THE ENERGY OF ARCHIVE: RE-MEMBERING THE CLOUD

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Abstract

We are living in a time where the wholesale storage of information exerts a dominant influence across the entire social system. The correlation between this archive and both the stability and sustainability of the social system is direct. Few people are cognizant that it takes real(!) energy to drive 'Big Data,' nor are they aware that such wide-scaled archiving (in 'The Cloud') directly affects the wider global environment.

This paper reflects on the fundamental energy (thermodynamic) conditions that apply to any ordered system. Order, as a temporal state—whether seen to arise autopoetically or whether created intentionally within a wider structured system—functions as an information transfer or communication system and always requires an influx of energy to be maintained. The crucial issues embedded at the root of any archive relate directly to this necessity. Where does that energy come from, how is it secured, and what is the cost? As a near-ubiquitous feature of any social structure, the archive—as an ordered expression of information—is one such system. As there are apparently no violations of the Laws of Thermodynamics in the observed universe, is the fate of the archive the same as that of the cosmos: a slow heat-death? Obliquely invoking an interpretation of systems theory, it is possible to 1) demarcate the trajectory of the archive (as (social) memory); 2) explain in the widest conceptual sense the cost of information storage and reproduction; and 3) predict the path that individual and collective knowledge takes into the future.

I will briefly introduce systems theory, some principles of thermodynamics, and of code that will, as models, undergird the discussion. Relating energy, order, and information, I will tie these conceptions into the actuality of the contemporary archive by exploring the question: What does it mean to have a sustainable archive? As a creative media arts practitioner and, as a consequence, an analog and digital archivist, I will include in the discussion pertinent fragments of personal narrative that arise from that lived praxis.

Keywords: archive, thermodynamics, entropy, energy, information, systems, code, analog, digital, media arts, sustainability

Introduction

As social creatures, we are surrounded by, immersed within, ordered structures of data, information, and knowledge projected from our past that drive the trajectory of our present and future lives. While much of our limited time is spent in securing energy inputs (resources) or their abstracted proxies (money) for surviving, a certain fraction of our life-energy is spent in the creation, propagation, and maintenance of coded and mediated forms of output. Not a few of us spend precious life-time insuring that the coded (abstracted!) manifestations of our selves and others are preserved for the future of the species. As both life-time and life-energy are limited there is a dilemma embedded in the perpetuation of this *archive*—how might we save enough information without saving too much as to compromise survival? This conundrum is implicit in the evolutionary condition that places collective (genetic) survival over that of the individual. Saving too much compromises the vitality of a system by diverting energy resources from the more critical functions of system propagation; and saving everything is anyways impossible (the map cannot contain the territory!).

The options that are left still leave us with the question of how much to save in the archive[1]: What is 'worth' saving? This is a crucial, ever-present, and scale-independent feature of existence within the wider social

system and the individual embodied organism.

It is not the intent of this text to parse the distinctions between the descriptors 'data', 'information', 'knowledge' except to note one characteristic that they all share is that they may be seen as *directed flows of energized matter*.[2] As social communications, they are carried from one point to another (Shannon, 1948). This somewhat obvious Cartesian consideration of movement has to include the temporal dimension as well: information is *order* that is maintained for a certain time. Thus a fundamental essence of the archive-as-information may be framed as a coherent flow of energy through time and space.

Shannon's general communication system is composed of devices and mediums that guide or order that energy flow. Independent of its function in this regard—that is, what is being carried, the content—it may be characterized as an organized system.[3] In generating his fundamental information theory, Shannon was not so concerned with the specific wider context or the ultimate materialization of his idealized communication system; he was more interested in the relationship between entropy and information (at least from a statistical point of view).

Instead of following the usual development of Information Theory into the statistical, mathematical, or coded[4], I propose following the 'entropy' lead back into the 'real world' of actual energy flows. Biologist Howard Odum (2007) suggests that

> *... information developed on earth in the evolution of life and is now operating with the social learning systems of humans and their computers. The development of information vastly improved the ways of building and sustaining structure. As plans are copied, duplicate structures and operations are made and widely shared. By means of information, systems structures could be made, improved, and replaced indefinitely.*

The presence of information is predicated on the anisotropic distribution of energized (and organized) matter in the universe. On all scales, from galaxies and stars to planets and organismic life, the rise of complexity along the arrow of time[5] may be uniformly quantified by analyzing the normalized flow of energy through open, non-equilibrium, thermodynamic systems. (Chaisson, 2005) The form of encoding that information takes—whether in genetic/molecular structure, or the structure imposed by a particular (social) code (language/protocol)—is one outgrowth of a vital bio-system and usually follows the same trajectory as the archive itself. All these elements, all these systems are absolutely intertwined.

The synergistic dynamic between life-sustaining energy flows and the maintenance of human social systems cannot be understated. The complex systems of information propagation that form and perpetuate of the entire (techno-)social- *and* bio-system are dependent on a relatively stable and continuous energy influx. Indeed, without that influx[6], life itself could not exist.

The suggested relationship between entropy—as a measure of the availability of energy—and order is intuitive though not always clearly definable. However, in the world we populate, there are many manifestations of energy flow that not only lend credence to our common-sense intuitions, but that are intimately related to our existence on the planet. All these flows have an impact on the archive-as-information.

To provide a wider perspective on the ramifications of entropic flows in relation to information, ordered structures, and the maintenance of life—all factors that impinge on the propagation and sustenance of the archive—I will invoke a holistic systems approach.

The Archive as System

The term 'system' is used throughout this text and because of this ubiquity, it needs expansion[7], though its history here has to be quite distilled. It is important to understand that what is now known as 'systems thinking' is a 'protocol'—literally a way of thinking (mapped into the energized body)—by which much of

the 'human constructed' world is now dominated.[8] It is integral to many branches of science, but more importantly, fundamental to the engineering of most aspects of our 'technological' world. A systems approach provides a means to explore widely differing phenomena that may very well share similar characteristics or processes. It forms a broad pathway through the contemporary complexity of the processes that humans control in their efforts to optimize their potential and their viability.

General Systems Theory as established by the Austrian biologist Ludwig von Bertalanffy (1950) suggests that different systems may share certain "isomorphisms" or characteristics of behavior and operation despite wide differences in scale, areal distribution, and overall function:

> *[T]he properties and modes of action of the higher levels are not explainable by the summation of the properties and modes of action of their components as studied only in isolation. But if we know all the components brought together and all the relations existing between them, then the higher levels are derivable from their components. (Bertalanffy, in Drack, 2009, p.566)*

The search for such shared characteristics reveals many systems that are—on a materialist basis—quite disparate but, applying a systems approach, may indeed be modeled or at least explored using frameworks that hold across their explicit categories.

This suggests that where a phenomena is comprised of a large number of complex and interacting and thus ordered elements (such as the archive and archiving in a social system), it is permissible to find a framework of a higher order that will treat this complexity as a single entity.[9] That some of the fundamental concepts in 'systems thinking' were universally applicable explains why it became such a crucial approach to a wide set of disciplines (Bertalanffy, 1950) at the same time as keeping in mind that everything is not systematic (Boulding, 1956): the approach is not a 'theory of everything!'

Perhaps the most basic set of rules that observable systems 'follow' are those related to thermodynamics. Simply put, the Laws of Thermodynamics apply to all systems that, so far, have been encountered within the scope of observation-based science. Of course, any scientific theory relies on models to expound on their efficacy, and woe to the scientist who makes the claim that a theorem applies to *everything*.[10]

Much of classical thermodynamics arose through the statistical consideration of closed and unorganized systems. It was not until physical chemist Ilya Prigogine (1972) began to explore the concept of open and organized systems as "dissipative structures" that the consequences of the thermodynamic model were seen to be a crucial, though enigmatic feature of autocatakinetic[11] (and living) systems and, of course, human (techno-social) systems may be seen as a subset of the wider self-organizing system of life on the planet.
The propagation of information is a constant process of flow through open systems without which those systems would lose their organizational structure and thus their functionality. This is the ultimate genesis of archive—the need for a human system to maintain its structural integrity in order to 'continue itself' in time: Life's *need* to project itself into the future.

While the descriptors associated with the complexity, order, and entropy (as a measure of disorder) of two different systems may not be compared directly, it may be said that any ordered open system exists within a wider field of energy flows:

> *Complexity is a property of systems concerned with component parts and their connections. Complexity is measured as permutations, entropy, information content, and statistical parameters and by energy flows. (Odum, 1994, p.302)*

Our bodies are the repository of information: bound in DNA and neural structures are the traces of information that is carried, *an archive*, from the past to the uncertain future of Life. The accumulated and intertwined structures of our social system are in no way immune from the same entropic paths. In any system of information transfer "error accumulates in structural damage over time." (Odum, 2007, p.225)

Within information theory, this is generally categorized as noise. Eventually, a system fails because of a diminishing of the energy influx that is necessary to maintain its order. Toleration for noise may be correlated with the relative energy-wealth of a system: an energy-rich system can 'allow' for more noise.

In a bio-system, the concepts of natural selection introduced by Darwin provide an explanation for the maintenance and evolution of species. The generation of offspring provides the opportunity for those most suited to surrounding conditions to survive and in turn produce more offspring. If all the offspring survive, there is no selection; a choice must be provided by excess creation and mechanisms of selection. The simplest is self-selection by the best adapted. Selection is the primary process in the generation of an archive.[12] The archive itself is evidence of a self-organized evolutionary system, and may be seen as a functional sub-system of the wider system of life on the planet.

Evolution may be represented as the 'mechanism' deployed by Life to optimize information storage, transfer, and retrieval in a (so-far) increasingly complex planetary system.[13] The recent rapid increase of organized complexity in the human social system may be directly related to the increased (technological) accessibility of hydrocarbon energy sources—solar energy sequestered over many tens of millions of years. These same core attributes apply to the archive.

Conversely, a social system has various mechanisms for maintaining its viability, and the archive is one of these. The archive provides energy-efficient information storage that allows the social system to optimize its potential. The archive may take a wide variety of physical forms from the embodied neural structures of memory to the vast *bibliothèque*, from encyclopedias to the digital 'Cloud' that is rapidly superseding and expanding upon many former manifestations of archive. At no point in history has so much energy been used to organize and save information.

The archive as an organized open system—regardless of its form—is a set of energy relations and flows that form an ordered pattern, a structure. It is also defined by processes that are periodic or ongoing—both internally, and between it and other external systems. It is this dynamic that is most crucial to understand when considering how to sustainably establish and maintain a store of information.

The (Art) Archive as Re-source

At a more personal level, reflecting on an art praxis that has generated a substantial archive[14] as an integral part of that process, the archive may easily become a burden that draws the life-energy and life-time away from the focused immediacy of *be-here-now* living. The balance between energy/time spent to just live and energy spent maintaining the archive is under constant scrutiny. The energy resources of any system are not infinite.[15] Because of this, the sustainability of different manifestations of archive need always be measured and considered against the resources of the system. How many redundant copies (on hard-drives, in other minds, in progeny)?; How often to copy and update (teach, propagate)?; What software (social protocol) to catalog with (what language to speak, who to procreate with)?; How to allow/provide access (interfacing, gate-keeping with the wider social system, what communities to participate in)?; What sampling algorithm (codec, reduction) is to be employed to keep the map from asymptotically approaching the complexity the territory.

A work of art, regardless of its form, can be considered both an open system and an archive that obeys all thermodynamic laws. Take, for example, the creative process of the work "I am sitting in a room…" by Alvin Lucier (1981) where there is a simple and definitive demonstration of the temporal archive (a recording) and the gradual effects of entropy (noise) on the (dis)ordering of communicative artifacts (in this case, sound) as a store of (energized) information that is moving into the future.

Then there is the occasion of the re-releasing of the archived information, as one listens to Lucier's 'archive': with its potential energy, one may be *in-spired*, energized. Otherwise, why create an archive to begin with if it is only a drain on energies? Recalling Howard Odum's dictum that information improves the persistence of structure suggests that within either a localized or wider system, the maintenance of a certain level of

information propagation is desirable and, ultimately is necessary.

Facing the condition that projecting ordered information into the future (memory *becoming*) requires an energy input, large quantities of my life-energy are spent maintaining my personal archive. Between time spent raising the abstract fiscal instruments that are convertible into numerous quadruply-redundant hard-drives, software platforms, acid-free containers, and simply life-time itself to impose order on what 'naturally' tends to disorder, the archive is a constant energy drain. Scalar open-system relations make the whole endeavor subject to wider energy flows: for example, the camera used to make the archived images could not have been produced without ample electricity and machinic systems themselves generated from hydrocarbons. This leads back to the fact that I exist—along with a majority of the people (as bio-system information carriers, archives of genetic diversity) and the complex human infrastructure around me—solely because of 'easy' access to hydrocarbon energy sources of the last 150 years (Zabel, 2009).

Art is information[16], and like many contemporary 'media' artists, a significant portion of my life-energy is expended in creating and maintaining a substantial personal media (information) archive. I often ask myself: Why is this a part of my practice? Currently the digital archive numbers more than 350,000 digital media objects that are meta-tagged and ready for use in *mediated analog* encounters with the Other.[17] One long-standing and ongoing practice is to use these objects as a *re-source*, data-mining it for potential novel configurations of resonant and creative wealth. The tech-no-mad (b)log[18] is one such expression.

As an archivist, one has to have a source to gather from. My source is, as I describe it both reverentially and glibly when asked: who I am with, what I am doing, and where I am.[19] Gathering traces of energy from the resonant continuum of lived existence evolves into the habit of having a text, audio, or camera-based[20] recording tool within reach much of the time. The subtle retreat from direct sensual experience in order to create fragments of mediated life is a dynamic that reflects on my relationship with that thread of life as it passes by. The precise genesis and nature of that dynamic I am unsure of. It could simply be an imitative act from early family experience, a psycho-social code: *tradition*. That, and it is broadly supported (even passive-aggressively mandated!) by the techno-social system that I am embedded within.

A Short Discussion of Code

There are two important concepts that have a deep bearing on the overall process of contemporary archiving: the first is money;[21] and the second, the 'digital' or 'code.'[22] A full treatment is far beyond the scope of this text, but it is apropos to reflect on both in brief, given their influence on the operation of an archive.

The abstracted instrument of social exchange, *money*, effectively obscures the associated pathways of energy and power flow. Much of the globalized system is regulated by a feedback system that is fully *mediated* by this abstract fiscal 'instrument.' Money, especially as a driver of optimization, is largely abstracted from the energy flows that it is deployed ostensibly to regulate. The use of money is rooted in the reliance of large and complex social systems on externalized collective memory (including the archive) and thus abstracted systems of representation. Money is ultimately a socially-formulated, variably convertible abstraction of life-energy. Provision of 'legal tender' controls the value and general (social) usage of the instrument. Its value is also affected by the trust of those participating in the social system—a trust in the conversion process from the abstract to real and vice versa. Abstraction obscures the direct relation of life-energy inputs and outputs in relation to the social system. There are direct and indirect correlations between money and real energy exchange, but exchange of monetary 'value' is *not* the exchange of energy. On the contrary, archiving *always* requires real energy movement: it is fundamentally not an abstraction of energy. To understand where the archive sits in the wider techno-social system, it is vitally important to look for the actual flows of energy and to not get lost in the labyrinth of abstraction constructed around fiscal instruments.

Code and money are both likewise abstracted representations of (social) power that have to be actualized through two means: 1) a social system comprised of participants who choose to believe in the potential of the abstraction to causally effect material change in their embodied existence and 2) a way for the abstracted instrument to interface with 'real' (energized) momentary existence. Abstracted power has to have a way to

apply change to individual and participatory life: it has to be *delivered* (as the essence of that change). The continued emphasis on the abstracted instrument permits the real power (structure) to remain intact, uncontested, and *in control*.

Code describes what a digital device can or should do in the abstract. Code needs the device (a configuration of energized matter) to realize its human-defined potential. Code without a consequent transmission of power (kilo-calories, joules, megawatts, whatever) is a complete abstraction and is of no consequence except as it persists as a temporal trace in the memory of the coder or the device. The machine or interface that actualizes the code is embedded in a specific field of power flows (i.e., the electrical generation and delivery system, manufacturing systems that depend on transportation networks that depend on hydrocarbon fuel power, etc.). This larger techno-social infrastructure is essentially a field of directed energy flows that depends on a whole host of humans *believing* that the code, via that system, will actualize improvements in their lives. If doubt arises that the code will not succeed in this, the whole system begins to unravel. If it becomes clear that the code is failing to bring vital power to the user, they will stop putting their life-energy into propping up the system that deployed the code.

Codes—of religious teaching,[23] of social behavior, of machinic protocol, and of economic instrument—all share the characteristic that they are completely dependent on being actualized this way, else they have no power. In the end, code is merely a socially prescribed pathway along which, potentially, real energy may be induced to flow. Because code, *the codex*, is especially efficient in the generation and deployment of rigid systems of protocol and standard, and most of all, command-and-control, code, as a system of digital representation, becomes more and more ubiquitous across the techno-social system.[24]

Belief in the code(d abstraction) of the digital produces a shared or centralized capital of potential power, but there always needs to be a tangible means for translation from code to embodied be-ing. The body is the primary means for code to become lived action or the source of applied and energetic change. It is the minimum device necessary, all other devices are simply collective amplifications of the body-as-energy source.

An archive may be described as a hybrid code/energy (digital/analog)[25] system. The difference between the two correlates with the abstraction process between money and energy. A digital signal is digital only in a static and dormant (potential) and provisional sense. Just as money is the abstracted social representation for (potential) real energy exchanges, the digital (as an abstracted protocol for the organization of information) is a representation of what is, at base, a movement of energy. Digital information is a representation of some originary flow of energy 'out there': when the digital it is in motion (to qualify it as information!), it is analog. Archiving a digital data-set does not impact the nature of the digital data-set in its abstraction. The archiving of a digital 'signal' is fundamentally the archiving of an analog energy flow: it is coded abstraction coming-to-be. By the discrete and representative nature of the digital, the energy consumed in 'digital' archiving is only an issue at the analog input and output. A 'digital' unit of data on a spinning hard drive disk is a temporary set of aligned magnetic dipoles (which take energy to align!). To transfer data is to duplicate the highly ordered arrangement of dipoles in another location through electromagnetic amplification (and transmission) following a precise pathway within a highly defined and strict set of protocols: what is the energy cost of one bit flipping? Duplication, transmission: *use* of the archive *requires* the movement of energy.

Remembering the cloud

Considerations of maintaining a 'traditional' archive—at a level that is sustainable within a particular social system—are typically couched in terms of funding, personnel, and physical space. In the case of the typical digital archive, all three of these factors, and especially the latter must be taken into account. To the detriment of the wider life-system that encompasses the entire planet, the physical aspect of the contemporary social-media-driven digital archive is commonly misrepresented as the permanent immateriality of 'The Cloud.' This is the same cloud that is consuming ever higher percentages of global hydrocarbon-driven electrical energy consumption (Mills, 2013). Just as the six of seven billion people on

the planet are seen as having come into being as a direct result of the availability of hydrocarbon extraction and use, so the appearance of The Cloud as a techno-social manifestation is tied to (transitory!) energy resources. This form of archive is not sustainable at present levels. Or, more precisely, it is sustainable only with massive expenditures of (mostly) hydrocarbon energy to maintain its high level of order and its sheer volume. As energy (re)sources continue to tail off and to be spread among a larger global population, order will eventually decrease, and noise less tolerated. The Cloud will be rained on by a parade of failures driven by entropic instability. And we will be forced to forget what that old friend from Junior High school—whose name we ourselves cannot summon— 'liked' last week.

When the issue of energy-use comes up the typical cloud industry defense is likely based on a local closed-system model where claims of economies of scale, cherry-picked energy-savings from other sectors, and increases in technical efficiency are invoked.[26] However, thermodynamics suggests that more information stored in a more complex indexing system[27] with ever-wider usage will cause higher energy consumption when the wider (planetary) system is being considered. Examining higher-tech 'solutions' at a wider scale—for example, increased information storage density—reveal a generally more energy-intensive manufacturing process to maintain ever-increasing standards of precision necessary to support the higher-density product. Given that a hard-drive of a certain scale and technological complexity will store a certain number of bits. To create another physical device that will double the density of that storage, one needs a technological manufacturing infrastructure that has to operate at a higher level of order to produce such a device. This increase in what Papentin (1980) describes as secondary order (as the degree of organization inherent in a pattern) predicates that consequently *more* energy will be used to produce and maintain that higher level of order. Intertwined with the required technological prowess, Moore's Law[28] is predicated on ever-increasing availability and usage of energy! The Cloud has a long tail.

There is no free lunch. Greater organization and higher information density—an archive that allows more complex searching, parsing, and general interactivity (with the wider system it is embedded within)—involves relatively greater flow of energy to maintain as an ongoing resource. If you want to remember the names of all your references for that series of lectures you are giving, you need to expend life-time in creating and maintaining an externalized (technological) memory infrastructure or you need to maintain a clear mind which likely is compromised by drinking heavily, not eating right, not getting enough sleep, and so on. You have to maintain your body-system to propagate your life-information-archive. This takes an (information) awareness of internal and external energy flows relevant to your bio-system.

The cost of participating in The Cloud is not insignificant: it can be calculated in life-time. That is, attention —eye-balls-on-the-screen-time—given over to those holding the codes and protocols that drive the Cloud. That time, that attention is not without cost, and it gives those creating the protocols great power over those who are locked into a relationship with this global techno-social system. Our lives are the ultimate energy source for The Cloud.

Closing Observations

What then of the archive? One perspective is that it is an energy tax imposed on anyone participating in life on the planet. Saving information always has an energy cost to the wider system. In a particular system experiencing a localized energy glut, the existence of archive is one ostentatious expression of that glut. It may include masses of information not precisely necessary for the continuance of that local system. Thus the question, in the face of declining energy sources is always: "What information is absolutely necessary (what shall be archived)?" This question underlines the crucial counter-point that *without* necessary information, survival is compromised.

Those three social factors affecting the archive—funding, personnel, and physical space—are inextricably rooted in the availability of surplus or dedicated energy available within the wider social system to fill those needs. Fiscal funding, a proxy for the last two, as the dominant field of abstract discourse (within the 'Market') often ignores the fact that in a situation of non-infinite energy (i.e., the entire observed cosmos!) not all information may be propagated into the future. One may still Google some topics for which there are

no real answers. When all knowledge is 'within' the Google archive, it will be time for the next Big Bang.

A particular living organism may be seen (merely) as a means to project (genetic) information into the future: allowing life in general to proceed more efficiently than having to re-create itself from a more primitive (less ordered) form in each successive generation. Likewise, for example—in a localized, personal, and embodied sense—building an archive from books will likely be far less energy-intensive than constructing one in meat-space memory from, say, face-to-face interviews of individuals—if one considers reaching the same end-point of information 'density' (or sustainable usefulness). The book-based archive, however, depends on the existence of precursor information-dense archives already created by the techno-social system, not to mention that the ultimate usefulness of the archive is a highly subjective metric to both the individual and to that wider techno-social system. This disparity between personal and collective information metrics is a facet of the frequent disjunct between individual and collective survival and of the contents of any information archive.

Thermodynamics ultimately suggests that the 'lifetime' of an archive follows a finite trajectory. Information is transitory, and consequently, social memory, personal memory, species memory, is an ever-changing flux in relation to correlate energy flows. The question of cost is intimately related to the question of duration and to the question of the architecture of the initial reductive process that distinguishes between the object of the archive and the essence that it is capturing. Without a profound consideration of the realities of energy movement, any prediction as to the duration and system cost of an archive, in the very widest sense, is fraught with the potentials for errors in judgement. The energy source or sources that the archive is dependent upon needs to be clearly identified at all scales.

In the context of all I have explored here so far, the digital archive stands as an example of externally stored memory. Restating: to project ordered information (memory) into the future requires an energy input, large quantities of life-energy are spent maintaining this archive. The archive is a constant energy drain: albeit on the sliding scale of energy correlated with information density. On the other hand, it is a *source* when shared: of the energy put into it, some may be retrieved. If you have read thus far, you have entered my archive; and so, I have entered yours, temporarily. The shared protocols of memory, of shared synaptic impression from events in the long past may be revived through these energized fragments; and perhaps the decrepitude of life's twilight years will be brightened with the formed and hoarded light and sound of years long past. In an energy-poor future, the archive—the analog at least—may also be burned for warmth.

An archive has to take into account all these things. And, as has been frequently been demonstrated in the past, without the energy to sustain an ordered social system that the archive exists within, the archive will vanish into less organized forms—whether into the flaming heat-death as happened in Alexandria or simply into a slowly decaying array of magnetic dipoles sitting on an un-plugged and spun-down hard drive being randomly peppered with cosmic rays.

The question arises again and again, though, as a media arts practitioner: why archive? Or, more precisely, what exactly should I commit to the archive? Why be concerned with projecting memory into the future? Why compromise present viability by pouring energy into augmenting and maintaining this ordered system? Is it a reaction to the fear of death, fear of not-being: an obsessive-compulsive reaction to mortality? I cannot answer this, but it is clear that when any system delegates too much energy towards information/data storage, that system is compromised. That is the case when the energy saved and shared through using this information is exceeded by that necessary to maintain the archive. Imagine erasing all digital instants shortly after recording them: that would perhaps be life-saving. In the end, this life-sourcing ends along with life, and the archive begins immediately to disintegrate to disorder unless another life-energy source comes along to maintain it. Perhaps it is best to recall *memento mori*[29] and leave it at that.

1 At this moment in history the ever-expanding surveillance state faces this problem. As an example, Václav Havel's well-known 1985 essay "The Power of the Powerless" contains a profound exploration of the nature of power in an extremely hierarchically-controlled social system near the end of its existence. It is a system that "for a thousand reasons, can no longer base itself on the unadulterated, brutal, and arbitrary application of power, eliminating all expressions of nonconformity. What is more, the system has become so ossified politically that there is practically no way for such nonconformity to be implemented within its official structures." It is the application of power via protocol that exerts the control and eliminates (as that exertion becomes more and more intense) any spaces for autonomy to exist. But these systems reach a saturation point where the control (and particularly the data feedback and thus, archiving) system, a necessary structural part of it, begins to absorb all the energy available to the system overall—destroying it from the 'inside.'

2 As in the title of Media and Culture professor, David Sholle's 1999 paper "What is Information? The Flow of Bits and the Control of Chaos," where he suggests that information "takes on an elemental quality, akin to matter or energy" and where "there is a definitional isomorphism between information as the flow of discrete bits and information as commodity."

3 "'Organized' systems are to be carefully distinguished from 'ordered' systems. Neither kind of system is 'random,' but whereas ordered systems are generated according to simple algorithms and therefore lack complexity, organized systems must be assembled element by element according to an external 'wiring diagram' with a high information content ... Organization, then, is functional complexity and carries information." (Wicken, 1979)

4 See, for example, Gray, R. M., 1990. Entropy and Information Theory. Document available at http://ee.stanford.edu/~gray/it.pdf. Accessed 06/04/2014.

5 Arthur Eddington, physicist, wrote an early description of the concept 'arrow of time' in *The Nature of the Physical World*, New York, NY: The Macmillan Company, p.69- 80, 1929.

6 In the context of the planetary system, the primary source is, obviously, the flux of solar radiation reaching earth's surface: David Price (1995) remarks, "[l]ife on Earth is driven by energy. Autotrophs take it from solar radiation and heterotrophs take it from autotrophs. Energy captured slowly by photosynthesis is stored up, and as denser reservoirs of energy have come into being over the course of Earth's history, heterotrophs that could use more energy evolved to exploit them. Homo sapiens is such a heterotroph; indeed, the ability to use energy extrasomatically (outside the body) enables human beings to use far more energy than any other heterotroph that has ever evolved. The control of fire and the exploitation of fossil fuels have made it possible for Homo sapiens to release, in a short time, vast amounts of energy that accumulated long before the species appeared."

7 system: An organized or connected group of objects. A set or assemblage of things connected, associated, or interdependent, so as to form a complex unity; a whole composed of parts in orderly arrangement according to some scheme or plan; rarely applied to a simple or small assemblage of things (nearly = 'group' or 'set'). Etymology: 1610s, "the whole creation, the universe," from L.L. *systema* "an arrangement, system," from Gk. s*ystema* "organized whole, body," from *syn-* "together" + root of *histanai* "cause to stand" from PIE base **sta-* "to stand." Meaning "set of correlated principles, facts, ideas, etc." first recorded 1630s. Meaning "animal body as an organized whole, sum of the vital processes in an organism" is recorded from 1680s. These meanings are sourced variously in the usage of the word as it arose from the Greek as the agency "to cause to stand together" and as an "organized whole, body" (OED).

8 Some fields that are involved in this broad area of 'systems' include: systems analysis, operations research, operations analysis, complex systems, systems ecology, statistical analysis, mathematical modeling and optimization, dynamical systems theory, probability theory, simulation, decision analysis, management science, etc. Hammond (2010) gives an excellent overview of the development of the underlying 'philosophy' of systems. Adams, 1988; Bertalanffy, 1950; Bailey, 1994; Boulding, 1956; Lotka, 1922a & b; and Odum, 2007 provide more detailed background. Systems thinking deals with complexity, interdependence, emergence, synthesis, synergy, holistic 'big pictures,' and networking among other attributes (Mulej, et al 2003), who also suggest that "Systems thinking is the practice of those who are holistic enough in their thinking, decision making, and action to cover all essential attributes because they are broad and interdisciplinary enough."

9 See (Miller, J., 1995) for an explicit model framework of the scalability of living systems that "exist at

eight levels of increasing complexity: cells, organs, organisms, groups, organizations, communities, societies, and supranational systems." See also (Miller, J.L. & Miller, J.G., 1992).

10 The public climate-change discourse suffers this condition—where 97 percent of the science community consensus is that global warming is in large part human-caused—(see, for example, Doran & Zimmerman, 2009; and https://skepticalscience.com/global-warming-scientific-consensus-intermediate.htm). Because scientists will invariably introduce non-absolute adjectives into their conclusions ('we are pretty sure...') it ends up that overall, public media introduces a 50/50 bias in the percentages of stories pro/con climate change (see also Boykoff & Boykoff, 2004; and http://stephenschneider.stanford.edu/Mediarology/Mediarology.html).

11 From *auto-* "self" + *cata-* "down" + *kinetic*, "of the motion of material bodies and the forces and energy associated therewith" from *kinein*, "to cause to move." (OED) A system maintains its "self" as an entity constituted by, and empirically traceable to, a set of nonlinear (circularly causal) relations through the dissipation or breakdown of field (environmental) potentials (or resources), in the continuous coordinated motion of its components. (see for example, Swenson, 1997; Swenson & Turvey, 1991)

12 And the archive, to pick one example, say, a written history, is often formed by forces arising as 'best-adapted' to the social conditions surrounding it. It may, also, of course, be propagated by happenstance, chance, or other mechanism.

13 "So human social organizations constantly reconstitute themselves through a flow of members and other adjunct materials, information, and energy. Many of these are selectively favored through a continuing expansion or effort to expand above their original size." (Adams, 1991)

14 The http://neoscenes.net and http://tech-no-mad.net/blog are ongoing public interfaces to that archive that first established an online presence in 1993. The analog archive comprises more than 100,000 objects, perhaps 3 m^3 of *stuff* (negatives, prints, tapes, CDs, and on paper); the digital presently around ten terabytes, or 350,000 discrete 'objects.'

15 Although, one could propose the situation where the more open the system, the more potential energy sources are available, increasing the survivability of the system, albeit in a more rapidly changing (unstable) state.

16 See for example, Sherman, T., 1995. *The Finished Work of Art is a Thing of the Past*. Available at: http://www.neoscenes.net/hyper-text/text/third/sherman.html [Accessed June 17, 2011].

17 Via email, fax, postal system, html, mailing list, prints, postcards, letters, the Web, the internet, telephone, conference papers, workshops, streaming media, IRC, *ad nauseum*.

18 http://tech-no-mad.net/blog/

19 In a 'traditional artistic' endeavor this might read: portraits, documentary, and landscapes. However, in the sense of energy flows, it is a combined stepping out of and tapping into the energized trajectory of lived life. It seems that the stepping out of the flow is requisite for creating the energized fragments that persist into the archive's uncertain future. By placing myself into the nexus of my own lived-life, I also acknowledge the *presence* of the observer: where Quantum suggests that the Observer changes that-which-is-observed. This aspect of reality makes the process of observing and archiving all the more in need of reverential care and attention to some energy source.

20 The flow-altering characteristics of optical glass should not be forgotten! It can be argued that the camera is a prophylactic for the vicissitudes of chaotic life-flows. I note a similar effect when recording audio—especially when wearing headphones—but there is an even more subtle effect that I believe also relates to the presence of the Observer. Perhaps this is precisely because the recording observer has to step into a form of filtered and attenuated presence and thus is slightly removed from full attentive presence. That absence is experienced in the surrounds.

21 "Where any view of Money exists, Art cannot be carried on, but War only" (Blake, 1820) was the pithy quote that sat as the header for my original "neoscenes" web site from 1994 until 2004 when it was finally replaced by an under-utilized Paypal donation button.

22 That is, computer code or any other system of laws, rules, regulations, signals, or instructions that act to direct actual flows of energy. (from Latin *cōdex*, later spelling of *caudex* trunk of a tree, wooden tablet, book, code of laws. (OED))

23 "Apparently, all societies develop religious institutions that give human individuals learned programs of dedicated behavior. Cultures prevail that motivate people to contribute to the maximum empower of society, but poorly adapted religions interfere with optimum functions. With the expanding role of society on Earth, the ethics of human behavior requires morality on a larger scale not much covered by earlier religious teaching." (Odum, 2007)

24 "Electronic surveillance by nation states and corporations aims at controlling the behavior of individuals and groups, i.e. they should be forced to behave or not behave in certain ways because they know that their appearance, movements, location, or ideas are or could be watched by electronic systems." (Fuchs, 2007) Our contemporary surveillance regime provides ample evidence of the profound and negative effects of information propagation (including Havel's sclerotic state-of-the-state!). The creative always suffers under surveillance.

25 The digital is the abstracted (sampled) representation of the analog: a sampling of a flow that reduces the energized sample to a numeric (abstracted) coded value. This is the essence of a 'digital-to-analog converter' that is the primary interface between the world of flows and the abstracted world of code. D-to-A conversion is a form of information transfer (and thus, *energy* transfer).

26 See "Google Apps: Energy Efficiency in the Cloud" published in 2012 by (you guessed it, Google, Inc. Available at: http://static.googleusercontent.com/media/www.google.com/en/us/green/pdf/google-apps.pdf [Accessed January 10, 2014].

27 The usefullness of an archive is directly related to the efficiency with which it can be accessed, parsed, searched, 'mined,' or interpreted—as a re-source to the system that spawned it. Discussions about 'Big Data,' another current buzz-word, usually neglect the point that more data means a higher degree of complexity to contend with. This increased degree of complexity makes the process of 'massaging' the data into useful forms ever more energy intensive.

28 Moore's Law simply states that the 'information density' of integrated circuits doubles every two years. This technological 'capacity' relies on the expansion (in degrees of complexity and precision) of a globe-spanning industrial production system which ultimately relies on hydrocarbon availability.

29 *Remember that you will die*.

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