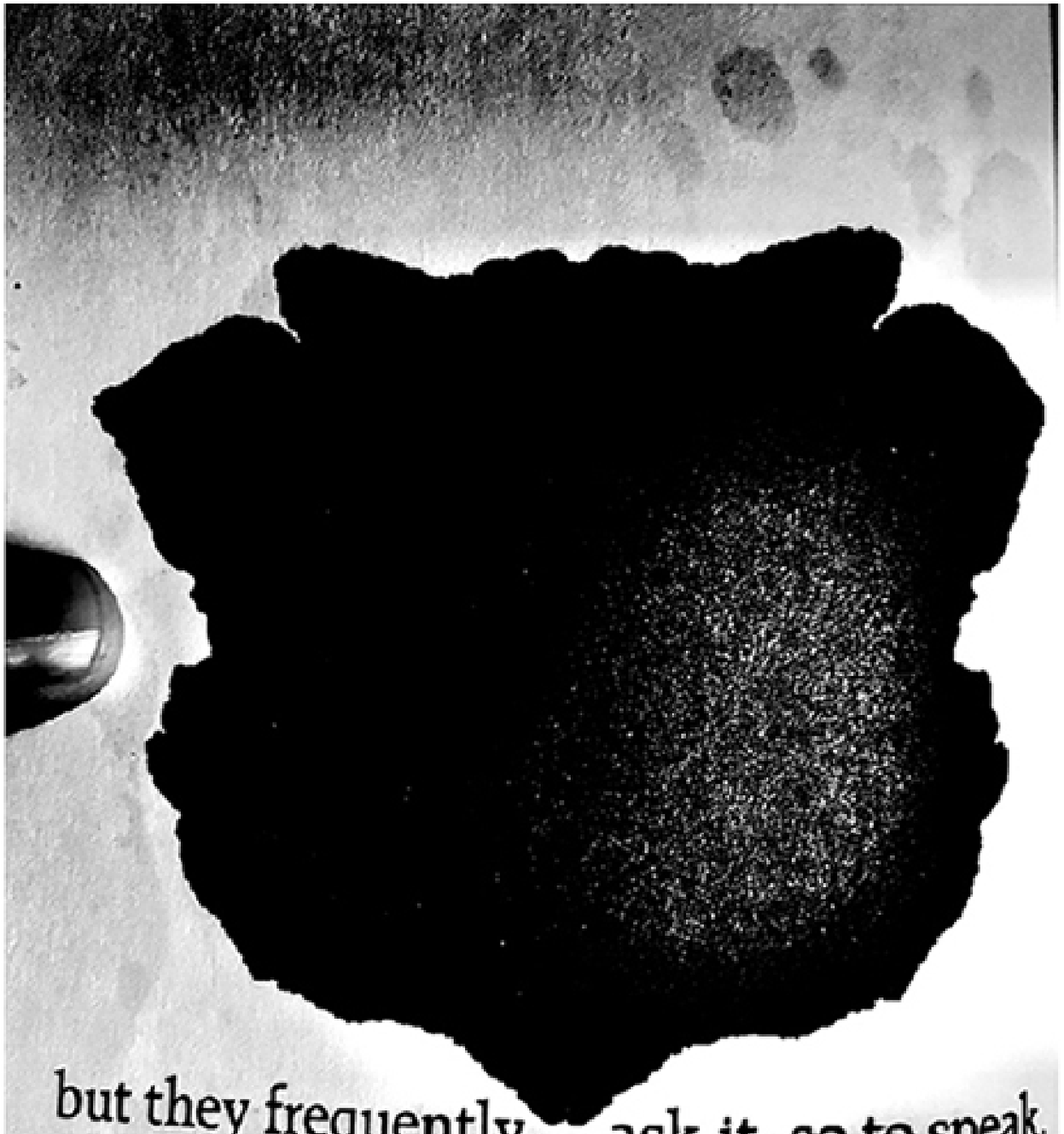
If I am a musical thinker,



I want to know what it is I'm thinking about, and in the hope of what outcome.

People are always asking

what music expresses;



but they frequently ask it, so to speak,
in the third person;

that is, they speculate on expression from a point of view exterior to the organism's felt need for expression, and exterior to anyone in particular's experience of expression.

So if I want to know

what music expresses,

and if I want to know why

I think about music,

I have to introspect

my own experience,

my experience of my own needs

and my experience

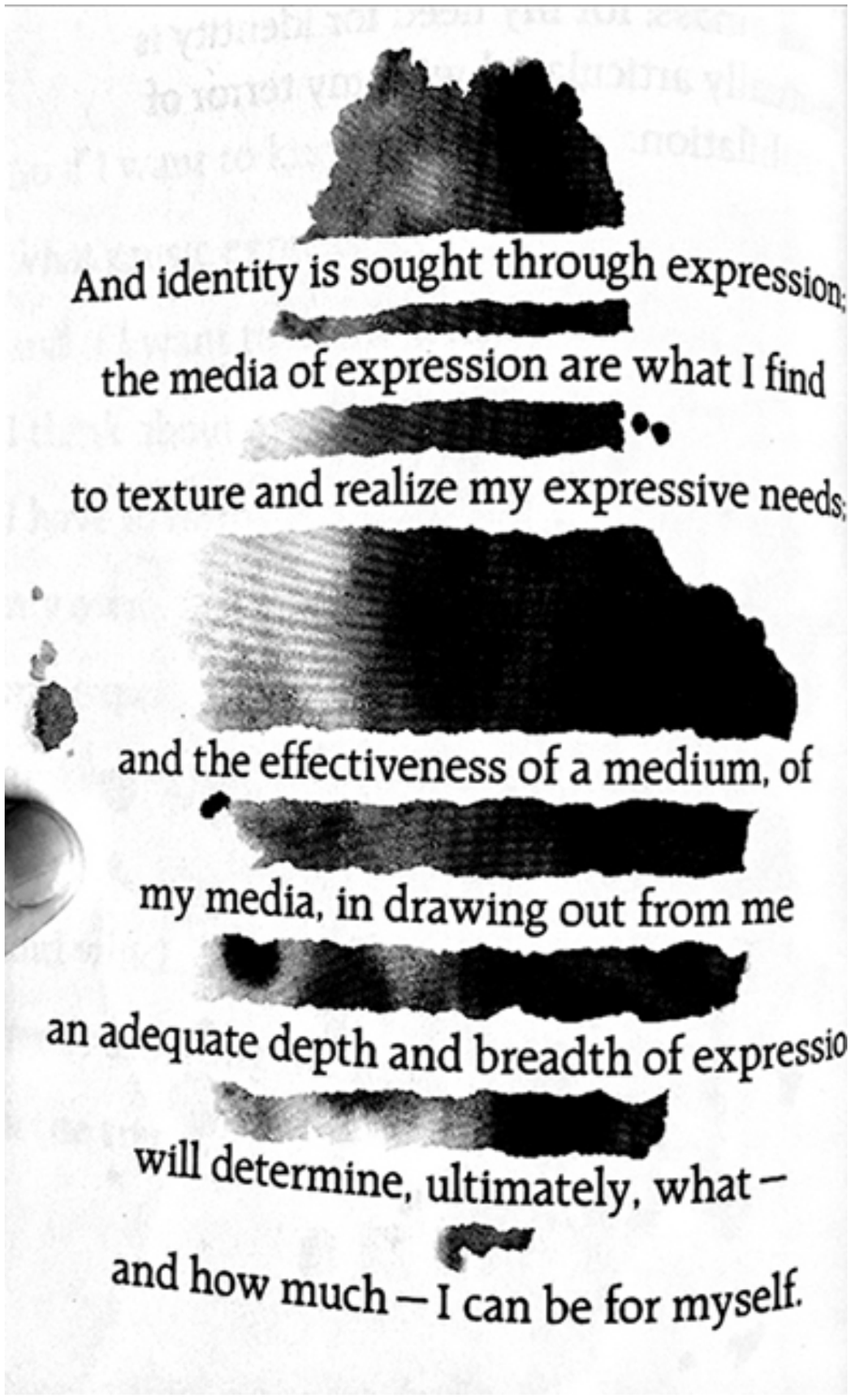
of how,

and which, and in what way,

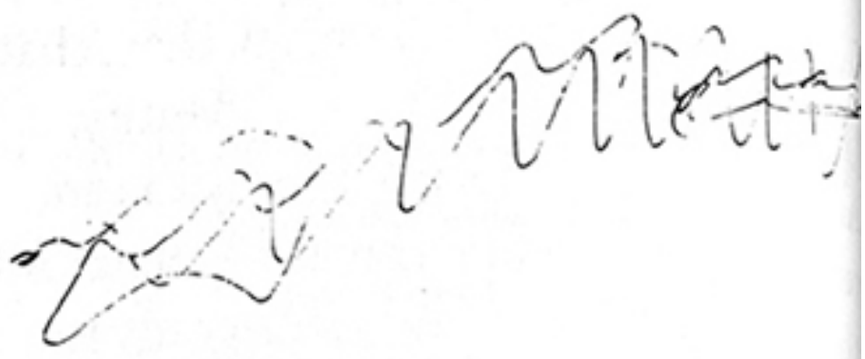
needs are being fulfilled or engaged

in the transaction of musical activity.

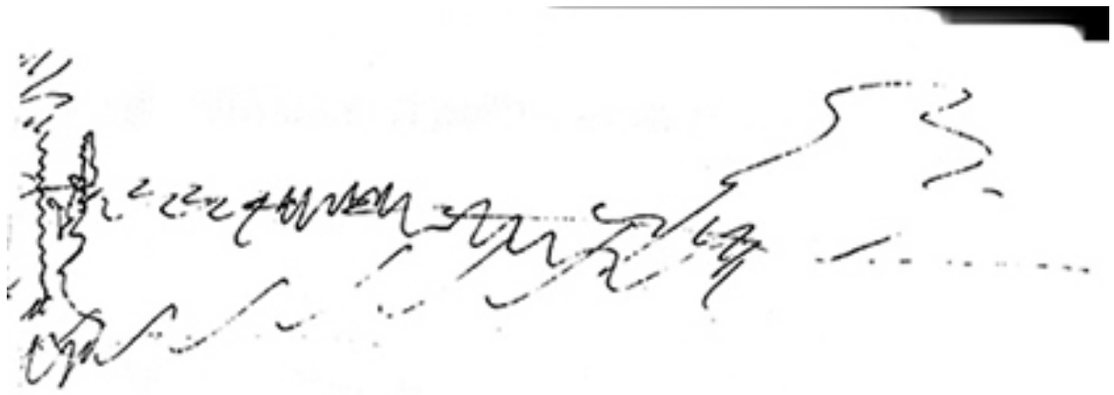
Primally, I need identity—as much of it as I can amass; for my need for identity is mutually articulated with my terror of annihilation.


And identity is sought through expression;
the media of expression are what I find
to texture and realize my expressive needs;
and the effectiveness of a medium, of
my media, in drawing out from me
an adequate depth and breadth of expressio
will determine, ultimately, what –
and how much – I can be for myself.

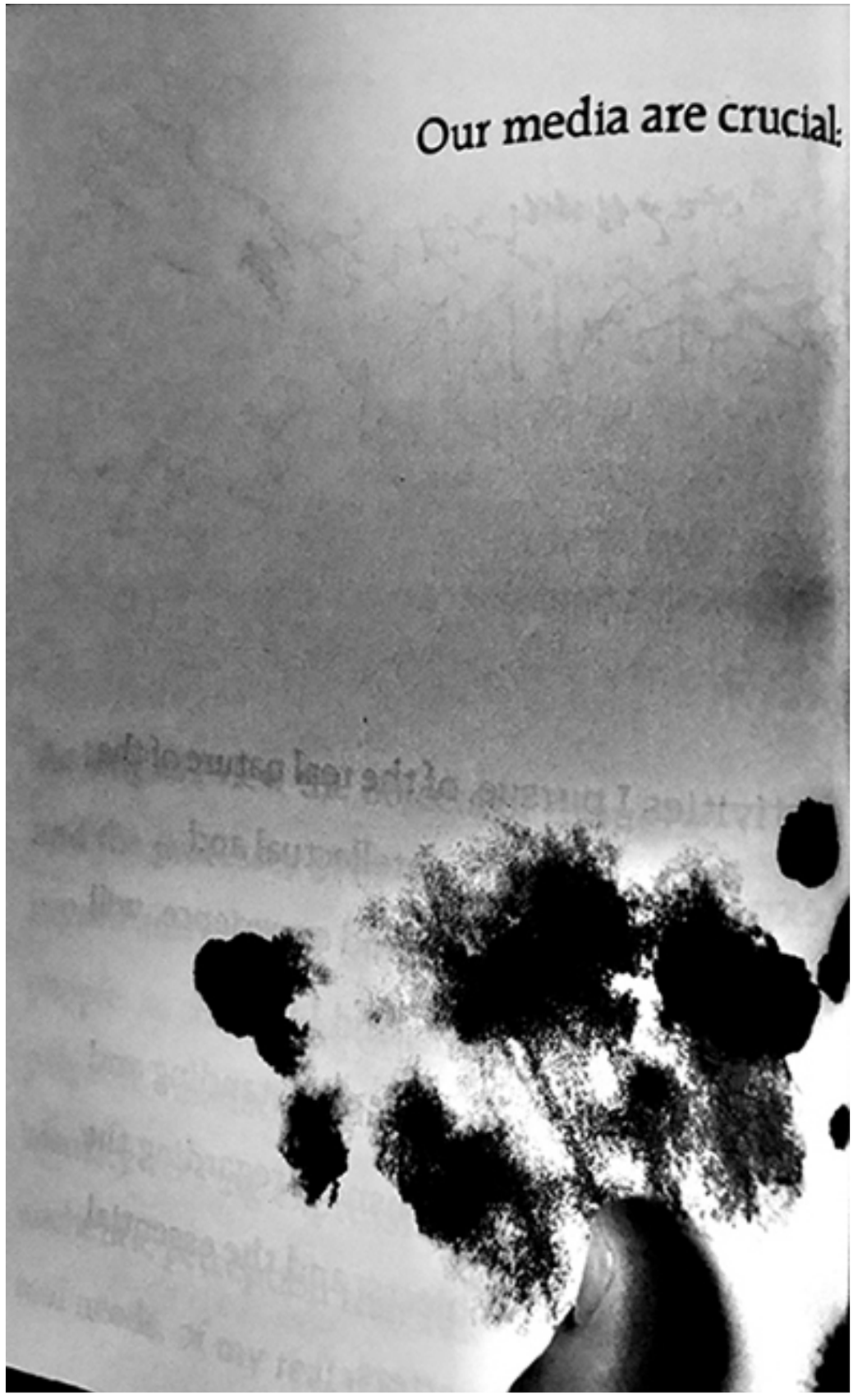
It is in the media of expression, then, that I fulfill — or try to fulfill — my identity. And it is as experience alone that I can realize, in expression, the fulfillment of the identity I need. And so not only is thought itself expressive, articulated in media of expression, verbal, external, or meditative, internal, but our thought about our other expressive media is crucial to our need to optimize our expression by inventing and optimizing our media of expression, to understand ourselves in relation to them, and through them, so we may understand how we are unfulfilled, and why, and so that we may authentically perceive our own true interests and needs and pursue their fulfillment with the full benefit of our intellectual power.



As long as I view the objects of thought and the processes of music as exterior to myself and exterior to the interactions of people, as something other than the palpable emanations of intense human identity-seeking expressive activity, the authentic perception that I need of my real needs, of my real interest in the



activities I pursue, of the real nature of the expressive objects, intellectual and musical, that I create and experience, will be unavailable to me; and I will be obscured from a clear understanding and an authentic consciousness regarding the nature of these objects, and the essential thrust of these matters.


Our media are crucial:

for the primal expressive energy

does not fulfill us

by mere, raw, evacuation.

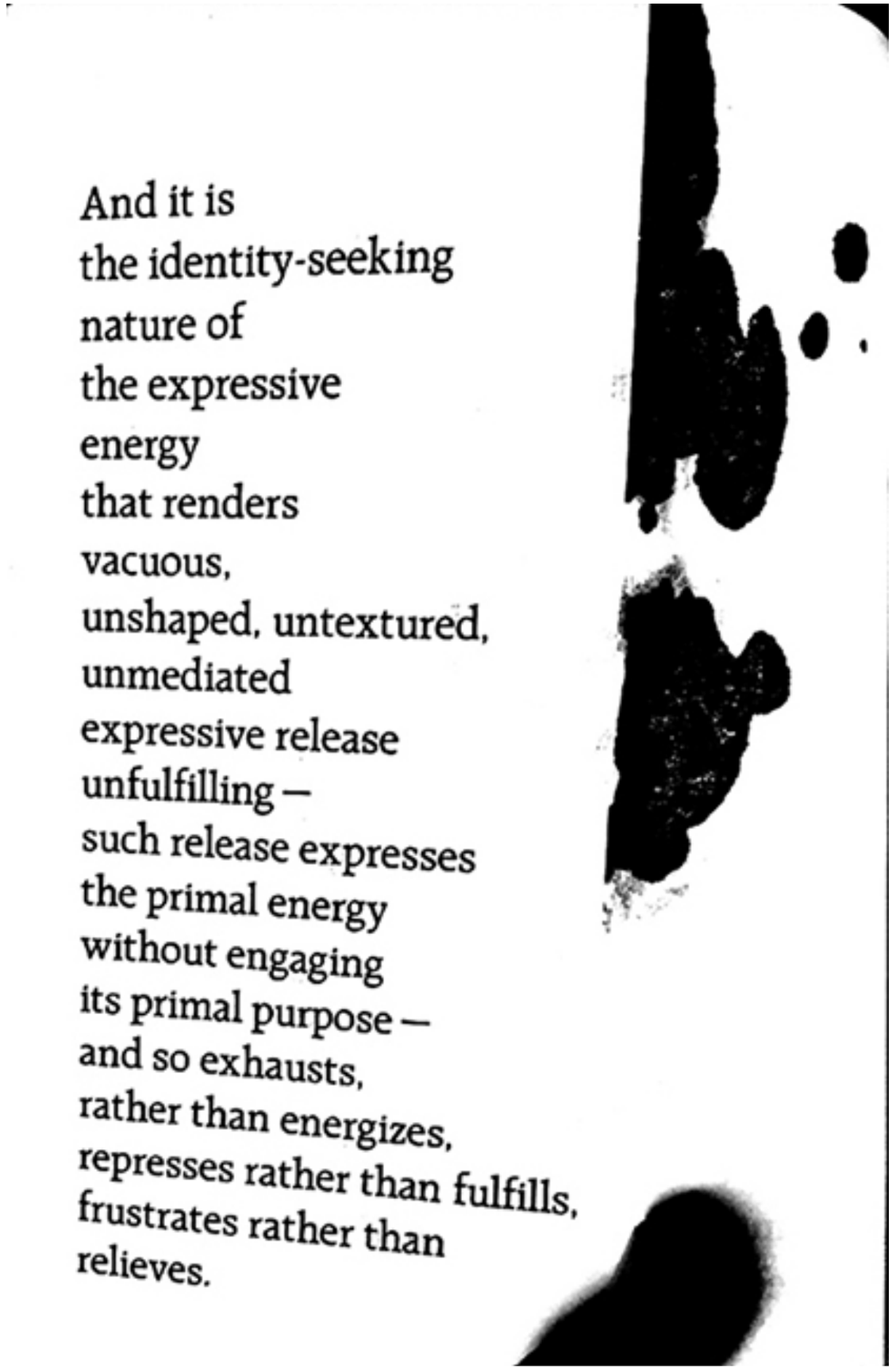
On the contrary, it is an energy that needs release into purpose –

– for the linkage of expression with identity means that the expressive energy needs to be released just so that it can create articulate **form** –

– it is built up internally precisely as an articulate-form-creation-needing energy –

– to fulfill itself by creating palpable realizations shaped and contoured and articulated to return to us, from without, the sense of being, the sense of being something in particular, the sense of being something significant, the sense of being in the world, the sense of being in the world with other beings –

– and **being** there, for ourselves, **among** them, even transparently and invisibly, but still not merely perceiving that **they** are there.



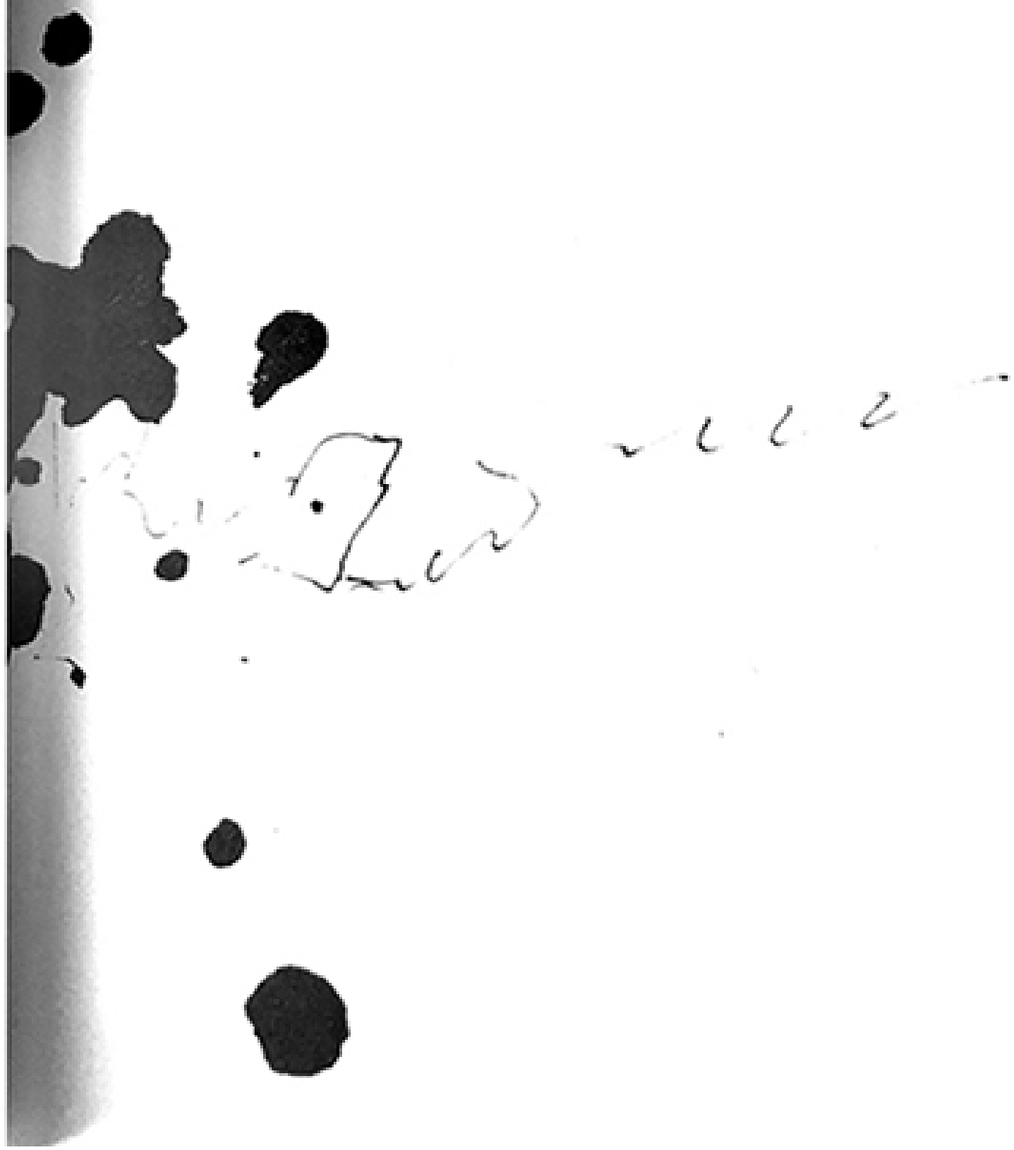
And it is
the identity-seeking
nature of
the expressive
energy
that renders
vacuous,
unshaped, untextured,
unmediated
expressive release
unfulfilling –
such release expresses
the primal energy
without engaging
its primal purpose –
and so exhausts,
rather than energizes,
represses rather than fulfills,
frustrates rather than
relieves.

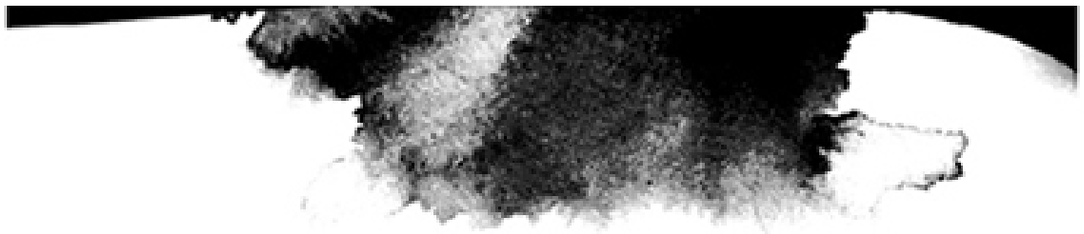
For, as every composer knows, sounds happen not when they are sounded, but in their resonant afterspace of silence and responsive, prolonging, and resonating successive sound.

The silence we preserve after an experience is a space, created for us as the space of the experience, within which, and on which, we dwell, prolonging the experience, extending it, culminating it, in order to have it, progressively, in more significant degree.

Our meta-experiential conversation is like the sound after a sound, in music, which amplifies the silence-resonant aftersound space to extend, to cumulate, to cultivate, to – yet further – **have** the experience our conversation is trying to keep us alive within.

And discourse extends the effort to retain and protract experience to a maximum frontier of time, space, and awareness.

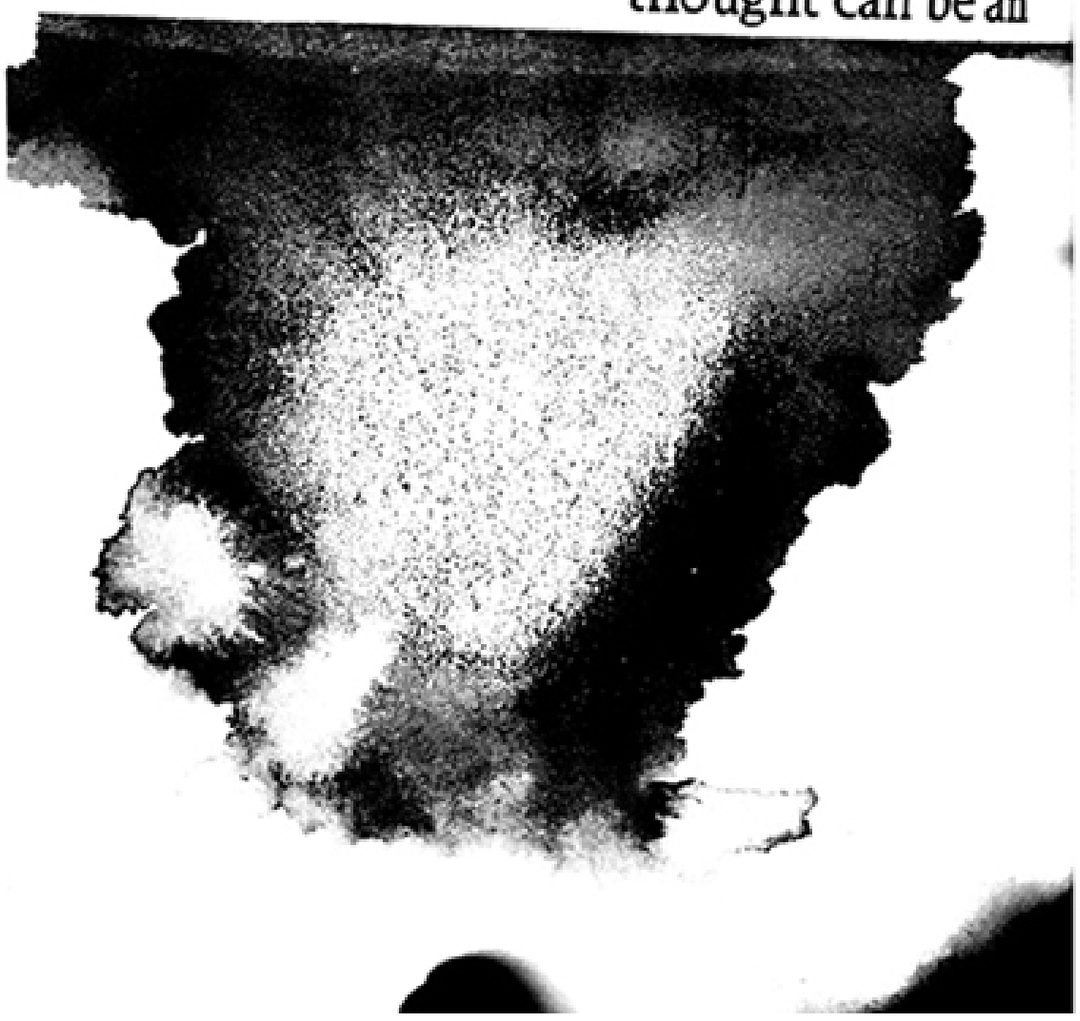


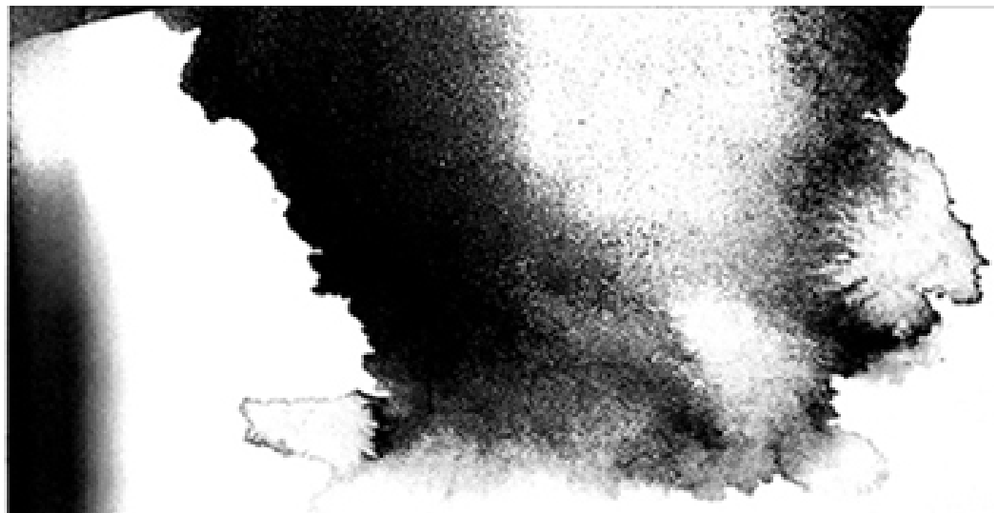


But sound can also annihilate sound;

conversation can also annihilate its
antecedent experience;

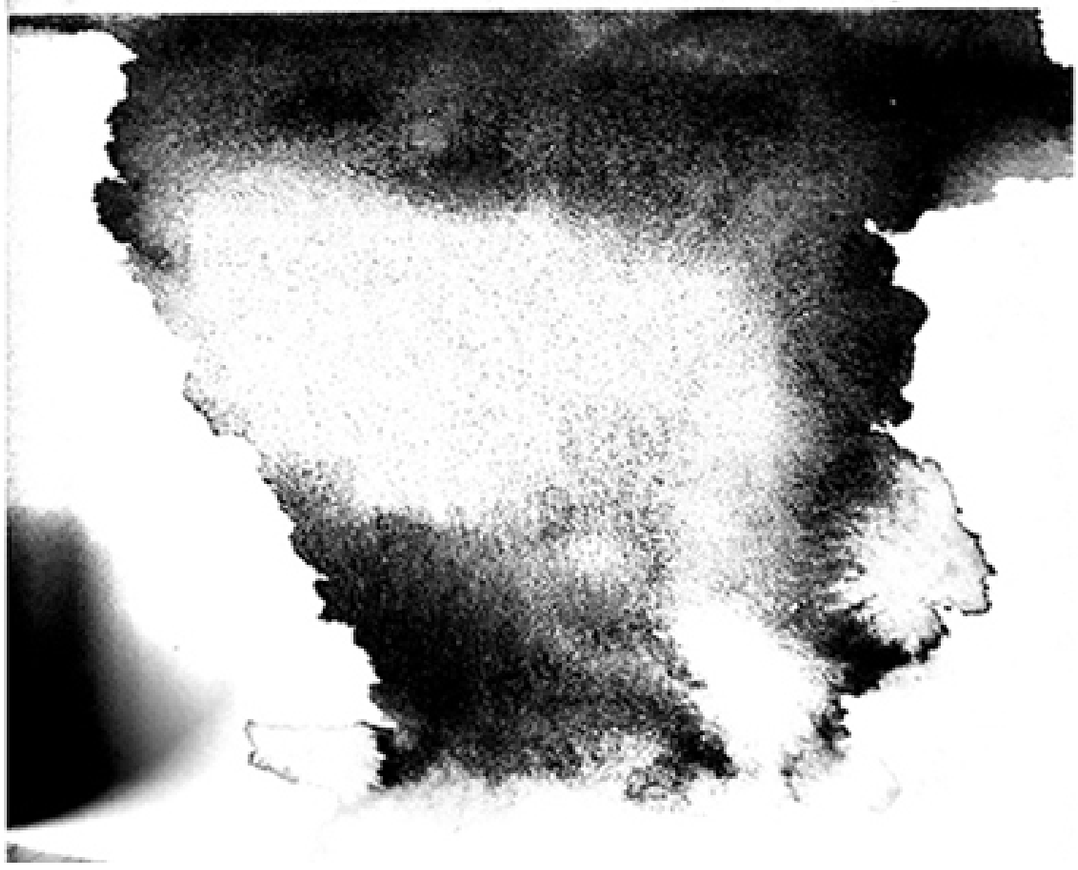
thought can be an





anechoic chamber for its objects;

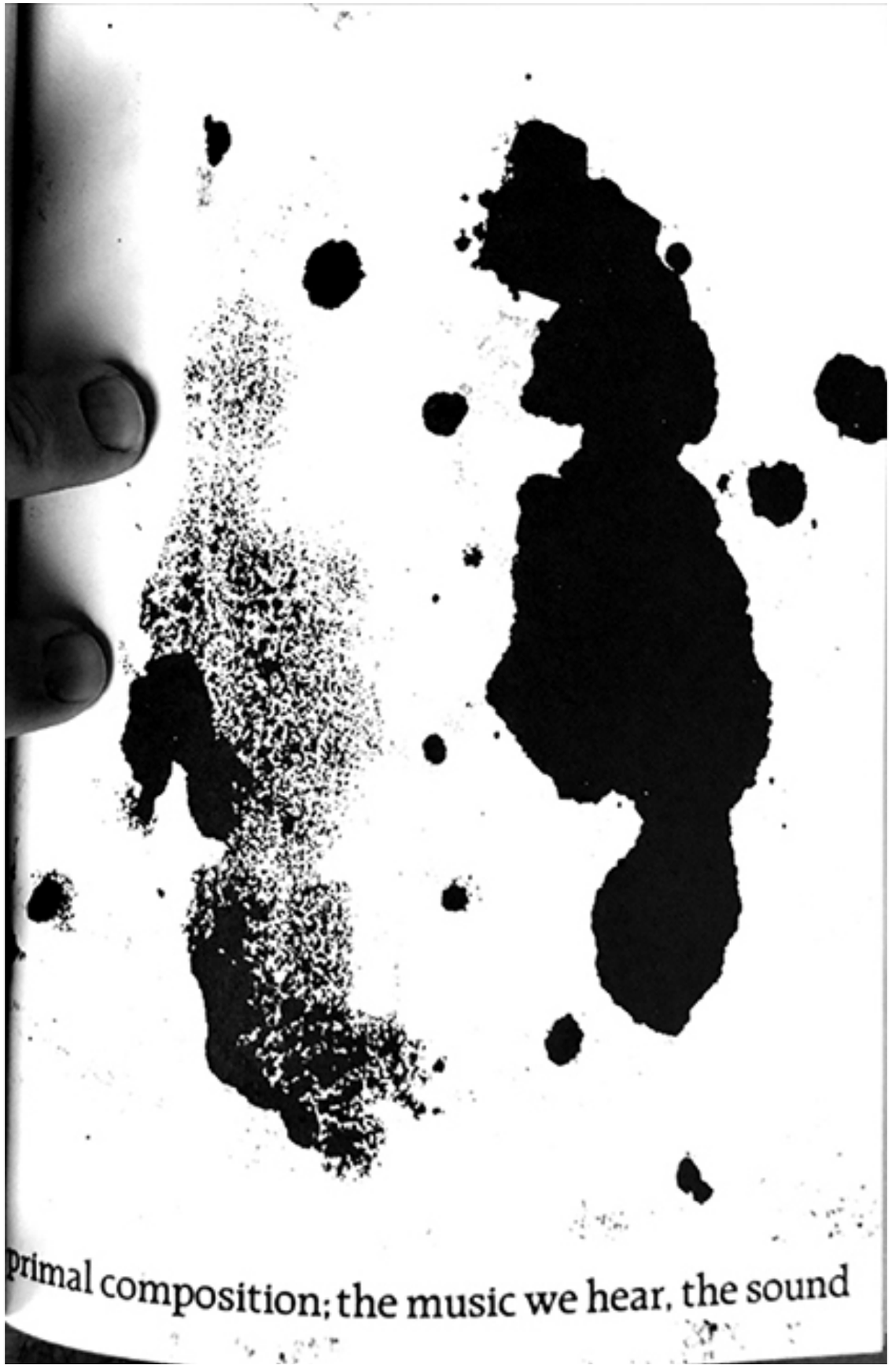
discourse can remove us from the
scene of our attention altogether.



So we need to think sensitively and introspectively and consciously—like expressive people—about our thought, our silence, our sound in music and talk; to **compose** our intellectual-social behavior so that it actually strives to be shaped to do for us what we, primally, need it for.

We cannot afford to deprive ourselves of our own expression by conventionalizing or institutionalizing our talk, or our thought, or our music; not because that is wicked, but because it deprives us of what we most need from those outlets, what we lusted after in the first place so as to find ourselves energetically engaged, for life, with them.

Listening is the primal expressive act: listening


primal composition; the music we hear, the sound


we hear, moves us to the core not because of th

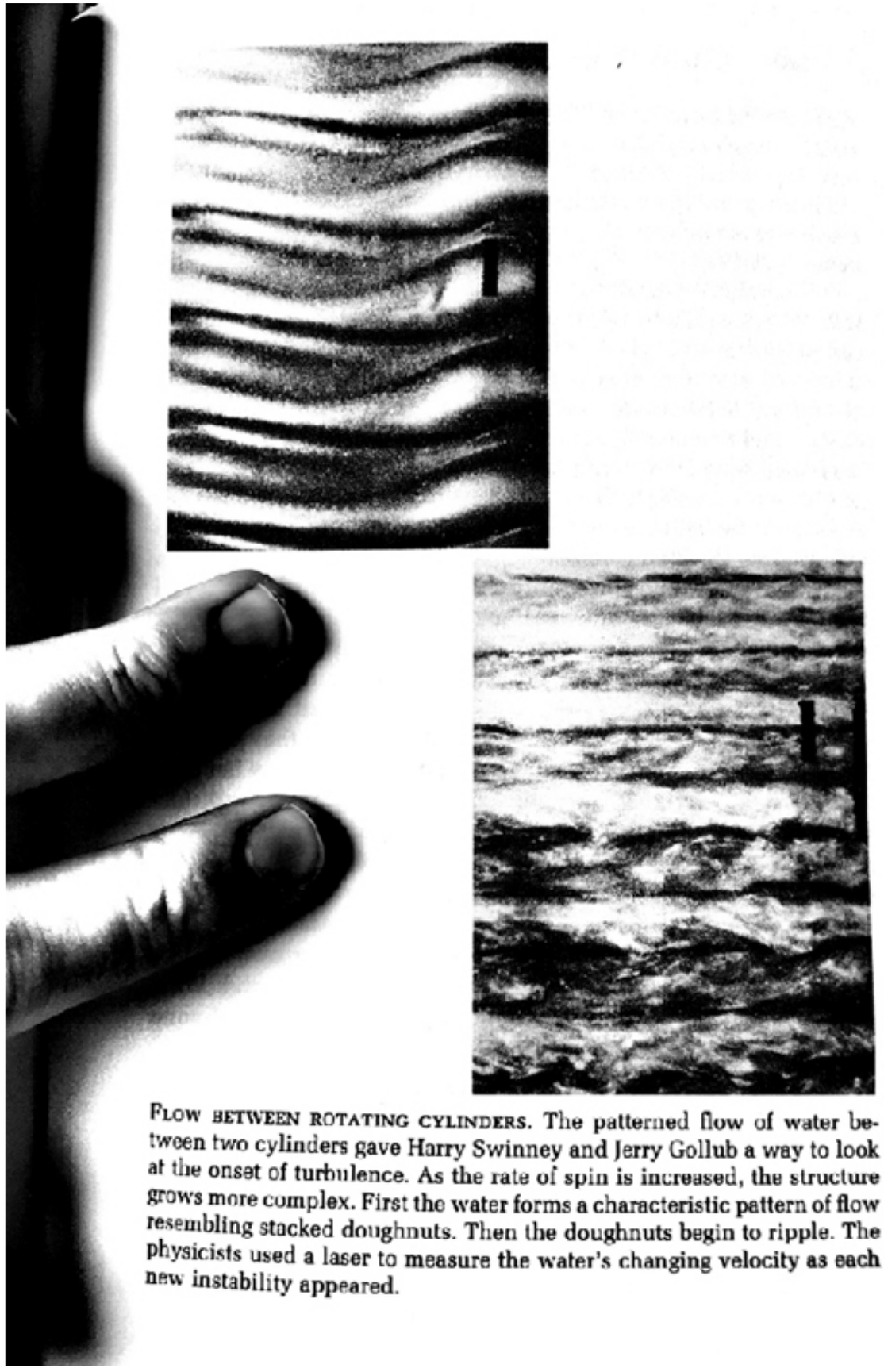
xternal things or persons it expresses, but exactly

between different kinds of irregularity. Physiologists found a surprising order in the chaos that develops in the human heart, the prime cause of sudden, unexplained death. Ecologists explored the rise and fall of gypsy moth populations. Economists dug out old stock price data and tried a new kind of analysis. The insights that emerged led directly into the natural world—the shapes of clouds, the paths of lightning, the microscopic intertwining of blood vessels, the galactic clustering of stars.

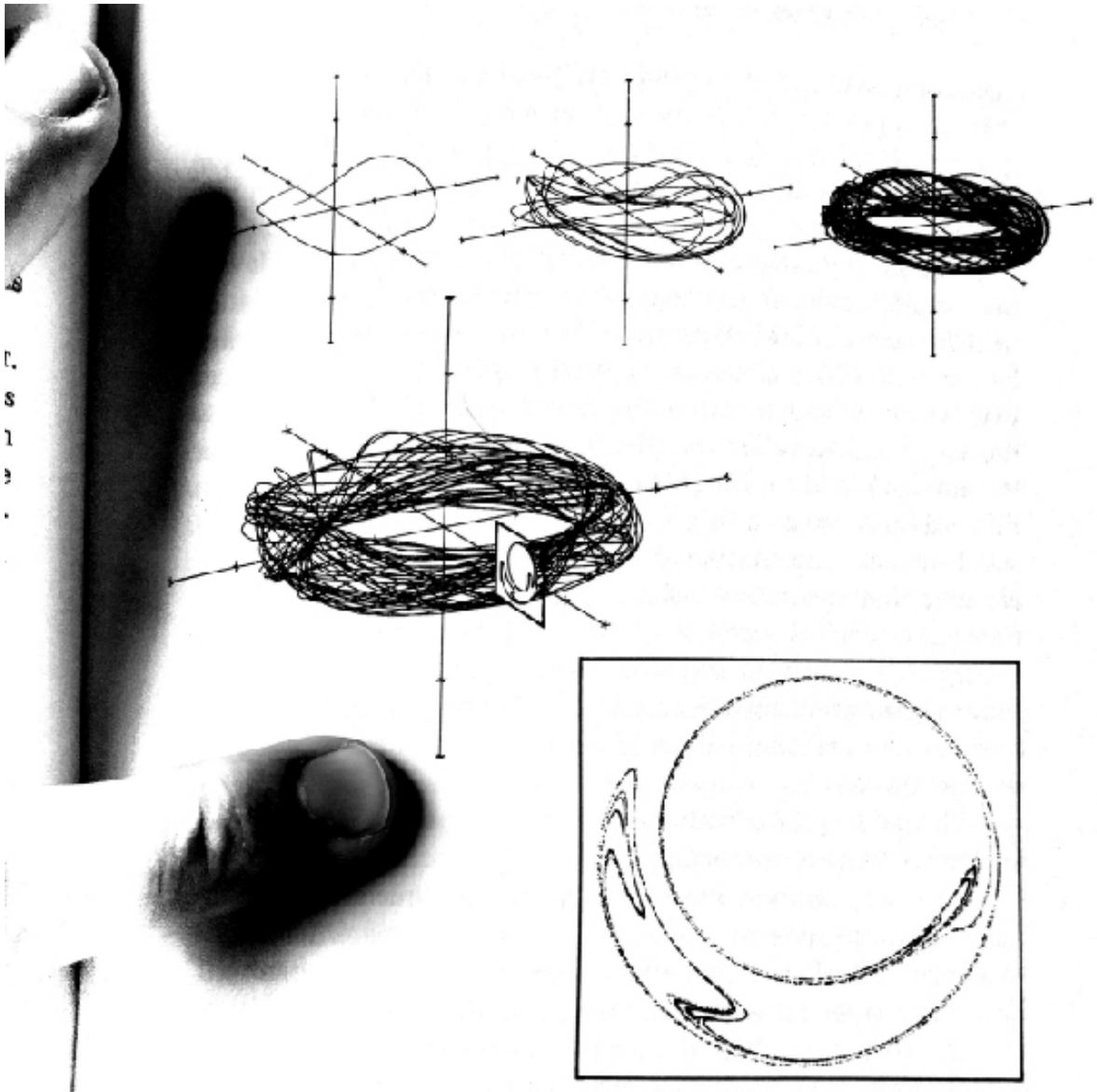
When Mitchell Feigenbaum began thinking about chaos at Los Alamos, he was one of a handful of scattered scientists, mostly unknown to one another. A mathematician in Berkeley, California, had formed a small group dedicated to creating a new study of "dynamical systems." A population biologist at Princeton University was about to publish an impassioned plea that all scientists should look at the surprisingly complex behavior lurking in some simple models. A geometer working for IBM was looking for a new word to describe a family of shapes—jagged, tangled, splintered, twisted, fractured—that he considered an organizing principle in nature. A French mathematical physicist had just made the disputatious claim that turbulence in fluids might have something to do with a bizarre, infinitely tangled abstraction that he called a strange attractor.

A decade later, chaos has become a shorthand name for a fast-growing movement that is reshaping the fabric of the scientific establishment. Chaos conferences and chaos journals abound. Government program managers in charge of research money for the military, the Central Intelligence Agency, and the Department of Energy have put ever greater sums into chaos research and set up special bureaucracies to handle the financing. At every major university and every major corporate research center, some theorists ally themselves first with chaos and only second with their nominal specialties. At Los Alamos, a Center for Nonlinear Studies was established to coordinate work on chaos and related problems; similar institutions have appeared on university campuses across the country.

Chaos has created special techniques of using computers and special kinds of graphic images, pictures that capture a fantastic and delicate structure underlying complexity. The new science has spawned its own language, an elegant shop talk of *fractals*

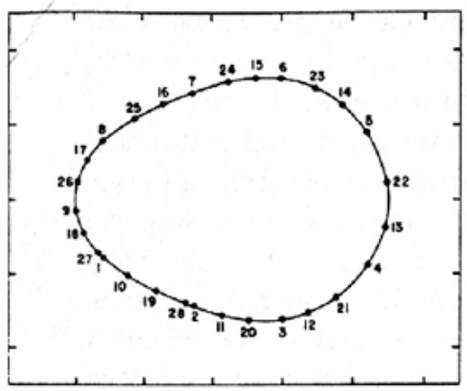


FLOW BETWEEN ROTATING CYLINDERS. The patterned flow of water between two cylinders gave Harry Swinney and Jerry Gollub a way to look at the onset of turbulence. As the rate of spin is increased, the structure grows more complex. First the water forms a characteristic pattern of flow resembling stacked doughnuts. Then the doughnuts begin to ripple. The physicists used a laser to measure the water's changing velocity as each new instability appeared.

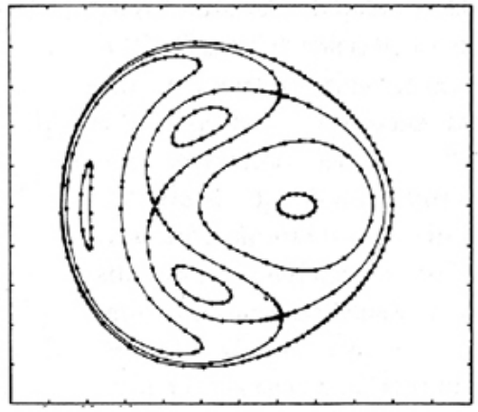


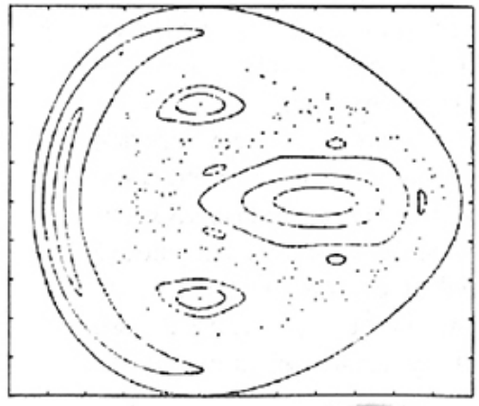
EXPOSING AN ATTRACTOR'S STRUCTURE. The strange attractor above—first one orbit, then ten, then one hundred—depicts the chaotic behavior of a rotor, a pendulum swinging through a full circle, driven by an energetic kick at regular intervals. By the time 1,000 orbits have been drawn (*below*), the attractor has become an impenetrably tangled skein.

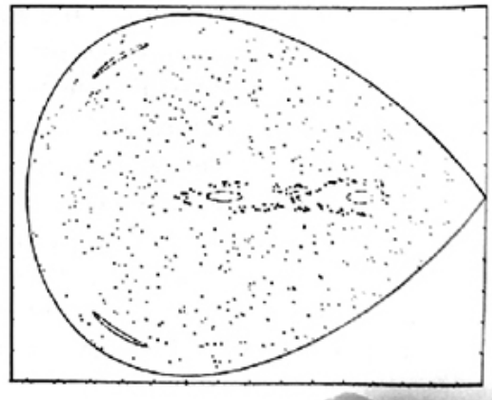
To see the structure within, a computer can take a slice through an attractor, a so-called Poincaré section. The technique reduces a three-dimensional picture to two dimensions. Each time the trajectory passes through a plane, it marks a point, and gradually a minutely detailed pattern emerges. This example has more than 8,000 points, each standing for a full orbit around the attractor. In effect, the system is "sampled" at regular intervals. One kind of information is lost; another is brought out in high relief.

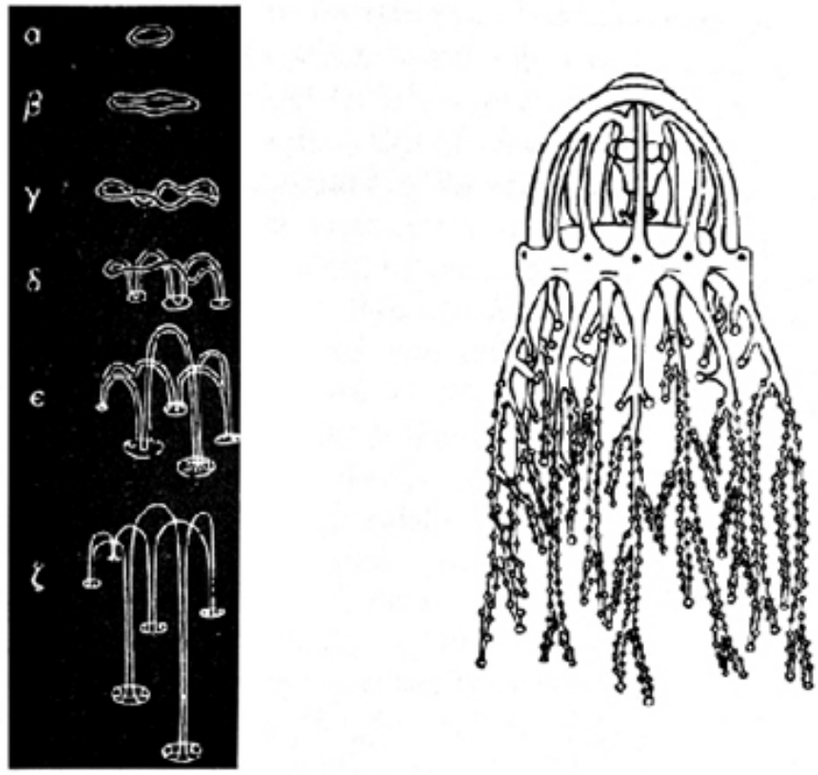


ORBITS AROUND THE GALACTIC CENTER. To understand the trajectories of the stars through a galaxy, Michel Hénon computed the intersections of an orbit with a plane. The resulting patterns depended on the system's total energy. The points from a stable orbit gradually produced a continuous, connected curve (*left*). Other energy levels, however, produced complicated mixtures of stability and chaos, represented by regions of scattered points.



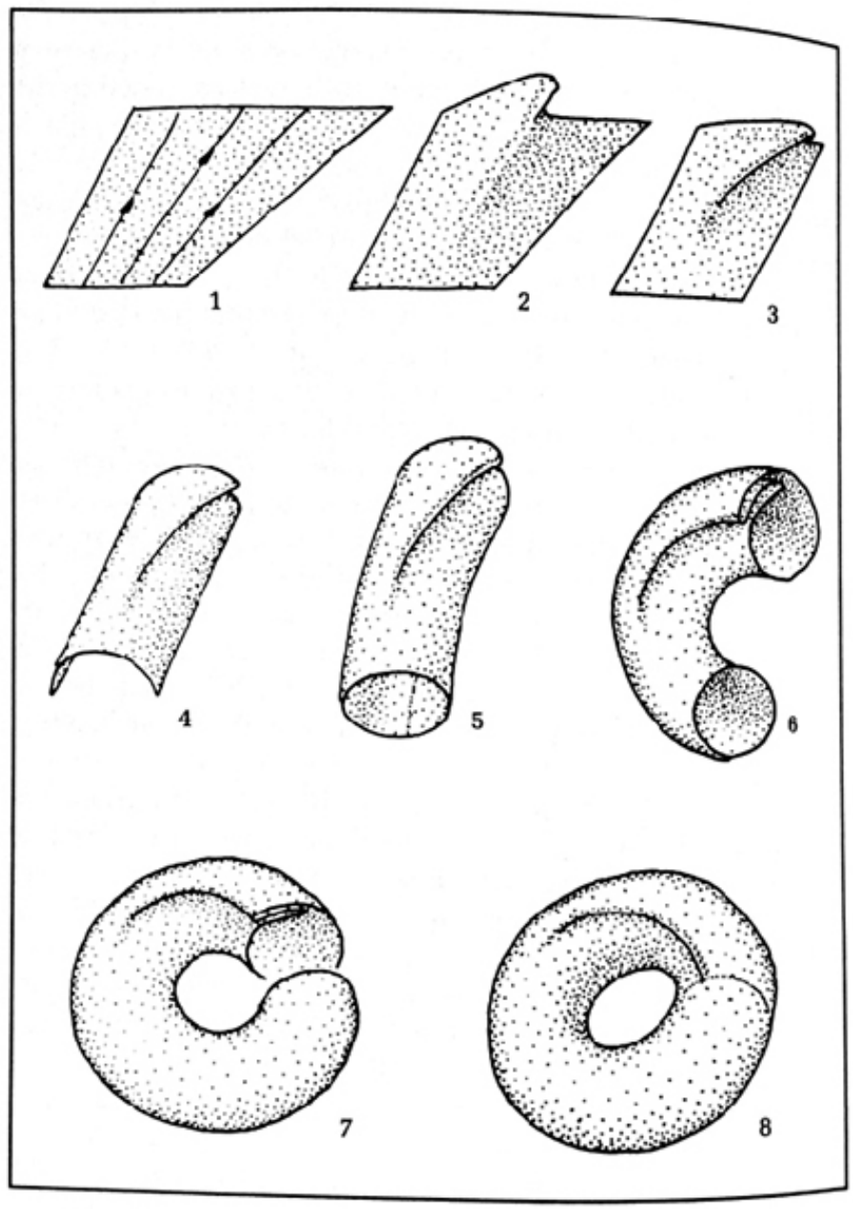




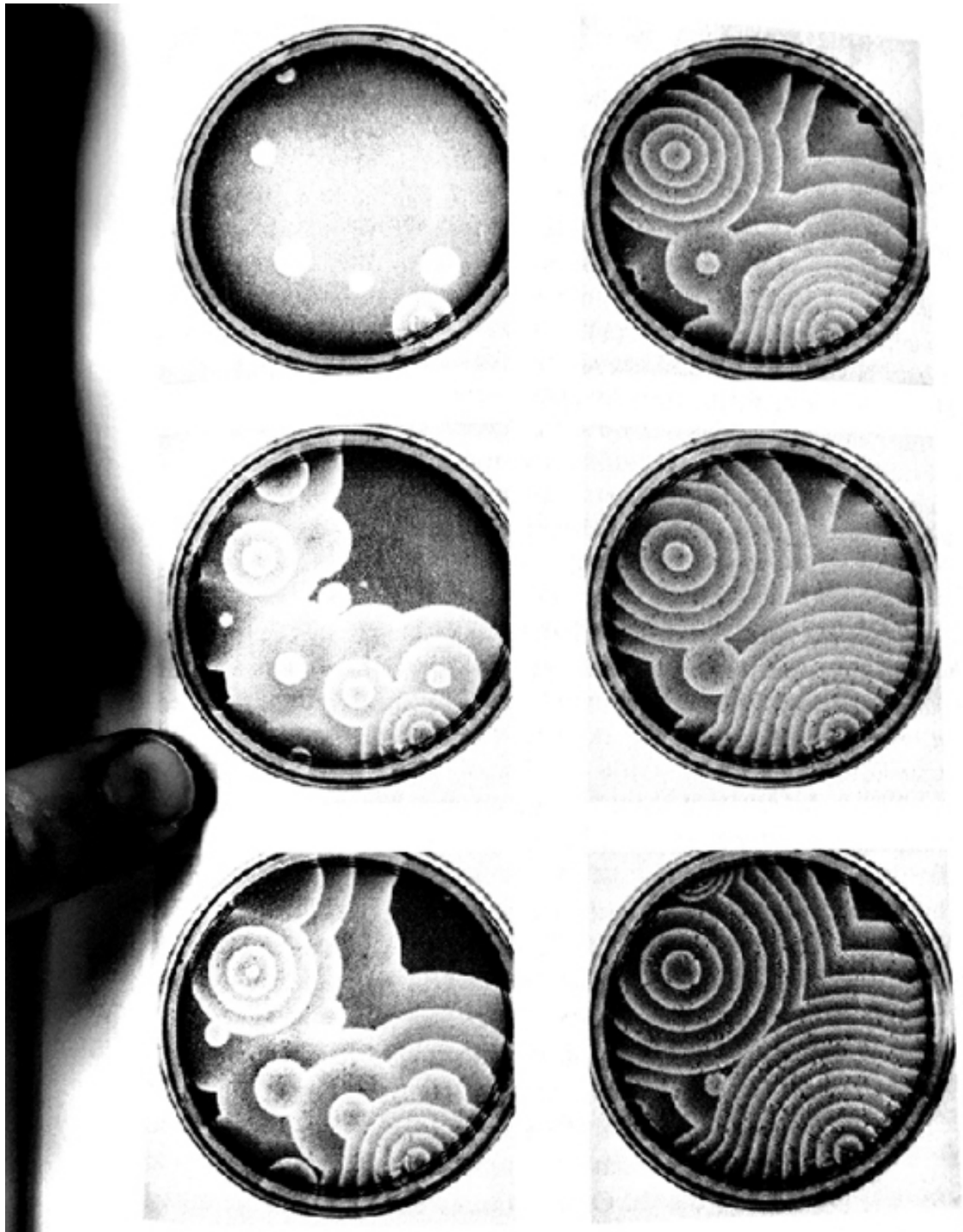


DROPS DESCENDING. D'Arcy Wentworth Thompson showed the hanging threads and columns made by ink drops falling through water (*left*) and by jellyfish (right). "An extremely curious result . . . is to show how sensitive these . . . drops are to physical conditions. For using the same gelatine all the while, and merely varying the density of the fluid in the third decimal place, we obtain a whole range of configurations, from the ordinary hanging drop to the same with a ribbed pattern. . . ."

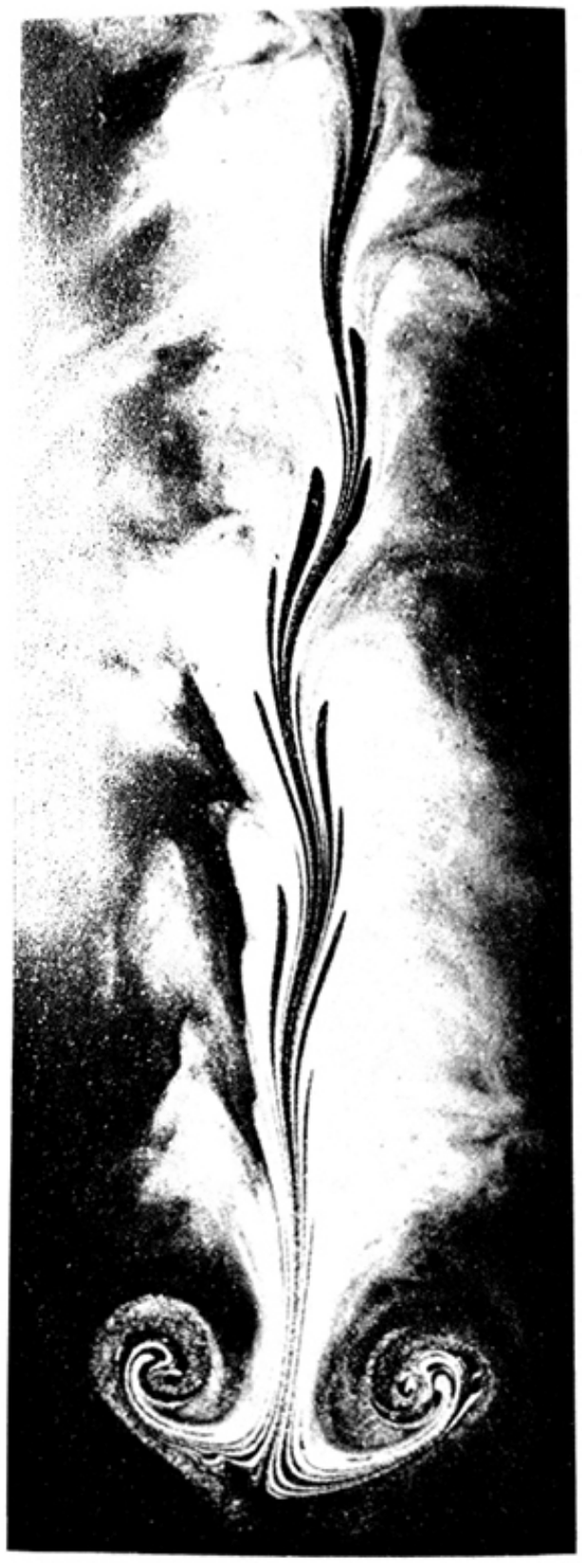
ologist has to read D'Arcy Thompson. Yet somehow the greatest biologists find themselves drawn to his book. Sir Peter Medawar called it "beyond comparison the finest work of literature in all the annals of science that have been recorded in the English tongue." Stephen Jay Gould found no place better to turn for the intellectual pedigree of his own growing sense that nature constrains the shapes of things. Apart from D'Arcy Thompson, not many modern biologists had pursued the undeniable unity of living organisms. "Few had asked whether all the patterns might be reduced to a single system of generating forces," as Gould put it. "And few seemed to sense what significance such a proof of unity might possess for the science of organic form."



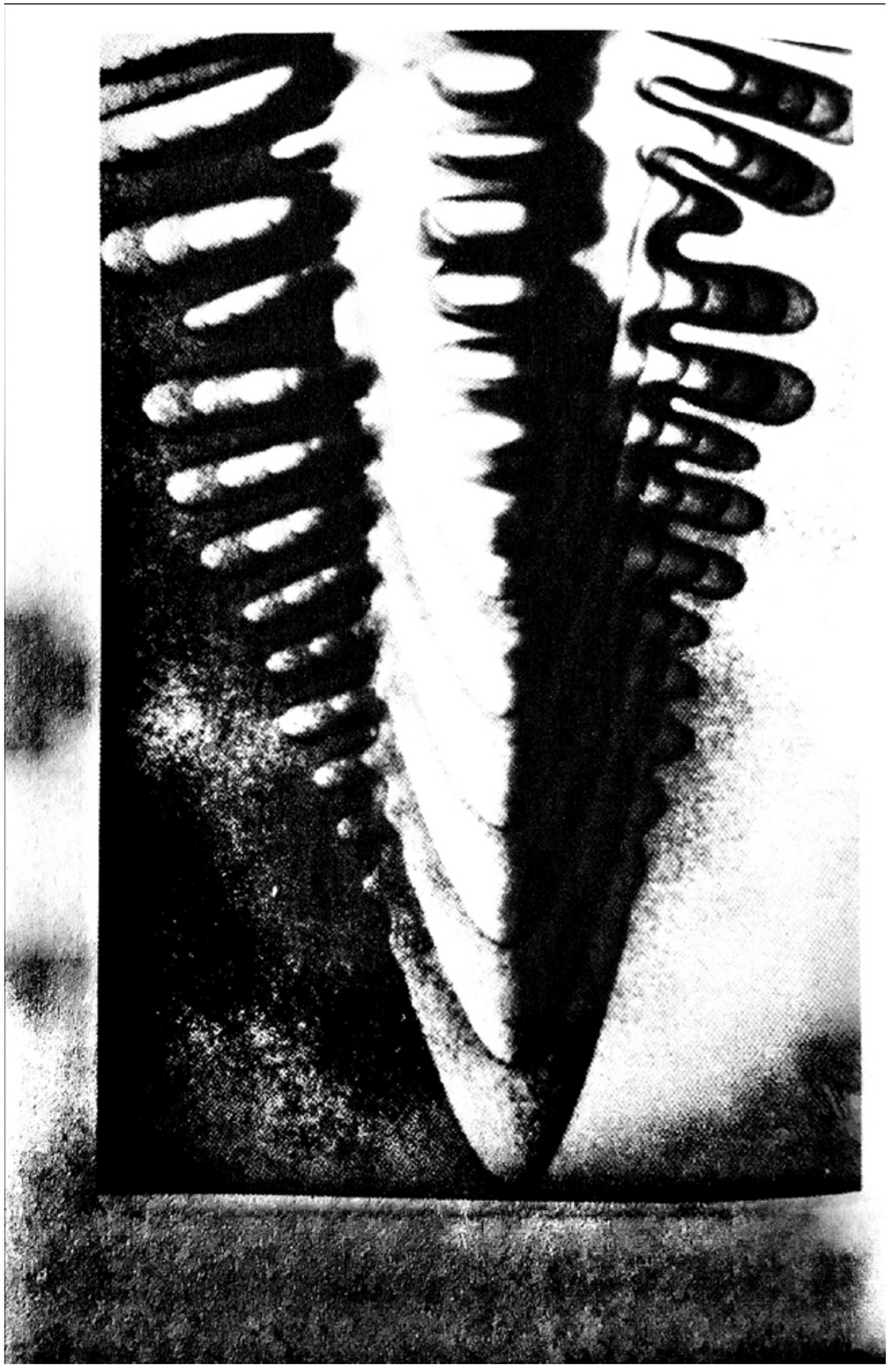
FOLDING PHASE SPACE. The topological reshaping of phase space creates an attractor, like a doughnut but folded in on itself, known as Birkhoff's bagel.



CHEMICAL CHAOS. Waves propagating outward in concentric circles and even spiral waves were signs of chaos in a widely studied chemical reaction, the Beluzov–Zhabotinsky reaction. Similar patterns have been observed in dishes of millions of amoeba. Arthur Winfree theorized that such waves are analogous to the waves of electrical activity coursing through heart muscles, regularly or erratically.



CHAOTIC FLOWS. A rod drawn through viscous fluid causes a simple, wavy form. If drawn several times, more complicated forms arise.



did not know why the echo was trying different numbers and saying arrow this arrow that, and all Imp Plus saw was that there was less space inside, and the capsule was more full, yet there was more of everything also, and the arraying of letters and numbers high and low breathed (for the dim echo said) a bond or bonds between the dim echo and him.

An *orbit* of bonds.

But then, CO_2 IS BEAUTIFUL, Imp Plus said to Earth, and metabolism crackled back like a code or laughter, and Ground said, SUIT YOURSELF IMP PLUS, YOU ARE DEVELOPING A SENSE OF HUMOR. WHAT IS CORRELATION BETWEEN THIS AND GLUCOSE INCREASE?

But what was metabolism? What he recalled put a shadow over what he thought he saw. He did not recall metabolism. Did he see it?

But now the dim echo reviewed orbital period, apogee, perigee, velocity. And Imp Plus thought there was no more camouflage: velocity could not be increasing, for in synchronous orbit perigee was as nearly equal to apogee as ellipse permits.

More crackling came. Ground said, IMP PLUS HOW DOES YOUR GARDEN GROW?

The crackling was acrid like camouflage. Arrows crackled from the dim echo. But arrows were only on a green space drawn partly white by an acrid hand. But crackling led by many lines which were now new holes to what now happened again: the caving in and out. This went faster to become silent, but the jets and the many sands of salt never fused no matter how fast, and Imp Plus did not himself have to tell anyone why, for the jets which were like strokes were not a pumping so much as an inclining so that he tilted in order to make a hill for the things to flow down or up. And, against the power outside, what was inside and was lately less was being pumped outside into what seemed more. And Imp Plus felt the caving in and out, and he thought because it burned it did not come through the protective window; then he felt the

nodes and of faldoream-ridges, folds of shearow. For all these four kinds were now a hard translucent record of their former life; they were not moving now; not moving even where they wove round the upper cables and also round those lower tubes in which there was still seed motion, tubes he had feared for in his muscles when Ground had sent the jolts.

His cells were a place *for* motion—that was it.

The ambering Sunbraids were everywhere in his fixed cells; and through these motions he could feel that the cells were holes held in a lattice, and were the lattice too; but they were also locus timers for tides of Sunbraid which were now harder to see although he felt no less timed or clear. The lattice was a field of times. He was as much the motion as its place. And the crimson process radiating (in his mind?) out from the two crossed lengths of bone which whorled hardness outward like light, illuminated the great lattice by driving the Sunbraids through the holes and beyond to the edges of himself where the equilibrium he must make Ground understand whirled its gyro-norm of seeming substance; but this was only part of the cycle, for then either the Sunbraids were sucked back by the crimson process tightening and restranding itself or they were themselves the cause of this helical recoiling.

Yet also both. Both. The word repeated, for he knew that he must hold on to whatever shot back and forth through a long ellipse of new pain—in order to see what this *was* inside the pain. Must hold on to. Or be held. Must hold on against new noise. Message pulses from Ground. Hold or he'd lose it. Lose what? Yet he did not have it: or he did: he had it to lose. Or had always had—even before radiation poisoning on Earth had had it: and now in the quantum moment at which he saw the secret mass of understanding, or rather saw he *was* the secret understanding, between the Sunbraids and the resilient strand, another thing happened: the wending-spirals round his edges were fading into fixity, fixed lattice, and he saw that their circuit had been fed by this bellows action between

Does one need foresight to make a choice? (Ye

transmission came from Imp Plus, and would credit the water, glucose, and power data; and Cap Com would accept that Imp Plus had a way to communicate to that point in the Pacific during a long dark period.

But wait: they would not: wait: the Acrid Voice proper and Cap Com were together now.

Yet Imp Plus held with the particled Acrid Voice a private frequency, which the Acrid Voice still sensed as its own thinking on that island but which yielded for Imp Plus, here in the shaping play of lattice light slowing toward growing fineness of fixity, both the particled image of Acrid Voice and its responses in layers like foresight. But as Cap Com twined with the other, bodily Acrid Voice on the beam oscillant from the breaths between Sunbraids and crimson coil, the lattice fields of Imp Plus became aware of what they had always inclined toward: that their private beam to the particled Acrid Voice had been carried by the main skein of beam, not the other way round. But though twined upon that skein of Sunbraids and crimson coil, the voices unwound as the lattice cells desired. And the Acrid Voice in slow-massed figures of the mutual light was flowing faster and faster as if it might, by gyrolibrium, map one single field or solvent for all the events of glucose, water, sight (which the lattice layers were capable of recalling), and of the whole growth—*What growth, what growth?*—while when Imp Plus, as yet unwilling to give, like a positional fix, data on star arms that lived like unmouthed hydra, data on membranes that polyped on light and even on sight itself, increases through which his shifting substance had swelled and divided and multiplied, asked if it was conceivable for brain cells to go back into their prior embryonic forms in order then to yield exponential multiples before developing into adult form all over again; and the Acrid Voice observed that Imp Plus although transmitting almost too slowly for clarity again seemed to have seen the phenomena in question and added that in fact for some years—*which* years? thought Imp Plus—projects had sought to split the neuron though to his knowl-

in Acrid Voice's particles on the Pacific island. But the flattened long oval of their personal circuit embodied his own current ellipse so exactly he recalled *dance*—mapped on some sweet grid of humor for those coming after to follow.

And through the going darkness of the long cycle came instead of Acrid Voice Cap Com's static division: between possible and alien, need and doubt: CAP COM TO IMP PLUS, ROUTINE IN-FLIGHT ALERTNESS TEST: IDENTIFY PROJECT TL DIRECTOR BY NAME. COME IN IMP PLUS.

But as, in his layers, he felt like an opposite of jolt a slower fixity, though a finer fixity—earned—and knew he would give Cap Com another, better answer than what it wanted, he found what he had foreseen beyond the Acrid Voice's main question *What growth?* that had been put into the Acrid Voice by Imp Plus. He found he had in one near-congruence of layers foreseen that he would not know how to answer the question.

And Imp Plus, who did not remember the other name of the Good Voice, answered Cap Com: THE ONE WE HAVE BEEN TALKING TO IS ACRID VOICE. REPEAT, THE ACRID VOICE.

On the Pacific island, ovals that felt like lost limbs yielded to bombardment, and this was Cap Com at the Acrid Voice, until WHY ACRID? came back from Ground.

But what Imp Plus had said had been the thing to say, because it helped.

For though Ground amid an accelerated swirl of reconstituted particles answered SAY THAT AGAIN IMP PLUS (and was ignored) Imp Plus knew that because the swirl of Acrid particles was more curious, to give the Good Voice's name would have made Cap Com think then that the name had after all been known as far outside the tight security of TL as Imp Plus at this point was bent past the communication line from that dry island in the Pacific. Cap Com would learn now from Acrid Voice why "Acrid"; and, learning this, Cap Com would believe that the

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S|S S

ABSTRACT How, and when, does it become possible to conceptualize a truly planetary crisis? The Cold War nuclear arms race installed one powerful concept of planetary crisis in American culture. The science enabling the US nuclear arsenal, however, also produced unintended byproducts: notably, a radical new investment in the earth sciences. Cold War nuclear science ultimately produced not only bombs, but also a new understanding of the earth as biosphere. Thus, the image of planetary crisis in the US was increasingly doubled during the Cold War – the immediacy of nuclear threat matched by concerns about rapid environmental change and the cumulative effects of industrial civilization on a fragile biosphere. This paper examines the evolution of (and competition between) two ideas of planetary crisis, since 1945: nuclear war and climate change. In doing so, the paper offers an alternative history of the nuclear age and considers the US national security implications of a shift in the definition of planetary crisis from warring states to a warming biosphere.

Keywords biosphere, climate change, earth sciences, Hurricane Katrina, national security, nuclear war, nuclear winter, radioactive fallout

Bad Weather:

On Planetary Crisis

Joseph Masco

Within the visual culture of the nuclear age, a very few sequences of film now stand as the core American cultural memory of the atomic bomb. The sequence of a forest experiencing nuclear blast, for example, has attained a kind of iconic status, reproduced repetitively in documentary and fiction films for the past half century to demonstrate the power of the exploding bomb (see Fig. 1). In presenting a forest bent to the breaking point, the intellectual value of these 3 seconds of film is to introduce viewers to an experience of the nuclear sublime.[1] The power of the blast, when mapped against one's own locality, also provides a rare point of physical reference in US nuclear footage, a recognizable human scale that has informed official statements, anti-nuclear activism, and Hollywood productions alike. In the slow-motion footage of a dense forest blown back like a thicket of grass, viewers are confronted with a moment of pure ecological devastation, a kind of fury that is at once unprecedented, uncontrollable, and yet also oddly familiar. It is this notion of ecological risk mediated by national security concerns that I interrogate in this essay. For the iconic status of these

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FIGURE 1
The trees of Operation Upshot-Knothole (stills taken from the DoD film, *Operation Upshot-Knothole*)

beat and broken trees addresses multiple registers of American insecurity. Uncannily mirrored in the video footage of recent natural catastrophes from the tsunami that hit Indian Ocean states in 2004 to the hurricanes that submerged New Orleans in 2005, this traumatized forest also allows us to

interrogate the relationship of 'national security' as a state project to the biosphere as the ultimate domain of security. For this sequence is undoubtedly a depiction of crisis, but of what kind? It is a military experiment involving a weapon of mass destruction (WMD), but it is also a military test of a specific ecosystem – it appears as both a tool of war and as a war on nature – a crisis of the future and of the now.

We live in an age of crisis – multiple overlapping crises, in fact, involving war, capital, law, public institutions – and have witnessed in recent years an extraordinary normalization of violence in everyday life via the 'war on terror'. This cinematic depiction of ecological fury contains within it a basic question about how to identify crisis, as well as expressing the conceptual power of war to override all other concerns. Revisiting these trees from a perspective of environmental risk reveals, I think, both the technoscientific contribution the Cold War arms race made to our understanding of the planet as an ecosystem, but also the power of the bomb to block collective thought and action. For when, and under what conditions, does it become possible for citizens to imagine a truly planetary crisis? I argue here that the Cold War nuclear project enabled a new vision of the planet as an integrated biosphere, but that it is precisely the security state's reliance on nuclear weapons to constitute US superpower status that blocks action on non-militarized planetary threats, and specifically, on climate change.

As we shall see, the Cold War nuclear arms race produced an unprecedented commitment to research in the earth sciences, enabling a new vision of the globe as integrated political, technological, and environmental space. The US nuclear project was linked very early on to concerns about weather and climate, enabling new public fears and visions of planetary threat. But, by elevating nuclear fear to the core instrument of state power, the Cold War arms race established a nationalized vision of planetary danger on very specific terms. In the early 21st century, the security state's effort to monopolize risk under a discourse of 'nuclear terror' came into direct confrontation with the scientific evidence of rapid ecological change. For the George W. Bush administration, the 'terrorist' armed with a 'WMD' trumps global warming as a planetary threat, underscoring the extraordinary politics involved in defining both 'terror' and the 'state of emergency'. The burnt and breaking limbs of this post-nuclear forest, however, not only offer an alternative genealogy of the nuclear age, but also allow an assessment of the distorting effects of the bomb on contemporary American ideas of threat.

In this essay, I examine three moments (in 1953, 1983, and 2003) in which nuclear crisis and ecological crisis are brought into mutual focus, and then assess the acts of political translation that enable diverse forms of risk to be configured as a singular national security problem, one supporting the geopolitics of the US security state. I begin with the formal linkage between the atomic bomb and weather in the early Cold War sciences; then explore how climate change was mobilized to effect nuclear policy in the 1980s; and finally, discuss how nuclear discourse has been mobilized in the 2000s to influence perceptions of global warming. Attending to the ecological coordinates of the nuclear revolution in this way fundamentally challenges

contemporary American ideas about planetary risk; it also reveals the conceptual and practical limits of a strictly 'national' form of security.

Part I: Militarizing Nature (1953)

While seeming to portray an alpine forest, the film footage is actually taken from the desert surroundings of the Nevada Test Site (see Fig. 2). Part of a nuclear test series known as Operation Upshot-Knothole in 1953, the forest was constructed out of Ponderosa Pines, which were cut and transported from California to Nevada. Each of the 145 trees was then sunk into concrete at the desert test site, creating a perfectly symmetrical, grid formation forest. This synthetic forest was loaded with sensors, and photographed from a variety of angles during the atomic blast. The goal, according to the once top-secret project report (US Department of Defense, 1953a), was:

> To determine effects of blast wave and association winds on trees – in terms of tree breakage, branch breakage and defoliation – located in a forest area of such stand density that the shock front and its accompanying winds are influenced by the presence of the stand.

As part of a larger effort to produce a comprehensive predictive capability for nuclear warfare, this synthetic forest was constructed by the US Department of Agriculture in order to be destroyed. Here is how the Department of Defense (DoD) originally presented the experiment to nuclear war planners and government officials in its once classified documentary film, *Operation Upshot-Knothole* (US Department of Defense, 1953b):

> A study of tactical importance: one hundred and forty-five ponderosa pines set in concrete, approximately 6400 feet [1950 m] from shot nine's zero. Instrumentation was thorough. A few major types being: pressure gauges at three heights, time-recording anemometers, phenotype dynamic pressure detectors, and snubber-wire arrangements to measure deflections. Pendulums were substituted for the lollipops of former operations, to provide mechanical simulation of tree response. As on many of these projects, cameras stations were set up to provide high-speed motion picture coverage of blast effects. Thermal input: 18 calories [75 J] per square centimeter – resulting in only mild char on tree trunks since the normal ground litter that will ignite at around three calories was lacking. Static pressures around four psi. Post-blast surveys indicated that approximately twenty percent of the trees were broken and the missile hazard from falling trunks and limbs would be substantial.

A study of tactical importance. As a military science experiment, this event was part of a larger US project to test the bomb against machinery and a variety of animal and human populations, as well as elements of the land, ocean, and atmosphere (Masco, 2004a). Part war fighting, part civil defense, part weapons science, the above-ground experiments conducted between 1945 and 1962 not only engineered the US nuclear arsenal, but they also produced and fixed American visual understandings of the technology on film. The technoaesthetics of the bomb were established for the American

FIGURE 2
Building the Test Forest at the Nevada Test Site (US National Archive Photograph)

public in this period, as the nuclear test regime went underground after 1963 eliminating most visual evidence of the blasts (Masco, 2004b). The visual record of the above-ground test period is thus not only an illustration of the logics of the security state – and the technoscience of producing atomic and thermonuclear explosions – but it remains a primary conceptual means of understanding the destructive power of the bomb.

Above-ground nuclear experiments were labeled 'tests' but the destruction was real, making each detonation an event with large-scale environmental consequences. The blast wave that bent this synthetic forest, for example, was only the most immediate of its environmental effects, as fallout from the explosion traversed the continental US. Indeed, the 11 atomic detonations of Operation Upshot-Knothole produced substantial radioactive fallout within the US, making it one of the most dangerous Nevada test series in terms of public health (Miller, 1986).[3] Today, the remnants of this synthetic forest exist in a series of symmetrically aligned stumps in the Nevada desert, a cryptic marker of a moment when the US Department of Agriculture was also a nuclear war-fighting agency (Johnson et al., 2000: 102). At its very

← get image?

most basic, the lesson of 'Project 3.19: Effects of Atomic Explosion on Trees in Forest Stands' was that a nuclear blast could profoundly damage a forest (US Department of Defense, 1953a). The study did not investigate other kinds of nuclear effects on the trees, from radiation levels to potential mutation rates over time, as this forest was dead at the moment of its fabrication. Lost in the history of the Cold War – and specifically the technoscience of megatons and missiles that informed the nuclear 'balance of terror' – is, however, this extraordinary new state commitment to atmospheric and earth sciences. In test ranges across the continental US to Alaska and the Marshall Islands, the development of the bomb not only produced unprecedented environmental damage, but also inaugurated a newly comprehensive scientific effort to understand the global biosphere as a post-nuclear environment (Doel, 2003). This synthetic forest is important not only because it reveals the official nuclear imagination in 1953, but also because it registers an early effort to study ecological effects, and because the film footage remains to this day an iconic image of atomic devastation.

Indeed, the first decades of the Cold War turned the entire world into an experimental nuclear theater. The 215 above-ground and underwater nuclear detonations the US conducted between 1945 and 1962 produced a vast range of environmental effects that transformed both the globe and the earth sciences.[3] In the South Pacific, for example, two of the largest thermonuclear explosions – 'Mike' in October of 1952 (a 10.4-megaton blast [see Fig. 3]) and 'Bravo' in February of 1954 (a 15-megaton explosion that was the single largest US nuclear detonation of the Cold War, measuring more than 1000 times the explosive power of the Hiroshima bomb) – delivered vast radioactive material into the upper stratosphere. Noting that 'for centuries meteorologists have thought of exploring large-scale atmospheric circulations by means of tracers', meteorologists Machta, List, and Hubert mobilized the fallout to study global wind patterns in their 1956 *Science* paper 'World Wide Travel of Atomic Debris'. Using data from the Mike and Bravo detonations, the researchers demonstrated that fallout entered the upper stratosphere and circled the earth, distributing fallout across the northern hemisphere. In the process, they mapped stratospheric wind patterns (see Fig. 4). Their work was part of a wide range of new research mobilizing the effects of atmospheric nuclear testing to study ecological transport and circulation (see also Hare [1962] and Kroening [1965]). For example, in the following year, Comar, Russell, and Wasserman (1957) tracked the global distribution of strontium-90 from nuclear tests through the food chain, demonstrating that fallout deposited in the soil could be traced through plant and animal vectors into human beings.

By tracking the distribution of radioactive elements produced by atomic testing through the global atmosphere and across plant, animal, and human populations, Cold War scientists were able to document the integration of the global biosphere. Mapping biology against geography and global wind patterns, for example, the Rand Corporation (1953) tracked the planetary distribution of strontium-90 from thermonuclear atmospheric weapons tests explicitly to determine its biological effects on people.

global enterprise, with US laboratories stretched from the continental US to Alaska and the South Pacific, but the effects of nuclear explosions were increasingly recognized to be global in scope, creating unprecedented health risks as well as new multi-disciplinary cartographic opportunities. In an early moment in what was to become human genome science, Rand initiated a global project to collect human bones (with a focus on children) to study strontium absorption rates and thus to study genetic damage; it also argued for a global project to monitor soils (as a central vector in spreading strontium-90 into the food chain), and contemplated the effects of nuclear testing on global weather patterns. Early Cold War scientists began to map the effects of radioactive fallout on human cells, plants, animals, landmasses, water systems, jet stream patterns, and the atmosphere with increasing precision, mobilizing the bomb as health threat, economic resource, and experimental lens. In other words, the military commitment to understanding the full range of nuclear effects generated unprecedented levels of funding for the earth and atmospheric sciences.

Throughout the above-ground test period, Americans voiced increasing concern about the health effects of radioactive fallout, generating both anti-nuclear and nascent environmental movements.[4] Reading across the scientific literatures on fallout from this period, one discovers a constant concern about atomic tests changing the weather and destabilizing the seasons.[5] Indeed, the public responded to the widely publicized US nuclear testing and civil defense programs (which were an explicit effort to psychologically and emotionally mobilize citizens as Cold Warriors) by attributing all manner of unusual natural phenomena – earthquakes, drought, floods, changes in agricultural cycles, hurricanes, insect plagues, changing animal migrations, and strange weather patterns – to the bomb. The Atomic Energy Commission formed a 'Committee on Meteorological Aspects of the Effects of Atomic Radiation' in 1956 to address these public concerns; their report concluded:

> No statistically significant changes in the weather during the first 10 years of the atomic age have been found, yet careful physical analysis of the effects of nuclear explosions on the atmosphere must be made if we are to obtain a definite evaluation of this problem. Although it is not possible to prove that nuclear explosions have or have not influenced the weather, it is believed that such an effect is unlikely. (Committee on Meteorological Aspects of The Effects of Atomic Radiation, 1956)

In the first 10 years of the atomic age. Despite the Committee's declaration, the mounting evidence from biological, earth, and atmospheric sciences was that nuclear testing had a vast range of effects. These effects not only traversed state territories (implicating non-nuclear states in the US nuclear program) but also damaged ecological systems around the globe.

While previous generations of scientists imagined the experimental laboratory as a model of the world, in the early Cold War the world itself became the laboratory. Experiments across a wide range of disciplines

of a 'global, precise, real-time, robust, systematic weather modification capability' [House et al., 1996].)

A central contribution of the Cold War state to a future theory of climate change was its focus on cartography – on measuring and mapping all aspects of planet earth, from the oceans to the landmasses and the ice caps to the airflows (Cloud, 2002; Hall, 2002; Hamblin, 2005). After 1960, the Corona satellite system provided a 'top secret' new level of resolution to mapping operations, replacing the illegal and highly dangerous covert U-2 spy plane flights over the Soviet Union (Ziegler & Jacobson, 1995). Satellite surveillance systems increased exponentially in resolution and data collecting power over the Cold War, ultimately measuring weather, temperature, and ozone, as well as nuclear silos, military bases, and troop movements (see, for example, Mason, 1968). Finally, the integration of these data sets into a comprehensive portrait of global climate was enabled by the long-term military investment in super computing (Edwards, 1996, 2000, 2006: 245). The history of supercomputing in the US is a history of the nuclear weapons programs. The complexity of modeling nuclear weapons explosions is perhaps only exceeded by the complexity of modeling global environmental change. In sum, weather, ice caps, atmospheric and space sciences, satellite cartography, and supercomputing all derive their initial funding and substantial support through the 20th century via the security logics of the nuclear state and its commitment to building the bomb – establishing the early data sets and infrastructure for climate science.[8]

Nonetheless, throughout the first decade of the Cold War there was a structural confusion installed in American culture about how to define 'national security' in relation to 'planetary threat'. The atomic bomb was the core technology in producing two rival notions of security – one in the form of a nuclear arsenal supported by deterrence theory, the other in the form of the closed world earth sciences producing increasing evidence of radiological damage from the nuclear test program itself. Key scientists who called for an end to nuclear detonations as a matter of public health were, at this moment, positioned as enemies of the state, and subject to intimidation (Wang, 1999; Hamblin, 2007). In other words, those who offered an alternative definition of security based on recognition of the accumulating industrial effects of the global nuclear complex were positioned as national security threats. Both enabled by Cold War funding and rejected by national security ideology, Cold War biological and earth scientists were both a resource and a threat to the evolving logics of the nuclear arms race. As a consequence, the regulation of military and non-military planetary science was increasingly determined less by funding than by where scientists published – in the open or classified literatures. As Doel (2003: 653) concludes:

> By the 1960s, two distinct 'environmental sciences' had emerged: one biology-centered, focused on the problems in ecology and population studies, and funded in part by agencies and managers concerned about human threats to the environment; the other geophysics-centered,

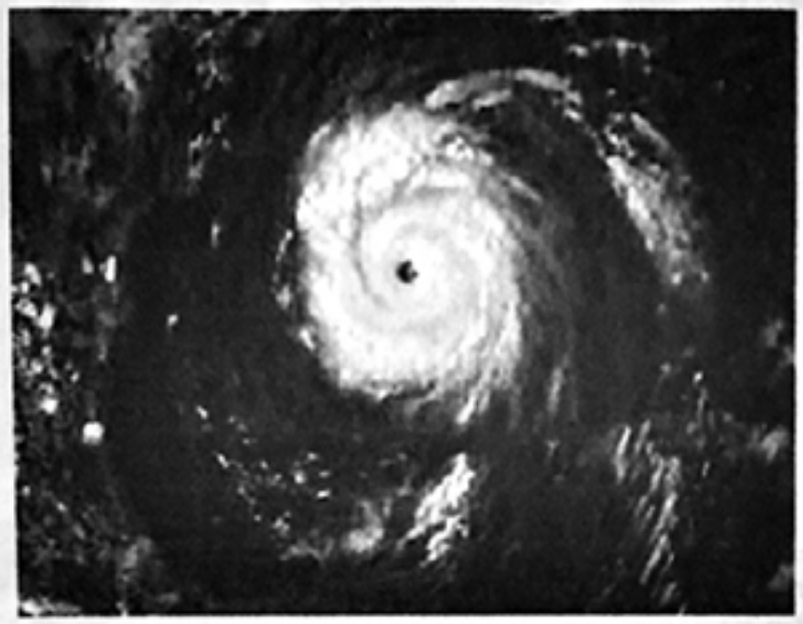
> focused on the physical environment, and responsive to the operational needs of the military services that support it. Studies by biological environmental scientists often appeared in the open literature, while significant results from the physical environmental sciences were often 'born classified'.

I would suggest that within these two sciences were also two different concepts of planetary threat, one focused increasingly on issues of global environment and the cumulative effects of industrial civilization, while the other continued to focus on how nature could be militarized for the benefit of the US national security state.

Thus, if a concept of the biosphere was shaped by the technoscience of the early Cold War state, the nuclear arsenal also severely distorted and limited the biopolitical lessons of the trees of Upshot-Knothole, Project Sunshine, or the Teak Shot. The nuclear state continued to privilege the military threat of state actors over that posed by a fragile biosphere. Nuclear policymakers did so by privileging a specific 'worst case' scenario form of military planning. Narratives of a sudden nuclear attack by the Soviet Union were supported by fantasies of bomber gaps, missile gaps, and other forms of US technological weakness. Predictions of large-scale genetic defects from radioactive fallout, contaminated food chains, and environmental damage on an unprecedented scale from the combined effects of nuclear industry and atomic tests were not constructed as 'national security' problems, except as they threatened nuclear production. Both discovered as an object of state interest and repressed as a political project, the damaged biosphere was ultimately contained by early Cold War geopolitics. The 'worst case' scenario mode of official thinking was limited, in other words, to the realm of state actors (and thus located in international relations) not radical environmental change (the biosphere), even as Cold War technoscience was developing a portrait of the planet as a fragile and integrated system.

Perhaps the purest illustration of this structural linkage between the bomb and biosphere in American political culture is that the first nuclear arms control treaty is also the first international environmental protection treaty. The 1963 Limited Test Ban Treaty (LTBT) eliminated nuclear detonations in the oceans, on land, in the air, and in outer space. Sold in the aftermath of the Cuban Missile Crisis as a means of reducing international nuclear tension, the LTBT was also a means of quieting public concerns about the effects of atmospheric fallout while continuing nuclear weapons production. The LTBT is now remembered at Los Alamos predominantly as a 'public health' initiative, one that took nuclear testing underground, and stabilized its experimental regime from 1963 to 1992 (Masco, 2004b). Without the visual evidence of new nuclear tests, as well as the protests over fallout, the move to underground testing also secured the bomb at the center of US national security logics for the remainder of the 20th century. The LTBT marks an important achievement for the environmental sciences as well: it demonstrated that industrial processes could damage the global biosphere, that negative environmental effects could be both cumulative

FIGURE 7
Hurricane Katrina Hitting the Gulf Coast (NOAA photograph)



Indeed, for many media commentators in the US, the first issue raised by Hurricane Katrina was not about violent weather – and the potential linkage of increasing hurricane strength to climate change – but rather about the national security state's ability to respond to a nuclear attack. Even as stranded residents of the Gulf Coast awaited rescue, cable news talk was significantly devoted to the failures of the Federal Emergency Management Agency (FEMA), not in response to an unfolding natural emergency but to an imagined nuclear one. On *MSNBC*, Chris Mathews asked FEMA and Department of Homeland Security officials what would we be facing if 'it was a bomb that went off, rather than a thunderclap of God's will?'[32] In addition to marking the failures in governmental emergency response, cable television used Katrina to rehearse 'WMD' preparedness, focusing not on floods, levy systems, and environmental change, but on biological warfare, chemical weapons, and terrorists armed with nuclear weapons. Commentators from across the political spectrum asked what the disaster revealed about the state of US civil defense, using the destruction left by Katrina to foment an image of future nuclear devastation in other cities. Not surprisingly, citizens of the gulf coast states called on the government to respond as promised in a state of nuclear emergency.

These responses to a devastating storm reveal how embedded nuclear concepts are in US political culture, and underscore the strange reliance Americans now have on nuclear threat to organize politics and experience – both foreign and domestic. Informing each of these comments is not only the trauma of Hurricane Katrina but also the powerful psychosocial effects of the atomic bomb on American security culture. For how is it that so many

storm, President Bush promised a thorough review of the emergency response effort, stating 'We want to make sure that we can respond properly if there is a WMD attack or another major storm.'[55] In doing so, he again inserted the nuclear terms of the 'war on terror' into a natural disaster. Mass death and destruction has meaning when framed within a nuclear discourse in the US precisely because the Cold War arms race turned the bomb into an organizing principle in American society.

In other words, the Katrina as Hiroshima discourse is an act of translation, rather than misrecognition. As we have seen, the 1950s, 1980s, and 2000s have all witnessed politically charged moments in the US in which the dangers posed by climate change and nuclear weapons were transposed. The designation of the US as a 'superpower' largely depends on the ability of the state to monopolize a discourse of risk, and to this end the atomic bomb has been an extraordinary instrument of state power. In declaring war on 'terror' in 2001, the Bush Administration did not declare war on all terror but rather expressed a more specific fear of the 'WMD'. Today, climate change directly competes with the 'WMD' as primary planetary threat, and demands a different political response. The tools for fighting climate change are in fact diametrically opposed to those informing the 'war on terror' – for a global response to CO_2 emissions requires a new kind of political cooperation, innovative economic and technological change, a shared vision of ecological sustainability, and above all, a willingness to substitute global concerns for national interests. Rather than sustaining a military–industrial economy, engaging climate change requires a new form of global governance.

Returning to the synthetic forest of 1953 (see Fig. 1), we can see in the fury of the nuclear blast a possible counter-narrative to the national security state, one grounded not in weapons but in a relationship towards the biosphere. For the lesson of these bent and broken trees is that if enough industrial force is applied to nature, it will break. The value of the 1953 synthetic forest is that it marks not only the power of the bomb, but also the fragility of even an artificially reinforced nature; it marks not only a new global effort to mediate international relations via nuclear technologies, but also the effects of industry on the biosphere. The mistaken lesson from Operation Upshot-Knothole is that war fighting and civil defense were all that were at stake in these experiments; for indeed, the nuclear blast that transformed 145 ponderosa pines into blades of grass blowing in an unnatural wind is but the most explicit manifestation of an industrial transformation of the natural world. The power of the bomb has been not only to link science and the state in a way that recognizes this fact, but also, to distort American political culture so that only international state threats are currently capable of mobilizing collective social action.

In the early 21st century, the imbrications of nuclear weapons and planetary threat remain so profound as to block both thought and action, allowing the security implications of a warming planet to elude the national security state. However, the ties between the bomb and climate change remain ever present: today, the same supercomputers that maintain the US

Hito Steyerl

A Sea of Data: Apophenia and Pattern (Mis-)Recognition

This is an image from the Snowden files. It is labeled "secret."[1] Yet one cannot see anything on it.

This is exactly why it is symptomatic.

Not seeing anything intelligible is the new normal. Information is passed on as a set of signals that cannot be picked up by human senses. Contemporary perception is machinic to large degrees. The spectrum of human vision only covers a tiny part of it. Electric charges, radio waves, light pulses encoded by machines for machines are zipping by at slightly subluminal speed. Seeing is superseded by calculating probabilities. Vision loses importance and is replaced by filtering, decrypting, and pattern recognition. Snowden's image of noise could stand in for a more general human inability to perceive technical signals unless they are processed and translated accordingly.

But noise is not nothing. On the contrary, noise is a huge issue, not only for the NSA but for machinic modes of perception as a whole.

Signal v. Noise was the title of a column on the internal NSA website running from 2011 to 2012. It succinctly frames the NSA's main problem: how to extract "information from the truckloads of data":

> It's not about the data or even access to the data. It's about getting information from the truckloads of data ... Developers, please help! We're drowning (not waving) in a sea of data – with data, data everywhere, but not a drop of information.[2]

Analysts are choking on intercepted communication. They need to unscramble, filter, decrypt, refine, and process "truckloads of data." The focus moves from acquisition to discerning, from scarcity to overabundance, from adding on to filtering, from research to pattern recognition. This problem is not restricted to secret services. Even WikiLeaks Julian Assange states: "We are drowning in material."[3]

Apophenia

But let's return to the initial image. The noise on it was actually decrypted by GCHQ technicians to reveal a picture of clouds in the sky. British analysts have been hacking video feeds from Israeli drones at least since 2008, a period which includes the recent IDF aerial campaigns against Gaza.[4] But no images of these attacks exist in Snowden's archive. Instead, there are all sorts of abstract renderings of intercepted broadcasts. Noise. Lines. Color patterns.[5] According to leaked training manuals, one needs to apply all sorts of massively secret operations to produce these kinds of images.[6]

But let me tell you something. I will decrypt this image for you without any secret algorithm. I will use a secret ninja technique instead. And I will even teach you how to do it for free. Please focus very strongly on this image right now.

Doesn't it look like a shimmering surface of water in the evening sun? Is this perhaps the "sea of data" itself? An overwhelming body of water, which one could drown in? Can you see the waves moving ever so slightly?

I am using a good old method called apophenia.

Apophenia is defined as the perception of patterns within random data.[7] The most common examples are people seeing faces in clouds or on the moon. Apophenia is about "drawing connections and conclusions from sources with no direct connection other than their indissoluble perceptual simultaneity," as Benjamin Bratton recently argued.[8]

One has to assume that sometimes, analysts also use apophenia.

Someone must have seen the face of Amani al-Nasasra in a cloud. The forty-three-year-old was blinded by an aerial strike in Gaza in 2012 in front of her TV:

"We were in the house watching the news on TV. My husband said he wanted to go to sleep, but I wanted to stay up and watch Al Jazeera to see if there was any news of a ceasefire. The last thing I remember, my husband asked if I changed the channel and I said yes. I didn't feel anything when the bomb hit – I was unconscious. I didn't wake up again until I was in the ambulance." Amani suffered second degree burns and was largely blinded.[9]

What kind of "signal" was extracted from what kind of "noise" to suggest that al-Nasasra was a legitimate target? Which faces appear on which screens, and *why*? Or to put it differently: Who is "signal," and who disposable "noise"?

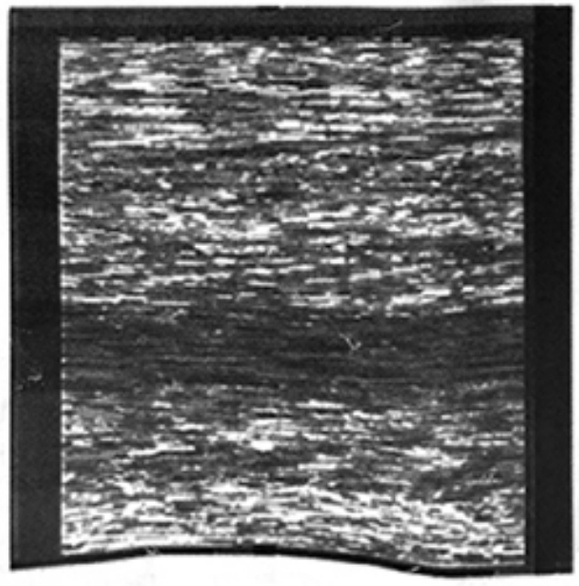
TARGET / CASUALTIES

Pattern Recognition

Jacques Rancière tells a mythical story about how the separation of signal and noise might have been accomplished in Ancient Greece. Sounds produced by affluent male locals were defined as speech, whereas women, children, slaves, and foreigners were assumed to produce garbled noise.[10] The distinction between speech and noise served as a kind of political spam filter. Those identified as speaking were labeled citizens and the rest as irrelevant, irrational, and

SECRET

This image from the Snowden files was captioned: "A single frame of scrambled video imagery."



potentially dangerous nuisances. Similarly, today, the question of separating signal and noise has a fundamental political dimension. Pattern recognition resonates with the wider question of political recognition. Who is recognized on a political level and as what? As a subject? A person? A legitimate category of the population? Or perhaps as "dirty data"?

What are dirty data? Here is one example:

> Sullivan, from Booz Allen, gave the example the time his team was analyzing demographic information about customers for a luxury hotel chain and came across data showing that teens from a wealthy Middle Eastern country were frequent guests.
>
> "There were a whole group of 17 year-olds staying at the properties worldwide," Sullivan said. "We thought, 'That can't be true.'"[11]

The demographic finding was dismissed as dirty data – a mocked up and worthless set of information – before someone found out that, actually, it was true.

Brown teenagers, in this worldview, are likely to exist. Dead brown teenagers? Why not? But rich brown teenagers? This is so improbable that they must be dirty data and cleansed from your system! The pattern emerging from this operation to separate noise and signal is not very different from Rancière's political noise filter for allocating citizenship, rationality, and privilege. Affluent brown teenagers seem just as unlikely as speaking slaves and women in the Greek polis.

On the other hand, dirty data are also something like a cache of surreptitious refusal; they express a refusal to be counted and measured:

> A study of more than 2,400 UK consumers by research company Verve found that 60% intentionally provided wrong information when submitting personal details online. Almost one quarter (23 percent) said they sometimes gave out incorrect dates of birth, for example, while 9 percent said they did this most of the time and 5 percent always did it.[12]

Dirty data is where all of our refusals to fill out the constant onslaught of online forms accumulate. Everyone is lying all the time.

Rose Mary Woods, Nixon's lifelong secretary, demonstrates the "Rose Mary Stretch," a gesticulation that purportedly led to the erasure of a section of the Watergate tapes. The quality of noise in this section of the tapes has been throughly analyzed to understand if the omission was intentional. Photo: Wikimedia commons.

wherever possible, or at least cutting corners. Not surprisingly, the "dirtiest" area of data collection is consistently pointed out to be the health sector, especially in the US. Doctors and nurses are singled out for filling out forms incorrectly. It seems that health professionals are just as unenthusiastic about filling out forms for systems designed to replace them, as consumers are about performing clerical work for corporations that will spam them in return.

In his book *The Utopia of Rules*, David Graeber gives a profoundly moving example of the forced extraction of data. After his mom suffered a stroke, he went through the ordeal of having to apply for Medicaid on her behalf:

> I had to spend over a month ... dealing with the ramifying consequences of the act of whatever anonymous functionary in the New York Department of Motor Vehicles had inscribed my given name as "Daid," not to mention the Verizon clerk who spelled my surname "Grueber." Bureaucracies public and private appear – for whatever historical reasons – to be organized in such a way as to guarantee that a significant proportion of actors will not be able to perform their tasks as expected.[13]

Graeber goes on to call this an example of utopian thinking. Bureaucracy is based on utopian thinking because it assumes people to be perfect from it's own point of view. Graeber's mother died before she was accepted into the program.

The endless labor of filling out completely meaningless forms is a new kind of domestic labor in the sense that it is not considered labor at all and assumed to be provided "voluntarily" or performed by underpaid so-called data janitors.[14] Yet all the seemingly swift and invisible action of algorithms, their elegant optimization of everything, their recognition of patterns and anomalies – this is based on the endless and utterly senseless labor of providing or fixing messy data.

Dirty data is simply real data in the sense that it documents the struggle of real people with a bureaucracy that exploits the uneven distribution and implementation of digital technology.[15] Consider the situation at LaGeSo (the Health and Social Affairs Office) in Berlin, where refugees are risking their health on a daily basis by standing in line outdoors in severe winter weather for hours or even days just to have their data registered and get access to

This photograph from June 6, 2012 shows a Sucore pilot and [illegible] operator training the controls of a MQ-9 Reaper in a ground-based cockpit during a training mission flown from Hancock Field Air National Guard Base, Syracuse, New York. Photo: AP Photo

services to which they are entitled (for example, money to buy food).[16] These people are perceived as anomalies because, in addition to having the audacity to arrive in the first place, they ask that their rights be respected. There is a similar political algorithm at work: people are blanked out. They cannot even get to the stage to be recognized as claimants. They are not taken into account.

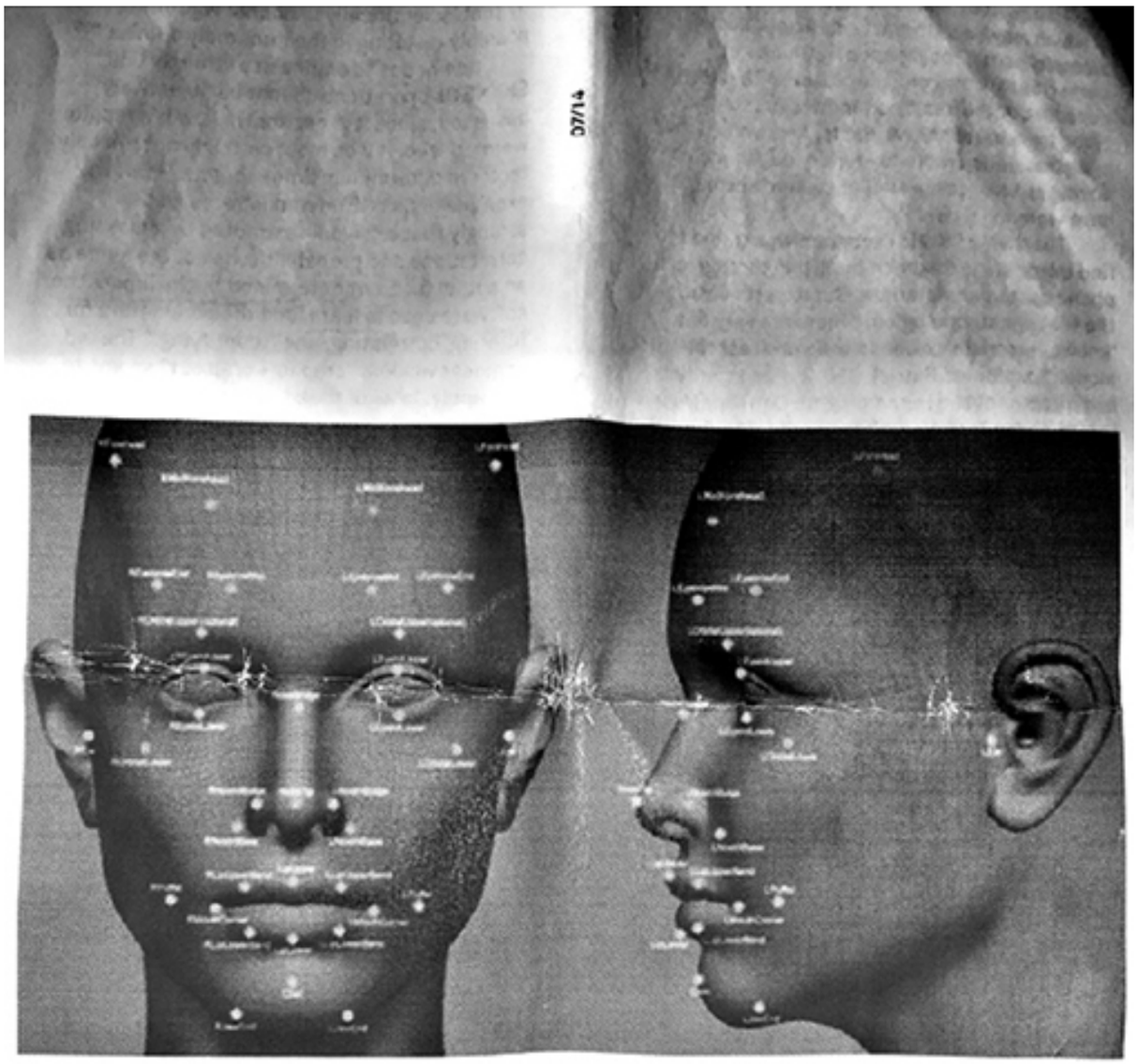
On the other hand, technology also promises to separate different categories of refugees. IBM's Watson AI system was experimentally programmed to potentially identify terrorists posing as refugees:

> IBM hoped to show that the i2 EIA could separate the sheep from the wolves: that is, the masses of harmless asylum-seekers from the few who might be connected to jihadism or who were simply lying about their identities ...
>
> IBM created a hypothetical scenario, bringing together several data sources to match against a fictional list of passport-carrying refugees. Perhaps the most important dataset was a list of names of casualties from the conflict gleaned from open press reports and other sources. Some of the material came from the Dark Web, data related to the black market for passports; IBM says that they anonymized or obscured personally identifiable information in this set ...
>
> Borene said the system could provide a score to indicate the likelihood that a hypothetical asylum seeker was who they said they were, and do it fast enough to be useful to a border guard or policeman walking a beat.[17]

The cross-referencing of unofficial databases, including dark web sources, is used to produce a "score," which calculates the probability that a refugee might be a terrorist. The hope is for a pattern to emerge across different datasets, without actually checking how or if they correspond to any empirical reality. This example is actually part of a much larger subset of "scores": credit scores, academic ranking scores, scores ranking interaction on online forums etc., which classify people according to financial interactions, online behavior, market

The Russian TV station Zvezda claimed this flock of birds over New York City appeared to form the shape of President Vladimir Putin's face. Youtube video screen shot.

A plate of spaghetti meatballs returns our gaze, courtesy of Google Inceptionism. Source: Mary-Ann Russon, "Google DeepDream robot: 10 weirdest images produced by AI 'inceptionism' and users online," International Business Times, July 6, 2015 http://www.ibtimes.co.uk/google-deepdream-robot-10-weirdest-images-produced-by-ai-inceptionism-users-online-1506513



CGI acupuncture. Faux Picture, a general-purpose animation system, promises efficiency in motion capturing actor's faces through its 32-point system.

data, and other sources. A variety of inputs are boiled down to a single number – a superpattern – which may be a "threat" score or a "social sincerity score," as planned by Chinese authorities for every single citizen within the next decade. But the input parameters are far from being transparent or verifiable. And while it may be seriously desirable to identify Daesh moles posing as refugees, a similar system seems to have worrying flaws.

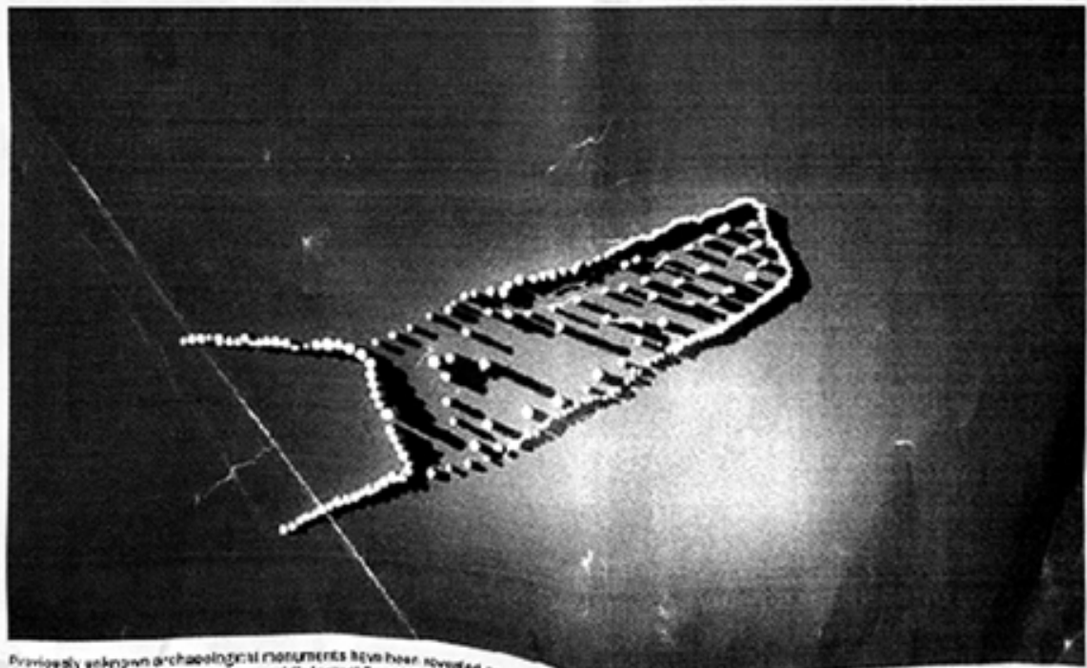
The NSA's SKYNET program was trained to find terrorists in Pakistan by sifting through cell phone customer metadata. But experts criticize the NSA's methodologies. "There are very few 'known terrorists' to use to train and test the model," explained Patrick Ball, a data scientist and director of the Human Rights Data Analysis Group, to *Ars Technica*. "If they are using the same records to train the model as they are using to test the model, their assessment of the fit is completely bullshit."[18]

Human Rights Data Analysis Group estimates that around 99,000 Pakistanis might have ended up wrongly classified as terrorists by SKYNET, a statistical margin of error that might have had deadly consequences given the fact that the US is waging a drone war on suspected militants in the country and between 2500 and four thousand people are estimated to have been killed since 2004: "In the years that have followed, thousands of innocent people in Pakistan may have been mislabelled as terrorists by that 'scientifically unsound' algorithm, possibly resulting in their untimely demise."[19]

One needs to emphasize strongly that SKYNET's operations cannot be objectively assessed, since it is not known how its results were utilized. It was most certainly not the only factor in determining drone targets.[20] But the example of SKYNET demonstrates just as strongly that a "signal" extracted by assessing correlations and probabilities is not the same as an actual fact, but determined by the inputs the software uses to learn, and the parameters for filtering, correlating, and "identifying." The old engineer wisdom "crap in – crap out" seems to still apply. In all of these cases – as completely different as they are technologically, geographically, and also ethically – some version of pattern recognition was used to classify groups of people according to political and social parameters. Sometimes it is as simple as, *we try to avoid registering refugees*. Sometimes there is more mathematical mumbo jumbo involved. But many methods used are opaque, partly biased, exclusive, and – as one expert points out – sometimes also "ridiculously optimistic."[21]

Corporate Animism

How to recognize something in sheer noise? A



Previously unknown archaeological monuments have been revealed as of September 2016 by the Stonehenge Hidden Landscapes Project. The findings include new information about the world's largest "super henge" and include ritual monuments such as the mortuary building pictured above in a 3-D reconstruction. Copyright: LDI ArchPro, Joachim Brandtner

striking visual example of pure and conscious apophenia was recently demonstrated by research labs at Google:[23]

> We train an artificial neural network by showing it millions of training examples and gradually adjusting the network parameters until it gives the classifications we want. The network typically consists of 10–30 stacked layers of artificial neurons. Each image is fed into the input layer, which then talks to the next layer, until eventually the "output" layer is reached. The network's "answer" comes from this final output layer.[23]

Neural networks were trained to discern edges, shapes, and a number of objects and animals and then applied to pure noise. They ended up "recognizing" a rainbow-colored mass of disembodied fractal eyes, mostly without lids, incessantly surveilling their audience in a strident display of conscious pattern overidentification.

Google researchers call the act of creating a pattern or an image from nothing but noise "inceptionism" or "deep dreaming." But these entities are far from mere hallucinations. If they are dreams, those dreams can be interpreted as condensations or displacements of the current technological disposition. They reveal the networked operations of computational image creation, certain presets of machinic vision, its hardwired ideologies and preferences.

> One way to visualize what goes on is to turn the network upside down and ask it to enhance an input image in such a way as to elicit a particular interpretation. Say you want to know what sort of image would result in "Banana." Start with an image full of random noise, then gradually tweak the image towards what the neural net considers a banana. By itself, that doesn't work very well, but it does if we impose a prior constraint that the image should have similar statistics to natural images, such as neighboring pixels needing to be correlated.[24]

In a feat of genius, inceptionism manages to visualize the unconscious of prosumer networks: images surveilling users, constantly registering their eye movements, behavior, preferences, aesthetically helplessly adrift between *Hundertwasser* mug knockoffs and Art Deco friezes gone ballistic. Walter Benjamin's "optical unconscious" has been upgraded to the unconscious of computational image divination.[25]

By "recognizing" things and patterns that were not given, inceptionist neural networks eventually end up effectively identifying a new totality of aesthetic and social relations. Presets and stereotypes are applied, regardless of whether they "apply" or not: "The results are intriguing – even a relatively simple neural network can be used to over-interpret an image, just like as children we enjoyed watching clouds and interpreting the random shapes."[26]

But inceptionism is not just a digital hallucination. It is a document of an era that trains smartphones to identify kittens, thus hardwiring truly terrifying jargons of cuteness into the means of production.[27] It demonstrates a version of corporate animism in which commodities are not only fetishes but morph into franchised chimeras.

Yet these are deeply realist representations. According to Gyorgy Lukacs, "classical realism" creates "typical characters," insofar as they represent the objective social (and in this case technological) forces of our times.[28]

Inceptionism does that and more. It also gives those forces a face – or more precisely, innumerable eyes. The creature that stares at you from your plate of spaghetti and meatballs is not an amphibian beagle. It is the ubiquitous surveillance of networked image production, a form of mematically modified intelligence that watches you in the shape of the lunch that you will Instagram in a second if it doesn't attack you first. Imagine a world of enslaved objects remorsefully scrutinizing you. Your car, your yacht, your art collection observes you with a gloomy and utterly desperate expression. *You may own us, they seem to say, but we are going to inform on you. And guess what kind of creature we are going to recognize in you!*[29]

Data Neolithic

But what are we going to make of automated apophenia?[30] Are we to assume that machinic perception has entered its own phase of magical thinking? Is this what commodity enchantment means nowadays: hallucinating products? It might be more accurate to assume that humanity has entered yet another new phase of magical thinking. The vocabulary deployed for separating signal and noise is surprisingly pastoral: data "farming" and "harvesting," "mining" and "extraction" are embraced as if we lived through another massive neolithic revolution[31] with it's own kind of magic formulas.

All sorts of agricultural and mining technologies – that were developed during the neolithic – are reinvented to apply to data. The stones and ores of the past are replaced by silicone and rare earth minerals, while a Minecraft paradigm of extraction describes the

processing of minerals into elements of information architecture.[32]

Pattern recognition was an important asset of neolithic technologies too. It marked the transition between magic and more empirical modes of thinking. The development of the calendar by observing patterns in time enabled more efficient irrigation and agricultural scheduling. Storage of cereals created the idea of property. This period also kick-started institutionalized religion and bureaucracy, as well as managerial techniques including laws and registers. All these innovations also impacted society: hunter and gatherer bands were replaced by farmer kings and slaveholders. The neolithic revolution was not only technological but also had major social consequences.

Today, expressions of life as reflected in data trails become a farmable, harvestable, minable resource managed by informational biopolitics.[33]

And if you doubt that this is another age of magical thinking, just look at the NSA training manual for unscrambling hacked drone intercepts. As you can see, you need to bewitch the files with a magic wand. (Image Magick is a free image convertor):

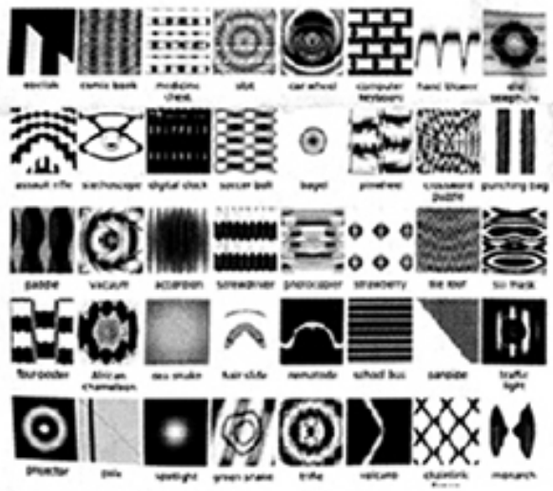
The supposedly new forms of governance emerging from these technologies look partly archaic and partly superstitious. What kind of corporate/state entities are based on data storage, image unscrambling, high-frequency trading, and Dooch Forex gaming? What are the contemporary equivalents of farmer kings and slaveholders, and how are existing social hierarchies radicalized through examples as vastly different as tech-related gentrification and jihadi online forum gamification? How does the world of pattern recognition and big-data divination relate to the contemporary jumble of oligocracies, troll farms, mercenary hackers, and data robber barons supporting and enabling bot governance, Khalifah clickbait and polymorphous proxy warfare? Is the state in the age of Deep Mind, Deep Learning, and Deep Dreaming a Deep State™? One in which there is no appeal nor due process against algorithmic decrees and divination?

But there is another difference between the original and the current type of "neolithic," and it harks back to pattern recognition. In ancient astronomy, star constellations were imagined by projecting animal shapes into the skies. After cosmic rhythms and trajectories had been recorded on clay tablets, patterns of movement

04.14.16 / 11:08:39 PLT

Could this image be a representation of the neo-neolithic? Source: Mary-Ann Russon, "Google DeepDream robot: 10 weirdest images produced by AI 'inceptionism' and users online," International Business Times, July 6, 2015 http://www.ibtimes.co.uk/google-deepdream-robot-10-weirdest-images-produced-by-ai-inceptionism-users-online-1509518

started to emerge. As additional points of orientation, some star groups were likened to animals and heavenly beings. However, progress in astronomy and mathematics happened not because people kept believing there were animals or gods in space, but on the contrary, because they accepted that constellations were expressions of a physical logic. The patterns were projections, not reality. While today statisticians and other experts routinely acknowledge that their findings are mostly probabilistic projections, policymakers of all sorts conveniently ignore this message. In practice you become coextensive with the data-constellation you project. Social scores of all different kinds – credit scores, academic scores, threat scores – as well as commercial and military pattern-of-life observations impact the real lives of real people, both reformatting and radicalizing social hierarchies by ranking, filtering, and classifying.



Source: Anh Nguyen, Jason Yosinski, and Jeff Clune. "Deep Neural Networks are Easily Fooled: High Confidence Predictions for Unrecognizable Images," cv-foundation.org, 2015 http://www.cv-foundation.org/openaccess/content_cvpr_2015/papers/Nguyen_Deep_Neural_Networks_2015_CVPR_paper.pdf.

Gestalt Realism

But let's assume we are actually dealing with projections. Once one accepts that the patterns derived from machinic sensing are not the same as reality, information definitely becomes available with a certain degree of veracity.

Let's come back to Amani al-Nasasra, the woman blinded by an aerial attack in Gaza. We know: the abstract images recorded as intercepts of IDF drones by British spies do not show the aerial strike in Gaza that blinded her in 2012. The dates *don't* match. There is no evidence in Snowden's archive. There are no images of this attack, at least as far as I know of. All we know is what she told Human Rights Watch. This is what she said: "I can't see – ever since the bombing, I can only see shadows."[34]

So there is one more way to decode this image. It's plain for everyone to see. We see what Amani *cannot* see.

In this case, the noise must be a "document" of what she "sees" now: "the shadows."

Is this a document of the drone war's optical unconscious? Of it's dubious and classified methods of "pattern recognition"? And if so, is there a way to ever "unscramble" the "shadows" Amani has been left with?

×

Acknowledgments: The initial version of this text was written at the request of Laura Poitras, who most generously allowed access to some unclassified documents from the Snowden archive, and a short version was presented during the opening of her show "Astro Noise" at the Whitney Museum. Further thanks to Henrik Moltke for facilitating access to the documents, to Brenda and other members of Laura's studio, to Linda Stupart for introducing me to the term "apophenia," and to Bea Bratton for fleshing it out for me.

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1
See https://www.documentcloud.org/documents/2699846-Anarchist-Training-mod5-Redacted-Compat.html

2
"The SIGINT World Is Flat," Signaly, Noise column, December 22, 2011.

3
Michael Sontheimer, "SPIEGEL Interview with Julian Assange: 'We Are Drowning in Material,'" Spiegel Online, July 20, 2015 http://www.spiegel.de/international/world/spiegel-interview-with-wikileaks-head-julian-assange-a-1044399.html

4
Cora Currier and Henrik Moltke, "Spies in the Sky: Israeli Drone Feeds Hacked By British and American Intelligence," The Intercept, January 28, 2016 https://theintercept.com/2016/01/28/israeli-drone-feeds-hacked-by-british-and-american-intelligence/

5
Ibid. Many of these images are currently part of Laura Poitras's excellent show "Astro Noise" at the Whitney Museum in New York.

6
In the training manual on how to decode these feeds, analysts proudly declared they used open source software developed by the University of Cambridge to hack Sky TV. See https://www.documentcloud.org/documents/2699846-Anarchist-Training-mod5-Redacted-Compat.html

7
See https://en.wikipedia.org/wiki/Apophenia

8
Benjamin H. Bratton, "Some Trace Effects of the Post-Anthropocene: On Accelerationist Geopolitical Aesthetics," e-flux journal 46 (June 2013) www.e-flux.com/journal/some-trace-effects-of-the-post-anthropocene-on-accelerationist-geopolitical-aesthetics/

9
"Israel: Gaza Airstrikes Violated Laws of War," hrw.org, February 12, 2013 https://www.hrw.org/news/2013/02/12/israel-gaza-airstrikes-violated-laws-war

10
Jacques Rancière, "Ten Theses on Politics," Theory & Event, Vol. 5, No. 3 (2001). "In order to refuse the title of political subjects to a category – workers, women, etc. – it has traditionally been sufficient to assert that they belong to a 'domestic' space, to a space separated from public life, one from which only groans or cries expressing suffering, hunger, or anger could emerge, but not actual speeches demonstrating a shared aisthesis. And the politics of these categories ... has consisted in making what was unseen visible; in getting what was only audible as noise to be heard as speech."

Noise to speech

11
Verne Kopytoff, "Big data's dirty problem," Fortune, June 30, 2014 http://fortune.com/2014/06/30/big-data-dirty-problem/

12
Larisa Bedgood, "A Halloween Special: Tales from the Dirty Data Crypt," relevategroup.com, October 30 2015 http://www.relevategroup.com/a-halloween-special-tales-from-the-dirty-data-crypt/#sthash.BWxNRaE.dpuf. The article continues: "In late June and early July 1991, twelve million people across the country (mostly Baltimore, Washington, Pittsburgh, San Francisco, and Los Angeles) lost phone service due to a typographical error in the software that controls signals regulating telephone traffic. One employee typed a '6' instead of a 'D.' The phone companies essentially lost all control of their networks."

13
David Graeber, The Utopia of Rules: On Technology, Stupidity and the Secret Joys of Bureaucracy (Brooklyn: Melville House, 2015), 43.

14
Steve Lohr, "For Big-Data Scientists, 'Janitor Work' Is Key Hurdle to Insights," New York Times, August 17, 2014 http://www.nytimes.com/2014/08/18/technology/for-big-data-scientists-hurdle-to-insights-is-janitor-work.html?_r=0

15
See "E-Verify: The Disparate Impact of Automated Matching Programs," chap. 2 in the report Civil Rights, Big Data, and Our Algorithmic Future, bigdata.fairness.io, September 2014 https://bigdata.fairness.io/e-verify/

16
See Melissa Eddy and Katarina Johannsen, "Migrants Arriving in Germany Face a Chaotic Reception in Berlin," New York Times, November 26, 2015 http://www.nytimes.com/2015/11/27/world/europe/germany-berlin-migrants-refugees.html?_r=0. A young boy disappeared among the chaos and was later found murdered.

17
Patrick Tucker, "Refugee or Terrorist? IBM Thinks Its Software Has the Answer," Defense One, January 27, 2016 http://www.defenseone.com/technology/2016/01/refugee-or-terrorist-ibm-thinks-its-software-has-answer/125484/. This example was mentioned by Kate Crawford in her brilliant lecture "Surviving Surveillance," delivered as part of the panel discussion "Surviving Total

surveillance," Whitney Museum, January 29, 2016.

18
Christian Grothoff and J. M. Porup, "The NSA's SKYNET program may be killing thousands of innocent people," *Ars Technica*, February 16, 2016, italics in original http://arstechnica.co.uk/security/2016/02/the-nsas-skynet-program-may-be-killing-thousands-of-innocent-people/. An additional bug of the system was that the person who seemed to pose the biggest threat of all according to this program was actually the head of the local Al Jazeera office, because he obviously traveled a lot for professional reasons. A similar misassessment also happened to Laura Poitras, who was rated four hundred out of a possible four hundred points on a US Homeland Security threat scale. As Poitras was filming material for her documentary *My Country, My Country* in Iraq – later nominated for an Academy Award – she ended up filming in the vicinity of an insurgent attack in Baghdad. This coincidence may led to a six-year ordeal that involved her being interrogated, surveilled, searched, etc., every time she reentered the United States from abroad.

19
Ibid.

20
See Michael V. Hayden, "To Keep America Safe, Embrace Drone Warfare," *New York Times*, February 19, 2016 http://www.nytimes.com/2016/02/21/opinion/sunday/drone-warfare-precise-effective-imperfect.html. The director of the CIA from 2006–09, Hayden asserts that human intelligence was another factor in determining targets, while admitting that the program did indeed kill people in error: "In one strike, the grandson of the target was sleeping near him on a cot outside, trying to keep cool in the summer heat. The Hellfire missiles were directed so that their energy and fragments splayed away from him and toward his grandfather. They did, but not enough."

21
Grothoff and Porup, "The NSA's SKYNET program."

22
Thank you to Ben Bratton for pointing this out.

23
"Inceptionism: Going Deeper into Neural Networks," Google Research Blog, June 17, 2015 http://googleresearch.blogspot.de/2015/06/inceptionism-going-deeper-into-neural.html

24
Ibid.

25
Walter Benjamin, "A Short History of Photography," available at monoskop.org http://monoskop.org/images/7/7a/Benjamin_Walter_1931_1972_A_Short_History_of_Photography.pdf

26
"Inceptionism."

27
See ibid.

28
Farhat B. Idris, "Realism," in *Encyclopedia of Literature and Politics: Censorship, Revolution, and Writing, Volume II: H–R*, ed. M. Keith Booker (Westport, CT: Greenwood), 601.

29
Is apophenia a new form of paranoia? In 1988, Frederic Jameson declared paranoia to be one of the main cultural patterns of postmodern narrative, pervading the political unconscious. According to Jameson, the totality of social relations could not be culturally represented within the Cold War imagination – and the blanks were filled in by delusions, conjecture, and whacky plots featuring Freemasons/Illuminati. But after Snowden's leaks, one thing became clear: all conspiracy theories were actually true. Worse, they were outdone by reality. Paranoia is anxiety caused by an absence of information, by missing links and allegedly concealed evidence. Today, the contrary applies. Jameson's totality has taken on a different form. It is not absent. On the contrary: it is rampant. Totality – or maybe a completed version thereof – has returned with a vengeance in the form of oceanic "truckloads of data." Social relations are distilled as contact metadata, relational graphs, or infection spread maps. Totality is a tsunami of spam, ethnicity porn, and gadget handshakes. This quantified version of social relations is just as readily deployed for police operations as for targeted advertising, for personalized clickbait, eyeball tracking, neurocurating, and the financialization of affect. It works both as social profiling and commodity form. Klout Score–based A-lists and presidential kill lists are equally based on obscure proprietary operations. Today, totality comes as probabilistic notation that includes your f-ability score as well as your disposability ratings. It catalogs affiliation, association, addiction; it caters to patterns of life and death by serial ethics.

This type of totality is actually something else, namely a "singularity." Singularity – the pet myth of California ideology – describes, among other things, a time when artificial intelligence take over. The NSA's SKYNET program was named after one of the most famous Hollywood singularities, an AI robot gunning for world domination in Schwarzenegger's cyborg vehicle *Terminator*.

Singularity (the exception)

But singularity also means something different: general rules no longer apply to this entity, especially not the rule of law. It is case-by-case instead, or rather, every-case-for-itself. Accordingly, there seem to be competing singularities. Another, even more powerful singularity of our times is most obviously the semi-divine mythical entity called "the markets," a set of organizations regarded as both autonomous and superintelligent, of such providence that reason has to bow to its vast superiority. If the myth of the market today can be said to have replaced the myth of socialism, then the actually existing singularities today – government surveillance and market domination, each dominated by singular laissez-faire ideas – plus the vast and confusing bureaucracies, oligarchies, quasi-states, informal dictatorships, dark net start-ups, economic "SWAT" teams, and unclassifiable para-monopolies sustaining their operations have replaced the actually existing socialisms of the twentieth century. Ideological enclaves spread out across junk space data centers, high-frequency trading exchanges, and vast zones of impunity and violence that create a completely biased and unsustainable distribution of both information and resources.

30
More recent, extremely fascinating examples include Christian Szegedy et. al, "Intriguing properties of neural networks," arxiv.org, February 19, 2014 http://arxiv.org/pdf/1312.6199v4.pdf; and Anh Nguyen, Jason Yosinski, and Jeff Clune, "Deep Neural Networks are Easily Fooled: High Confidence Predictions for Unrecognizable Images," cv-foundation.org, 2015 http://www.cv-foundation.org/openaccess/content_cvpr_2015/papers/Nguyen_Deep_Neural_Networks_2015_CVPR_paper.pdf. The first paper discusses how the addition of a couple of pixels – a change imperceptible to the human eye – causes a neural network to misidentify a car, an Aztec pyramid, and a pair of loudspeakers for an ostrich. The second paper discusses how entirely abstract shapes are identified as penguins, guitars, and baseballs by neural networks.

31
"Do We Need a Bigger SIGINT Truck?" Signals, *Nsaw* column, January 23, 2012.

32
See Jussi Parikka, "The Geology of Media," *The Atlantic*, October 11, 2013 http://www.theatlantic.com/technology/archive/2013/10/the-geology-of-media/280523/

33
Contemporary soothsayers are reading patterns into data as if they were the entrails of sacrificial animals. They are successors of the more traditional augurs that Walter Benjamin described as photographers avant la lettre: "Is not every spot of our cities the scene of a crime? Every passerby a perpetrator? Does not the photographer – descendent of augurers and haruspices – uncover guilt in his pictures?"

There is a decisive distinction, though, between the twentieth-century photographer and the filterers and dowsers of the twenty-first. Contemporary pattern extractors are not mainly supposed to recognize the guilty after the fact. They are expected to predict the perpetrator as well as the crime before it ever happens – and to preempt it. Every spot of our cities is mapped out as a probable crime site, fully decked out with gender- and age-based targeted advertising – surveilled by animated commodities, divinatory cellphone cameras, and aerial views from tapped drones.

34
"Israel: Gaza Airstrikes Violated Laws of War."

shades of green as wildly contrasting or as flatly indistinguishable as the traits themselves.

The remaining fields – where no changes to the seed had yet been tested, and no predictions could be made – were classified as *indeterminate*. Here, the one tried code, the known landmark, was shown as gray against white: a mountain peak protruding through a band of clouds which concealed everything to the east or west of it. No more detail could be resolved from afar; whatever lay beneath the clouds could only be discovered firsthand.

Whenever the conceptory created an orphan, it set all the benignly mutable trait fields to valid codes chosen at random, since there were no parents to mimic or please. Then it selected a thousand indeterminate fields, and treated them in much the same fashion: throwing a thousand quantum dice to choose a random path through *terra incognita*. Every orphan was an explorer, sent to map uncharted territory.

And every orphan was the uncharted territory itself.

The conceptory placed the new orphan seed in the middle of the womb's memory, a single strand of information suspended in a vacuum of zeros. The seed meant nothing to itself; alone, it might as well have been the last stream of Morse code, fleeing through the void past a distant star. But the womb was a virtual machine designed to execute the seed's instructions, and a dozen more layers of software led down to the polis itself, a lattice of flickering molecular switches. A sequence of bits, a string of passive data, could do nothing, change nothing – but in the womb, the seed's meaning fell into perfect alignment with all the immutable rules of all the levels beneath it. Like a punched card fed into a Jacquard loom, it ceased to be an abstract message and became a part of the machine. ABSTRAX1

When the womb read the seed, the seed's first shaper caused the space around it to be filled with a simple pattern of data: a single, frozen numerical wave train, sculpted across the emptiness like a billion perfect ranks of sand dunes. This distinguished each point from its immediate neighbors further up or down the same slope – but each crest

As the orphan turned toward ver, it caught sight of a star far brighter than all the rest, much smaller than the familiar sight in the Earth's sky, but unfiltered by the usual blanket of gases and dust.

"The sun?"

Gabriel said, "Yes, that's the sun." The golden-furred citizen floated beside Blanca, who was visible as sharply as ever, darker even than the cool thin background radiation between the stars.

Inoshiro whined, "Why did you bring Yatima? It's too young! It won't understand anything!"

Blanca said, "Just ignore ver, Yatima."

Yatima! Yatima! The orphan knew exactly where Yatima was, and what ve looked like, without any need to part the navigators and check. The fourth citizen's icon had stabilized as the tall flesher in the purple robe who'd adopted the lion cub, in the library.

Inoshiro addressed the orphan. "Don't worry Yatima, I'll try to explain it to you. If the gleisners didn't trim this asteroid, then in three hundred thousand years – ten thousand teratau – there'd be a chance it might hit the Earth. And the sooner they trim it, the less energy it takes. But they couldn't do it before, because the equations are chaotic, so they couldn't model the approach well enough until now."

The orphan understood none of this. "Blanca wanted me to see the trimming! But I wanted to play a new game!"

Inoshiro laughed. "So what did ve do? Kidnap you?"

"I followed ver and ve jumped and jumped … and I *followed ver!*" The orphan made a few short jumps around the three of them, trying to illustrate the point, though it didn't really convey the business of leaping right out of one scape into another.

Inoshiro said, "Ssh. Here it comes."

The orphan followed vis gaze to an irregular lump of rock in the distance – lit by the sun, one half in deep shadow – moving swiftly and steadily toward the loose assembly of citizens. The scape software decorated the asteroid's image with gestalt tags packed with information about its chemical composition, its mass, its spin, its orbital parameters;

the orphan recognized some of these flavors from the library, but it had no real grasp yet of what they meant.

"One slip of the laser, and the fleshers die in pain!" Inoshiro's pewter eyes gleamed.

Blanca said dryly, "And just three hundred millennia to try again."

Inoshiro turned to the orphan and added reassuringly, "But we'd be all right. Even if it wiped out Konishi on Earth, we're backed-up all over the solar system."

The asteroid was close enough now for the orphan to compute its scape address and its size. It was still some hundred times more distant than the farthest citizen, but it was approaching rapidly. The waiting spectators were arranged in a roughly spherical shell, about ten times as large as the asteroid itself – and the orphan could see at once that if it maintained its trajectory, the asteroid would pass right through the center of that imaginary sphere.

Everyone was watching the rock intently. The orphan wondered what kind of game this was; a generic symbol had formed which encompassed all the strangers in the scape, as well as the orphan's three friends, and this symbol had inherited the fourth citizen's property of *holding beliefs about objects* which had proved so useful for predicting its behavior. *Maybe people were waiting to see if the rock would suddenly jump at random, like Blanca had jumped?* The orphan believed they were mistaken; the rock was not a citizen, it wouldn't play games with them.

The orphan wanted everyone to know about the rock's simple trajectory. It checked its extrapolation one more time, but nothing had changed; the bearing and speed were as constant as ever. The orphan lacked the words to explain this to the crowd … but maybe they could learn things by watching the fourth citizen, the way the fourth citizen had learned things from Blanca.

The orphan jumped across the scape, straight into the path of the asteroid. A quarter of the sky became pocked and gray, an irregular hillock on the sunward side casting a band of deep shadow across the approaching face. For an instant, the orphan was too startled to move – mesmerized by the scale, and the speed, and the awkward, purposeless

have been just a [redacted] of plausible fantasy. In the end, it had come down to one question: *Inoshiro went ahead and did this alone, would it turn them into strangers?* Yatima had found, to vis surprise, that this wasn't a risk ve was willing to take.

Ve suggested hesitantly, "We might not want to stay for the full twenty-four hours, though." *Eighty-six megatau.* "What if the whole place is empty, and there's nothing to see?"

"It's a flesher enclave. It won't be *empty*."

"The last known contact was centuries ago. They could have died out, moved away … anything." Under an eight-hundred-year-old treaty, drones and satellites were not permitted to invade the privacy of the fleshers; the few dozen scattered urban enclaves where their own laws permitted them to clear away the wildlife completely and build concentrated settlements were supposed to be treated as inviolable. They had their own global communications network, but no gateways linked it to the Coalition; abuses on both sides dating back to the Introdus had forced the separation. Inoshiro had insisted that merely puppeting the gleisner bodies via satellite from Konishi would have been morally equivalent to sending in a drone – and certainly the satellites, programmed to obey the treaty, would not have permitted it – but inhabiting two autonomous robots who wandered in from the jungle for a visit was a different matter entirely.

Yatima looked around at the dense undergrowth, and resisted the futile urge to try to make vis viewpoint jump forward by a few hundred meters, or rise up into the towering forest for a better view of the terrain ahead. *Fifty kilotau. Fifty-one. Fifty-two.* No wonder most fleshers had stampeded into the polises, once they had the chance: if disease and aging weren't reason enough, there was gravity, friction, and inertia. The physical world was one vast, tangled obstacle course of pointless, arbitrary restrictions.

"We'd better start moving."

"After you, Livingstone."

"Wrong continent, Inoshiro."

"Geronimo? Huckleberry? Dorothy?"

"Spare me."

The interf[illegible]e the [illegible]ed set gleis[illegible] [illegible] describing the predicted effects on the Earth, [illegible]e the mood of the audience. Flesher gestalt, limited [illegible]much more subdued than the polis versions, but ve [illegible] detect a growing number of faces expressing consternation. [illegible]as no dramatic change sweeping through the hall, but ve decided to interpret this optimistically: anything was better than panic.

Francesca moderated the responses. The first came from the representative of an enclave of statics; he spoke a dialect of English, so the interface slipped the language into Yatima's mind.

"You are shameless. We expect no honor from the simulacra of the shadows of departed cowards, but will you never give up trying to wipe the last trace of vitality from the face of the Earth?" The static laughed humorlessly. "Did you honestly believe that you could frighten us with this risible fairy-tale of 'quarks' and 'gamma rays' raining from the sky, and then we'd all file meekly into your insipid virtual paradise? Did you imagine that a few cheap, shocking words would send us fleeing from the real world of pain and ecstasy into your nightmare of perfectibility?" He gazed down at them with a kind of fascinated loathing. "Why can't you stay inside your citadels of infinite blandness, and leave us in peace? We humans are fallen creatures; we'll never come crawling on our bellies into your ersatz Garden of Eden. I tell you this: there will always be flesh, there will always be sin, there will always be dreams and madness, war and famine, torture and slavery."

Even with the language graft, Yatima could make little sense of this, and the translation into Modern Roman was equally opaque. Ve dredged the library for clarification; half the speech seemed to consist of references to a virulent family of Palestinian theistic replicators.

Ve whispered to Francesca, dismayed, "I thought religion was long gone, even among the statics."

"God is dead, but the platitudes linger." Yatima couldn't bring verself to ask whether *torture and slavery* also lingered, but Francesca seemed

vis time was almost up, th[illegible] reverently *at* their destination. In a y[illegible] Fomalhaut hadn't brightened noticeably, and there were no close stars to be seen streaming away from it, so even Merak had to admit that there was nothing much to single it out.

Blanca didn't have the heart to remind them that they'd deliberately blinded themselves to the most spectacular sign of the polis's motion: at eight per cent of lightspeed, the Doppler-shift starbow centered on Fomalhaut was far too subtle for them to detect. The scape itself was based on data from cameras with single-photon sensitivity and sub-Ångstrom wavelength resolution, so the sight was there for the asking, but the idea of cheating their embodiment to absorb this information directly, or even just constructing a false-color sky to exaggerate the Doppler effect to the point of visibility, would have filled them with horror. They were experiencing the trip through the raw senses of plausible space-faring fleshers; any embellishments could only detract from that authenticity, and risk leading them into the madness of abstractionism.

Ve bid them farewell until next time. They gamboled around ver, protesting noisily and pleading with ver to stay, but Blanca knew they wouldn't miss ver for long.

Back in vis homescape, Blanca admitted to verself that ve'd actually enjoyed the visit. A brief dose of the Puppies' relentless enthusiasm always helped shake up vis perspective on vis own obsession.

Vis current homescape was a fissured, vitreous plain beneath a deep orange sky. Mercurial silver clouds just a few delta from the ground rose in updrafts, sublimated into invisible vapor, then recondensed abruptly and sank again. The ground suffered quakes induced by forces from the clouds that had no analog in real-world physics; Blanca was beginning to get a feel for the patterns in the sky that presaged the big ones, but the precise rules, complex emergent properties of the lower-level deterministic laws, remained elusive.

This world and its seismology were just decoration and diversion, though. The reason ve'd elected to experience time on the voyage at all

his work on the three-body problem, Max Planck discovered energy quanta and Albert Einstein published his special theory of relativity. For the next half-century physicists and mathematicians were fascinated by the revolutionary developments in quantum physics and relativity theory, and Poincaré's groundbreaking discovery moved backstage. It was not until the 1960s that scientists stumbled again into the complexities of chaos.

6.3 Principles of nonlinear dynamics

6.3.1 Trajectories in abstract spaces

The mathematical techniques that have enabled researchers during the past four decades to discover ordered patterns in chaotic systems are based on Poincaré's topological approach and are closely linked to the development of computers. With the help of today's high-speed computers, scientists can solve nonlinear equations by techniques that were not available before. These powerful computers can easily trace out the complex trajectories that Poincaré did not even attempt to draw.

As most readers will remember from school, an equation is solved by manipulating it until you get a final formula as the solution. This is called solving the equation "analytically." The result is always a formula. Most nonlinear equations describing natural phenomena are too difficult to be solved analytically. But there is another way, which is called solving the equation "numerically." This involves trial and error. You try out various combinations of numbers for the variables until you find the ones that fit the equation. Special techniques and tricks have been developed for doing this efficiently, but for most equations the process is extremely cumbersome, takes a long time, and gives only very rough, approximate solutions.

All this changed when the new powerful computers arrived on the scene. Now we have programs for numerically solving an equation in extremely fast and accurate ways. With the new methods nonlinear equations can be solved to any degree of accuracy. However, the solutions are of a very different kind. The result is not a formula, but a large collection of values for the variables that satisfy the equation, and the computer can be programmed to trace out the solution as a curve, or set of curves, in a graph. This technique has enabled scientists to solve the complex nonlinear equations associated with chaotic phenomena and to discover order beneath the seeming chaos.

To reveal these ordered patterns, the variables of a complex system are displayed in an abstract mathematical space called "phase space." This is a well-known technique that was developed in thermodynamics at the turn of the nineteenth century. Every variable of the system is associated with a different coordinate in this abstract space, and every single point in phase space describes the entire system (see Box 6.3). As the system changes over time, the values of its variables change and thus the point traces out a trajectory, known as an attractor, which is a mathematical representation of the system's long-term behavior.

Over the past twenty years, the phase-space technique has been used to explore a wide variety of complex systems. In case after case scientists and mathematicians would set up

Box 6.3

Attractors in phase space

We shall illustrate the phase-space technique with a very simple example, a ball swinging back and forth on a pendulum. To describe the pendulum's motion completely, we need two variables: the angle, which can be positive or negative, and the velocity, which can again be positive or negative, depending on the direction of the swing. With these two variables, angle and velocity, we can describe the state of motion of the pendulum completely at any moment.

If we now draw a Cartesian coordinate system, in which one coordinate is the angle and the other the velocity (see Figure 6.6), this coordinate system will span a two-dimensional space in which certain points correspond to the possible states of motion of the pendulum. Let us see where these points are. At the extreme elongations the velocity is zero. This gives us two points on the horizontal axis. At the center, where the angle is zero, the velocity is at its maximum, either positive (swinging one way) or negative (swinging the other way). This gives us two points on the vertical axis. Those four points in phase space, which we have marked in Figure 6.8, represent the extreme states of the pendulum – maximum elongation and maximum velocity. The exact location of these points will depend on our units of measurement.

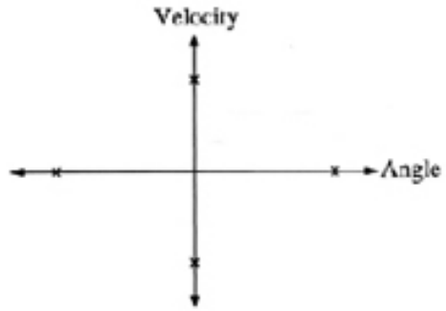


Figure 6.6 The two-dimensional phase space of a pendulum.

If we were to go on and mark the points corresponding to the states of motion between the four extremes, we would find that they lie on a closed loop. We could make it a circle by choosing our units of measurement appropriately, but in general it will be some kind of an ellipse (as shown in Figure 6.7). This loop is called the pendulum's trajectory in phase space. It completely describes the system's motion. All the variables of the system (two in our simple case) are represented by a single point, which will always be somewhere on this loop. As the pendulum swings back and forth, the point in phase space will go around the loop. At any moment, we can measure the two coordinates of the point in phase space, and we will know the exact state – angle and velocity – of the system. Note that this loop is not in any sense a trajectory of the ball on the pendulum. It is a curve in an abstract mathematical space, composed of the system's two variables.

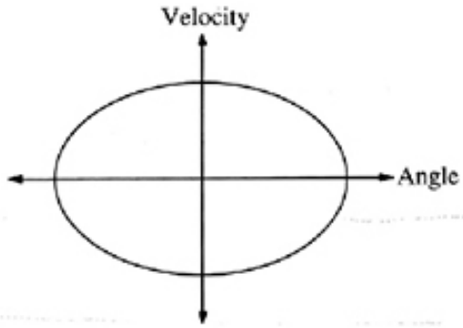


Figure 6.7 Trajectory of the pendulum in phase space.

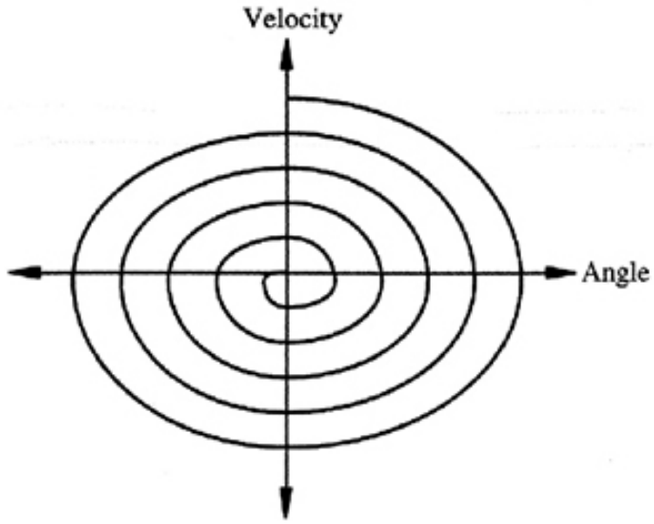


Figure 6.8 Phase space trajectory of a pendulum with friction.

So this is the phase-space technique. The variables of the system are pictured in an abstract space, in which a single point describes the entire system. As the system changes, the point traces out a trajectory in phase space – a closed loop in our example. When the system is not a simple pendulum but much more complicated, it will have many more variables, but the technique is still the same. Each variable is represented by a coordinate in a different dimension in phase space. If there are 16 variables, we will have a 16-dimensional space. A single point in that space will describe the state of the entire system completely, because this single point has 16 coordinates, each corresponding to one of the system's 16 variables.

Of course, we cannot visualize a phase space with 16 dimensions; this is why it is called an abstract mathematical space. Mathematicians do not seem to have any problems with such abstractions. They are just as comfortable in spaces that cannot be visualized. At any rate, as the system changes, the point representing its state in phase space will move around in that space, tracing out a trajectory. Different initial states of the system correspond to different starting points in phase space and will, in general, give rise to different trajectories.

Now let us return to our pendulum and notice that it was an idealized pendulum without friction, swinging back and forth in perpetual motion. This is a typical example of classical physics, where friction is generally neglected. A real pendulum will always have some friction that will slow it down so that, eventually, it will come to a halt. In the two-dimensional phase space, this motion is represented by a curve spiraling inward toward the center, as shown in Figure 6.8.

The shape of a system's trajectory in phase space is known as an "attractor." A closed-loop trajectory, such as the one representing the frictionless pendulum, is called a "periodic attractor," whereas a trajectory spiraling inward is called a "point attractor." The reason for this choice of metaphor is that the attractor represents the system's long-term dynamics. A complex system, typically, will move differently in the beginning, depending on how it starts off, but then will settle down to a characteristic long-term behavior represented by its attractor. Metaphorically speaking, the trajectory is "attracted" to this pattern whatever its starting point may have been.

We emphasize the origin and correct definition of the term "attractor" because there seems to be a common misconception among nonscientists that an attractor is some entity distinct from the system, which attracts the system to a certain portion of phase space. This is incorrect. In complexity theory, an attractor is a mathematical representation of a dynamic (the system's long-term behavior) that is intrinsic to the system.

nonlinear equations, solve them numerically, and have computers trace out the solutions as trajectories in phase space. To their great surprise, these researchers discovered that there are a very limited number of different attractors. Their shapes can be classified topologically, and the general dynamic properties of a system can be deduced from the shape of its attractor.

There are three basic types of attractors: point attractors, corresponding to systems reaching a stable equilibrium; periodic attractors, corresponding to periodic oscillations; and so-called "strange attractors," corresponding to chaotic systems. A typical example of a system with a strange attractor is the "chaotic pendulum," studied first by the Japanese mathematician Yoshisuke Ueda in the late 1970s. It is a nonlinear electronic circuit with an external drive, which is relatively simple but produces extraordinarily complex behavior. Each swing of this chaotic oscillator is unique. The system never repeats itself, so that each cycle covers a new region of phase space.

However, in spite of the seemingly erratic motion, the points in phase space are not randomly distributed. Together they form a complex, highly organized pattern – a strange attractor, which now bears Ueda's name.

The Ueda attractor is a trajectory in a two-dimensional phase space that generates patterns that almost repeat themselves, but not quite. This is a typical feature of all chaotic systems. The picture shown in Figure 6.9 contains over 100,000 points. It may be visualized as a cut through a piece of dough that has been repeatedly stretched out and folded back on

Figure 6.9 The Ueda attractor (from Capra, 1996).

itself. Thus we see that the mathematics underlying the Ueda attractor is that of the "baker transformation."

One striking fact about strange attractors is that they tend to be of very low dimensionality, even in a high-dimensional phase space. For example, a system may have 50 variables, but its motion may be restricted to a strange attractor of three dimensions, a folded surface in that 50-dimensional space. This, of course, represents a high degree of order.

It is evident that chaotic behavior, in the new scientific sense of the term, is very different from random, erratic motion. With the help of strange attractors a distinction can be made between mere randomness, or "noise," and chaos. Chaotic behavior is deterministic and patterned, and strange attractors allow us to transform the seemingly random data into distinct visible shapes.

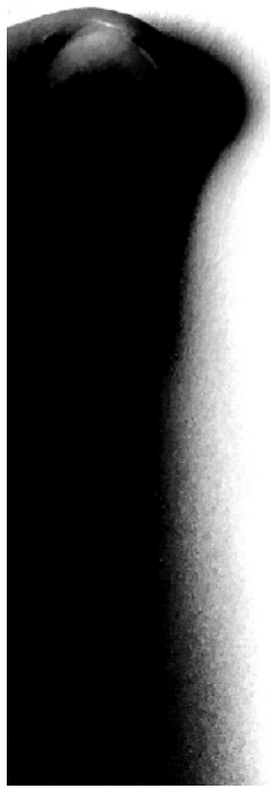
Time is more fundamental than space.
It is, indeed, the most pervasive
of all the categories
in other words
theres plenty of it.
And it stretches things themselves
until they blend into one,
so if youve seen one thing
youve seen them all.

I held the reins of his horse
while he went into the desert
to pee. *Yes*, he reflected
when he returned, that's less.

How long, he asked
have you been in this territory.

Years I said. Years.
Then you will know where we can have
a cold drink before sunset and then a bed
will be my desire
if you can find one for me
I have no wish to continue
my debate with men,
my mare lathers with tedium
her hooves are dry
Look they are covered with the alkali
of the enormous space
between here and formerly.
Need I repeat, we have come
without sleep from Nuevo Laredo.

might call an obsession
about the man —
don't tell me you're
still looking for him
I mean they say,
can't prove it by me,
this Hughes —
Howard? I asked
Hey Slinger you better shut
that boy up!
Cut it, my friend
I was just —
Drop it!
Anyway, they say
this Howard is kinda
peculiar about bein Seen
like anywhere anytime
sort of a special type
like a lotta texans I know
plumb strange the way
they operate.



You know,
I had to deal with a texan once
nearly drove one of my best girls Out,
insisted on her playing black jack
with his stud horse
who was pretty good
held the cards with his hooves
real articulate like and could add
fastern most humans
recall before I put a stop to it
we had special furniture
hauled in from Topeka.

inlaid around the string cut hole
pulsated as do
stars in the ring
of a clear night
Hi! Digger
the drifting guitarist greeted
the Bombed Horse
who was in his saddle bags
rummaging
Heidigger? I asked
the Xtian statistician
is that who you are?
Are you trying
to "describe" me, boy?
No, no, I hastened to add.
And by the way boy
if there's any addin
to do around here
I'll do it, that's my stick
comprende?
Where's my dark ace?

Into the cord of that question
a stranger turned his brilliantined head
pulled open his fabrikoid coat
and Said
What's your business
with Any dark ace!
The scene
became a bas-relief
as the length of the bar froze
arms and legs, belts and buckles caught
drink stilled in mid-air

Questioner, you got some strange
obsessions, you want to know
what something *means* after you've
seen it, after you've *been* there
or were you *out* during
That time? No.
And you want some *reason.*
How fast are you
by the way? No local offense
asking that is there?
No.

I like you mi nuevo amigo
for a mortal you're exceptional
How fast are you?
Oh, average fast I suppose
or maybe a little more
than average fast, I ventured.
Which means
you gotta draw.
Well, yes.
Umm, considered the Gunslinger
taking the telescope
from the Turned On Horse.

Please don't hold my shortcoming
against me oh Gunslinger
and may I enquire of you —
Enquire? he breathed
don't do *that*
Well then may I . . .
no I wouldn't do that Either

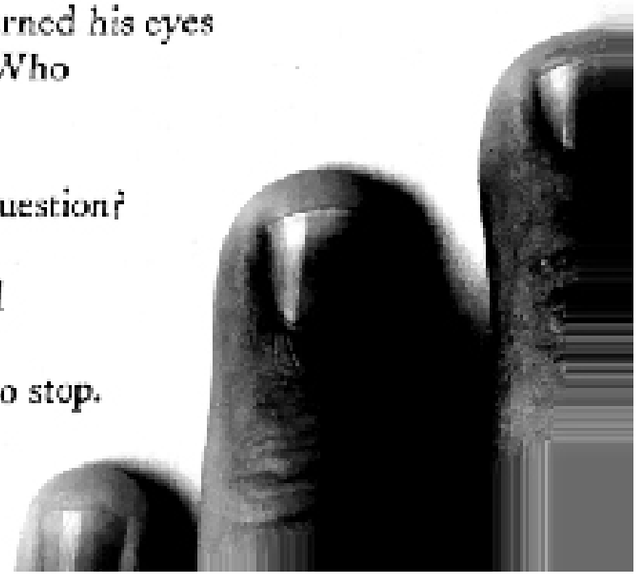
Aye singer. O absolutist.
You have sung a spelling account
of this Zone, yet
what a way to begin the morning!
Aye, Aye, you have lyricd
somewhat predestinarian
as all things of the imagination
must be. Thank you nomad,
for that rendering
of the Panorama.

The singer took away
the yellow rose
from his pleated blousecuff
and presented it
to the morning wind
then turned to adjust his astrolabe
and applied the oil of Atropine
to its working parts.
Andromeda turns and flashs
on the far shore, he observed.

The Slinger crossed his sheathèd legs
and pulling on his vest
fastened the mescal buttons
thereon and truly turned his eyes
into the landscape, Who
is this? he asked.

Is that an abstract question?

No, it seems material
but we'll know more
if the horses choose to stop.



12. The *Medusa* was part of a convoy of French ships en route to Senegal in July 1816. Due to the inexperience of the captain, the ship ran aground on ocean shoals many miles off the African coast. After two days a decision was made to abandon the ship; however, because of negligence, there were only a few serviceable lifeboats. To accommodate everyone, a raft was hastily assembled out of the ship's timbers and 150 passengers rode on it, towed by one of the lifeboats. When the crew in the lifeboat realized the raft was impeding their own progress to safety they cynically cut the cable, leaving the raft and its company to drift on the open sea. Thirteen days later, after storms, drunken and murderous

24. That the rescuing ship, the *Argus*, was actually named after a mythological creature with a hundred eyes has struck many as an extraordinary coincidence. Less often remembered is that the full mythological name was Argus Panoptes, accidentally evoking a range of forms through which the capacities of an individual (merely mortal) human observer were exceeded, including the pancrama and Panopticon. Savigny and Corréard report that "One, among others said, joking, 'If the brig is sent to look for us, let us pray to God that she may have the eyes of Argus,' alluding to the name of the vessel, which we presumed would be sent after us. This consolatory idea did not quit us, and we spoke of it frequently." Savigny and Corréard. *Narrative of a Voyage,* 132–133.

Music and the Mind: "It will never be possible to establish the origins of human music with any certainty; however, it seems probable that music developed from the prosodic exchanges between mother and infant which foster the bond between them." So sounds which we would describe as ambient, functional or mysteriously alien have laid the foundations of musical creativity.

But the day when Claude Debussy heard Javanese music performed at the Paris Exposition of 1889 seems particularly symbolic. From that point – in my view the beginning of the musical twentieth century – accelerating communications and cultural confrontations became a focal point of musical expression. An ethereal culture, absorbed in perfume, light, silence and ambient sound, developed in response to the intangibility of twentieth century communications. Sound was used to find meaning in changing circumstances, rather than imposed as a familiar model on a barely recognisable world. Inevitably, some of this music has remained in fragments; some has been moulded from fragments into mantras and other solid structures.

Much of the music I discuss could be characterised as drifting or simply existing in stasis rather than developing in any dramatic fashion. Structure emerges slowly, minimally or apparently not at all, encouraging states of reverie and receptivity in the listener that suggest (on the good side of boredom) a very positive rootlessness. At the same time, a search for meaningful rituals recurs again and again, surely a response to the contemporary sense that life can drift towards death without direction or purpose. So this is a book about journeys, some actual, some imaginary, some caught in the ambiguity between the two. Although the narrative jumps, loses itself and digresses, my central image was signals transmitted across the aether. This applies as much to the Javanese musicians and Debussy in the colonial era of the nineteenth century as it applies to music in the digital age at the turn of the millennium. This past hundred years of expansiveness in

dialogue he'd written. Nothing at all like something she would say and yet how could she know what word or words were still to be spoken. The character had fainting spells. The character sometimes sat all night in doorways. The character's underwear stank. Successive reflections. Halfway through *Eminent Stammerers*, Jean had imagined herself as a Modern Library Giant. Sticking with her title even after she discovered that it was not quite as technically precise as *Eminent Stutterers* would have been, she filled a limited number of pages with a relaxed commentary (it wasn't the deepest of texts) on the neurosis of the speech tract; on the possibility that stuttering (interruption of word-flow) is, like glossolalia (extended word-flow), an example of learned behavior that calls for negative practice or unlearning; on the phenomenon of being alienated by one's own voice; on word-fear as a threat to sanity. She wondered, now, crawling for her blank sheet, how she'd ever expected to complete the multitude of pages necessary to qualify one's book for candidacy as a Modern Library Giant. Surely to those who suffered from it (Aristotle, Aesop, Darwin, Dodgson, Moses, Virgil, among those eminent enough to be mentioned in the text), stammering to some extent represented the "curse" of verbal communication, the anfractuous blacktop route from the pure noise of infancy. It was also a "recording" of one's mental processes, a spontaneous tape of that secret pandemonium to which childhood is often prone. Imagine, nonstammerer, the terror of this simplest question: "What is your name, little girl?"

What she'd completed thus far, since abandoning the idea of a nonfiction book on Logicon, amounted to no more than a thin scattering of pages. Some of these pages even had words on them. A few, yes, a very few had words scribbled and typed here and there, starting from the top. The others, which she considered no less a part of the thin scattering of first-draft material, were lacking in formal content, although clearly numbered and therefore distinguishable from each other. The very page she was on the floor searching for happened to be numbered but otherwise blank and yet distinguishable from the other pages not only by number but in the nature and quality of the words she had not yet set down on this page. To overcome one's tonic block; to master

the reporters' task – looking for a needle in a haystack, armed only with mundane materials like pencils, library cards, and public records, as they try to expose some of the country's most powerful men[2] – it is given a more speculative reading by Fredric Jameson, for whom it embodies at once a social metaphysics and a political aesthetic:

> The mounting camera shot, which diminishes the fevered researches of the two investigators as it rises to disclose the frozen cosmology of the reading room's circular balconies, confirms the momentary coincidence between knowledge as such and the architectural order of the astronomical totality itself, and yields a brief glimpse of the providential, as what organizes history but is unrepresentable within it.[3]

Jameson compares the shot to a series of views from the French New Wave director Alain Resnais's short essay-film, *Toute la Mémoire du Monde* (1956). That film – an exploration of France's Bibliothèque Nationale which doubles as a general meditation on human memory and knowledge – ends with an overhead shot of the Parisian library's reading room, the narrator telling us that the activities of the readers, each focused on his own small segment of knowledge, 'each working on his slice of universal memory, will have laid the fragments of a single secret end to end, perhaps a secret bearing the beautiful name of "happiness".' Jameson remarks that 'happiness' may not be the best term for this secret, as for us in the present, 'the ultimate referent, the true ground of being in our time', is capital.[4]

Overviews such as these dramatise, in the most general way, the processes of inquiry and sight involved in the endeavour to understand the world, and the magnitude of the ambition behind such an all-encompassing will-to-know. They also introduce us to tensions in how we approach the cognisability of nature and society, cosmos and capital. In the thirty-five years

Since the Eames made their film, increasingly sophisticated technologies have allowed cartographers to map the world, astronomers to map the universe, molecular biologists to map genomes, and atomic physicists to map the building blocks of the universe with every greater precision (the smallest measurement, planck length, being 10^{-35} and the size of the known universe being 46 billion light years in any direction, or about 10^{27} metres). In the time since the works by Pakula and Resnais, and especially with the recent shift into the age of 'Big Data', the vastness of these national collections has grown apace (the Library of Congress adds about 10,000 items to its collection per day).[5] Yet, to echo our epigram from Brecht, what do these filmic sequences – depicting knowledge as an overview, a vertical scaling-up and scaling-down, a modern *scientia dei*, or God's eye-view – tell us about the intelligibility of political economy and social conflict? If Jameson is correct, if the study of 'capital itself' is 'now our true ontology', then how can we shift from the way we imagine the absolute mapping of the universe and our knowledge of it to a cartography of capital as world-system?[6] If the image of world-knowledge as seamless continuum, so compellingly choreographed by the Eames, is hard to square with the complex and contested nature of scientific representations, an understanding of our social world that takes its cue from the related technologies of GPS and Google maps, while of unimpeachable military and commercial expediency, will prove a remarkably unreliable guide. The map will hinder the mapping, as we come to be captivated by fetishes of scale and precision that smooth over the world's contradictions; views which, to paraphrase Hito Steyerl, allow the vertical zoom to distract us from – or to punitively distort – a condition of 'free fall', in which neither our aesthetic devices nor our political strategies can comfort themselves with a 'single unified horizon'. As she observes:

> The view from above is a perfect metonymy for a more

employs it, in the singular, with reference to what he calls 'the aesthetic of cognitive mapping'. In a combative conference presentation in the mid-eighties, in the midst of Reaganite neo-liberalism and at a low-point of Left energies in the North (and not only), Jameson called for the emergence of such an aesthetic – a call intertwined with the broader effort to counter a widespread repudiation of the Marxist dialectic as a compass for cultural critique. The phrasing is important here: he didn't announce its existence, detecting its presence in a corpus of works, but stressed instead the political need for its elaboration in both theory and practice.

Such an aesthetic called for the imperative elaboration of a cultural and representational practice adequate to the highly ambitious (and, Jameson suggests, ultimately impossible) task of depicting social space and class relations in our epoch of late capitalism or postmodernity. Behind this call lay the claim – splicing the original formulation of 'cognitive mapping' by the urban planner Kevin Lynch with Althusser's definition of ideology as the subject's imaginary representation of their relation to the Real – that an inability to cognitively map the gears and contours of the world system is as debilitating for political action as being unable mentally to map a city would prove for a city dweller.[11] The absence of a practice of orientation that would be able to connect the abstractions of capital to the sense-data of everyday perception is identified as an impediment to any socialist project.[12]

Works emerging under the banner of this aesthetic would enable individuals and collectivities to render their place in a capitalist world-system intelligible: to enable a situational representation on the part of the individual subject to that vaster and properly unrepresentable totality which is the ensemble of society's structures as a whole'.[13] While such artworks and narratives would not be merely didactic or pedagogical, they would of necessity *also* be didactic or pedagogical, recasting what political

It is in Jameson's attempt to tackle the imperial genealogy of cognitive mapping that we perhaps get the clearest sense of how representation, visibility and the aesthetic are articulated. The predicament of imperial modernism, so to speak, underscores how '*representational* effects' are also 'objective effects'; the spatial disjunction, and its ideological expression, is constitutive of the political economy of imperialism. It is in the *aesthetic* realm – whether in the formal innovations of 'high' art or in the containment of otherness performed by the racial imaginaries of popular art (e.g. adventure stories) – that we can register 'the most obvious consequences' of problems of representation that transcend literature and the arts. It is there that 'the mapping of the new imperial world system becomes impossible, since the colonized other who is its essential other component or opposite number has become invisible'.[18] In other words, a kind of political and economic invisibility undergirds a representational order which is in its turn both registered and transfigured at the aesthetic level. Conversely, we could argue, to *propose* an aesthetic of cognitive mapping under conditions of late capitalism could be taken as an attempt to force into being a certain kind of political visibility and thus to counter the objective, material effects of a dominant regime of representation.

Needless to say, cultural producers, for the most part, do not literally attempt to generate maps of the new interconnected global reality, or even to address it frontally. Rather, it is the task of the critic to tease out the symptoms of, at one and the same time, the consolidation of a planetary nexus of capitalist power and the multifarious struggles to imagine it – we could even say that such symptomatic reading, and dialectical criticism with it, gain in salience precisely with the actualisation of that 'world market' which is both capitalism's goal and its presupposition. Jameson points to the way in which, with the consolidation of the age of empire, various writers independently forged what he terms 'monadic relativism'. In Gide, Conrad, Pessoa, Henry

cognition and cartography truly comes into its own.

Jameson argues that in the West, the consequence of the radical separation between the public and the private, 'between the poetic and the political', is 'the deep cultural conviction that the lived experience of our private existences is somehow incommensurable with the abstractions of economic science and political dynamics'.[29] Modernism's abstraction – manifest in its conceptions of space, time and agency, as well as in the formal inventions that it created to respond to or intensify the rifts in subjectivity – has to be understood in terms of its 'absent cause': the realisation, at the level of the 'political unconscious', that the causes of 'our' social life are elsewhere, in the processes of extraction, dispossession and subjugation that constitute imperialism and colonialism. The novels of Virginia Woolf, for example, are not *about* imperialism, but imperialism inhabits them, namely by shaping their form – like a strange attractor whose existence can only be registered in the deformations it elicits.[30] Considering this imperial genesis of cognitive mapping complicates its identification with the phenomena of postmodernity, expanding its geographical and temporal range, and revealing it as a complex product of an imperialist capitalist world-system spanning the late nineteenth, twentieth and twenty-first centuries.

The hypothesis that the forms of aesthetic experience are mediated by the geographies and rhythms of historical capitalism, and that we cannot understand the mutations of narrative without thinking through the disjunction between experience and abstraction, everyday life and the forces of capital in a fundamentally unequal world, lie behind a text by Jameson, written in the wake of his 'Cognitive Mapping' essay, which was the target of intense criticism from Aijaz Ahmad and a series of postcolonial critics: 'Third-World Literature in the Era of Multinational Capital'. We won't enter into the debate (qualified defenses of Jameson have been provided by Neil Lazarus, Neil Larsen and Mashava Prasad, among others[31]) but what's inter-

Penguin, 1976), p. 92.

71. Slavoj Žižek, *In Defense of Lost Causes* (London: Verso, 2008), p. 454.

72. Both soliloquies can also be found on YouTube. Here are their texts, a much impoverished substitute. Ned Beatty as Arthur Jensen (script by Paddy Chayefsky): 'You have meddled with the primal forces of nature, Mr. Beale, and I won't have it! Is that clear? You think you've merely stopped a business deal. That is not the case! The Arabs have taken billions of dollars out of this country, and now they must put it back! It is ebb and flow, tidal gravity! It is ecological balance! You are an old man who thinks in terms of nations and peoples. There are no nations. There are no peoples. There are no Russians. There are no Arabs. There are no third worlds. There is no West. There is only one holistic system of systems, one vast and immane, interwoven, interacting, multivariate, multinational dominion of dollars. Petro-dollars, electro-dollars, multi-dollars, reichmarks, rins, roubles, pounds, and shekels. It is the international system of currency which determines the totality of life on this planet. That is the natural order of things today. That is the atomic and subatomic and galactic structure of things today! And YOU have meddled with the primal forces of nature, and YOU... WILL... ATONE! Am I getting through to you, Mr. Beale? You get up on your little twenty-one inch screen and howl about America and democracy. There is no America. There is no democracy. There is only IBM, and ITT, and AT&T, and DuPont, Dow, Union Carbide, and Exxon. Those are the nations of the world today. What do you think the Russians talk about in their councils of state, Karl Marx? They get out their linear programming charts, statistical decision theories, minimax solutions, and compute the price-cost probabilities of their transactions and investments, just like we do. We no longer live in a world of

nations and ideologies, Mr. Beale. The world is a college of corporations, inexorably determined by the immutable bylaws of business. The world is a business, Mr. Beale. It has been since man crawled out of the slime. And our children will live, Mr. Beale, to see that... perfect world... in which there's no war or famine, oppression or brutality. One vast and ecumenical holding company, for whom all men will work to serve a common profit, in which all men will hold a share of stock. All necessities provided, all anxieties tranquilized, all boredom amused. And I have chosen you, Mr. Beale, to preach this evangel.' Hume Cronyn as Maxwell Emery (script by David Shaber): 'When the Arabs learn of word of what they've been doing is out they may panic... move a big chunk of funds too fast or the wrong way...really destabilize the monetary markets. Then the dollar will collapse. Whereupon there will be a lot of jaw boning by the President, and that won't work. Then they'll go to selling gold, and that won't work either. Then they'll have to go to capital controls, freeze foreign assets, stop any money from going in or out, and that will be the end of all the markets. That'll really be the finish. Then you'll see a worldwide depression that'll make the 1930's look like a kindergarten. In two months you'll have bread lines in Detroit, riots in Pittsburgh. In six months you'll see grass right over Rodeo Drive, and Michigan Avenue and 5th Avenue. And I won't have done it, Hub, you will. All because you tried to stop a movement that couldn't be stopped anyway. Listen to me, Hub. Money, capital, has a life of its own. It's a force of nature. Like gravity. Like the oceans. It flows where it wants to flow. This whole thing with the Arabs and gold is inevitable. We're just going with the tide. The only question is whether you want to let it go like an unguided missile and raise hell, or whether you want to keep it in the hands of responsible people. Keep it

question of accuracy or resemblance, in which aesthetic form would be a mere instrument for knowledge, but constitutes a kind of force-field in which our conceptions of both modes of production and aesthetic regimes are put to the test.

While, as this introduction amply testifies, we have been influenced by the manner in which Jameson has insistently posed the problem of representing capital, what follows is not an application of the aesthetics of cognitive mapping to the recent past. First, while much of our focus is on the contemporary, we also reflect on many works that appeared long before Jameson called for the emergence of this aesthetic – for example, linking the construction of a 'complex seeing' in the contemporary visual arts to the dialectical montages of the 1920s.[40] Secondly, Jameson's theory of cognitive mapping is, in Colin MacCabe's words, one of the 'least articulated' of Jameson's categories.[41] Beyond the call for the emergence of the aesthetic and a few mentions sprinkled throughout his books, it is never presented as such as a coherent aesthetic, technique or theory. Its ephemeral status is of course also an index of its ubiquity, and a goad to its systematisation.

Cognitive mapping is not just a synonym for class consciousness, it is also intimately linked to the idea of dialectical criticism, the problem of Marxism and form, the Sartrean idea of totalisation. Though many of these themes from the Western Marxist critical canon will resonate in what follows, we are not seeking to systematise the unsystematisable. Jameson's formulation can still function as a cue for thinking about the present precisely because it does not provide a method, or advance a concept; rather, it poses a *problem* which is at once political, economic, aesthetic and existential. This problematic understanding of cognitive mapping also requires that, following Neil Smith's pointed criticisms of the convergent turns to space and culture in the 1980s, we remain sensitive to the how spatial metaphors can serve as a 'powerful mask', and work to 'fill in the conceptual abyss between metaphorical and material space'.[42]

One of the reasons we have latched on to the phrase 'cartographies of the absolute' is because of how it encapsulates the problem of visualising or narrating capitalism today. As the science or craft of map-making, cartography connotes a technical endeavour, judged by its accuracy. And so we experience it in our everyday, especially through the saturation of our lifeworld by the imperative of navigation (or, more sinisterly, of *targeting*). The 'absolute' is a theological and then a philosophical category, gesturing towards that which defies representation, which, contrasted to our mortal perception, is infinite and unencompassed. 'Cartographies of the absolute' is a wilfully paradoxical expression, but one that directs us towards the way in which picturing our social and economic world is a predicament at once technical and, so to speak, philosophical. Capitalism, after all, is a religion of everyday life, an actually-existing metaphysics.

Cartography is one of the privileged forms taken by contemporary critical art. In a manner that both mirrors and inflects a broader cultural and visual predicament, saturated with SatNavs, GoogleMaps and GIS, critical representations of society increasingly appear as mediated, both literally or metaphorically, by maps. In the fine arts, the past few years have seen significant collective exhibitions like *Uneven Geographies: Art and Globalisation*, curated by T.J. Demos and Alex Farquharson at Nottingham Contemporary and *Whose Map Is It?* at INIVA in London, not to mention individual works at countless shows and biennials.[43] Indicative surveys and advocacies of a cartographic political aesthetics include titles like *The Map As Art, An Atlas of Radical Cartography, Else/Where Mapping: New Cartographies of Networks and Territories* and many more. The 'cartographic' turn in the arts responds with a genuine and at times militant curiosity to the mutations being wrought by global capitalism and the oppositional counter-moves that sometimes meet it. The most interesting artists and groups producing work in this register demonstrate a capacity to address the question of cartog-

tation of a total and unverifiable Power. Indeed, Lombardi has been criticised by other practitioners of art as political research (or political research as art) for producing indisputably beautiful images whose cognitive consistency is nevertheless as tenuous as the pencil-drawn lines between the named 'nodes' of collusion.[100]

As the painter Greg Stone claims, reflecting on Lombardi's drawings, 'We didn't know what we were looking at when we read about it (the political and economic scandals, etc.) – it had to be articulated visually'.[101] An enormous amount of research went into the drawings, yet their pedagogic capabilities – narrowly conceived in terms of their ability to inform the viewer about a given scandal – are severely limited. As Robert Hobbs notes, 'Instead of simply solving crimes, Lombardi's work often intensifies their mystery'.[102] Lombardi's rhizomes eschew any hierarchy of responsibility, and instead depict networks of sometimes only loose association, never coming together in a simple solution, some kind of cognitive or political epiphany. His 'structures' are painstakingly neat, their immediate visual effect is one of ordered complexity; but cognitively, and politically, they are nothing if not messy: 'his brilliantly detailed drawings actually make things harder to understand, not easier. Looking at the endless miasma of names, institutions and locations, his charts are more about obfuscation than revelation ... Lombardi's drawings are like a pointillist work, best viewed from afar. From a distance you can see that a system has been revealed, but the closer you get to it the more invisible it becomes.'[103] If studiously explored, they could at best orient and punctuate an investigation, driving the researcher back to the archives to discover the precise texture of the links and transactions between different actors – whose types are minimally indicated by Lombardi with simple, broken or crenellated lines.

Pausing in front of these vast sheets, whether for seconds or hours, but unable herself to plunge into the thickets of research into the 'deep state', it is difficult to imagine what the uninitiated

visitor to a museum or gallery might 'learn' from Lombardi's work. Even if endowed with a decent knowledge of the BCCI scandal or the networks in which Roberto Calvi or George Bush (I and II) operated, it would take a considerable investment of intellectual labour to make any 'sense' of the drawings, to specify their structure and project a coherent narrative onto them. No doubt, this was something that Lombardi was aware of when elaborating his practice. In that respect, the drawings are intentionally opaque. In later works, for instance, the viewer isn't even provided with a legend to explain the difference between a solid line, a dotted line, and the squiggles that intervene in some of the lines of connection. Lombardi's obsessive passion for inquiry is writ large, but it is also evident that he judged that the results of this research could not be presented with the kind of direct communicational economy endorsed by Tufte. Thus, as much as Lombardi's work is about the actual conspiracies revealed by his drawings, it is also about the very gap – the perhaps unbridgeable gap – between lay viewers and the activities of, and collusion between, the 'overworld' and the 'underworld'.[104]

Among Lombardi's papers are two unpublished manuscripts, one on the 'parapolitical' links between the US government and the drug trade, entitled *On Higher Grounds*; the other a history of the panorama as art form.[105] Lombardi, who had worked in minimalist and conceptual registers, began to produce his drawings as research aids for personal investigations into covert dimensions of US state power. The diagrams – which tellingly shifted from a timeline approach to spherical configurations – eventually attained autonomy, becoming a distant contemporary equivalent of the kind of enclosed and encompassing history paintings that were a privileged genre for many of the panoramas studied in Lombardi's other, art-historical manuscript. Lombardi's narrative structures thus reiterated that fertile tension between totalisation and fragmentation, clarity and opacity, overview and oversight, which, following Crary, we

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Distance

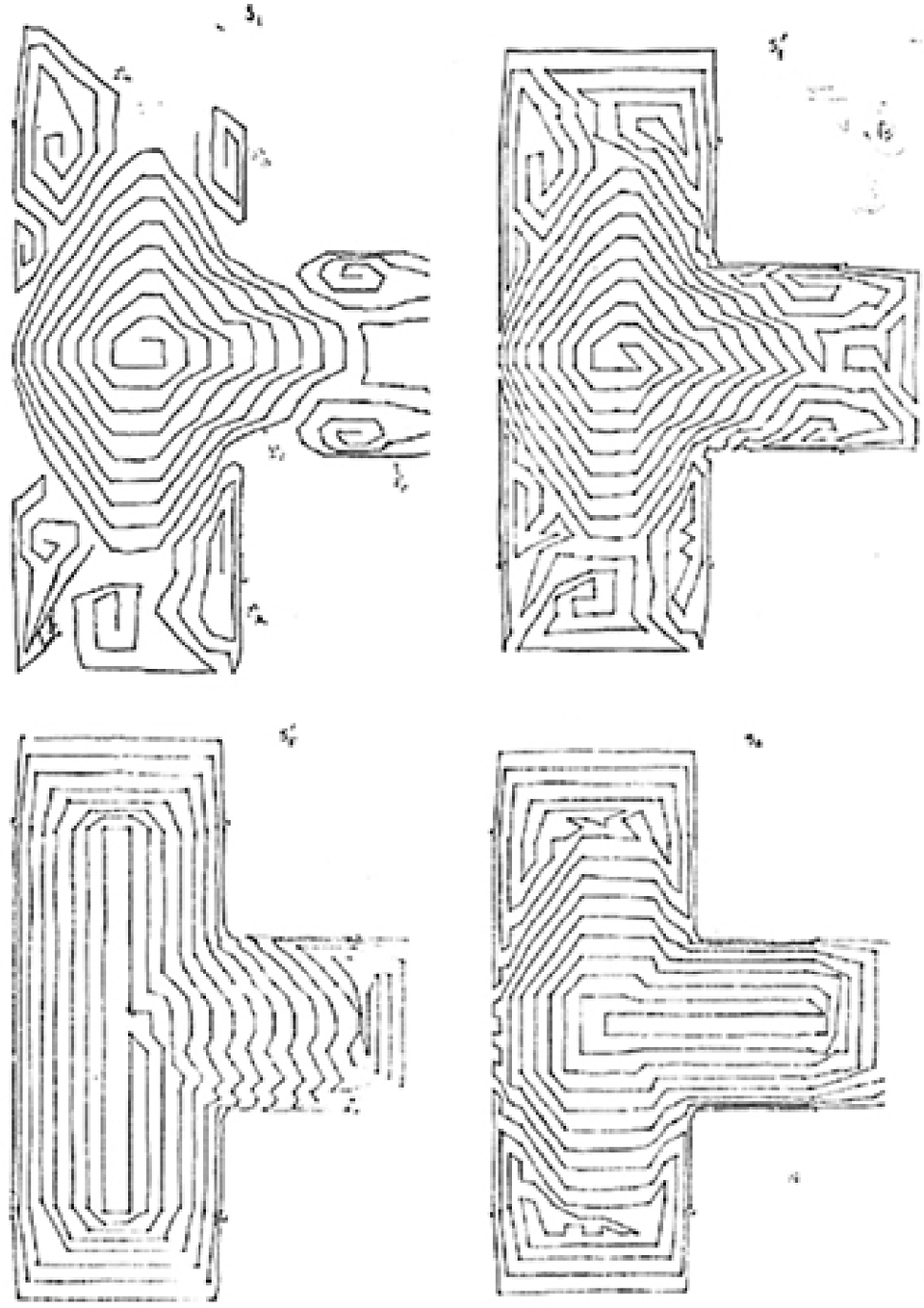
BECAUSE the distance between the grids was so great, there was less in the way of comfort. The middle distance had been a comfort. But the middle distance had fallen away. The grid of national life was very large now, but the space in which one man felt at home shrank. It shrank to intimacy.

Intimacy

IT followed that people were comfortable only with the language of intimacy. Whatever business was done had to be done in that language. The language of "You are not alone." How else would a person know? The language of intimacy spread. It was meant to be reassuring. But during the same period, in a most upsetting way, real intimacy came to seem to be a kind of affliction.

Pseudo-Intimacy

THINGS very distant came powerfully close, but just for a minute. It was a comfort. And useful to men who wished to enforce childish agreements, because the progress of the *advertisement* is toward the destruction of distance between the product and the person who might consume the product.



PL. 62
Study for Polytope de Cluny (light trajectory diagram), c. 1972

Wonder

WONDER was the grace of the country. Any action could be justified by that: the wonder it was rooted in. Period followed period, and finally the wonder was *that things could be built so big.* Bridges, skyscrapers, *fortunes*, all having a life first in the marketplace, still drew on the force of wonder. But then a moment's quiet. What was it now that was built so big? Only the marketplace itself. Could there be wonder in that? The size of the con?

History

THAT movement, from wonder to the wonder that a country should be so big, to the wonder that a building could be so big, to the last, small wonder, that a marketplace could be so big — that was the movement of history. Then there was a change. The direction of the movement paused, sat silent for a moment, and reversed. From that moment, vastness was the start, not the finish. The movement now began with the fact of two hundred million, and the movement was toward a unit of one, alone. Groups of more than one were now united not by a common history but by common characteristics. History became the history of demographics, the history of no-history.

History

HISTORY had been the record of growth, conflict, and destruction.

works, but since no adult is supported by the voice of the culture (which is now a childish voice), it does not work well.

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Experts

IN the absence of adults, people came to put their trust in *experts*.

Experts

ONLY an *expert* can deal with a problem. Only an expert or a pleasant man on television with access to experts. Only an expert or a man on television who knows how to welcome an expert or a problem or love for a problem. An expert or a man on television or — in certain cases, an expert trained in the modes of action — a *matron*. In the age of no-authority, these are the authorities.

Important Programming

IMPORTANT programming is programming that recognizes the problem.

Important Programming

IF it is just a problem — teen-age alcoholics who need to talk to Matron — then it is a little boring after a while, because it is only one-half of the problem. Then

set of resistances to the remaking of labor time on which capitalism depended fundamentally from the start. The "natural conditions" of agrarian life prevented the necessary control over the time of production; hence the need for an unprecedented "residence," unencumbered by the long weight of customs and rhythms that reached far back into prehistory. The first requirement of capitalism, he wrote, was the dissolution of the relation to the earth. The modern factory thus emerged as an autonomous space in which the organization of labor could be disconnected from family, community, environment, or any traditional interdependencies or associations. Agriculture, as Marx presciently observed, would only be able to be industrialized retroactively.

Arkwright's Cotton Mills conveys the physical proximity of these two spheres, one natural, one invented, and also a sense of their incommensurability and fatal incompatibility. Only after capitalism had established its abstract order everywhere else—in fact, only after the destruction of World War II—could it fully impose itself on agriculture, with a factory-farming model applied to both animals and crops. More recently, corporations such as Monsanto and Dupont have achieved the final overcoming of Marx's "natural conditions" with genetically modified and patented agricultural materials. But this relatively early image of an irreconcilable adjacency nonetheless counters the notion of an "industrial revolution" that devastated the countryside and quickly herded rural laborers into cities and factories. Instead there was a protracted and piecemeal deterioration of older forms and spaces.

achievement of faster speeds for the shipment of goods or the attainment of near-instantaneous communications. Rather, if circulation was an essential process of capital, it was because of "the *constant continuity* of the process." In effect, Marx is positing 24/7 temporalities as fundamental to the workings of capital; he understood that these durational processes were also metamorphic. Within this "constant continuity" occurs "the unobstructed and fluid transition of value from one form into the other." That is, value was in a state of unending transformation, appearing "at one time as money, at another time as commodity, then again as exchange value, then again as use value." These networks operated on principles that would remain in force through numerous technological materializations, up to the present. They were not simply neutral high-speed conduits; rather, they were alchemical instruments for generating the abstractions integral to capitalism, which was necessarily destined to be global. Not just manufactured goods but languages, images, forms of social exchange were all to be remade to ensure their compatibility with these systems. It was hardly to be a one-time transmutation, for with each successive upgrading and expansion of these networks, new forms of fluidity and convertibility emerged.

But for the next century and a half (roughly from the 1850s to the 1990s) the metamorphoses and accelerations of an always globalizing capitalism only slowly and partially impose themselves on social and individual life. Modernity, contrary to its popular connotations, is not the world in a sweepingly transformed state. Rather, as some critics have shown, it is the

hybrid and dissonant experience of living intermittently within modernized spaces and speeds, and yet simultaneously inhabiting the remnants of pre-capitalist life-worlds, whether social or natural. Wright of Derby's image is an early revelation of modernity's concurrence and contiguity of ultimately incompatible systems. Factory manufacturing, for example, did not abruptly extinguish the long-standing diurnal rhythms and social ties of agrarian milieus. Instead there was an extended period of coexistence during which rural life was incrementally dismantled or subsumed into new processes. There are endless instances of the durability, even if broken and impaired, of older forms, values, techniques, and hierarchies within capitalist modernization. Fredric Jameson suggests that, even by the early twentieth century, "only a minute percentage of the social and physical space of the West could be considered either fully modern in technology or production or substantially bourgeois in its class culture. These twin developments were not completed in most European countries until the end of World War II."[4]

While one might debate the pervasiveness of modernization at various points in time, Jameson's periodization reminds us that the nineteenth century and a good part of the twentieth were effectively a patchwork of disjunct spaces and times, some rationalized and shaped by new institutional and market-based requirements, while in many others premodern patterns and assumptions obdurately survived. Especially significant is the provisional designation of 1945 to indicate a historical turning point. On the mundane level of historical specificity this means

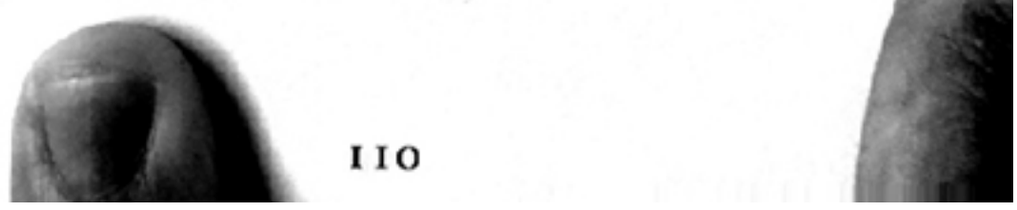
before the world fully recomposes itself into its unthought and unseen familiarity. It is an instant of disorientation when one's immediate surroundings—for example, a room and its contents—seem both vague and oppressive in their time-worn materiality, their heaviness, their vulnerability to dilapidation, but also their inflexible resistance to being clicked away in an instant. One has a fleeting intuition of the disparity between one's sense of limitless electronic connectedness and the enduring constraints of embodiment and physical finitude. But such dislocating moments were generally restricted to the physical sites in which non-portable apparatuses were available. With increasingly prosthetic devices, these kinds of transitions occur anywhere, in every conceivable public or private milieu. Experience now consists of sudden and frequent shifts from absorption in a cocoon of control and personalization into the contingency of a shared world intrinsically resistant to control. The experience of these shifts inevitably enhances one's attraction to the former, and magnifies the mirage of one's own privileged exemption from the apparent shoddiness and insufficiency of a world in common. Within 24/7 capitalism, a sociality outside of individual self-interest becomes inexorably depleted, and the interhuman basis of public space is made irrelevant to one's fantasmatic digital insularity.

According to the digital way of thinking, anything could be transformed into anything else and no one need worry about being cheated because this alchemy relied not on cunning sophistry, economic sleight of hand, or cultural bad faith, but on the bland, automated, everyday magic of numbers. The hope was that everything would be reduced to a common currency, i.e., binary code, which would allow effortless transmission with no value lost on conversion. The dream of the cloud was complete meltdown, such that everything became liquid to be pumped here, injected there, siphoned from me, and redirected to you. The aim of such a frictionless state was that anything, not only virtual but physical, might eventually be exchanged for absolutely anything else. Only not by you! The moment you snapped a photo, some force beyond you would transmogrify it into numbers, money, power; it might become a song, or a law, or a healthcare plan, or a disease vector, or a drone strike. The act of creating a thing therefore took on new stakes: producing a TV ad was no longer a matter of executing a short film—it concerned the minting of style, and attitude, it meant cultivating a pirate mycelium capable of migrating across platforms: visual

media, social media, and any media that might succeed them. In the material world the constant was entropy; here, the constant was metamorphosis. The message was similar regardless of whether you were talking about advertising or finance or art or digital networks: values rise and fall; you can't count on fixity; all shall be fungible, morphable, and easily synthesized and ported and versioned and pirated; the lowest shall be highest and the highest, lowest, and you'll be a pauper if you can't surf this, play it, game it. *Everything can be recuperated!* It sounded like a Christian idea but was probably the opposite, whatever that was.

Once again, what did it all mean? This was not only the big question—it always had been—it had metastasized into a kind of meta-question: what does that even mean, to ask what it means? The so-called digital age was, first and foremost, a tremendous challenge to the idea of *meaning* as a category. It was not yet clear if this category had been emptied out or filled up or magicked into something new, but there was tremendous anxiety about the shift.

He had developed a slightly off-the-wall theory about this shift to digital. Sometimes people talked about the shift in economic terms, where an



A phase space is the set of all the possible states of a system. Objects in phase space are intriguing and strange. If, for example, you plot the sum of weather events in phase space, you discover an attractor, a shape that looks like a folded figure *8* (Figure 7). Edward Lorenz discovered the first strange attractor (the Lorenz Attractor) in precisely this way. A high enough dimensional being could see global warming itself as a static object. What horrifyingly complex tentacles would such an entity have, this high-dimensional object we call global warming?

As it is, I only see brief patches of this gigantic object as it intersects with my world. The brief patch I call a *hurricane* destroys the infrastructure of New Orleans. The brief patch I call *drought* burns the plains of

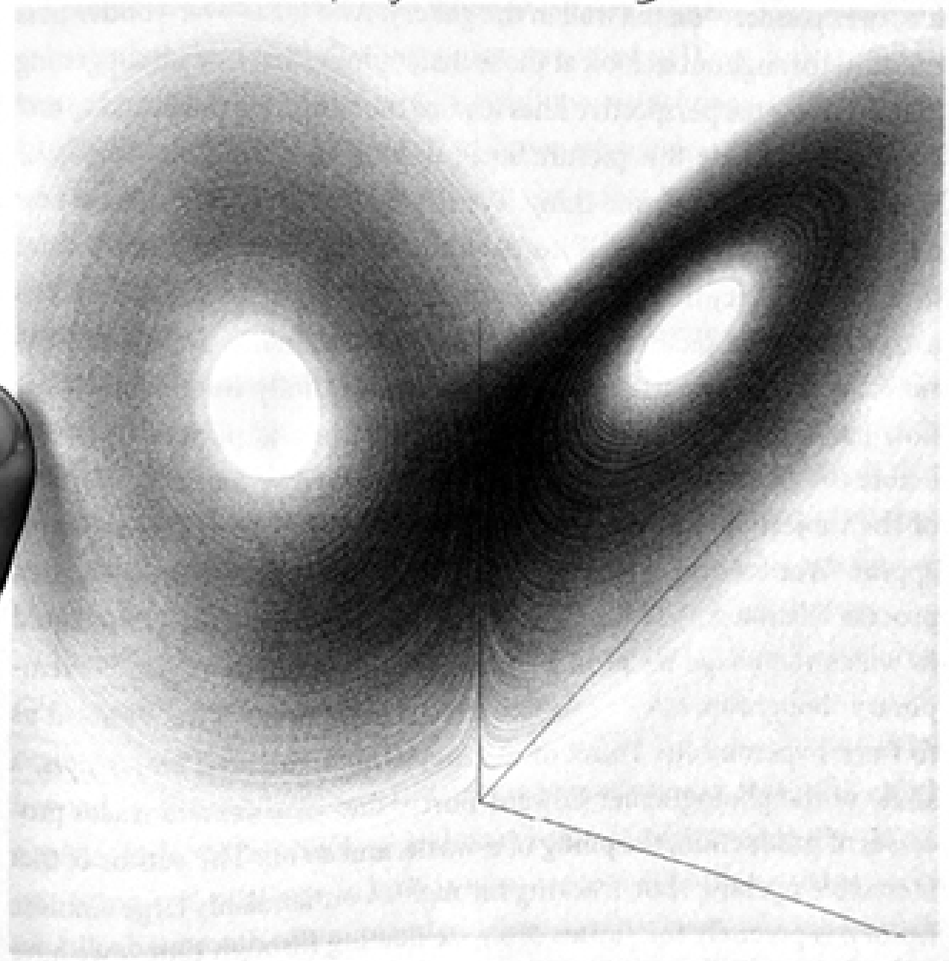


FIGURE 7. Lorenz Attractor. The first strange attractor was this pattern made by weather events plotted in a suitably high dimensional space.

when one wave cancels out part of another wave. For a beat to exist, there must be $1 + n$ waves that intersect. Phasing happens because one object translates another one. This is a feature of how objects affect one another in general, and we should explore this a little before accounting more fully for how hyperobjects are phased.

An MP3 sample compresses a sound wave in a "lossy" way by cutting some of it out. The preferred sampling rate for music recording is now 44,000 cycles per second, so there are 44,001 holes in between and on either side of one second of sound. (Now they know how many holes it takes to fill the Albert Hall.)[7] Likewise, a JPEG is a lossy, compressed sample of an image, and when you make a copy of a JPEG, the copy has [illegible]t than the original, so each JPEG copy becomes increas- [illegible] When a JPEG is made, optically sensitive electronics [illegible] bombarded with photons, some of which are translated [illegible]isible information in pixels on a screen. A series of tools executes a function, withdrawn into the background against the image that results. When we scrutinize the whole system, we find a bunch of gadgets that work on one another, transducing and otherwise altering inscription events such as photons or sound waves into electronic signals or electrochemical ones.

A hyperobject passes through a thousand sieves, emerging as translated information at the other end of the mesh. Thick raindrops tell me of the coming storm, which flashes lightning in an unusual way that is an index of global warming. Phasing is an *indexical sign* of an object that is massively distributed in a phase space that is higher dimensional than the equipment (our ears, the top of my head, a weather vane) used to detect it. An index is a sign that is directly a part of what it indicates. In the mesh of interconnectivity, the sieve through which hyperobjects pass, smaller things become indexes of the hyperobjects inside which they exist. A flock of birds stays on the lake for a curiously long period. Frogs huddle for warmth and moisture on a wet doorstep.

What we are dealing with, with the phenomenon of phasing, is an indexical sign that is a *metonymy* for the hyperobject. Metonymy is the mereological figure, the figure that deals with parts and wholes and relationships. What we encounter when we study hyperobjects is a strange

mereology in which parts do not disappear into wholes.[8] Quite the reverse. Indeed, what we seem to have is what in Lacanian terminology is called a *not-all* set. Objects seem to contain more than themselves. A flock of birds on a lake is a unique entity, yet it is also part of a series of hyperobjects: the biosphere, evolution, global warming. There is an inevitable dislocation between the hyperobject and its indexical signs. Otherwise, what's the fuss all about? Gaia will eliminate its pathogens and get on with the business of being itself. But an object is and is not itself, at the same time, because it has parts that cannot be wholly subsumed into it. Otherwise phasing, and the beats and more generally the indexical signs that are aspects of interactions between things, would fail to occur. A phasing object is a sign of a rupture at the heart of being.

This rupture is not a physically definable place, like a crack or a seam. It cannot be physically located "in" space or time, since space and time are precisely on "this" side of it. Hyperobjects are big enough relative to us that they cause us to become aware of the rupture, which following Heidegger I have begun to call *the Rift*. The Rift exists at an *ontological* intersection, not a physical one. The intersection is between a thing and its appearance-for another thing, or things. Thus, the mesh of relations is on one side of the Rift, the hither side, while what I call the strange stranger is on the yonder side—again, not spatially but ontologically.

Now because of the strange mereology we have spoken of, one of these "other things" can be the very object in question! An object can be a member of itself, thus giving rise to set theoretical paradoxes that plagued Russell. If a set can be a member of itself, then one can imagine a set of sets that are not members of themselves. In order to cope with such paradoxes we can do one of two things. One is to forget everything we have just found out about hyperobjects. The other is to allow for the existence of contradictory entities. It is the [illegible] that we shall take in this book. The path has been well estab[illegible]logician Graham Priest, in a number of groundbreaking bo[illegible]

Russell's set paradox is the stepchild of s[illegible] mathematical hyperobjects, the transf[illegible]iscovered[illegible]or. Think of [illegible]. Now split the li[illegible] by cutting

AT MELVILLE'S TOMB

Often beneath the wave, wide from this ledge
The dice of drowned men's bones he saw bequeath
An embassy. Their numbers as he watched,
Beat on the dusty shore and were obscured.

And wrecks passed without sound of bells,
The calyx of death's bounty giving back
A scattered chapter, livid hieroglyph,
The portent wound in corridors of shells.

Then in the circuit calm of one vast coil,
Its lashings charmed and malice reconciled,
Frosted eyes there were that lifted altars;
And silent answers crept across the stars.

Compass, quadrant and sextant contrive
No farther tides . . . High in the azure steeps
Monody shall not wake the mariner.
This fabulous shadow only the sea keeps.

Visual and Acoustic Space

Marshall McLuhan

While in elementary school, Jacques Lusseyran was accidentally blinded. He found himself in another world of collision and pressure points. No longer could he pick his way through the ordinary "neutral" world of reflected light. It was the same environment that we are all born into but now it came to him demanding exploration:

Sounds had the same individuality as light. They were neither inside nor outside, but were passing through me. They gave me my bearings in space and put me in touch with things. It was not like signals that they functioned but like replies...

But most surprising of all was the discovery that sounds never came from one point in space and never retreated into themselves. There was the sound, its echo, and another sound into which the first sound melted and to which it had given birth, altogether an endless procession of sounds ...

Blindness works like dope, a fact we have to reckon with. I don't believe there is a blind man alive who has not felt the danger of intoxication. Like drugs, blindness heightens certain sensations, giving sudden and often disturbing sharpness to the senses of hearing and touch. But, most of all, like a drug, it develops inner as against outer experience, and sometimes to excess...."[1]

We, who live in the world of reflected light, in visual space, may also be said to be in a state of hypnosis. Ever since the collapse of the oral tradition in early Greece, before the age of Parmenides, Western Civilization has been mesmerized by a picture of the universe as a limited container in which all things are arranged according to the vanishing point, in linear geometric order. The intensity of this conception is such that it actually leads to the abnormal suppression of hearing and touch in some individuals. (We like to call them "bookworms.") Most of the

how was this intensified or rejected by the panorama?

information we rely upon comes through our eyes ; our technology is arranged to heighten that effect. Such is the power of Euclidean or visual space that we can't live with a circle unless we square it.[2]

But this was not always the expected order of things. For hundreds of thousands of years, mankind lived without a straight line in nature. Objects in this world resonated with each other. For the caveman, the mountain Greek, the Indian hunter (indeed, even for the latter-day Manchu Chinese), the world was multicentred and reverberating. It was gyroscopic. Life was like being inside a sphere, 360 degrees without margins; swimming underwater; or balancing on a bicycle. Tribal life was, and still is, conducted like a three dimensional chess game; not with pyramidal priorities. The order of ancient of prehistoric time was circular, not progressive. Acoustic imagination dwelt in the realm of ebb and flow, the logos. For one day to repeat itself at sunrise was an overwhelming boon. As this world began to fill itself out for the early primitive, the mind's ear gradually dominated the mind's eye. Speech, before the age of Plato, was the glorious depository of memory.

Acoustic space is a dwelling place for anyone who has not been conquered by the one-at-a-time, uniform ethos of the alphabet. It exists in the third world and vast areas of the Middle East, Russia, and the South Pacific. It is the India to which Gandhi returned after twenty years in South Africa, bringing with him the knowledge that Western Man's penchant for fragmentation would be his undoing. There are no boundaries to sound. We hear from all directions at once. But the balance between inner and outer experience can be precise. If our eardrums were tuned any higher we would hear molecules colliding in the air or the roaring rush of our own blood. Sound comes to us from above, below, and the sides. As Lusseyran says, it passes through us and is rarely limited by the density of physical objects. Most natural materials act as a tuning fork. The human baby cannot move out into the environment until sound teaches depth-which the child adapts to the demands of Euclidean or visual space later on.

Each of these modalities is a sensory preference of the culture. For the society that accepts it, that modality, whether acoustic or visual, is the foundation on which it recognizes its own perception of sanity. But we wish to advance an idea that you, the reader, won't in all probability, initially accept. And that is for several thousand years, at least, man's sensorium, or his seat of perceptive balance, has been out of plumb.

The term *sensus communis* in Cicero's time meant that all senses, such as seeing, hearing, tasting, smelling, and touch, were translated equally into each other. It was the Latin definition of man in a healthy natural state, when physical and psychic energy were constant and distributed in a balanced way to all sense areas.[3] In such a condition it is rather difficult to hallucinate. In any cultural arrangement, trouble always occurs when only one sense is subjected to a barrage of energy and receives more stimulus than all the others. For modern Western men that would be the visual state.

As psychologists understand sense ratios, overstimulation and understimulation can cause thought and feeling to separate. Sleeping may be regarded as the dimming down of one or two sensory inputs. Hypnosis, on the other hand, is a steady assault on one sense, like a tribal drumbeat. Modern torturers in Chile break down prisoners by putting them in cells where everything—walls, furniture, utensils, window covers—is painted white. In Vietnam, Communist interrogators discovered (as police interrogators everywhere) that unexpected beatings and random electric shocks create sharp peaks of floating anxiety and subsequently a ready uncritical conviction.

Without being aware of it, North Americans have created the same kind of violence for themselves. Western man thinks with only one part of his brain and starves the rest of it. By neglecting ear culture, which is too diffuse for the categorical hierarchies of the left side of the brain, he has locked himself into a position where only linear conceptualization is acceptable.

Euclid and Newton fixed Western man's body in rigid space and oriented him toward the horizon.[4] As neurosurgeon Joseph Bogen puts it, the linear sequential mode of the left hemisphere underlies language and analytical thought. The right hemisphere of the brain, which is principally concerned with pattern recognition of an artistic and holistic quality, grasps the relationship between diverse parts readily and is not bound up with a rigid sequence of deductions. The intellectual legacy of Euclid and Newton therefore is a substitution of perspective for qualitative thinking, which is always composed of multi-sensual elements.

Everything in life after the Greeks was reduced to the uniform and the homogenous, Swift's island of Laputa. Thought had to have a beginning, a middle, and an end. No thesis was acceptable unless all ideas were interconnected to project an e-x-t-e-n-d-e-d point of view, which is the interior structure of the essay, we might add.

If you think of every human sense as creating its own space, then the eye creates a space where there can only be one thing at a time. The eye acts as a machine-like a camera. Light focused on the back of the eye ensures that two objects will not occupy the same place at the same time. The mind teaches the eye to see an object right side up, on a plane and in perspective space. As children, when perspective (or the vanishing point) arrives—when we learn to focus an inch or two in front of the page—we learn to read and write. The phonetic alphabet gives us a point of view since it promotes the illusion of removing oneself from the object.

It would almost seem that the very physiology of the eye promotes the idea that everything is in sequence—that is, in its proper place, at the proper time, and in linear relationship. The kind of mentality the prompted Shakespeare's King Lear to divide his kingdom among his daughters, to abstract himself from the medieval perception that England was contained in himself is more modern than tribal. What we are saying is that the human eye appears to be the father of linear logic. Its very nature encourages reasoning by exclusion: something is either in that space or it isn't.

The constraints of Western logic are tied to our sense of sequential relationships—logic made visual. The middle ground, however accounted for initially, is eventually excluded. It is either-or. If your culture nurtures you to favor the eye, your brain has difficulty giving equal weight to any other sense bias. You are trapped by visual only assumptions. For centuries, the Japanese, unlike Westerners, have treasured the pictorial space between objects in a painting, the *ma*; and have viewed such space as more dominant than all objects portrayed. Like the yin/yang complementarity of wave/particle in physics.

Anyone who has been involved in gestalt, or studied primitive societies—once he or she gets over the impulse to measure these societies with Western templates—is aware that either-or is not the only possibility. Both-and can also exist. People who have not been exposed to the phonetic alphabet, that is, the "uncivilized", can easily entertain two diametric possibilities at once. Edmund Carpenter pointed out to us that the Inuits, or the Eskimos, cannot visualize in two dimensions. If they are asked to draw the animals they hunt on

a flat surface, the result—to our eyes—is often grotesque. But ask them to draw the same figure on, let us say, the rounded surface of a walrus tusk, and the etched drawing will take on a three-dimensional life as you roll the tusk in your fingers.

[...H]ere we have a clue to the mentality of the pre-literate, that world of oral tradition that we eventually left behind about the end of the Hellenic period. It is the mentality of the multitude, or as Yeats put it; everything happening at once, in a state of constant flux. For the genuinely tribal man there is no causality, nothing occurring in a straight line. He turns aside from the habit of construing things chronologically-not because he can't, but as Edmund Carpenter says, because he doesn't want to.

Carpenter advises us that the Trobriander Islanders only recognize now, the eternal present. Bronislaw Monilowski and Dorothy Lee, who studied these people, discovered that they disdained the concept of why. European man was to them hung up on the idea of setting priorities, of making past and future distinctions. "To the Trobriander, events do not fall of themselves into a pattern of cause and effect as they do for us. We in our culture automatically see and seek relationships not essence. We express relationships mainly in terms of cause or purpose...." The Trobriander is only interested in experiencing the current essence of a person or object. He is interested in his yams, his stone knife, his boat, as those objects are today. There is no such thing as a "new" or an "old" boat, a blooming yam or a decayed one. There is no past or future, only the essence of being that exists now. The Trobreinder, like the Inuit, directly experiences a sense of timelessness, so he is never bothered by such questions as "who created the creator." The English language, in fact most Western languages, suggests through its tense structure that reality can only be contained within a concept of a past, a present, and a future which rather incongruously implies that man is capable, like a God, of standing outside the time continuum. The hubris of Western man may very well lie in the priority-setting propensity for quantitative reasoning [....]

To summarize, visual space structure is an artifact of Western civilization created by Greek phonetic literacy. It is a space perceived by the eyes when separated or abstracted from all other senses. As a construct of the mind, it is continuous, which is to say that it is infinite, divisible, extensible, and featureless-what the early Greek geometers referred to as *physics*. It is also connected (abstract figures with fixed boundaries, linked logically and sequentially but having no visible grounds), homogenous (uniform everywhere), and static (qualitatively unchangeable). It is like the "mind's eye" or visual imagination which dominates the thinking of literate Western people, some of whom demand ocular proof for existence itself.

Acoustic space structure is the natural space of nature-in-the-raw inhabited by non-literate people. It is like the "mind's ear" or acoustic imagination that dominates the thinking of pre-literate and post-literate humans alike (rock video has as much acoustic power as a Watusi mating dance). It is both discontinuous and nonhomogenous. Its resonant and interpenetrating processes are simultaneously related with centers everywhere and boundaries nowhere. Like music, as communications engineer Barrington Nevitt puts it, acoustic space needs neither proof nor explanation but is made manifest through its cultural content. Acoustic and visual space structures may be seen as incommensurable, like history and eternity, yet, at the same time, as complementary, like art and science or bioculturalism.

Occasionally, certain persons in history have been in the right place at the right time to be truly bicultural. When we say bicultural we mean to have a foot placed,

as it were, in both visual and acoustic space, like Hemingway in his Cuban village hideaway or Tocqueville in America. Marco Polo was such a one. The Phoenicians, the earliest cultural brokers between East and West, having brought a cuneiform method of accounting to the Egyptians and the phonetic alphabet to the Greeks, were likewise blessed.

The phonetic alphabet underlies all of Western linguistic development.[6] By the time it had gone through the Greeks and Romans and reasserted itself in the print literature of the Renaissance, Western sense ratios had been firmly altered. The Greeks gave a new birth to the alphabet as a mode of representation having neither visual nor semantic meaning. Egyptian ideographs, for instance, were directly related to particular sensuous sounds or actions, with unique graphic signs. On the other hand, the matrix of the Greek alphabet could be used to translate alien languages back and forth without changing the form and number (twenty-four) of the original alphabetic characters. It became the first means of translation of knowledge from one culture to another. The reader in the process became separated from the original speaker and the particular sensuous event. The oral tradition of the early Greek dramatists, of the pre-Socratics, and Sophocles, gave way very gradually to the written Pan-European tradition and set the emotional and intellectual posture of the West in concrete, as it were. We were "liberated" forever from the resonating magic of the tribal word and the web of kinship.

The history of the Western world since the time of Aristotle has been a story of increasing linguistic specialism produced by the flat, uniform, homogenous presentation of print. Orality wound down slowly. The scribal (or manuscript) culture of the middle ages was inherently oral/aural in character. Manuscripts were meant to be read aloud. Church chantry schools were set up to ensure oral fidelity. The Gutenburg technology siphoned off the aural-tactile quality of the Ancients, systemized language, and established heretofore unknown standards for pronunciation and meaning. Before typography there was no such thing as bad grammar.

After the public began to accept the book on a mass basis in the fourteenth and fifteenth centuries—and on a scale where literacy mattered—all knowledge that could not be so classified was tucked away in the new "unconscious" of the folk tale and the myth, there to be resurrected later as the Romantic Reaction.

But since World War I and the advent of those technical wavesurfers Marconi and Edison, the rumbles of aural-tactility, the power of the spoken word, have been heard. James Joyce in *Finnegans Wake*, celebrated the tearing apart of the ethos of print by radio, film (television), and recording. He could easily see that Goebbels and his radio loudspeakers were a new tribal echo. And you may be sure that emerging mediums, such as the satellite, the computer, the data-base, teletext-videotext, and the international multi-carrier corporations, such as ITT, GTE, and AT&T, will intensify the attack on the printed word as the "sole" container of the public mentality, without being aware of it of course. By the twenty-first century, most printed matter will have been transferred to something like an ideographic microfiche as only part of a number of data sources available in acoustic and visual modes. This new interplay between word and image can be understood if we realize that our skulls really contain two brains straining to be psychically united [....]

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NOTES

1 Lussoyran, And There Was Light, tr. Elizabeth Cameron (Boston: Little, Brown, 1963), pp. 23-24, 48-49.

2 F.M. Cornford, "The Invention of Space," Essays in Honour of Gilbert Murray (London: Allen and Unwin, 1936), pp. 215-235.

3 Cicero's training, through Plato's disciples, was influenced by an earlier religious usage that logos (a primitive utterance of the word) structured the kosmos and infused man's being with a wise concept of world order or common sense. Heraclitus, The Cosmic Fragments, ed. Geoffrey S. Kirk (London: Cambridge University Press, 1954), pp. 70, 356, 403. Also, Harold Innis in Empire and Communications (London: Cambridge University Press, 1951), pp. 75, says "The structure of man's speech was an embodiment of the structure of the world." Cicero's rhetorical theory, as an interchange of both thought and feeling (inventio, dispositio, elocution, memoria and pronuntia) became the academic anchor for the medieval trivium; for a form of summation consult Marcus Tullius Cicero, De Oratore, trs. E.W. Sutton and H. Rackham (Cambridge: Harvard University Press, 1967), pp. 97-109.

4 Cornford, "The Invention of Space," p. 219.

5 The eternal present: Summarized from an extended exchange between Edmund Carpenter and Marshall McLuhan during a student discussion of Carpenter's first draft essay "Thinking Through Language," at the Centre for Culture and Technology, University of Toronto. Also, cf. Dorothy Lee, "Lineal and Nonlineal Codifications of Reality," Explorations in Communication: An Anthology, pp. 136-164.

6 Eric Havelock, "Origins of Western Literacy" in Ontario Institute for Studies in Education, Monograph Series no. 14 (Toronto: 1971) p. 43.

19.

To Thomas Butts.

11th September 1801.

My dear Sir,—I hope you will continue to excuse my want of steady perseverance, by which want I am still your debtor, and you so much my creditor; but such as I can be, I will. I can be grateful, and I can soon send some of your designs which I have nearly completed. In the meantime, by my sister's hands, I transmit to Mrs. Butts an attempt at your likeness,[1] which I hope she, who is the best judge, will think like. Time flies faster (as seems to me here) than in London. I labour incessantly. I accomplish not one half of what I intend, because my abstract folly hurries me often away while I am at work, carrying me over mountains and valleys, which are not real, into a land of abstraction where

[1] Gilchrist (1880) vol. ii. p. 212, No. 39. In the possession of Mrs. Butts, at Parkstone. Bust: full face, slightly turned to left: powdered, curly hair: blue uniform, with gold buttons and shoulder piece, a red collar: holding a book in his right hand (see Plate).

spectres of the dead[1] wander. This I endeavour to prevent; I, with my whole might, chain my feet to the world of duty and reality. But in vain! the faster I bind, the better is the ballast; for I, so far from being bound down, take the world with me in my flights, and often it seems lighter than a ball of wool rolled by the wind. Bacon and Newton[2] would prescribe ways of making the world heavier to me, and Pitt[3] would prescribe

[1] cp. *Milton*, p. 3 (invocation): "Daughters of Beulah! Muses who inspire the Poet's Song | . . . Come into my hand | By your mild power; descending down the Nerves of my right arm | From out the Portals of my Brain, where by your ministry | The Eternal Great Humanity Divine planted his Paradise, | And in it caus'd the Spectres of the Dead to take sweet form | In likeness of himself."

[2] Types of rational philosophy and empirical science, both enemies of Imagination. cp. *Jerusalem*, p. 54, ll. 15–18: "But the Spectre like a hoar frost & a Mildew rose over Albion, | Saying, I am God, O Sons of Men! I am your Rational Power! | Am I not Bacon & Newton & Locke who teach Humility to Man? | Who teach Doubt and Experiment"; *Milton*, p. 43, ll. 1–8: "To bathe in the waters of Life: to wash off the Not Human. | I come in Self-annihilation & the grandeur of Inspiration, | To cast off Rational Demonstration by Faith in the Saviour, | To cast off the rotten rags of Memory by Inspiration, | To cast off Bacon, Locke & Newton from Albion's covering, | To take off his filthy garments & clothe him with Imagination, | To cast aside from Poetry, all that is not Inspiration | That it shall no longer dare to mock with the aspersion of Madness, cast on the Inspired"; and the remark quoted by Crabb Robinson in his journal (Gilchrist, 1880, vol. i. p. 384): "Bacon, Locke and Newton are the three great teachers of atheism, or Satan's doctrine." The subject of one of Blake's "printed drawings" is Newton overshadowed by utter darkness, drawing a geometrical figure with compasses on a scroll upon the earth.

[3] The promoter of war. cp. "The Spiritual Form of Pitt guiding Behemoth," in the National Gallery: Behemoth representing war by land.

distress for a medicinal potion. But as none on earth can give me mental distress, and I know all distress inflicted by Heaven is a mercy, a fig for all corporeal! Such distress is my mock and scorn. Alas! wretched, happy, ineffectual labourer of Time's moments that I am! who shall deliver me from this spirit of abstraction and improvidence? Such, my dear Sir, is the truth of my state, and I tell it you in palliation of my seeming neglect of your most pleasant orders. But I have not neglected them; and yet a year is rolled over, and only now I approach the prospect of sending you some, which you may expect soon. I should have sent them by my sister; but, as the coach goes three times a week to London, and they will arrive as safe as with her, I shall have an opportunity of enclosing several together which are not yet completed. I thank you again and again for your generous forbearance, of which I have need; and now I must express my wishes to see you at Felpham, and to show you Mr. Hayley's library,[1] which is still unfinished, but is in a finishing way and looks well. I ought also to mention my extreme disappointment at Mr. Johnson's[2] forgetfulness, who appointed to call

[1] See note 1, p. 85.

[2] Rector of Yaxham with Welborne, Norfolk: cousin and friend of Cowper. Blake made a miniature of him when he was on a visit to

poems, as I have suggested. The Homeric poems include *The Iliad*, *The Odyssey*, and the *Homeric Hymn to Demeter*, the last of which tells of the founding of the Eleusinian Mysteries, as we have noted. There are several other extant Homeric Hymns and "Homerica" which will not particularly concern us; but it will serve us, before looking at the mythical and spiritual world of Eleusis, to see how the mythical world surrounding it came to be. The poem is *The Theogony*, meaning an account of how the gods came into being, and its poet is Hesiod.

The Theogony imagines a beginning of existence in a condition that Hesiod calls *Chaos*, but this *Chaos* is not the random turmoil that the English word derived from it denotes. It is rather a gap or open space conceived as a chasm or void and ultimately pregnant with all of existence. The chasm *Chaos* is accompanied by *Eros*: raw hunger or desire. After *Chaos* and *Eros*, Earth—*Ge* or *Gaia*—came into being. Thus for Hesiod, as poet Charles Olson says, "Earth 'came into being' / extraordinarily early" [Olson MAX, p. 334]—early not only in time but in order of creation. Earth is *the primordial*, in existence only after empty space and the desire to fill it. Note this well. Earth takes precedence over everything that comes after it—over the heavens and over the gods. Earth is the primal source of creation, and even when the Heavens become part of the picture, the cosmic status of *Gaia* is clearly the higher or rather the richer of the two.

With the chasm *Chaos* that preceded the earth, the function called *Eros* is immediately in play. "*Eros*" is the ordinary Greek word for love and sexual desire, as much raw appetite as human amorousness, though that too. *Eros* is characterized in Hesiod and the Homeric poems by a Greek phrase that means something like "the one who loosens the limbs." Olson, working from his sense of Hesiod, writes that love

> ...unnerves the limbs and by its
> heat floods the mind and all gods and men into further nature
>
> [OLSON MAX, p. 172]

Co-eval with the chasm *Chaos*, then, is the erotic principle that is going to get creation going and keep it going—nature itself producing "further nature" from the beginning until now and beyond. It is because of the extraordinarily "early" position of *Eros* that Hesiod will write his theogony—his account of how the gods came into being—in the form of a genealogy.

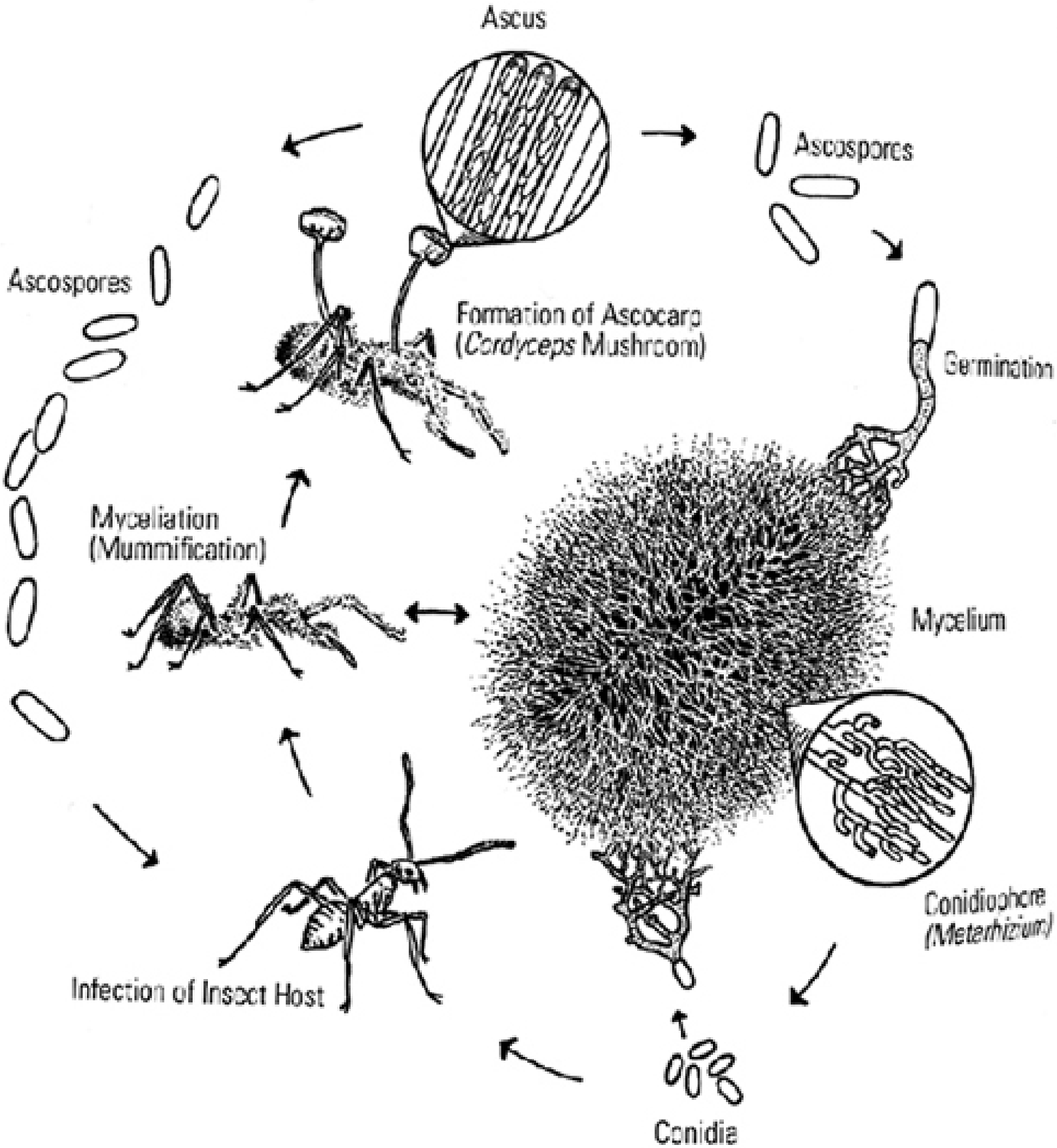
Co-eval with Earth was *Tartaros*, a dark and terrifying region far, far below Earth that eventually becomes the prison where the gods conquered by the Olympians will be forced to dwell. Co-eval too with Earth was Dark Night and *Erebos*, another sub-terrestrial region that later will serve as a name for the House of Hades. Night cohabits with *Erebos* and generates Day and Bright Air. Again, note it well: Night gives birth to Day. Darkness gives birth to the light. Empty space gives birth to solid earth. This will be an important sequence to remember when we look at the details of the Mysteries.

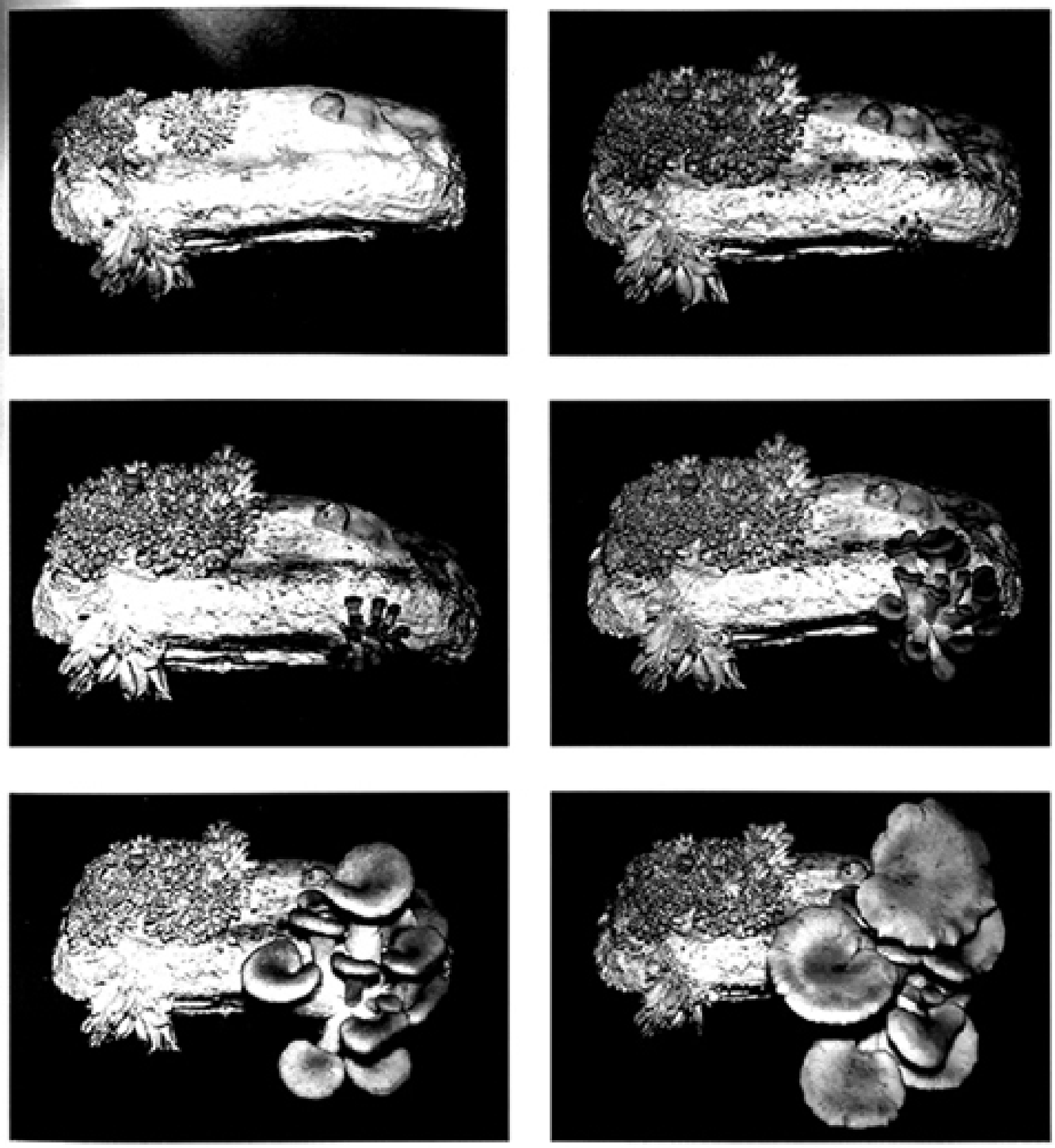
Earth begins creation simply by putting beings up out of herself. She was stretched out along *Chaos* and created Ouranos, the sky, by parthenogenesis, causing him to stretch out above her equal in expanse to herself. Then she produced, in this way, geographic features—long mountains and the Nymphs who dwell in pleasant mountain glens. She put forth the sea, again, without sexual union. Finally, she cohabited with Ouranos and bore a series of deities, including Hyperion, the earliest sun god, Themis, the principle of Right, Mnemosyne, Memory, who later gives birth to the Muses, and finally Kronos, the father of Zeus and a major player in the tale to come. Along the way she also bore the Kyklopes (Cyclopes)—three of them—the one-eyed giants. This differs from the account in *The Odyssey* where a single Cyclops is the son of Poseidon. And she bore three powerful beings named Kottos, Briareos, and Gyges, with fifty heads and one hundred arms each. Hesiod calls these three brothers "unshapen hulks," but we should not take this apparently negative epithet as a term of disapprobation. They will aid Zeus in his war against the others and be treated as heroes. In general, extraordinary forms are taken as things to wonder at, not unnatural abominations.

g the insect to ascend to the top of the forest y, the mushroom can release spores that fly far ide, ensuring wider distribution than would be le nearer the ground. Many such fungi use

▼ FIGURE 116

The *Cordyceps-Meterhirium* life cycle.





▲ **FIGURE 74**

Daily time-lapse photos of oyster mushrooms fruiting from corncobs.

years for life to evolve on Earth.) Thus far 120 planets outside our solar system have been discovered, and more are being discovered every few months. Astrobiologists believe that the precursors of DNA, prenucleic acids, are forming throughout the cosmos as an inevitable consequence of matter as it organizes, and I have little doubt that we will eventually survey planets for mycological communities. The fact that NASA has established the Astrobiology Institute and that Cambridge University Press has established *The International Journal for Astrobiology* is strong support for the theory that life springs from matter and is likely widely distributed throughout the galaxies. I predict an *Interplanetary Journal of Astromycology* will emerge as fungi are discovered on other planets. It is possible that protogermplasm could travel throughout the galactic expanses riding upon comets or carried by stellar winds. This form of interstellar protobiological migration, known as *panspermia*, does not sound as far-fetched today as it did when first proposed by Sir Fred Doyle and Chandra Wickramasinghe in the early 1970s. NASA considered the possibility of using fungi for interplanetary colonization. Now that we have landed rovers on Mars, NASA takes seriously the unknown consequences that our microbes will have on seeding other planets. Spores have no borders.

The Mycelial Archetype

Nature tends to build upon its successes. The mycelial archetype can be seen throughout the universe in the patterns of hurricanes, dark matter, and the Internet. The similarity in form to mycelium may not be merely a coincidence. Biological systems are influenced by the laws of physics, and it may be that mycelium exploits the natural momentum of matter, just like salmon take advantage of the tides. The architecture of mycelium resembles patterns predicted in string theory, and astrophysicists theorize that the most energy-conserving forms in the universe will be organized as threads of matter-energy. The arrangement of these strings resembles the architecture of mycelium.

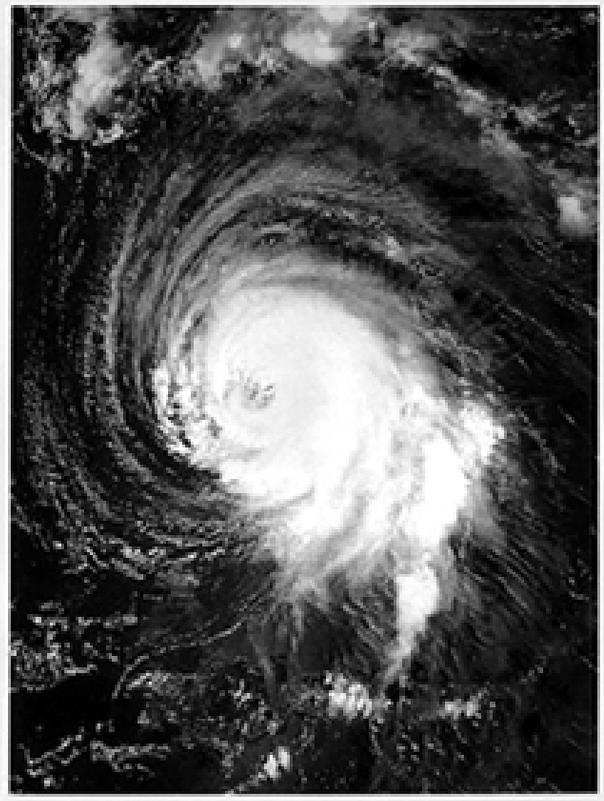


FIGURE 10

Hurricane Isabella approaches North America in October 2003.

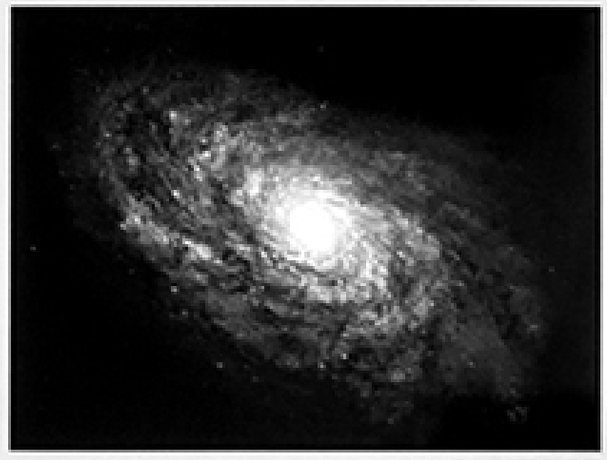


FIGURE 11

Spiral galaxies conform to the same archetypal pattern as hurricanes and mycelium.

When the Internet was designed, its weblike structure maximized the pooling of data and computational power while minimizing critical points upon which the system is dependent. I believe that the structure of the Internet is simply an archetypal form, the inevitable consequence of a previously proven evolutionary model, which is also seen in the human brain; diagrams of computer networks bear resemblance to both mycelium and neurological arrays in the mammalian brain (see figures 3 and 4). Our understanding of information networks in their many forms will lead to a quantum leap in human computational power (Bebber et al. 2007).

Mycelium in the Web of Life

As an evolutionary strategy, mycelial architecture is amazing: one cell wall thick, in direct contact with myriad hostile organisms, and yet so pervasive that a single cubic inch of topsoil contains enough fungal cells to stretch more than 8 miles if placed end to end. I calculate that every footstep I take impacts more than 300 miles of mycelium. These fungal fabrics run through the top few inches of virtually all landmasses that support life, sharing the soil with legions of other organisms. If you were a tiny organism in a forest's soil, you would be enmeshed in a carnival of activity, with mycelium constantly moving through subterranean landscapes like cellular waves, through dancing bacteria and swimming protozoa with nematodes racing like whales through a microcosmic sea of life.

Year-round, fungi decompose and recycle plant debris, filter microbes and sediments from runoff, and restore soil. In the end, life-sustaining soil is created from debris, particularly dead wood. We are now entering a time when myco-filters of select mushroom species can be constructed to destroy toxic waste and prevent disease, such as infection from coliform or staph bacteria and protozoa and plagues caused by disease-carrying organisms. In the near future, we can orchestrate selected mushroom species to manage species successions. While mycelium nourishes plants,

▲ **FIGURE 12**

Close-up of mycelium.

mushrooms themselves are nourishment for worms, insects, mammals, bacteria, and other, parasitic fungi. I believe that the occurrence and decomposition of a mushroom pre-determines the nature and composition of down-stream populations in its habitat niche.

Wherever a catastrophe creates a field of debris—whether from downed trees or an oil spill—many fungi respond with waves of mycelium. This adaptive ability reflects the deep-rooted ancestry and diversity of fungi—resulting in the evolution of a whole kingdom populated with between 1 and 2 million species. Fungi outnumber plants at a ratio of at least 6 to 1. About 10 percent of fungi are what we