How to Look at Clouds: Energy Beyond Atmosphere in Architecture

FILIP TEJCHMAN
University of Wisconsin-Milwaukee

With the progressive influx into architectural practice of new techniques of dynamic visualization and simulation, the nature of energy has gradually become more material. How to Look at Clouds: Energy Beyond Atmosphere in Architecture, examines the nature of this productive disruption and explores the recent work of a range of practitioners, interpreted through the visual categories articulated by Gyorgy Kepes. The result is a proto-guide; instructions on how to envision energy in architecture, that addresses how architects can leverage these emergent tools to author novel compositional and material opportunities, yielding new insights into the relationship between architecture and energy.

DISCLAIMER

At this moment, here in this room, but also in this specific historical moment, it is customary and expected when mentioning the weather, to participate in a form of collective penance and immediately cite the many pathologies related to our environmental crisis — melting sea ice, super-storms, the great pacific garbage patch, and mass extinctions. Our lifestyle and survival are under a very real threat. This is a crisis, one that Bruno Latour describes as, "a profound mutation in our relation to the world," it must be recognized and a response is necessary.[1] Recognition implies familiarity, suggesting that the identification of a thing is contingent on our ability to locate it within or connect it to what is already known. Can we recognize ourselves in this crisis? And if so, how? Despite its best intentions contemporary architecture is not particularly well equipped conceptually, linguistically, or technically, to do more than reinforce a range of anachronisms. To put it bluntly: by attempting to update a 20th-century model of thinking, that celebrates 19th-century modes of production, in order to address the concerns of the 21st-century, we are more likely to indulge in our desire to do-good than accomplish anything of lasting merit. In "The Great Derangement", the writer Amitav Ghosh provides this diagnosis, "the climate crisis is also a crisis of culture, and thus of the imagination."[2] Regardless of the source, it is accepted that the construction, maintenance, and operations of buildings accounts for a staggering proportion of the annual greenhouse gasses emitted into the atmosphere.[3] Perhaps this crisis of architectural imagination is not founded on an inability to represent and reveal the problem? It could reflect our disciplines uncanny capacity to conceal the latter, though it is doubtful that any of our peers and colleagues would confess to willingly participating in the coordinated practice of obscuring the scope and nature of the situation. This essay proposes an alternative understanding of this relationship between architecture and the environmental crisis, which cannot be reduced to quantifying and measuring the consumption of resources, or endlessly searching for a quick-fix.

While crisis, have the capacity to bring about radical reconfigurations in our collective and personal lives. To make a crisis productive, demands that the outcome be rooted in understanding the problem, its scope, associated contingencies, biases, underlying causes, and liabilities. Admittedly, the very nature of a crisis makes attaining this degree of reflective objectivity — already a questionable enterprise — a little bit challenging. We are unquestionably trapped in our own subjectivity, but are at every moment capable of, and often contribute unconsciously to, the transformation of those boundaries. "How to Look at Clouds," is therefore not intended to explicitly solve or address a discrete crisis, rather its purpose is to nudge, tickle, and prick, your conception of energy in ways that I hope will eventually contribute to some change, perhaps positive, and most likely unpredictable, to the modes of cognition through which we construct and understand our relationship to the world.

HOW TO LOOK AT CLOUDS

When we look at clouds, what do we see? Do we see a shadow of the formless, an insignificant residual vapor foretelling the storm about to pass over, promising rain, or withholding those "meteors" because of an unseen spite?[4] Is it the rising and falling of air-currents, buoyed by the changing volume of air born from variations in temperature?[5] Do we see a fragment, a discrete reminder of the persistent cycles of evaporation and condensation? Do we "see" through the autonomous eyes of the other "cloud," an indeterminate system of data, a constellation of information that teases at the possibility of predictability and revelation?[6]

Figure 1: Luke Howard, Cirrocumulus, cloud study, c 1803-1811. Image courtesy of the Science and Society Picture Library/ Science Museum Group UK

It was in 1802, that clouds began their transition from atmospheric figment to weather pattern. Clouds were first organized into categories and assigned a nomenclature based on their "structure and manner of aggregation," through the repeated observations carried out by Luke Howard, a British chemist/pharmacist and amateur cloud-gazer, and whose primary mode of study consisted of sketches and water-colors that attempted to document with some regularized consistency the ever-changing dynamic forms that he observed.[7] The concept of cloud certainly existed prior to this; in his treatise on Meteorology, Aristotle speculated on the correlation between temperature and wind as the underlying mechanism for the evaporation and condensation of water vapors into clouds. Aristotle's attentions, however, did little to alter the perceived insignificance of clouds as simply masses of water condensation helplessly adrift in the wind. Clouds were also a common painterly trope at this time; a picturesque landscape would not be considered complete unless it included a layer of atmospheric drama in the background.[8]

Undeterred by these artistic tendencies and the historically low opinion that his object of study had sustained, Howard prefaced his work by stating that: "If Clouds were the mere result of the condensation of vapour in the masses of atmosphere which they occupy, if their variations were produced by the movements of the atmosphere alone, then indeed might the study of them be deemed an useless pursuit of shadows, an attempt to describe forms which, being the sport of winds, must be ever varying, and therefore not to be defined."[9] His intuition that the significance of clouds was underestimated may have been sustained by a series of experiments and discoveries concerning the relationship between temperature, pressure, and the behavior of gasses, which were conceived by Young and Laplace, as a sort of pre-thermodynamics exploration of the mechanical behavior of fluids.

Howard's intention was to provide a universal reference, an explicit frame of knowledge that would "…enable the meteorologist to apply the key of analysis to the experience of others, as well as to record his own with brevity and precision."[10] His efforts were first presented as a lecture and later published in, "An Essay on the Modification of Clouds" (1865). Though the emphasis was on the discrete examination of the formation of clouds, his analysis implied a relationship between these dynamics and the patterns of weather taking shape around him, he described this as "subject to certain distinct modifications, produced by the general causes which affect all variations of the atmosphere: they are commonly as visible indications of the general operation of these causes as the countenance (is) of the state of a person's mind or body."[11]

This codification of clouds as developed by Luke Howard would ultimately serve as the basis for continued refinement of the subject and later appear in another seminal work on the developing discipline of meteorology, entitled, 'Researches about Atmospheric Phaenomena' (1813), by Thomas Forster, a British botanist and amateur astronomer. Forster's publication reflects that era's growing recognition that weather is a global condition in which,"The atmosphere and its phenomena are everywhere, and thunder rolls, and rainbows glitter in all conceivable situations, and we may view them whether it may be our lot to dwell in the frozen countries of polar ice or in the mild climates of the temperate zone, or in the parched regions which lay mote immediately under the path of the sun."[12] As a bit of foreshadowing, the latter statement also implies a tacit re-ordering of climate as an unexceptional and dependable component of the commonwealth of natural resources — a thing to be harvested, monetized, or otherwise ignored.

Figure 2: "Fluid Forms" by György Kepes (1944) Copyright: the Estate of György Kepes. Through fused-glass paintings and high-speed photography, Kepes explored the fundamental instability of matter, and attempted to replicate the organizational and aesthetic effects of energy.

To recognize a cloud as cumulus, stratus, or cirrus, is just one manifestation of the technological epsiteme associated with a broad "scientification of knowledge" that occurred during the late 18th and early 19th-centuries.[13] This era was witness to the parsing of the sciences and natural philosophy into disciplines; new and specialized areas of knowledge-making, characterized by the establishment of institutional or otherwise universally-agreed-upon protocols for observing, measuring, and representing the natural world.[14] It was a moment when the familiar and everyday became subjects of study, subordinate to governmental rule, regulation, codification, naming, hoarding, management, and control.[15]

This period overlaps with the prominence of romanticism in the arts and humanities, a convergence that is often reductively interpreted as a reaction by one to the other — the rationalized and regularized space of the newly ascendent and technologically enabled bourgeois juxtaposed with the untamed and emotionally vibrant space of a raw and virginal nature.[16] While extreme examples of a mechanized humanity are often contrasted with the spiritual wildness of nature to illustrate this point (see: Mary Shelley's Frankenstein; or, The Modern Prometheus, 1818), the more populous and complicated middle-ground, is characterized by the sublimation of "truth-to-nature" protocols apparent in scientific image-making and the cultures of representation in the arts. These image-making and image-reproducing protocols, whether based in the application of instrumentation to the physical world, or more appropriately, the intervention by these tools and techniques to rationalize and discipline the human senses in order to construct an instrumental mode of cognition are what Jonathan Crary, refers to as "subjective vision."[18]

Within a relatively brief span of time, insignificant vapours became categories of clouds, recognized as indicators of the weather, which — eventually — became a global climate. While links to ocean currents, jet streams, and greenhouse gas emissions would come later, the immediate cognitive transformation was manifested in the cloud studies and paintings artists such of JMW Turner. The painterly abstractions of Turner, may have been nothing more than a revelatory gesture to thermodynamics, but they demonstrate what Michael Baxandall introduces in Patterns of Intention (1985); "to live in a culture is synonymous with a specific education of the senses," an idea that Antoin Picon later described as, "the cultural construction of perception." [19] That the romantic representation of nature developed in reciprocity to its simultaneous translation into information by systems of vision and visuality premised on the construction of a measurable "objectivity," hints at the origins of the dichotomies that comprise our current modes of recognizing nature.

The latter definition of "culture" sublimates the explicit knowledge created by a persistent instrumentality with a popular subjectivity. How we look at clouds today, is built upon a similarly constrained range of political, instrumental, and ecological biases, alienated from the fundamental instability of nature.[20] Clouds, though familiar and recognizable, are a manifestation of what Jane Bennett refers to as, "vibrant matter," an ontological term that reconciles Henri Bergson's "latent belief in the spontaneity of nature," the mechanisms of weather do have a tendency to surprise, after all, and the what the political philosopher Jaques Rancierre, terms the "partition or distribution of the sensible," which is comprised of the a priori laws "which condition what is possible to see and hear, to say and think, to do and make".[21]

The historical trajectory that the transformation of clouds from individuated fragments to data points within a global climate system made visible by an autonomous mode of vision, is not the culprit. Rather, it is a reflection of our culturally constructed partition of the sensible, which reinforces a concept of nature predicated on our absence, while simultaneously partitioning the specificity of that concept along disciplinary boundaries. It would seem then that to look at clouds requires confronting the impossibility of de-instrumentalizing our modes of cognition. However, an alternative to removing the partitions imposed by instruments and disciplines is to conceive of those mechanisms as actants that participate in the formation of those structures. How then might the analogy of looking at clouds inform a similar cognitive inversion of the relationship between architecture and energy?

The post-war episteme, saw the proliferation of numerous new sciences and methodologies. The formulation of General Systems Theory, was one of these outgrowths; its origins can be attributed to multiple contributors and sources. Though appearing at different moments in this history, computation, cybernetics, numerical analysis, and statistical mechanics, eventually intersected in ways that yielded a synthetic and flattened view of the relationship between energy, matter, and information, redefined and unitized into discrete resource flows.

In a closed "system, one of the fundamental and dependable principles of the first law of thermodynamics is that energy cannot be destroyed, it can, however, be transferred and transformed. An application of these scientific principles as a way to measure energy flows in the environment, was conducted by Howard T. Odum and Eugene Odum, and published as, Fundamentals of Ecology (1953); their work incorporated the use of electrical-circuit and Sankey diagrams, retooled as an "energy systems language," allowing for the mapping and accounting of resource flows through ecosystems. Widely adopted and adaptable, these abstract diagrams sought to align the flow of matter, with that of information, capital, bodies, and goods, compressing all into a false and flattened equivalence, and conflating the proximate and the remote, into the diagrammatic logistics of ecologies. The latter transformed the accounting and measure of energy into a political and cultural practice, while simultaneously estranging energy from its event-driven materiality.

Besides their relentless annihilation of difference and promotion of energy as resource, these diagrams have another critical flaw; because they fixate on the use of closed-systems as the underlying model, they cannot account for all of the entropy that would result in the process of energy transfer. This residual shadow, is thus reduced to an ambiguous cloud of smoke, exhaust, and respiration; its seeming insignificance a contrast to its hulking magnitude.

In his seminal book, Energy Flows in Biology (1968), the biophysicist Harold Morowitz addressed this deficiency by positing that, "the energy that flows through a system acts to organize that system."[23] There is a shocking obvious-ness latent in this statement; Morowitz, like the Odum's, based his theories on the application of the laws of thermodynamics to ecosystems as a means to account for the transfer of energy between plants and animals. One critical distinction is that Morowitz assumed that ecosystems were open, rather than closed, meaning that energy is allowed to enter and leave through a virtually porous set of boundary conditions. Entropy is generally defined as the degradation of the available energy in a system, its ability to do work, or its gradual decline in quality. For Morowitz, the definition is extended to reflect the degree of complexity that matter exhibits as a result, suggesting that if given enough time and a steady flow of some form of energy, matter will eventually become organized in proportion.[24] His conclusion echoes the revelations made by Howard and Forster while observing clouds; the structuring of matter is a process driven by the transfer of energy from one state to another and the resulting patterns represent the trajectories and intensities of those flows.

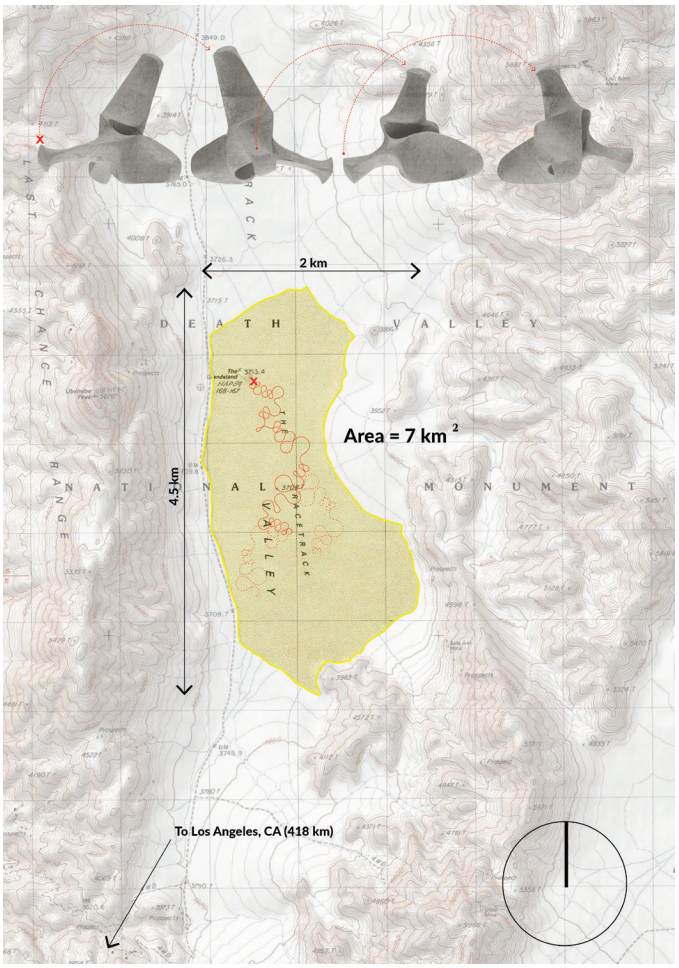

Figure 3: "Motivational Rock" (2017) by Filip Tejchman / The movement of the Motivational Rocks is driven by the shifting center of mass caused by the phase-change of the materials inside (the rocks are hollow). The selected materials, Water and a blend of Hydrogenated Fats, react to temperature by changing their volume or density. These changes cause the center of mass of the Motivational Rock to shift, allowing it to "walk" across the Racetrack Playa powered only by the rising and setting of the sun.

Energy and the organizational patterns that emerge in matter, share another variable: information; that ability to recognize within a fragment the capacity for communication between and across multiple scales and beyond the perceptual limits of the human bodies physiology, is analogous to identifying a particular type of cloud as relating to a warm or cold front, or to the jet-stream.

PATTERN-SEEING

During a brief sojourn in England, and prior to arriving in the United States, the Hungarian painter and film-maker, Gyorgy Kepes, became acquainted with a group of scientists involved in applying statistical numerical analysis to their respective fields. Among this group, were the science-writer, J.G. Crowther and the biologist J.D. Bernal. It is impossible to distill or summarize the career of someone like Kepes, however, it is in this pair of acquaintances that we find the origins of what became a career-long pursuit in developing a new instrumentality, anathema to the siloing of disciplines, and informed

Figure 4: “Motivational Rock” (2017) by Filip Tejchman

by Crowther's statement that,"energy is the symbol of the modern world".[25]

But which, energy, are we referring to? There are two distinct paradigms which emerged during the post-war episteme, and which share the same underlying roots to the convergence of general systems theory; as mentioned, the dominant modality privileges the logisticians flattening view of energy as discrete one-directional resource flow, or "closed-systems". Kepes, in contrast, was keen on developing other paradigms for vision, extending what he saw as,"the worlds infinitely complex fabric is in a process of never-ending change." Post-war Art and Architecture contended with this by exploring varying definitions of environment through systems of indeterminacy, entropy, and ecology, that were informed by the concept of "open-system"s.

In 'The New Landscape in Art and Science' (1956), Gyorgy Kepes first defined the problem, one that dealt with understanding how novel methods of "vision," originating in the sciences, could be utilized in training architects and artists to perceive and manipulate the various energetic flows of matter and information that sublimate the spaces and environments we inhabit. Kepes organized this exploration of visual techniques into four categories or rubrics (magnification of optical data, expansion and compression of events in time, expansion of eye's sensitivity range, modulation of signals) providing a "new axes of reference" through which to conceive of the relationship between architecture and energy, that resisted the flattening and diagrammatic tendencies of information and systems theory.[27]

The New Landscape, introduced these rubrics in order to "advanced a cognitive and perceptual technology that would orient the arts to the borderline between knowledge and agency occupied by the sciences."[28] With the insights culled from the analysis of a range of instrumental views of the natural world, ranging from xrays, microstructures, and radiograms, Kepes determined that, "What scientists considered before as substance shaped into forms, and consequently understood as tangible objects, is now recognized as energies and their dynamic organization." and that "Although we see it as an entity - unified, distinct, from its surroundings - a pattern in nature is a temporary boundary that both separates and connects the past and the future of the processes that trace it. Patterns are the meeting points of actions, Noun and verb must be seen as one: process in pattern, pattern in process"[29]

CONCLUSION

By definition, pattern-seeing as a method of identifying the entropic flow or transfer of energy exhibits a bias towards the aesthetic tropes associated with theories of emergence. The principles of self-organization, for example, in which open-systems of matter assemble into progressively complex structures are indicative of this bias for visible structure. Within recent architectural memory, the preference for a legible reciprocity between information and its expression as form — whether conceived as the mid-century organicism of Kepes's milieu, or the more familiar formal exuberance of contemporary digital parametricism — could be categorized as a new picturesque. Luke Howard's observation of clouds succeeded in regularizing an aspect of nature through the lens of a "subjective-vision," thus ossifying the dynamic transformation of clouds into categories of knowledge that could be further instrumentalized. In many ways, the distinctions drawn by Howard between cirrus, cumulus, and stratus clouds, are analogous to the various classifications of types of energy that define the institutional and disciplinary boundaries among the sciences (mechanical, chemical, photonic, nuclear, for example).

"Pattern-seeing", as articulated by Kepes, is intended to operate in opposition to this paradigm. A critical distinction must be drawn between the appearance of a thing and our ability — or inability— to recognize it. The rubrics outlined by Kepes are a framework for cultivating an ability to defamiliarize the instruments of autonomous and semi-autonomous perception in relationship to the subjects that they observe, as means to construct new cognitive structures for recognizing what we perceive. By this I mean that the vast computational weight currently being thrown at developing ever increasingly sophisticated and accurate simulations that predict the transformation of global weather patterns might only serve to establish a new normal that inadvertently succeeds in regularizing the exceptional and until now unimaginable. Similar efforts within architecture, that isolate and narrowly define energy as resource and a unit of power, may appear to provide a workable strategy for reconciling the relationship between energy and buildings, but only serve to reinforce and extend a culture of practice that perpetuates the false dichotomies in which man-made forms remain colonialized spaces conceived to merely co-exist with a romantic view of nature. As alternative techniques for observation, the magnification of optical data, expansion and compression of events in time, expansion of eye's sensitivity range, and modulation of signals, introduce al tool-kit with the potential to reveal the numerous permutations of energy as distinct from resource or commodity. This echoes a notion explored by Jane Bennett in the book, 'Vibrant Matter', in which she asks: "what difference would it make to the course of energy policy were electricity to be figured not simply as a resource, commodity, or instrumentality but also more radically as an 'actant'". Thus what was first presented as architectures uncanny success in the concealment of environmental crisis, reveals a more nuanced and complex situation in which architectural disciplinarity —and its associated orthodoxies —become a potential liability in the face of a radically altered environmental context.

To look at clouds is to look at one momentary and discrete scale of permutation, a release of information that occurs through the organization of matter during the transfer of energy. A similar cognitive process allows us to conceive of the reciprocity between a fragment of iron ore and the microstructure of steel, as well as the resulting pattern in the landscape. Imprinted in the rings of a tree, is an index of clouds, and imprinted in the transformation of matter from one organizational state to another, is us, always present, and romantically obsessed with our un-naturalness, despite evidence to the contrary.

AFTERWORD: MOTIVATIONAL ROCK

The Motivational Rock project (Fig.3 and 4) is cited as an example of how the transformation of matter as a result of energy transfer can produce other orders of organization. The rocks were conceived as a meditation on the geological passage of time, which exists just beyond the threshold of human perception, yet is always present. Situated with the Racetrack Playa in Death Valley, CA, the Motivational Rocks perform an elaborate — though impossibly slow — choreography of movement in counterpoint to the existing geography. The playa is home to a phenomenon popularly referred to as "sailing stones," which are rocks that "mysteriously" move across the valley floor immediately following a rare rain storm… provided that it rains during a time when the diurnal temperature swing in the valley is extreme enough that the water will freeze. As the sailing stones move, they carve traces into the silty surface that remain in place for decades. There are several theories for what specific combination of forces are at the root cause. The most current attributes the movement to "ice shove," a process that occurs after the valley floor freezes into a thin sheet. Once the sun rises, the sheet begins to break up like a melting glacier into floating fragments. A strong wind will push these fragments against the stones and cause them to move.

The project design question was best characterized as: how to build a better rock? How that is interpreted invariably reveals biases that problematize and undermine the litany of performative criteria that buildings are subject to. Efficacy, efficiency, legibility, iconography, meaning, function, economy, desirability, commodity, firmness and delight, map an intractable set of historical and contemporary ambitions related to energy in architecture. The Motivational Rock is hollow, its cavity is filled with a combination of phase change materials that change their volume and density as they shift between solid, liquid and gaseous states. The global geometry of the rock is highly unstable since the centroid is located outside of the internal volume. As one material changes phase it displaces the other and shifts the location of the center of mass. Thus these rocks move across the valley floor in slow increments, without the need for an extreme temperature swing.

Every narrative, measurement, and description is ultimately contingent on some institutional, instrumental, or cultural bias, producing subjectivities that reinforce or distract from the immanent material reality, limits, constrained behaviors, and variable emerging qualities that release and channel the flow of energy. In every representation, we see some evidence of the transformation of matter, some aspect of the nature of energy manifested in form, space, and pattern. Buildings are endings, they are the object as evidence of the passage of energy, capital and labor through a space. Motivational Rock, is architectural evidence, extending the duration and space of events beyond the perception of the human body. During their long sojourn through the desert, they inscribe an indeterminately looping series of marks on the valley floor, an architectural representation of entropy, created for the future, and emerging at the speed of geology.

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ENDNOTES

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