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Pandemonium: An Essay on Predation and Modernity

by

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE MASTER OF ARCHITECTURE

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ABSTRACT

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Our modern world is driven by processes of abstraction. These processes have recently begun to generate criteria of industrial and organizational formation radically different from those to which we became accustomed during the modernist era. And as we are not held in thrall so much anymore to Law, to de jure formations and judicial enforcement, as we are to the de facto methods by which we communicate and the technological, social, and economic forces that shape this communication, our attempts to divert communication flow, and so to carve out a space of freedom, must be aimed at the level of communication infrastructure, and at the processes by which this infrastructure determines the shape of our social worlds.
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Retina 1
Protocol 8
Neuron 13
Paraboloid 20
Stress 27
Bürolandschaft 34
Distributed system 38
Predation 45
Work cited 47
Appendix: Extended Pandemonium Fonts 49
Our modern world is driven by processes of abstraction. These processes have recently begun to generate criteria of industrial and organizational formation radically different from those to which we became accustomed during the modernist era. The advent of miniaturization in mid-century telecommunications and information processing for example has led to a new order of technologies that sociologist Daniel Bell has called "communications." In communicational milieus, the act of information processing begins to transpire so quickly (at the order of nanoseconds) that is is said to seem essentially timeless; thus communications networks quickly developed to the point where information processing became indistinguishable from the act of communication itself. The medium itself, and by extension, the various and complex acts of mediation, for all intents and purposes, became invisible.

The trajectory of technological development was already by 1977 portrayed through five trends: that of miniaturization of electronic components; increases in processing speed and the resultant transformations in communications systems; automation through cybernetics; the unprecedented explosion of quantity of information itself, and the corresponding need for standardized knowledge retrieval banks; and the collapse of time and space through instantaneous communication systems. The debate here was formulated around problems of networking and interconnectivity, the protocol of connection language necessary for "rational cooperation" with the machine. "In that fundamental sense," Bell argued, "the space-time framework of the world oikoumene [was] set."

Daniel Bell, "Teletext and Technology: New Networks of Knowledge and Information in Postindustrial Society" in *The Winding Passage* (Cambridge, MA: ABT Books, 1980) pp. 39. This landmark article, originally printed in *Encounter* (London), XLVIII, no.6 (June 1977), was drawn from a larger manuscript, "The Social Framework of an Information Society," prepared for the Laboratory of Computer Science at M.I.T. in 1975 and printed in Michael Dertouzos and Joel Moses, *The Computer Age: A Twenty Year View* (Cambridge, MA: The M.I.T. Press, 1975.) The essay was funded by AT&T, IBM, the Office of revised form in Encounter, a London-based journal with which Bell had been associated since the 50s and one of the earliest forums for neo-conservative ideas. Encounter was hit by scandal in 1967 when it was revealed that it, along with several other journals of its type and the Congress of Cultural Freedom, had been covertly funded by Naval Research, and MIT, and was reprinted in the CIA. (On the Encounter affair, see Frank Kermode, "Life at Encounter," *Partisan Review*, v.62, Fall 1996, pp. 661-73; and Neil Berry, "Encounter," *Antioch Review*, v.51, Spring 1993, pp. 194-211.)
Just as in the case of the biological evolution of the human eye, where the retina became the site upon which raw visual data was both received and coded into neural impulses readable by a central nervous system, so the host of everyday telecommunications devices to whose logic we are increasingly becoming subjected (fax machines, cellular phones, internet protocols, VCRs, etc.) are the social the selective filtering and shaping of information is taking place. This technologically mediated form of capital—information—has long since become a global lingua franca: What system of border controls and State institutions could halt the flow of information, a substance that could never appear ‘foreign’ because it is by definition already reconstituted as universal?

The collective machinic, or technological vision machine becomes a tool not just for gathering information, but for giving it form, for defining context, for placing all information within the realm of technological reproduction and simultaneous transmission. The volume of information generated through the massive increases in computing power and data-collection devices has forced a radical shift in the processes of communication and control necessary to filter the seas of information for valuable data. The filtering problem was at first principally a program of military intelligence analysts dealing with the logistics of processing
the explosion of information generated in battle. Today it is that of our entire social-industrial system.

Capitalism itself, it has often been remarked, is shifting in response to this and other crises of information. It is almost no longer at all embodied in Fordist mass production, or Keynesian supply and demand equations. Modern capital is shifting to a military-style economy (extension of platoon-style hierarchies into the economy, continued interweaving of domestic and military institutions) where the goal is the mobilization of forces—productive, consumptive, and structural—and the continued acceleration of progress. The well-known Keynesian formulation of wage-driven consumption, organized around the concept of equilibrium at a macroeconomic scale and which promotes equality between wage increases and marginal labor productivity, has shifted to a scenario where productivity is increasingly divorced from labor. The economy is seen as merely an accelerator of forces, a facilitator of constant growth and expansion.

Within this crisis of capitalism, centralized citadels of power whose tendency is to restrict the flow of information are gradually removed, in favor of less viscous decentralized organizations and environments. A useful distinction may be made between citadels and environments. Citadels form coherent, distinct entities
The Keynesian model begins to plummet as an article of faith in macro-economic circles during the years of the Vietnam War. This chute was reinforced by a series of economic crises beginning in the late 1960's, and characterized by widespread social unrest, followed by a shortage of raw materials, rising inflation, and economic stagnation. These crises have broadly taken two forms. Michael Piore and Charles Sabel refer to the first as a "regulation crisis," resulting from a disruption of the balancing mechanisms connecting production with consumption. They derive this (but at the same time differentiate it) from the French régulation, which does not connote regulation in terms of control exerted from outside (i.e., in the sense of governmental regulation), but rather an internal "balancing mechanism," or "equilibration." It is this sense of self-equilibration that neo-classical economic theory (and the 19th century marginalist theory from which it is derived) view the functioning of the market.

The second, and less obvious, concerns what Lewis Mumford referred to as technics, or the sum of methods and means used in production. This sort of crisis admits that a change in mode of production effects far more than the way in which goods are produced; it is a change in the very substance of society itself, in its generalized systems of exchange, in the "abstract diagrams" through which elements and processes are conceived of, interrelated, and subsequently directed. Keynes, and the state-regulated capitalism enacted throughout the developed countries of the West, had sought to mitigate such crises in the economic system that had developed around mass-production technologies. The new economic model, following the lines of development of the cybernetic and informational technics, achieves its stability within instability, in an economy for which the economic crisis is a permanent state of affairs.

which have the property of distance, and exert control over their agents from outside. The subject of history has traditionally, indeed by definition, been a history of citadels, be these of States, Cities, Production Processes, or Egos. Now control within environments, on the other hand, may be said to be exercised within, and the relationship of controller and controllee being one of intimacy or closeness. The difference here is that one is not made a subject to an environment, one is rather enslaved within it: one is absorbed and redefined into the environment as an integrated, productive part. As such, regulation within

“Closeness” as a property is a measure of the extent to which the formal relationships between two entities are dissolved. Without this formal relationship, the message and the medium are reconstituted beneath the skin; received in a state of distraction, like a waking dream. “The equipment-free aspect of reality here has become the height of artifice; the sight of immediate reality has become an orchid in the land of technology.” For Walter Benjamin, what has been lost is the “unique existence of things”, the existential presence or “aura,” that requires a view from outside. The mass reproduction techniques of the art object, culminating in the film, frees the object from tradition, and follows a desire of society to be surrounded close-up by the likenesses of things. Yet, at a time when the manufacture of identity is a motive force of the economy (the proliferation of branded and blue-chip culture), we assert on the contrary, that aura has not truly disappeared; it has become mobile, “liquidated” only in the sense of “made fluid.” Aura is performative, and like information, defined not by its substance but by the effects it produces, by the way that it closes a circuit, embeds—subsumes—two entities within a channeled relationship. The substance of the aura—its identity—is then capable of any sort of transformation, as aura is no longer grounded in a static metaphysic. It is itself embedded within an environment, a field, through which value and substance are constantly shifting, a network of fragmentary existences, through which even apparently subversive activity may be directed. The “universal equivalence of things” of which Benjamin spoke can only be a universality of capture, leading to homogeneity within connection protocol, often cloaked beneath supposed difference.

environments does not require, and is in fact often hampered by, the presence of a “centralized” force, such as a dominant ideology or a police state. The history of the late 20th century can be seen globally as the surreptitious replacement of citadels by environments, and the subsumption of information within capital. It operates simultaneously towards the exterior expansion of its sphere of power, towards invading previously unknown territories, and internally, towards a progressively more intimate and fine parsing of those factors over which it already has control. This new techno-economic apparatus can be imagined as an eye constantly scanning the environment for information that may be valorized, producing market environments wherever they emerge and at the very moment of their apprehension. This generalized vigilance, this scanning process, can truly be called predatory in nature, for it activates all that it apprehends with a view simply to seizing it. It may be understood as a Pandemonic Eye.

The “Pandemonic Eye” is meant to convey the properties and movements of the technics of control within a general regime of decentralizing processes, though with the added insistence that all decentralizations are constituted only within more comprehensive hidden recentralizations. The present historical movement toward decentralization, toward the cyborg for example, is no more a path to absolute liberation, as is often claimed, as a constitution of mechanisms of a new social control. In the same way, the post-modern shift towards multiplicity, towards the blurring of subject and object, is not itself immune to the operation of power: this theoretical shift was in many ways preceded by the evolution of power structures which use strikingly similar techniques. The Pandemonic Eye conveys in a single motion an apprehension and reformulation of a certain type. [The Pineal Eye of Bataille, which unites in simultaneity both vision and desire, and the camera eye of film criticism.] Just as the phenomenological camera eye captures and deploys information in a way entirely specific to the medium of film, so the pandemonic eye, and the technological development which it represents, works along characteristic lines of development, in the formation of the specific milieu that it engenders.
A new organizational imperative can be said to be infiltrating all levels of society, through all fields of human endeavor: in the cognitive sciences and conceptions of the mind, following developments in artificial intelligence; in the field of economics, with a new realization of the potentials and extensions of markets and market institutions (i.e. computer-aided arbitrage and advanced credit institutions); in the realization of the "bounded" (or heuristic) rationality of economic decisions, and the coefficient of friction which is necessarily present in the coordination of information; in those communicational technologies which provide smooth informational channels to reduce that friction to the point of virtual instantaneity; in new (i.e. Post- or Neo-Fordist) techniques of organizing and controlling labor to better harness the nervous apparatus of workers; in the relation between labor and machines following the use of cybernetic and information technologies; and finally in the playing out of this milieu of production in the formation of place, from the office and the factory to the reorganization of urban and even global fabrics along the new imperatives of communication flow.
What exactly is Pandemonium? Its evocation suggests chaotically activated surfaces, a swirl of constant motion, perhaps even brutal ubiquitous insurrection. In any case it is a chaos not without intention, efficacy or essential properties. Literally, it is an environment of “all demons”; an environment made animate through daimons, who, for the Greeks, were those emissaries between the gods and man considered to be beyond human control, to unbalance the careful plans of Men: a sort of diabolic friction between heaven and earth.* During the renaissance pandemonium was said to emerge from the sleep of reason, to pose a threat of excess, superstition, a manifestation of the disorder seething behind the cool, Platonic edifice. The battle between the two realms was constant.

Today paradoxically, the emergence of so-called communications and the new informational economy signals the rationalist triumph of the old Pandemonic forms of organization over the staid citadels of the old Reason. The shift is occurring across the spectrum of information technologies as we move away from models of the global application of intelligence, with their universality of application and frictionless dispersal, to a model of local applications, where intelligence is site-specific and fluid. We have long since abandoned the mechanistic universe, the universe of discrete parts. Questions of taxonomy and classification (which constitute perhaps

* Homer used daimon to emphasize the actions (as opposed to the theos, or personality) of the gods, so that daimons became associated with contingency and sudden supernatural interventions: with Fate and the unexpected as opposed to Reason and clarity. The Pandemonium of Milton’s capital of Hell was the realm of those angels (interveneing between God and Man) who distorted the perfect clarity of the Word of God.
a science of distance) fade in relevance to the search for patterns in the behavior of systems. The signature technique of the late 20th Century has become the computer simulation. Simulations are not meant to specify unknown variables in a mechanistic sense; the power of simulation lies in finding similarities or analogies across time in complex processes for which the precise actions of variables remain unknown. The simulation accepts the unspecified interaction of constitutive variables for the sake of visualizing larger environmental patterns. Today, that information which is most valuable is irreducibly embedded within an ever-changing environment, from the interactions of institutions in a market to the interactions of neurons in a human brain.

With the need, and the newly-acquired ability, to generate and deploy unprecedented amounts of information came the logistical problem of how to filter that information, how to discern patterns within the torrents of data. For serial computer architectures, which process information sequentially at the level of bits (the binary digit, the primal yes/no, A/not-A of classical symbolic logic), the capacity to perceive patterns is limited. While such machines are capable of incredible feats of arithmetical number crunching, they are virtually unable to usefully filter data from their environment. The cognitive capacities of sequential
Central to the problem of control within distributed systems is the problem of filtering. A filter operates through the identification of patterns or unique signatures within raw, or previously unorganized data. As automatic filters become more sophisticated, vaster and more disparate sets of data may be subjected to analysis and mined for work (useful information), allowing the use of increasingly far-ranging techniques of information gathering. As author Manuel DeLanda has shown, this two-pronged evolution of information technology has led to the generation of vast amounts of information through the employment of exhaustive “vacuum cleaner” methods, to which the “intelligence analyst” applies techniques of pattern recognition. For the United States government, the vanguard of intelligence gathering techniques have congealed around two large bureaucratic agencies specializing in different media: photoanalysis at the CIA and cryptoanalysis at the NSA (National Security Agency). The vacuum cleaner approach used by these agencies underlines the importance they attribute to information technology: the NSA believes it must stay five years ahead of the state of the art in commercial information technology. The technically sophisticated combination of exhaustive intelligence gathering techniques and methods of data filtering and analysis based on electromagnetic media led DeLanda to coin the term Panspectron: “There are many differences between the Panopticon [of Jeremy Bentham] and the Panspectron being assembled at the NSA. Instead of positioning some human bodies around a central sensor, a multiplicity of sensors is deployed around all bodies: its antenna farms, spy satellites and cable-traffic intercepts feed into its computers all the information that can be gathered. This then is processed through a series of ‘filters’ or keyword watchlists. The Panspectron does not merely select certain bodies and certain (visual) data about them. Rather, it compiles information about all at the same time, using computers to select the segments of data relevant to its surveillance tasks.”

computer architectures can thus be easily distinguished from human cognition. We humans are continually exposed to a flood of sense-perceptions, and must abstract from this flood developmental patterns that relate to the situation at hand. The solution to the problem of complex, adaptive machine perception lies in Pandemonium based architectures.

A Pandemonium, or massively parallel, computer architecture consists of a multitude of quasi-independent software agents, known as "demons," which are interconnected, and operate simultaneously. In the case of an early Pandemonium model (c. 1960) designed to recognize hand-printed letters, one demon for example would be assigned the task of recognizing horizontal strokes, emitting a "shriek" whose intensity is proportionate to how closely the data fit its search and decision-making criteria (i.e., more loudly with the letters A or T, less with O or S). At the next hierarchical level, a cognitive demon would be attentive to the shrieks of demon population below it, and would assign a value based on the relative "weights" or intensities of the shrieks. Other demons would simultaneously be performing disparate tasks at this level, subjecting the letter to grids of various kinds, and the data they gathered would be continually funneled up the demon hierarchy, until, finally, a judgment would be made.

[Diagram of demon hierarchy]

Original demon hierarchy, Sellridge 1958

The letter A subjected to pandemonic pattern recognition
The data set or the environment inhabited by the Pandemonium model is in this way rendered globally active through the busy presence of the demons. The quasi-independent nature of the demons enables them to act with a certain kind of limited initiative; that is, they can become activated and run their subprograms based upon environmental cues rather than in obeisance to a direct command from the Central Processing Unit. The demon is a potentiality, like an enzyme, that roams across an environment until triggered into action by an informational prompt or environmental cue.*

In contrast to the monolithic hierarchy of serial architectures, where decisions are processed one at a time by a Central Processing Unit, pandemonium architectures process multiple levels of information simultaneously, allowing for behaviors which often appear more intuitive than programmed, more fluid in operation, more sensitive to environmental data, and which are, most significantly, capable of learning from experience. The ability to process information in a way analogous to biological structures opens up new territories for the Pandemonic Eye; within the realm of information processing there now exists the ability to filter data in a way which approaches the scope of wet systems like human cognition.

* For Oliver Selfridge, the original theorist of the Pandemonium model of computer architecture, sequential processing, or von Neumann architecture, is “more natural for the machine,” but requires elaborate checking and back-tracking procedures when dealing with “noisy” situations which do not deal with simple and reasonable dichotomies. To process data as the human mind does requires a parallel processing computer architecture, where “all the questions are asked at once, and the answers presented simultaneously to the decision-maker.” The von Neumann bottleneck—data passing bit by bit through a Central Processing Unit—is far removed from the complexity of human learning.

The history of Artificial Intelligence is inseparable from developments in the neurosciences and in information theory in general; breakthroughs in the conception of one field have found immediate correlations in the others. Newly founded disciplines, such as cognitive psychology, have served to increase the linkages between these disciplines, further blurring the distinction between machinic and human cognition.∗

The Pandemonium model itself arises from the locus of multiple fields, combining concepts from the neurosciences, cybernetics, administrative sciences, and human information processing. The driving force behind the convergence of these fields was military. Armies and their command systems had need to deploy effectively the avalanches of information generated in any modern battlefield situation. The theorist of the Pandemonium model, Oliver Selfridge, was an assistant at MIT to Norbert Weiner, father of cybernetic control systems. Selfridge developed his own model while working at the RAND Corporation and at Lincoln Lab, a high-security research institute associated with both the Army and MIT.

∗Daniel Dennett, among others, has used Pandemonium models to explain human cognition: “They [the specialist demons] are often opportunistically enlisted in new roles, for which their narrative talents more or less suit them. The result is not bedlam only because the trends that are imposed on all this activity are themselves the product of design. Some of this design is innate, and is shared with other animals. But it is augmented, and sometimes even overwhelmed in importance, by microhabitats of thought that are developed in the individual, partly idiosyncratic results of self-exploration and partly the predesigned gifts of culture. Thousands of memes, mostly born by language, but also by wordless “images” and other data structures, take up residence in an individual brain, shaping its tendencies and thereby turning it into a mind.” Daniel Dennett, Consciousness Explained (New York, Back Bay Books, 1991) p. 263.
The establishment of institutions like the RAND Corporation and the Lincoln Laboratory at the close of WW2 reflect the military's realization of the escalating importance of pioneering new technologies, new tactics, and, in short, new deployments of information in warfare, hot and cold. Encouraged by the success of wartime projects like the Manhattan Project and the Radiation Laboratory of MIT, the military sought to further harness the cutting-edge speculation and experimentation of the academic realm, along with the productive power of industry, to its own directives. Project RAND (from "research and development") began as a contract between the Army Air Force and Douglas Aircraft Company in 1946. It brought academics and scientists into contact with a number of government departments and private corporations, founded as "a program of study and research on the broad subject of intercontinental warfare other than surface," to recommend "preferred techniques and instrumentalities." What the Air Force sought to gain from RAND was summarized succinctly by an Air Force officer at the time: "Because of the diversity of skills and knowledge required to cope with current and future problems of national security, and because of the interest which all on the research staff share in the solutions of these problems, an organization like RAND represents one (rare) device for overcoming the increasing compartmentalization and specialization of knowledge."

The realization that policy decisions and technology are inseparable led to the creation of a totally new type of institution: "We had to fit into existing molds. For example, the Douglas Company did not have an existing job description for a philosopher. By reading the job-salary table backward, we discovered he was Design Specialist A." During its first fifteen years, RAND consulted an astoundingly diverse set of issues, including policy research (especially the formulation of a deterrence strategy in the Cold War), strategic air bases and air defense systems, nuclear weapons and weapon strategy, communications and satellite systems, missiles and space warfare, project cost analysis and the logistics of transport and information processing, economic and political policy, systems analysis ("choice among alternative future systems, where degrees of freedom and uncertainties are large"); meteorology, games theory (applied to Cold
War issues), mathematics (yielding interesting correspondences between different phenomena: "For example, the problem of efficient assignment of targets to aircraft leads to advances in methods of decentralized planning in a large-scale organization"); and the uses of computers (including heuristics, and the development of efficient command and control systems). In its first 15 years, over one million copies of 7,000 RAND publications (from technical papers to books) were distributed, not including the amount of work that was considered classified.

The Lincoln Laboratory was founded in 1950 out of the Radiation Laboratory, which was MIT's great wartime laboratory of WW2. The Rad Lab, funded through the Army and Navy, became best known for inventing and producing radar equipment for both aerial and sea warfare. Lincoln Laboratory was organized much like the Rad Lab into a number of divisions (including Communications and Components, Long-Range Communications, Secure Communications, Aircraft Control and Warning, and the Digital Computer Laboratory); at the same time, the military projects which it was given required continuous transfer of expertise and technology across these divisions. While funding came from the military, Lincoln Labs worked extensively with industry, including IBM, Bell Telephone Laboratories, the Western Electric Company, Convair, Hughes Aircraft, Raytheon, and Jackson and Moorland. Projects of the 50s included NOMAC (Noise Modulation and Correlation), which led to technologies of secure military transmissions through the use of noise signals: signals spread so thin as to escape notice, as it was only a fraction of the normal transmission noise; and the use of one of the earliest computers (called Whirlwind) to develop an air defense system based along an extensive network of radars: an "electronic fence" (this project, called SAGE, or Semi-Automatic Ground Environment, involved consultation with RAND). While these projects employed MIT faculty and graduate students, the work was highly classified; Lincoln Labs moved off campus in 1952 to better ensure its privacy.

The entry of MIT into what Eisenhower called the military-industrial complex forced it to radically alter its method of operation. James Killian, the president of MIT from 1949 to 1959, noted that "there were times when both labs [Lincoln Labs and the similar Instrumentation Laboratory] posed problems for us that gave us concern about their future impact on MIT...These big labs are not without
their complications. For one thing, they tend to have an inflationary effect on the institutions. And when, for instance, the Instrumentation Laboratory philosophy of cradle-to-grave development began to involve the Institute in contracting with industry for many elements, we thought these presented inappropriate kinds of decisions for an academic institution." In the academic year 1968-69, the Instrumentation Laboratory received $54.6 million, mostly from the Department of Defense (DOD) and NASA, while Lincoln Labs received $66.8 M. At the same time, on-campus sponsored research totaled $55.8 million, although only 27% of this was DOD related. The changing face of MIT can be seen through a comparison with pre-WW2 conditions: from the academic years 1938-39 to 1968-69, total sponsored research increased from $18,932 to $171,294,000. During this period, the ratio of faculty to undergraduates nearly doubled (from 1:8.5 to 1:4.4), while the ratio of graduate students to undergraduates more than tripled (1:3.5 to 1:1). The blurring of academic, military, and industrial realms was justified through an appeal to national defense; Julius Stratton, who became president of MIT in 1959, reported on MIT's policy toward Lincoln Labs: "The Institute has always accepted sponsored research projects as an integral part of its educational system. Such work, whether on campus or in the defense laboratories, provides unusual opportunities for both graduate students and faculty to participate in research at the frontiers of their respective fields. We recognize also that urgent demands will be made upon our resources in times, such as the present, when the safety and strength of the free world depend so greatly on advanced science and technology."

Also at RAND was Herbert Simon, whose work in industrial administration led directly to concepts central to the development of intelligent machines; he co-wrote what is now widely considered to be the first Artificial Intelligence program, the Logic Theorist, in 1955. Before Simon, economists theorized that companies and individuals considered all alternatives to a given problem, with the attempt to maximize or minimize a given function, such as profit or loss. In his theory of bounded rationality, Simon argued that the search for alternatives necessarily requires the expenditure of time and energy by the decision-maker. Bounded rationality differs from that instrumental rationality (far too often taken as an essential and unchanging component of modernity) which presumes to have access to the optimal arrangement of means to a given end, to the greatest possible efficiency and utility. Optimization of informational milieus is a fanciful idea at best, due to the complexity of empirical environments, and the cost-factor assigned to both the gathering of information and the coordination of entities through information.

In denying the global perspective assumed by instrumental rationality, Simon urged one instead to consider ways in which information could be made more fluid, to reduce the viscosity of information through selectively channeling it.
This is the decisive idea behind what came to be known as heuristics, the rules-of-thumb according to which people make decisions without becoming immobilized by considering every possible aspect of a problem. This more fluid approach could be applied to all forms of organization: from the wiring of computers to the behavior of large institutions in a market environment (Simon won a Nobel Prize in economics precisely for this work). Much like the redistribution of the modern army from tight, centralized formations of the renaissance into the decentralized platoons linked by radio of WW2, social and industrial organizations are now urged to give up the idea of operating toward a global set of objectives, to operate instead through the use of sub-goals to allow a far more supple response to complex situations. These sub-goals would then be united into the larger goals of the organization in a way similar to Pandemonium architecture.*

But at the center of these information processing systems, whether they take place in the hardware of a computer or the bureaucracy of a transnational corporation, is the model of the neuron. Most of the major advances in the information technologies have been speculations on to the functioning of the nervous system. What is the secret behind the brain’s ability to take neurons, which are five to six

* The type of rationality advocated by Simon is one which is distributed throughout the environment within which the decision-maker is situated. He denies the possibility of the rational, privileged view above the economic fray: “however adaptive the behavior of organisms in learning and choice situations, this adaptiveness falls far short of the ideal of ‘maximizing’ postulated in economic theory. Organisms adapt well enough to ‘satisfice’, they do not, in general ‘optimize.’ If this is the case, a great deal can be learned about rational decision making by taking into account, at the outset, the limitations upon the capacities and complexity of the organism and by taking account of the fact that the environments to which it must adapt possess properties that permit further simplification of its choice mechanisms.”

orders of magnitude slower than silicon logic gates, and assemble them in such a way as to perform certain operations many times faster than any digital computer now in existence? The dream of the information technologists is to render all surfaces active and massively parallel. These surfaces should all be capable of instant modification through the modularity of their parts and the flexibility of their pathways, and they should form a totally malleable environment with respect to facilitating the flow of information. Citadel structures, such as labor unions, city grids, the skills of the artisan, and, in sum, all things which provide insoluble, grave, and singular units resistant to processes of abstraction, must be liquidated and reconstituted within information capital.

The neuron model of organization is fast becoming a cultural and technological imperative thanks to the synthesis of communications systems with the emerging global market economy. The neuron model's task is to reformulate the world, to learn from it and to translate it into its own abstract vocabulary. Through the operation of the Pandemonic Eye, constantly scanning the boundaries of its territory, transforming and absorbing all that it apprehends, the regime of abstraction is expanded, and the directed fluidity of information, the speed of its apprehension and deployment, is increased.
The liberation of information processing techniques from the human body entered industrial production in the 70s through the adoption of neo-Fordist principles, or flexible specialization, effecting a transformation of the worker's relation to the machine. Where under the Fordist regime of the semi-automatic assembly line the rhythms of production were dependent upon the rhythms of labor, the arrival of cybernetic machines, servo-devices, and numerical control, severed that connection between production and labor. Within this new regime, the worker is absorbed—subsumed—into the matrix of production, as part of a machine-human apparatus. Both humans and machines now function as relays in a total production environment.

Among the principle tasks of the "scientific" management of labor in the early 20th century was to choreograph labor to the movements of simple machines, abstracting the skills of craftsmen into quantifiable, diagramatic, and repeatable routines. The implementation of cybernetic and continuous-process production in the second half of the century has necessitated the introduction of far more supple techniques of labor control, extending the inherently modern processes of abstraction along cybernetic rather than merely mechanistic lines. As a result, those methods of social control wielded in the old mass production economy have been superceded by a wholly new system, leading Gilles Deleuze and Felix Guattari to distinguish the "social subjection" analyzed by Marx, where the worker is a free subject to capitalism under the wage relation, with an emergent condition of "machinic enslavement." Yet machinic enslavement was actually first a property of archaic empires (what Lewis Mumford called megamachines) and operated by casting human beings as constituent parts of a mechanism controlled by a higher entity. On the other hand, through the formal relationship of the wage relation, where naked labor comes into contact with capital, the worker is exterior to the tool used and to the labor process itself. It could be said that under machinic enslavement, the force of production enters into a relation to the worker characterized by closeness (immanence), while social subjection is characterized by distance. For Deleuze and Guattari, the advent of cybernetics and communications technologies has lead to the formation of a third situation, a technologically sophisticated megamachine. "If motorized machines constituted the
second age of the technical machine, cybernetic and informational machines form a third age that reconstructs a generalized regime of subjection: recurrent and reversible ‘humans-machines systems’ replace the old recurrent and nonreversible relations of subjection between the two elements; the relation between human and machine is based on internal, mutual communication, and no longer on usage and action.”

This shift can be seen in the formation of places of production at all scales. The third age of the machine, and the continuous-process industries and information-technology manufacturing that now dominate the industrial landscape, has liquidated what Jean-Paul Gaudemar called the "factory-fortress," which was the place of social subjection. While in some cases the factory has grown more concentrated, accentuating the possibilities of large-scale production, and in other cases the factory has dispersed into a matrix of producers, suppliers, and subcontractors, this double movement of concentration and dispersion works to increase the mobility and fluidity of production factors, towards ensuring a more supple fit to market demands.

It is in this context that the often discussed divide between skilled and unskilled workers has occurred. As the brunt of labor in information-technology manufacturing is automated, we have seen, on one hand, the privileging of those technically-skilled workers and system-analysts who control and maintain the machinery, while on the other hand, the growing pool of unskilled workers, whose only asset is their mobility. This change is reflected on a global scale as well, as whole nations become equivalents of mobile unskilled labor, only useful to the global market for cheap routinized labor or the export of raw materials, under the auspices of a comprador capitalism. Gaudemar asks (and this question applies on the factory floor as well as it does in a globalized market): "Is the fate of the worker thus tied to a future in which only two possibilities remain: to be a controller of flux or an element of flux?"

The machinist no longer uses the machine as a tool, but in the cybernetic age, is engaged with the machine in a dance of mutual surveillance. A critical step in this process was the development of Numerical Control (or N/C), a term coined by two engineers at MIT's Servomechanism Lab. The first N/C machine was a three-axis milling machine (operating along the x, y, and z coordinates), receiving its commands through punched paper tape. Three hydraulic power servos were used to replace the hand-operated controls of a standard milling machine. These servos received simultaneous but distinct commands from a computer connected to the milling machine electronically, called the director. The director would read the binary input on the punched tape and convert these numbers into electronic pulse trains for each of the space coordinates, and finally convert these pulse trains into angular positions for each of the three servos. The machine was completed in March of 1952. N/C was first implemented in factories in 1953; by 1960 a machine tool show in Chicago featured nearly one hundred numerical-control units, indicating its commercial success. This marked the first intrusion of the computer on the factory floor, as well as the first case of purely digital information being used to shape real objects.

Among the first numerically controlled machines were textile looms: the Falcon (1728) and the Jacquard (1800). Numerical control technology was subsequently used only for novelty items such as player pianos until the 20th Century, when cybernetic technology, which united feedback control with information theory, was invented. For the sake of the current argument, we will focus on the line of development which has pushed numerical control towards its present capital-intensive, computer-based paradigm. The Parsons Corporation, headed by John T. Parsons, the son of a machinist, was at the time the country's largest manufacturer of helicopter rotor blades. Rotor blades are difficult to design: they do not follow a fixed plane of rotation like an airplane propeller, but constantly change pitch during revolutions around a mobile hinge, that must also be able structurally to carry the weight of the helicopter. Typically, it took a full person-year to design a single rotor blade. In 1947, after receiving an Air Force contract which would have required untold hours of tedious calculations, Parsons rented an IBM business
tabulating machine, and found that with it he could run the calculations for a rotor in a matter of days. Further, the computer could generate an extra number of Cartesian points along the curve of the rotor which could be used as guidepoints for a jig boring mill. The rotor could then be filed down to the guidepoints, simultaneously allowing greater accuracy and decreasing the skill necessary to the machinist. This development interested the Air Force enough that it awarded the Parsons Corporation a contract in partnership with IBM, and later MIT's Servomechanism Laboratory, to develop this technology further.

MIT's Servo Lab was established in 1940 as an outgrowth of a Navy program for developing accurate and rapid gun-positioning on ships. The Lab became occupied with developing a general purpose digital computer, named Whirlwind, while working on a Navy contract for flight simulators. MIT gradually took control of the project from Parsons, who had only been interested in finding a solution to a manufacturing problem, and began to entertain the possibilities of using digital control to automate the machining process. "Entranced by the possibilities of full continuous path control, Pease and McDonough, the project leaders, quickly transcended the original problem—automatic machining of wing panel surfaces—to contemplate an even more general, ambitious, and elaborate application. They imagined a continuous path system for controlling three axes of motion simultaneously, in synchronization, to carve out, sculpt from solid material, any mathematically defined surface." This transformation in goals, from that of solving specific technical problems using computing as a tool, to elaborating a system of general digital control, enlisting computers to ensure total control for the design engineer, illustrates, according to historian David Noble, the effects of a marriage of technocratic academics, interested in furthering their "scientific and institutional interests," with the driving force of military prerogatives.

The elliptical paraboloid pictured here was milled by an experimental five-axis numerically controlled milling machine at MIT in 1962. The surface markings are exaggerated to show cutting vectors. The 3D spiral-cut pattern is computer-generated from a mathematical description; for all previous N/C machines, each cutting vector would have been programmed separately. Although it was created under strict technological imperatives, as a demonstration of how this early form of computer-modeling could reduce programming time (only six additional commands beyond those necessary to describe the 2D elliptical base were needed to sculpt the 3D object), it has a seductive sculptural power, a resonance perhaps derived from the new type of blurring that it represents between idea and matter. Its complete reproducibility places it firmly within the great enterprise of abstraction, and the universal exchangeability of things engendered by this enterprise.
N/C was developed primarily through a relationship between MIT and the Air Force, which was searching for a method of gaining greater control over the machining of airplane components. In 1957, the Air Force Deputy Chief of Staff for Materiel stated that “heretofore, regardless of how carefully drawn and specified on paper, a finished piece [of machinery] could not be any better than the machinist’s interpretations.” N/C delivered maximal control of the machine to management: “since specifications are converted to objective digital codes of electronic impulses, the element of judgment is limited to that of the design engineer alone.”

The desire of the management for the level of control possible with complete digitalization can be seen in the rejection of an alternate technology called Record Playback (R/P), which was at once less expensive and more reliable than N/C. The Record Playback system used an analog tape to record the motions of a machinist at a lathe, and the machine would merely play back the tape to execute the same motions in subsequent iterations of the process. This technology, however, though full of nuance, failed to reduce fluid geometry to discrete numbers; in other words, it was guilty of permitting the individual machinist’s specialized knowledge to remain in the loop.
The technology of numerical control has been endowed with an unmistakably military flavor, due to the importance of the Air Force in the early stages of its development. This military influence however transcends specific technological developments, rather inciting and defining further development along a particular trajectory responding to military preoccupations. These preoccupations—specifically, performance, command, and modern methods—become embedded critically within the broader methodologies and directions of industrial research done in the United States. "Performance" includes meeting objectives through the use of integrated systems following "the uniformity principle." Integrated systems, using interchangeable parts and highly abstracted forms of labor, allow the fast turnaround times in production that the military argues is necessary for national survival. "Control" essentially expresses the desire to shorten chains of command, to lessen the amount of intervention between order and execution, and "modern methods" conveys the military's consistent preference for high-tech solutions, and hence, capital-intensive production.

Record-playback differs from numerical control both in preserving the need for a pool of highly skilled machinists, and in lending itself to programming on the shop floor, rather than in offices under the control of management. With R/P, the skill of the machinist, the ability to make subtle adjustments based on intuitions about materials, is enhanced and extended. In computerized numerical control, each of the specific material and machine events must be translated into algorithms, often of daunting complexity. One solution to this problem involves increasing capital expenditure in creating a machinic cognition capable of employing algorithms much like heuristics.

The skills of the artisan machinist, because they are embodied within the density of the artisan's bodily experience and not yet translated into an abstracted and numerical context, provide a quotient of viscosity, an obstacle to frictionless flow in the circuit of information capital. And yet, as is still the case in the aeronautics industry, production systems are not yet advanced enough to transfer all skilled labor to the machine and thereby realize the dream of the workerless factory. In the illustration of the sectioned helicopter blade rotor can be seen the agonistic boundary between the expanding domain of the numerically controlled machine, and the skill reservoir of the artisan machinist.

Flexible specialization on the work floor divides workers into two categories: the skilled worker, who has specialized knowledge, for example, in running automated machines, and who is considered a core asset of the company; and the unskilled worker, who is now in a less stable position than the worker under the Fordist regime due to the diminished power of organized labor within the new "Post-Fordist" system of production. Within the Fordist regime, the labor union had worked to both regulate supply and demand (by making it possible for workers to consume commodities and
thus guarding against the very real threat of overproduction) and to better mobilize the work force. The economies of scale brought about by Fordism and its mass production facilities brought together large groups of workers into concentrated areas. To guard against the dangers of the open mass, new methods of controlling large groups were required. This led to the increasing power of labor unions through the mechanisms of the "Keynesian consensus," which fostered class awareness and solidarity among workers, though in a way that served to integrate them further into the production process.

In the ten years following the second world war, the country experienced the most intense period of strikes in its history, following this increase in the power of unions, along with wartime wage freezes and no-strike bans. This was mitigated by management through the employment of two strategies. Many factories moved from the city to the suburbs. This served to break down the sort of group identification fostered within the urban milieu. Management also aggressively pursued a program of industrial automation to further solidify their control of the factory. These developments signaled a sharp decline both for the labor union and for the role of labor itself within the production process.

The social control of large groups was unquestioningly mediated by the so-called Keynesian consensus between state, management, and unions. After WW2, the Western countries went through 20 years of steady growth, carrying out the policies of the New Deal in the United States, and those adopted by European states after WW2, which tied increases in wages to increases in labor marginal productivity. These policies were heavily influenced by Keynesian thought. Keynes justified spending by the State to counter unemployment, as a 'exogenous shock' to the system. This was radical in terms of neoclassical theory, because it abandoned the quantity theory of money and the labor-market theory of employment. These theories relied on a conception of long-term equilibrium operating within economies: that unemployment and other crises were only moments of disequilibrium caused by inequalities in supply
and demand functions. As such, labor could cause unemployment by demanding wages above the "natural" level set by the economy. Governmental intervention was likewise seen as a disequilibrating force. In any case, the neoclassical theorist would view these crises as occurring in the "short-term", passing as the economy returned to equilibrium.

Perhaps Keynes' most critical move was a denial of long-term equilibrium. This denial became the foundation of his Principle of Effective Demand. In the Principle of Effective Demand, the level of employment is determined by expected demand for output, and prices are set by this expected demand, along with supply conditions. Here Keynes shifts the determining factor in employment from long term equilibria to an idea of short term equilibria. The wages demanded by labor are no longer a determinant of employment, as in the labor-market theory, but are macroeconomic outcomes over which labor has little control. If effective demand is too low, unemployment will result regardless of the actions of labor. Hence, if the producers' demand is met without reaching full employment, a situation of unemployment equilibrium can be reached. This equilibrium could not be broken by reducing wages, as a drop in wages would result in a drop in effective demand. The State is then justified in its role as an arbiterator between labor and management, and in using government spending as an "exogenous shock" to ward off the effects of structural unemployment by increasing effective demand. "The increase in effective demand will, generally speaking, spend itself partly in increasing the quantity of employment and partly in raising the level of prices. Thus instead of constant prices in conditions of unemployment, and of prices rising in proportion to the quantity of money in conditions of full employment, we have in fact a condition of prices rising gradually as employment increases."

New forms of control within factories were also used, following the Pandemonic imperative to promote environments of local intelligence over the citadels of global information control of Fordism and Taylorism. The neo-Fordist regime, whether referred to as flexible specialization, just in time production, or lean production, differs from previous regimes in its Pandemonic sensitivity to market and production conditions. While Ford and Taylor were instrumental in abstracting the labor process, the "rationailsm" of their modes of control led them to analyze the problem of labor in a sense analogous to the dictates of a Central Processing Unit; that is, they analyzed and imposed solutions from above. Further developments, in what is often referred to as neo-Fordism, have emphasized the "bounded rationality" of those overseeing the labor process, and have recognized the necessity that even the workers themselves be able to diagnose problems on the fly. In this way, decision-making in production ceased to be strictly a top-down affair, but grew to incorporate the totality of the factory floor.

Yet this should not be seen as empowering for the worker. The new mental or nervous discipline required of the worker, now invested with a small and carefully defined degree of initiative and local intelligence, has generated around it a multitude of new techniques of surveillance and control aimed at extracting initiative
Management interests found two difficulties with the Keynesian system. The first had to do with the loss of control over the production process that they suffered with the validation of unions within the Keynesian consensus. The second had to do with "regulation crises" in equilibrating the supply and demand relation, including the oversaturation of the domestic market for consumer goods, the availability of cheaper overseas labor, and the growing lack of satisfaction of consumers with mass-produced goods. Yet underneath Keynesian policies, the new modalities of control available with the invention of cybernetic and information technologies provided a way out, both enhancing control over labor and dealing with the regulation crises.

As early as 1949, Norbert Weiner, the founder of the science of cybernetics, saw the danger of the new kinds of control available through these technologies, and aligned himself with the struggles of labor. In a letter written that year to Walter Reuther of UAW, Weiner argued that "any labor which is in competition with slave labor, whether the slaves are human or mechanical, must accept the conditions of work of slave labor." For Weiner, this kind of control was only too susceptible to exploitation by "a certain type of businessman and a certain type of military man to get rid once and for all of the labor unions, of all forms of socialization, and of all restrictions to individual profiteering."

As such, the period of Keynesian policies served only as a holding pattern, a stop gap, allowing the new production techniques to take hold gradually, to develop and refine themselves, while alleviating the massive social unrest that might have resulted with sudden, sweeping changes. It is during this period in that flux and change became the tools of power relations. Following the crises of regulation, these technologies set the stage for the abandonment of the Keynesian consensus. The technique employed involved the subsumption of productive elements within the controlled and regulated time of the cybernetic machine, to emerge as semi-autonomous entities or demons: the slave labor already clearly intuited by Weiner.

from the worker. Among the more astonishing of these control devices is the insidious Andon board, developed as part of the Toyota company's strategy of lean production. This method was first put to use in the United States in a joint venture between Toyota and Chevrolet in California, the New United Motors Manufacturing, Inc. (NUMMI), in the mid 1980s. The Andon board is an electronic display unit which represents each worker's station as a rectangular box. If the pace on the line becomes too great, the worker is instructed to pull a cord, causing that station to light up on the central board. The overseers of the line, however, whose job it is to carefully analyze all the data passing through the device, do not seek to keep the lights from flashing. The lights, on the contrary, are meant to be constantly flashing, on and off, as the management continually stresses the system, searching for ways to extract ever more productivity from the workers. Such a situation might be characterized as hyper-Taylorist; its aim is not only to measure, abstract, and quantify the motions made by the workers, but to do so using techniques of local distributed intelligence, continually stressing the system and verifying whether it is able to return to equilibrium. The data thus generated does not make claims for universal applicability, as did the data generated by Taylor, but seeks rather to push the local system to discover its own limit.
"Management by stress" is how Mike Parker and Jane Slaughter have referred to the productive apparatus surrounding the Andon board. They deny the claims of the system's proponents that it operates through a democratic process of team work lacking in Taylorist models. In truth, "team work" belongs itself to a more systematic strategy to extract increasing amounts of work from the worker. For instance, if a worker is absent or working slowly, the team must make up for this deficiency, creating a powerful peer pressure to work effectively and to be at work on time. Workers are encouraged to take part in "quality circles" on their own time in order to discuss ways of improving the production process. While this may appear, and is certainly presented as empowering (gives the worker more responsibility), it must be remembered that teams have no control over the work process itself. Further, with respect to Taylorism, lean production retains, and even enhances, the painstaking cataloging and specification of each gesture and motion the worker must use to complete a given task. The use of "team work" effectively raises Taylorism to the collective level, subsumes workers more fully within the process of production, utilizes their nervous systems to the highest possible extent, by investing workers feel personally responsible for a production process over which they have no say. A manual distributed at a Michigan Mazda plant reads: "If you are standing at your machine doing nothing, you are not gaining respect as a human being."

The benefits of this system are many: decreasing absenteeism, increased productivity, and more pliable workers. Lean production works in concert with "just in time" inventory control, technology minimizing indirect labor (warehousing, etc.), extensive use of subcontracting, and continuous speedup. All of these techniques serve to put each part of the production process into a continuous state of stress. In effect, an "economy of stress" is being created, to fill in all available time in the interest of maximizing production. Here decentralization moves capital into a time-based regime as the Keynesian consensus is eclipsed.

With the invention of Bürolandschaft, or office landscaping, in the late 1950's, the Quickborner Team für Planung und Organisation, a management consulting group based in a suburb of Hamburg, precipitated a fundamental shift in the design of the office environment. Like most of the significant designs of the late twentieth century, the office landscape was formulated towards meeting the needs of abstract organizational and bureaucratic criteria. In the pure formation of spaces, the project of freeing the flows of information-capital had the general effect of transforming places into zones of homogeneity and complete malleability. By dissolving the walls of the traditional office building with its myriad small, private offices and central corridors, leaving in its wake a tempest of whirling workstations in a vast, open space, the Quickborner team literally recast the office as a dynamic parallel processing machine.

The connections between the various nodes of the office were enhanced, quickening the tempo of information exchange, and greatly increasing the surveillance power of management. The apparent chaos of their office plans belies the fact that the Quickborner team used no less than 68 rules to generate their desired configurations, strictly controlling environmental variables from acoustic levels to sight lines. The circulation between separate departments was painstakingly
analyzed, resulting in diagrams with no superficial resemblance to the demon hierarchy charts in Pandemonium architecture.

The office landscape posits an environment shaped by communication flow, and like conversations, are capable of almost total flexibility and reconfiguration. The development of systems office furniture, beginning with Herman Miller's Action Office in 1964, further transformed the office into an infinitely flexible space, saturated with interchangeable nodes. The dissolution of walls and citadel formations leads to a situation where office workers must come to view themselves as part of a matrix, part of the metabolizing organization, of unrestricted universal capital. The worker is reconstructed as a demon or sub-routine within the disciplinary matrix, and further reconstructed individually and physically through the use of ergonomic systems furniture that anticipates his movements with pre-cleared, frictionless pathways. Bürolandschaft represents the moment of take-off, one which has culminated in the virtual office of today with the indefinite extension of the office through the use of modems, fax machines, portable computers, pagers, voice mail, and cellular telephones.
The Bürolandschaft model reconstitutes the social field according to a logic of dispersal. Indeed, the Bürolandschaft planners attempted nothing short of place-making solely from the demands of expediting "communication flow." Distractions, visual, aural, and tactile, which are an element of friction to this communication flow, were removed: visually through indirect sight-lines, movable screens and plants, light file carts used to minimize the clutter of paper and other stored items, and carefully controlled lighting conditions and neutral colors throughout; aurally through carpeting, the isolation of noisy equipment, and the use of various "white noise" devices; and temporally, by placing those departments which interact more frequently closest to one another, in order to minimize circulation time, and through the use of light furniture and portable screens (which carry ducts for electricity and communications systems), so that the office may be quickly reformulated to fit the changing needs of communication flow.

Indeed an almost haptic sense of continuity is called for through the preference of "large, open, and unencumbered" spaces, with a minimum of 100 people per room: a uniformity of space, reduced to a single tactile, visual, and aural dimension, so that the only apparent differences are those which have to do with the imperatives of communication and organizational flow. It is, in a sense, the fulfillment of the potentials of "universal space" which some persist in viewing, like instrumental rationality, as a wholly neutral development of modernism, a space without cultural overtones. In Bürolandschaft universal space (in the use of modularity, the blank curtain wall, the uninterrupted floor slab) amounts to a certain kind of sensory deprivation, a genericity which does not speak toward the opening up of potentials and the lack of regulation, but rather to the dissolution of the workplace-as-citadel, which allow workers to be more fully embedded within the directed temporal aspects of communication flow.

In this transition from the workplace-as-citadel to the workplace-as-environment, design is not used to signify hierarchy or the operation of power: hierarchy is constituted by the way that one moves through the office environment, by the pathways that one takes. The office becomes performative, as it is an environment
created in the process of moving through it; the office could be said to *individuate* its workers on the basis of this movement. This distinction can be seen in a larger, urban context as well: one's position within the social hierarchy has much to do with how one communicates (the technological devices one uses, for instance), and with how one moves through increasingly dispersed urban and suburban environments. In this Bürolandschaft Urbanism, the skilled workers and system analysts on one hand, and the mobile unskilled worker on the other, move through two separate cities superimposed upon one another, a sort of placeless and artificial provincialism based upon one's position within systems of post-industrial production. For Manuel Castells, this is the space of production engendered through information-technology manufacturing; it is the "milieu of innovation", which is "able to generate within itself a continuous flow of the key elements that constitute the basis for innovative production of information technologies, namely: new scientific and technological information, high risk capital, and innovative technical labor." In the environment of constant innovation, communication is all-important: "there is little need of spatial proximity because of transportation costs; but there is much need to be able to exchange personal views on last night's software breakthrough, or on a recent trip to Japan."

The post-industrial city, mobile and malleable, operating as a distributed system of enclaves, can be seen as a device for the creation of workers within this milieu, for fostering the sense of constrained individualism necessary for the functioning of these workers within conditions where they must display controlled forms of intelligence and innovation. The dispersion of forms in the contemporary urban fabric, seen for example in the multiple or non-existent centers of these new cities, is possible only through the creation of a common connecting fabric, a kind of information-time that binds objects together as performative constituents of a distributed system. In this sense, the figures in the landscape have given way to the landscape itself.

The landscape of production is now a massively parallel set of interconnected distributed systems. This diagram (ill. no. x) was generated by the Quickborner team as part of the planning process for the layout of an office landscape. The boxes here represent office departments or equipment, while the lines connecting them display the relative intensity of the interactions between departments.

These diagrams were created to abstract from the configuration of the office the patterns of communication flow, manipulated to become idealized space plans, then fitted to actual available space to create plan layouts. But could this diagram not just as easily refer to any number of de-hierarchized organizations (the network of suppliers, producers and distributors in just-in-time manufacturing, the flow of currency between major trading centers, or a heterarchy of demons within a Pandemonic system) which are directed through shared protocols, interconnections, and directed rates of flow, rather than through the presence of a centralized chain-of-command? Diagrams of communication flow are the abstract formulations of the distributed systems which form the dominant environment of the second half of the twentieth century. These distributed systems are driven by a new set of organizational strategies; the signs of their existence are manifold, their scope of effects pervasive.
As communication technologies drastically increase the amount of information available to be gathered and filtered, and as new forms of organization subsequently become available, the economy is driven to become a distributed system, to best take advantage of the sea of information within which it is now submerged. Like the military's realization during WW2 of the primary importance of decentralized command and communications systems in complex battlefield situations, so the expanding presence of information (whether in the growing complexity of networked financial institutions, massive demographic research databases, or techniques of production and distribution) has brought into sharp focus the sheer complexity of interactions which make up an economy, and the subsequent need for dehierarchized, localized tactics to best apprehend and direct these interactions. And just as the chaos of battle became harnessed to fluid platoon-style command structures, so has the chaos of information been harnessed to the imperatives of market institutions.

This new bond between information and market institutions, a bond which is at the heart of neoconservative economic theory today, was forged by the Austrian School of Economics, founded by Carl Menger in 1870. Menger argued that market order, like the evolution of law and language, was the unintended, spontaneous
result of myriad human actions and historical events, and because of this, central-
ized planned economies of the socialist (and later, the Keynesian) type became
untenable: for the fullest economic use of resources, they argued, may occur only
through a laissez-faire market price system, applied not only to final products, but
intermediate ones as well. With an explicit analogy between social and natural
orders, the market coordinates economic factors through mutual adaptation, like
the functioning of a biological organism. While the use biological analogy is not in
itself new (Adam Smith spoke of the natural price towards which prices will tend,
and Turgot compared the circulation of money with the circulation of blood, both in
1776), what is new is the conception (extended and systematized by the two most
brilliant protégés of the Austrian School, Joseph Schumpeter and Friederich von
Hayek) of spontaneous order within an economic environment of complexity and
disequilibrium.

This conception of the regulatory powers of the market should not be seen as a
reformulation of a classical argument for laissez-faire policies based on equilibrium
theories of market regulation, such as Jean-Baptiste Say’s law of automatic
balance of supply and demand (of 1803). Classical and neoclassical economic
theory conceived of the market as an equilibrating force which “exogenous”
forces such as political unrest, could only temporarily disrupt. The modeling of economic theory here treats men and materials as perfectly mobile entities, and considers the dissemination of information to be frictionless and unobstructed. Indeed, the mathematical economist Leon Walras, who demonstrated in elegant mathematical form a process of successive approximations, or tâtonnement (trial-and-error groping), by which partial equilibria could give rise to a "general equilibrium" that could not have been predicted in advance, viewed private property as resistant to the smooth functioning of the market; so that Walrasian thought became the theoretical basis for a form of market socialism. For this reason, the Austrian School viewed Walras's "pure and perfect competition" as an imaginary construction which in actuality banishes competition from the market. With the realization that information could be treated as a fluid material came the logistical attempt to maximize the speed of information processing and transmission. On the scale of economies, in the working of the global market, this program is executed as the attempt to make economic factors fluid so that they may be better coordinated. For Friedrich von Hayek, perhaps the father of neoconservative economics, the solution to the problem of the imperfect dissemination of information is to make it a commodity: information is more fully
exploited when subjected to market conditions. Social and economic formations are complex and environmental; like demons in Pandemonium, people follow abstract, localized rules, ignorant of the movement of the whole; yet their actions are coordinated through the operation of the market. Ironically, perhaps, the "spontaneous order" so praised by Hayek and Menger for its liberating potential would only further the range of control available to bureaucratic and institutional interests. The market here is transformed from a static mechanism for the exchange of goods to an accelerator, a dynamic mechanism for the mobilization of information capital.

The discovery of the viscosity of information and the bounded rationality of heuristics, together with the growing importance of the role of research and development (and of knowledge in general) to industry and the development of cybernetics and communication networks, has transformed the market into a colonizing force. The market, now a self-propelling force, continually extends its inherent systems of abstraction into previously inviolate territories, to render all surfaces (communication interfaces, the boundary between idea and matter, spatial and temporal relationships) subject to its modulations and control, within a system of fluid command hierarchies and interconnections. The history of
tion for policies precisely because its operations are unknown and inaccessible. Hence, Hayek defends the market against central planning and government intervention based not on arguments about human rationality, but on human ignorance. Schumpeter, however, departed from the Austrian School with the theme that in a sense haunted him throughout his career: what he saw pessimistically as the decline of capitalism (which he always associated with the heroic figure of the entrepreneur) through bureaucratization, in a process leading ultimately to socialism. While the bureaucratization of innovation has indeed occurred (particularly in the field of information technology), Schumpeter, who died in 1950 was unaware of the burgeoning fluid bureaucratic techniques which would soon come to define the post-war world. This technologically-mediated decentralization, which lead to the success of the kind of social control referred to by Gaudemar as the "institutionalization of fluctuation", has turned innovation into an organizational imperative.

As in Pandemonium computer architecture, agents move across the economic landscape, performing functions and following rules, without access to the behavior of the whole system. It is precisely this ignorance of the system that allows the system to function optimally, bringing about unintended benefits that could not have been rationally predicted. Lack of prediction does not mean lack of control; Hayek includes cybernetics as "a special discipline which is also concerned with what are called self-organizing or self-generating systems". Neo-conservative economics conceives of these agents as operating within a common network which coordinates actions to become mutually consistent, and which provides the vital means of control. This common network is the market. For an economist like Gary Becker, then, it is possible to subsume all human actions and relationships as economic actions and relationships, justified by the primal need of "maximizing behavior." The market, now pandemonic in scope and effect, spontaneously allows the "optimal or rational accumulation of costly information."

corresponds precisely to the history of the market, and one need only study the effects of these systems, such as highways and airports, advanced credit institutions, global corporations, suburbs and televisions, on the formation of the city, the global order, and life itself, to see the transformative effect of the flow of abstract information.

Distributed systems require for their operation a homogenous standard of interconnectivity. This protocol endows the distributed system with what we have been calling its environmental quality and with the corresponding property of close-ness, the ability to be all-encompassing, totalizing, absorptive and denaturing. This is in sharp contradiction to the function of the city as a citadel or cluster of citadels, which creates distinct subject relations, which maintains separation and distance and which is constructive and differentiating. As the market relentlessly expands its grip upon the city, moving both outwards towards new territory and inwards to further parse that which it has already absorbed, the city itself, as a locus of human culture, as a distinct and separate citadel structure, disintegrates.
As information is increasingly subsumed as a commodity—medium within capital, and as communications systems continue to provide a venue for the ever-accelerating transmission of information and social relations of capital to populations of unprecedented size and dispersal, the tasks of information processing are being dramatically recast. Under a market system whose mode of being proceeds through expansion and the increasing mobilization of things, the more easily disseminated forms of information will be selected and privileged over those modes of information that resist easy translation into the digital realm of compunicational abstraction. By subsuming the flow of information to its own ends and in the absence of an external entity or citadel formation such as a State apparatus, the market itself now achieves a new means of social control. Control may now be exercised simply through the exposure of information to market forces, through the transvaluation of information into a commodity, refashioning it at the moment of its abstraction to fit the computational milieu.
The Pandemonic Eye is predator, embedding its rapacious logic ever more deeply into the social fold. It is constantly and relentlessly expanding, apprehending and assimilating new prey, driven by the feedback loops of a capitalist enterprise availing itself of vast amounts of cheap energy, enlarged, yet supple, scales of production, and ever faster and more intermeshed telecommunications and information processing systems. What remains is the blurring of all citadel structures, from the State, to the aura and authority of works of art, to the solemn autonomy of the Ego, within the expanding and directed environment of information capital. It is the drama of unique existence constantly supplanted by the universal equality of things. And as we are not held in thrall so much anymore to Law, to de jure formations and judicial enforcement, as we are to the de facto methods by which we communicate and the technological, social, and economic forces that shape this communication, our attempts to divert communication flow, and so to carve out a space of freedom, must be aimed at the level of communication infrastructure, and at the processes by which this infrastructure determines the shape of our social worlds.
Work Cited


Appendix: Expanded Pandemonium Fonts
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While working on this project, I became dissatisfied with existing fonts for the design of a book about Pandemonium. In place of the gratuitous complexity that might be expected with the word "pandemonium", I wanted a font that would, like Bürolandschaft, be simultaneously banal, insidious, strangely beautiful, and unstable: governed by a system of design that could lead to the creation of a number of possible outcomes. It was hoped that the resulting font(s) would work subtly on the reader's attention. The 36 fonts of Expanded Pandemonium Fonts were blended from six parent fonts (a, e, i, m, q, u), created by modifying and expanding blends of Helvetica Bold with:

a) Avenir Light  
e) Geneva  
l) Monaco  
m) DIN Mittelschrift  
q) Akzidenz Grotesk Bold  
u) Univers Black.

to create a font that would be both generic and mobile: a continuously morphing and unstable genericity. Helvetica, as the ubiquitous Modernist font, became the base of Expanded Pandemonium, with the other six fonts chosen for both their dissimilar resemblances to Helvetica, and their relative weights. The fonts were produced so that a number of blending pathways through the fonts would be available. The following font map shows all 36 fonts, arranged by increasing weight from top to bottom and increasing hybridity from left to right, as well as the blended pathways between them.
indicates parent font, from which others are blended.