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"Ochre Center," painting by George Vandensluis.
Images of Energy:
Syracuse Scholar Colloquium

Seymour Fisher, Mario R. Garcia, H. Richard Levy, Werner Seligmann, Kameshwar C. Wali, Judith Weissman, with an overview by Judith Weissman

"Images of Energy: Syracuse Scholar Colloquium" is a transcript of a series of six short talks delivered at Syracuse University on February 17, 1981. Each of the panel members addressed the subject of energy from the perspective of a given discipline. Following the talks, the speakers exchanged comments among themselves and answered questions from the audience. Judith Weissman, who spoke on images of energy in literature, has written an overview of the speakers' comments and the exchange that followed. Her original talk, as well as her general observations on the ideas presented, are included here.

Seymour Fisher

It is a paradox that many people who stoke themselves with the greatest inputs of energy expend the smallest quantities. There is clear evidence that obese people who eat enormous quantities of food are often characterized by less muscular movement and related forms of energy output than are most other people. Actually it is not at all unusual to find such paradoxes in human energy patterns. One of the really unique aspects of human energy behavior is that it has become inseparably bound up with images of good and evil, guilt and virtue. As people release energy, they are constantly asking themselves questions: Am I putting out as much energy as a good person should? Am I lazy? Am I working as hard as I ought to be working? Energy has become a substance whose flow is carefully monitored as part of a constant self-evaluation process. One study has reported that there are people who experience a sense of unworthiness if, by the end of the day, they have not worked hard enough to feel really tired. To feel worthy they must have vivid discomforting bodily evidence of how much energy they have sacrificed.

This introduces a major form of irrationality into human energy output. People are inclined to dispense their energies in relation to ex-
treme notions about the meaning of energy expenditure as such, not in relation to realistic task requirements. Many in our culture are obsessed with conspicuous energy output as an end in itself. We have only to think of the recently popularized type-A person who is forever rushing around, speeding through life, still desperately trying to prove his endless capacity for output even as his heart registers its final protest. Another example is the manic-depressive patient who hursts himself into maximum energetic action with the obvious hope that his extraordinary output, irrespective of its basis in reality, will magically elevate him to success. It is apropos here to mention one study of manic patients: as children they were given the parental message that extraordinary output and achievement were expected of them.

There is no doubt that energy expenditure which is based on guilt and which attempts to prove one’s worthiness is irrational. However, there is the interesting possibility that it is this very irrationality that has led to some of the most creative of human works. If people simply put out energy proportionate to each discrete problem they encountered, it is doubtful that we would see the great surges represented by the Renaissance or the Industrial Revolution. Advances in every area have been led by driven people who, largely unreasonably, demanded all-out effort from themselves. It is this strange fanaticism about energy output that is distinctly human. Sigmund Freud was making the same point when he linked creativity and civilized works with sublimation, a process that supposedly feeds on libido or on energy that has been repressed as a result of anxiety and guilt.

Freud has actually been one of the few personality theorists to assign major importance to energy as an explanatory concept. He conceptualized each person as having a relatively fixed and limited amount of psychological energy (whatever that is). He told us that our energy supply had preferred body sites at which it concentrated: very early it focused in the mouth, then shifted to the anal region, and with the attainment of maturity was supposed to concentrate around the genitals. All kinds of dire things could happen if your energy focus did not shift smoothly from oral to anal to genital. You could become one personality type rather than another as a function of the site at which your energy got stuck. If it was stuck around the mouth, you were an oral character; if it was fixated around the anal area, you were an anal character; and so forth. In Freud’s scheme, energy was scarce; it moved its storage depots progressively from one body area to another, and its management was largely based on unconscious, illogical motives. Freud’s concept of personality functioning was largely depicted in images of energy moving, shifting, and mobilizing. He even thought of many kinds of hysterical bodily symptoms as resulting from an unusual concentration of libido energy in particular body parts or organs.

In studies I have conducted of how people experience their own bodies, I have found a widespread feeling that our bodily energies are potentially dangerous. People seem to fear the energy stuff within themselves. They unconsciously visualize their bodies as boilerlike containers filled with energy under high pressure, which is difficult to control and even capable of exploding. They wonder whether they can keep all of the valves properly closed. This type of anxiety has often
been dramatized in science-fiction stories about people who become dangerous to others after they accidentally become charged up with some new devastating form of radioactivity or atomic power. They are so charged up that they destroy anything they touch. It is interesting that Freud really conceptualized libido energy in analogously dangerous terms. For him, libido was always getting out of control, and it was difficult to keep it confined to proper socialized functions. It could so easily get into the wrong places in the body and cause trouble.

Overall, I have the impression that most people are uncomfortable with themselves as energy systems. They are nagged by doubts as to what is a proper flow. They are rarely free of guilt about whether they are putting out enough energy and whether it is going into the right channels. But they are also concerned about a possible buildup of ‘too much’ energy within themselves that could get out of control. A state of personal energy crisis is an old story for most people.

Mario R. Garcia

To the graphic communicator, visual perception of a message requires at least two kinds of energy. One concerns the physical requirements for movement patterns: motion from left to right, right to left, top to bottom, bottom to top, and so forth. The other deals with the abstract level of perception: energy the reader applies based on personal interest in a given subject matter.

I will deal first with physical energy. As the eyes sweep through a printed page, they are most likely to begin moving at the upper-left-hand corner, then follow a journey to the right and to the bottom of the page, in an inverted S pattern. An assumption is made by the visual communicator (designer) that the reader will follow this direction. The lead item in most newspapers, for example, is usually positioned accordingly. Visual energy can be controlled by the designer, however. If a strong element is placed at the bottom of a page and the top is free of any strong elements, the reader is likely to move to the bottom of the page. Similarly, if the right-hand side of the page outweighs the left, then the reader will probably move towards the right.

Physical energy, as described here, is also influenced by reading habits. In Western cultures we read left to right, top to bottom. The visual communicator, therefore, takes this into account when he emphasizes areas of concentration for eye movement. The human eye favors the lower-left-hand area of any field rather than its center, and when scanning a field tends to feel comfortable in that zone.

The visual communicator devotes most of his efforts towards creating impact that will lead to a greater level of physical energy. If the impact of a message is so powerful that it lures the reader’s eyes instantly, then the message, or the more abstract form of the content, will probably receive its due attention.

Once the visual material in a page has been accepted, attention centers on the words of the message, that is, on the abstract level of perception. At this level we assume that the reader will apply himself through a process that involves selection of content, analysis, and finally acceptance and consumption of the message. Although the
reader is following a visual process all along as he moves his eyes through the page, he is also applying a sort of mental energy to set priorities, that is, what to read, what to discard, what to scan, what to return to at a later time.

At this level of energy, the psychological aspects of communication enter into play. Following Gestalt psychology, we note these points:

1. The parts of a visual image may be considered, analyzed, and evaluated as distinct components.
2. The whole of a visual image is different from, and greater than, the sum of its parts.

Taking Gestalt's perceptual factors one step further and incorporating them into our patterns of visual energy as analyzed here, we can say that the physical energy of eye movements is meaningless without the more abstract energy of selection and comprehension. It is the interplay of these two forms of energy that leads to better organization and perception of visual images.

H. Richard Levy

The image of energy currently held by biologists and biochemists is, I think, both more prosaic and more precise than the images conveyed by my colleagues. This image developed slowly over the past two hundred years, and we can define it with considerable precision. But I will sketch it here in its barest outlines.

All living beings on earth, from microbes to man, use energy to do work. The ultimate source of all this energy is the sun. Green plants have the capacity to capture solar energy and to transform it into chemical energy. Both plants and the animals that eat plants further transform this chemical energy into a special, useful form with which they do work of various kinds. We may compare the flow of energy through the biological world to the flow of energy from a waterfall through a hydroelectric power station to the electricity in your house: the plunging water contains kinetic energy, transformed by the turbine to mechanical energy, which, as it drives a generator, is converted into electrical energy. Electrical energy is useful to us for performing various kinds of work because numerous machines have been devised that utilize this form of power. Similarly, biological machines have evolved that use a special form of chemical energy to perform biological work. Beyond this superficial analogy, there are major differences in the biological and inanimate worlds, both in the processes of energy transformation and in the kinds of work performed.

When we think of energy in relation to living beings, we are apt to imagine some sort of vigorous or sustained activity; energetic people play tennis or jog. Among animals that we would consider energetic are migrating birds, spawning salmon, the cheetah and its running prey. Neither the turtle nor the sloth evoke such an image in our minds, yet they are quite busy, in their unassuming ways, converting energy into work.

Our image of energy is inextricably linked with mechanical work, with muscle power. But mechanical work is only one type in the biological world, and muscle is only one kind of organ exemplifying mechanical work; some other organs are flagella, such as those that

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propel the sperm toward the egg; the tiny, hairlike cilia that line our respiratory passages and sweep out foreign particles inhaled; and the microtubules, less than a half-millionth of an inch in diameter, which pull apart the chromosomes whenever cells in animals or plants divide. Like muscles, these minute machines convert chemical energy into mechanical work.

Another type of work performed by all forms of life is osmotic work, essential in preserving a particular internal chemical environment. This work is manifested as the accumulation of essential substances from the environment and the excretion of waste materials. It is called transport, and the machines that perform it are biological membranes. To carry out transport, the biological membranes, like muscles, require chemical energy.

The third major form of biological work is chemical work. It, too, requires a great expenditure of chemical energy. Chemical work results in growth and in metabolism, and it proceeds constantly in every cell of every living being. When cells cease to do chemical work, they die.

The performance of the different forms of biological work I have described requires chemical energy of a special, useful form contained in a chemical compound called adenosine triphosphate, or ATP, which is found in all forms of life. ATP does for living beings what electricity does in your house: it runs virtually everything that requires energy. The energy stored in ATP is released when biological work is performed—and during the process ATP is converted to another chemical called adenosine diphosphate (ADP). Other processes occur that assure the regeneration of ATP from this ADP so that more work can be done.

Where does the energy in ATP come from? In animals it is derived from ingested food. As the carbohydrates, fats, and proteins are broken down during digestion and metabolism, they are oxidized by a process called respiration, involving some seventy chemical reactions. The energy in these components of the food is captured by ADP, thereby converting it to ATP. Chemical work is performed during this transformation, and waste products are generated. For example, when we eat the carbohydrate glucose, it is absorbed, digested, and then metabolized. The glucose is oxidized to form carbon dioxide and water during this process, and the energy stored in the glucose is captured by ADP, which is converted to ATP. The ATP can then be used by the mechano-chemical machine, the muscle, to do work. We might note, parenthetically, that there are other ways to release the energy stored in glucose. One is to burn it—a process also involving oxidation, in which the energy is released as heat. The logs that burn in your fireplace actually contain large quantities of glucose. Burning and respiration are similar overall processes, but they differ greatly in chemical detail and in the manner in which the concomitant release of energy occurs.

Let us turn, for the moment, to some imagery from nearly two hundred years ago and quote Séguin and Lavoisier:

In general, respiration is nothing but a slow combustion of carbon and hydrogen, which is entirely similar to that which occurs in a lighted lamp or candle....if animals did not regularly replace by means of food aliments that which they lose by respiration, the lamp would soon lack oil, and the animal would
perish, as a lamp is extinguished when it lacks nourishment. . . . One may say that this analogy between combustion and respiration has not escaped the notice of the poets, or rather the philosophers of antiquity, and which they had expounded and interpreted. This fire, stolen from heaven, this torch of Prometheus, does not only represent an ingenious and poetic idea, it is a faithful picture of the operations of nature, at least for animals that breathe; one may therefore say, with the ancients, that the torch of life lights itself at the moment the infant breathes for the first time, and it does not extinguish itself except at death.\(^1\)

Returning to our analogy: the transformation of the chemical energy in glucose into the biologically useful form in ATP resembles the generation of electricity in a generator—which in turn derives its energy from the falling water via a turbine. Similarly, the energy in glucose is derived ultimately from solar energy during photosynthesis. Although photosynthesis is exceedingly complex and requires over a hundred chemical reactions, I shall try to summarize the process in greatly simplified form:

Green leaves of plants contain, within their cells, organelles called chloroplasts, each about 0.0002 inches long, packed with chlorophyll. The chemical structure of chlorophyll causes it to absorb sunlight and thereby to become chemically excited. In its excited state it can become oxidized by a special chemical compound, also present in chloroplasts. The net results of this process of photosynthesis are that water is split into oxygen and a form of hydrogen. The sun's energy is trapped by ADP, which is converted to ATP. The hydrogen interacts with carbon dioxide, which the plants take in from the atmosphere, and utilizes the ATP to synthesize glucose.

Green plants and animals are part of a vast energy cycle on earth, and their interdependence can be summarized by putting together the two processes we have just described. The plants utilize solar energy to convert CO\(_2\) from the air, along with water from the ground, into glucose and oxygen. Animals that eat the plants use the glucose and oxygen to generate ATP, and they return the CO\(_2\) and water back into the air and ground. Eventually, as the ATP is used to perform work, some of the energy is dissipated as heat and entropy. Whereas matter is constantly recycled, the flow of energy through the biological world is unidirectional. The complexity of living matter is maintained at the constant expense of this energy degradation.

I have stressed that the capture of energy and its conversion to work are complex processes requiring many chemical reactions. It is an astonishing fact that in every living cell many hundreds of chemical reactions occur at all times under the mild conditions and temperatures within those cells. If we try to duplicate these reactions in the test tube, we need extraordinary means—extreme temperatures and pressures, or strong acids or alkalis. That only mild physiological conditions are necessary in the living cell is because special biological catalysts called enzymes are present—one for each reaction. Enzymes are complex protein molecules, and we cannot describe how they work here. But the fundamental principle of their effectiveness is also related to energy. For every chemical reaction there is an activation energy; in order for one compound to be chemically converted to

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another, it needs to be activated. It is a little like starting a car: you first have to use some of the energy stored in the battery. One way to activate a chemical compound is to heat it: heat is a form of energy, and if enough is imparted to a compound, the compound becomes sufficiently active so that it can react chemically. Such a process of activation is ruled out in the biological world, however, since few forms of life can survive extremely high temperatures. Instead, enzymes lower the activation energy a compound needs to enable it to react chemically.

Energy, then, is used throughout the biological world to drive the various forms of biological work. Life itself is a constant transformation of one form of energy into another. To be energetic, then, is to be alive.

Werner Seligmann

As a result of the energy crisis, much attention has been focused on the role of architecture in helping to reduce the nation's energy consumption. Alternative approaches such as solar energy, new systems of cooling and heating, a more careful response to climatic and microclimatic conditions, improved methods of isolating inside from outside, and new designs for the building envelope are perceived to have a major influence on the architecture of the future. For the lay public these developments produce images of a Buck Rogers-type world. This popular perception speaks of the continued American fascination with gadgetry and technological invention, in contrast to the hope of the architect/designer that the energy concerns will produce an architecture of simplicity and common sense with a minimal reliance on equipment, more carefully thought-out spaces, and a more permanent, higher quality of construction. After decades of a constantly increasing proportion of the construction budget consumed by mechanical equipment, it is the general feeling that we will be embarking on a reverse trend. The present concern of the public for preservation is an indication of a genuine awareness of the limit of our resources. As architects, we are looking forward to a future in which permanence, concern for the environment, and common sense, rather than expediency and gadgetry, will again become important determinants for the creation of our physical environment.

This discussion so far is hopeful conjecture on my part. While the topic of energy consumption and preservation is obviously of great interest generally, it constitutes only one of many concerns of the architect. It falls under the heading of shelter and is intellectually not a very rewarding subject. Architects make a strong distinction between the creation of architecture and the production of shelter. The latter is undeniably part of architecture, but architecture is not necessarily part of shelter. Since I am an architect, I would like to discuss some less frequently considered ideas about energy in architecture.

It should be obvious that architecture in itself is a manifestation of energy, both in its struggle with gravity and through the visible evidence of the act of building. The pyramids of Egypt not only offer a powerful, memorable image but also exude a specific symbolic meaning. The pyramid and the cone are pure formal, visual demonstrations of a primitive distribution of load, and make us speculate about the
relationship of the demonstration of gravity to the symbolic content.

From the beginning of architecture, the needs of ritual and ceremony demanded structures that contain space. Thus began a struggle with the forces of gravity in an effort to envelop space that was safe and at the same time displaced material for access, light, and construction. This struggle with gravity has always been a highly visible development. An architecture of walls and beams was then succeeded by an architecture in which the wall was reduced to columns and lintels, and in turn the potential for making space was expanded through the Roman invention of vaulting. Anyone who has ever seen the Pantheon has been awed by the extraordinary accomplishment of the structure and has sensed the spiritual meaning that the space must have held for the Romans. The Pantheon is undeniably still today a wonder of human energy and intelligence.

Almost nowhere, however, is the human will to control the forces of gravity as eloquently demonstrated as in the mastery of stone construction of the Gothic builders, in which the visible tracery of the structural forces at work speaks of the human will and mind to conquer matter. We are generally familiar with the spiritual qualities of Gothic space, the symbolic metaphors and expressive forces of the architecture, yet we might not quite understand the enormous organizational and purely managerial skills that were required to orchestrate the production of materials, the available labor force, and the design. Gothic architecture encapsulates large spaces with minimal energy and amounts of material.

For the brevity of this discussion I will allow myself a huge leap in time and proceed to the moment of modern architecture, which must be considered as born out of revolution: to some historians this means the French Revolution; to others, the Russian and German revolutions in the aftermath of the First World War.

Modern architecture became equated with the overthrow of the old order—social, political, economic. Contrary to what is often believed, the movement was not the product of a linear advancement of building technology. It did not generally invent its own technology but rather availed itself of existing scientific and engineering advances in other fields, towards its own artistic and programmatic ends—that is, political and social ends. This new architecture was seen as the physical manifestation of a new world emerging from the revolution. Technology was the means by which to accomplish this mission. By organizing production of buildings, by standardizing and systematizing the product, by rationalizing the planning and articulating the service networks, architecture was expected to achieve not only an ideal new world for mankind but also a reduction of human effort, thereby freeing time to pursue a more useful, healthful, satisfying life. Architecture became a symbol of this revolution.

In order to distinguish itself, the new architecture had to have visible characteristics clearly separating it from the past. Instead of the building resting on a foundation, the new building would float above the ground on columns; instead of the wall as support, the wall would become a screen from the elements. Gravity appeared to present little resistence to the ideas behind the making of space—as demonstrated by Le Corbusier's Villa Savoye (Poissy, 1929–30), appearing to float above the landscape, or the floating slabs of Mies van der Rohe's
Barcelona Pavilion (Barcelona, 1929), in which the chrome-plated columns, through their reflection, virtually make all sense of support disappear. The articulation of the elements of architecture—particularly of structure from enclosure—result in the free plan, the free space, the free façade. With minimal distinction between inside and outside, with walls as changeable screens to denote degrees of privacy or separation of uses, the aim ultimately is for a state of architecture in which enclosing surfaces are magically held in suspension by invisible forces such as magnetic fields and where invisible rays keep out the elements.

No one expressed this idea more through his work, his writing, and his teaching than Buckminster Fuller. Nearly forty years ago Fuller delivered a paper entitled “Designing a New Industry,” in which he described and proclaimed for architecture the concept of performance per pound. In this paper, which was presented to the American Institute of Architecture, he described the advantages of mass fabrication, which reduced the cost of the average automobile to approximately 1/100 the cost of producing it singly—that is, a cost of fifty cents per pound for a normal automobile and, as he noted, five dollars per pound for “a snob-class Rolls-Royce.” The idea was that if a similar technological effort could be applied to the production of housing, and the house could be reduced in weight to that of an automobile, housing would become an easily affordable commodity. Trying to produce a model house that would be suitable for production by an industry modeled after the auto industry, Fuller designed the first Dymaxion house, a structure suspended from a central pole with a weight equivalent to that of the average automobile.

Only after the Second World War was Fuller able to produce and build the second Dymaxion house and, subsequently, the geodesic dome. Fuller, who unfortunately is primarily known for his domes, represented the foremost thinking in building technology at the time. The second Dymaxion house, produced in aluminum and tooled according to aircraft technology, was also suspended from a central mast, was composed of sets of identical parts, and weighed only 2,000 pounds. In 1947 Fuller wrote the paper “Earth, Inc.,” which directed itself towards the diminishing resources of the world. The Dymaxion houses and the geodesic domes were part of a much larger investigation to produce, as he called it, “the autonomous dwelling unit,” which was to be free of all energy and utility dependence. The Dymaxion houses together with a large number of other efforts epitomized the spirit of modern architecture—using the least amount of energy to produce maximum results.

The arts, and in particular architecture, are continuously plagued by a philosophical dilemma produced by the involvement with progress, on the one hand, and the avowed claim to art and thus permanent values and timeless qualities, on the other hand. Judging by that architecture which has survived history and has provided continued inspiration and emotional enrichment, it is in the intrinsic intellectual, experiential, and expressive qualities that architecture finds its true significance. A piece of architecture can be charged with the greatest emotional and spiritual energies, as is a sculpture by Michelangelo or the Sistine Chapel ceiling. The quality that infuses a lifeless piece of material such as marble with emotion and energy, with an inner ten-
sion as in Michelangelo's Slave, also pervades the entry to the Laurentian Library in Rome, with the stair pressing the confines of the space. The experience of this quality is reserved not only for the work of Michelangelo or the Renaissance. The history of architecture is full of the work of great masters who have been able, through their art, to nourish the spirit of humanity. History sets the standards and aspirations for the creative architect. Even though the means and the circumstances change, the true task for the architect remains the same. In the words of Le Corbusier, "Passion can create drama out of inert stone."

Kameshwar C. Wali

Everyone knows that the concept of energy and the law of conservation of energy are basic to physics. There are no known processes in nature that violate the absolute conservation of energy. Only once in recent history was its strict conservation questioned, and by none other than Niels Bohr, the father of the quantum theory of the atom. He dared to propose that in subatomic processes relating to the disintegration of radioactive nuclei, the so-called beta decay, energy may not be conserved (along with another physical quantity—the angular momentum). Bohr was quickly shown to be wrong experimentally; and theoretically, to save the principle of conservation, Pauli, one of the grand masters of twentieth-century physics, proposed the possible existence of a new particle called the neutrino. This neutrino turned out to be the most elusive of all the elementary particles. It took nearly twenty years to prove its existence; but in the meantime, its key role in nuclear reactions which generate the immense amount of energy in stars like our sun was firmly established. We now know that these neutrinos, which interact weakly, pass easily through the earth, leaving no trace; they fill the universe and may even dominate the matter content of the universe.

Then what is energy?

A physicist, as a child, learns that there are different kinds of energies: potential energy, energy by virtue of position (an object in a higher position relative to the ground—an electrically charged particle in an electric field, for example), kinetic energy by virtue of motion, heat energy, light energy, electric and magnetic energies, and so on. As the physicist grows up, he learns that the different forms are interconvertible subject to the absolute conservation law. The distinction between matter and energy, which he has been taught earlier, he is asked to forget as he makes his acquaintance with Einstein and memorizes the famous equation \( E = mc^2 \). He is told to ponder how much potential energy there is in every grain of sand, by virtue of its having a mass. Is energy divisible ad infinitum? No, he is told. The smallest atom of any energy is the quantum (\( h/2\pi \)), which once created cannot remain still; it must run with the speed of light. It also has acquired at its birth an intrinsic angular momentum called spin of one unit (\( h/2\pi \)). As the physicist learns more and more about the quantum and how it behaves in its interaction with matter, he becomes a strange person who has lost the ability of everyday language. He is advised not to worry about it, as long as he can get all his equations and formulas right.
So what is energy?
We turn to Feynman. Speaking about the law of conservation of energy, he says:

It states that there is a certain quantity, which we call energy, that does not change in the manifold changes which nature undergoes. That is a most abstract idea, because it is a mathematical principle. It is not a description of a mechanism, or anything concrete; it is just a strange fact that we can calculate some number and when we finish watching nature go through her tricks and calculate the number again, it is the same. 1

Afraid that he is confusing the beginning students in physics, Feynman illustrates what he wants to say by an analogy. I call it Feynman’s fable:

Imagine a child, he says, who has blocks that are absolutely indestructible and cannot be divided into pieces. Each block is the same as the other. Let us suppose that the child, whom we shall call Dennis, has 28 blocks. At the beginning of each day, Dennis’s mother puts him into a room with his blocks. At the end of the day, being curious, Mother counts the blocks very carefully and discovers a phenomenal law: no matter what Dennis does with the blocks, there are always 28 remaining! Mother continues this same procedure for a while until one day she finds only 27 blocks; a little investigating reveals a block under the rug. On another day there seem to be only 26 blocks. Careful examination indicates that the window is open; when Mother looks outside, she finds the two missing blocks.

On still another occasion, 30 blocks are discovered. This causes considerable consternation until Mother realizes that Bruce had come to visit, bringing his blocks with him, and had left a few at Dennis’s house. After Mother has disposed of the extra blocks, she closes the window and no longer lets Bruce in. Everything is going well until one day Mother counts the blocks and finds only 25. She remembers that there is a toy box in the room; when she goes to open it, Dennis screams, “Do not open my toy box!”

Somewhat ingenious, Mother invents a scheme: She knows that a block weighs 3 ounces. She weighs the toy box when she sees 28 blocks in the room and learns that the empty box weighs 16 ounces. The next time she wishes to check the contents of the box, she weighs it, subtracts 16 ounces, and divides by 3. She discovers the following:

\[
\text{(number of blocks seen)} + \frac{(\text{weight of box}) - 16 \text{ ounces}}{3 \text{ ounces}} = \text{constant.}
\]

There then appear to be some new deviations. But Mother’s careful study indicates that the dirty water in the bathtub is changing its level. Dennis is throwing blocks into the water, and Mother cannot see them because the water is so dirty. But she can find out how many blocks are in the tub by adding another term to her formula. Since the original height of the water was 6 inches, and each block raises the level \( \frac{1}{4} \) inch, then:

\[
\text{(number of blocks seen)} + \frac{(\text{weight of box}) - 16 \text{ ounces}}{3 \text{ ounces}} + \frac{(\text{height of water}) - 6 \text{ inches}}{\frac{1}{4} \text{ inch}} = \text{constant.}
\]

With the gradual increase in the complexity of her world, Mother finds a whole series of terms representing ways of calculating how many blocks are in places where she is not allowed to look. As a result, she finds a complex formula—a quantity which has to be computed but which always stays the same in her situation.

To a physicist the above fable describes the essence of the conservation-of-energy law as it is manifested in his physical world. But it is clear that the physicist has no knowledge of what energy really is. He has only methods of measuring and determining its constancy. It is therefore appropriate that the title of this symposium is "Images of Energy." In physics we have several images of energy without a concrete picture or mechanism, and we have formulas to associate a numerical quantity with each one of these images. If we calculate correctly, there is a number which remains the same throughout nature's myriads of changes. If we do not find that this is so, we have made an error in our calculation; we have neglected something and had better look again—maybe there is even a more bizarre, elusive particle like the neutrino!

Judith Weissman

The world did not always believe Blake's maxim that energy is eternal delight. In our culture, energy has replaced gold as the product most sought by alchemists of all sorts; everyone seems to want more energy of every kind—heat, electricity, aggressiveness, sex, speed, ambition. It is hard for us to remember that energy was not always considered something good. In fact, although the word goes back to Greece, it first appears in Bartlett's *Familiar Quotations* in the works of Jefferson—in the eighteenth century! Other words of value—love, truth, justice, beauty—are consistently important in literature from Homer and the Bible onward. Energy is a relatively new value in literature; for hundreds of years, it was treated with more suspicion than admiration.

Energy has never, of course, been absent from literature. Movement and change are inherent in the fact that all literary works are read and heard in time; and virtually all literature contains some description of human, natural, or divine activity, which also implies energy. In other arts, certain objects can be seen as static, perfect, beautiful forms, liberated from the human energy which created them—some primitive sculpture, the paintings of Mondrian, glass-faced skyscrapers. In literature, the most formal sonnet, the sharpest epigram, the quietest elegy, all move. And it is probably safe to assume that the speed, rhythmic power, verbal excitement, of a work reflects what an author is trying to say about energy. For example, in Shakespeare's *Antony and Cleopatra*, the speed with which characters appear and disappear on the stage is connected with the enormous sexual energy of the characters themselves; and the contorted slowness of the first acts of *Hamlet* itself suggests the hero's depression and lassitude, his lack of energy. There is more energy in the sweeping, rushing blank verse of *Paradise Lost* than in the elegantly rhymed, symmetrical stanzas of Chaucer's *Troilus and Criseyde* at least partly because there is more energy in the subject, revolution in heaven.

Yet, English literature before the eighteenth century varies more in

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the way it embodies energy than in what it actually says about energy. Most authors saw energy in human beings as a dangerous quality, and barely mentioned its existence in the natural world. True power and energy belonged to God, the creator of the world and the source of goodness. Literary texts admonished human beings to control their energies—then called by the less affirmative name of passions—rather than to cultivate them. A great deal of misguided literary criticism has been based on readers’ inability to believe that an author could truly have meant his energetic characters to be evil. The Wife of Bath, Satan, Edmund (and later characters like Becky Sharp and Anna Karenina), are lively and inventive and powerful and sexy, everything that popular magazines exhort us to be. They are also evil.

I would choose Fielding’s Tom Jones as the single most important new character in eighteenth-century English literature. He is highly sexual, spontaneous, active, and yet radically innocent, in contrast to his decorous and prudent half brother, the apparent incarnation of all good eighteenth-century virtues, who is actually a conniving villain. Human energy is changed in this book, but energy itself remains uncelebrated, for Tom is still a character, still playing his part in a very formal structure, and is still in need, finally, of taming, integration into the community through marriage. The formal narrative structures that control all eighteenth- and nineteenth-century English novels preclude the isolation of energy as a force independent of individual characters.

It is impossible to explain why writers changed their attitudes toward energy: each possible cause demands another. Rousseau offered a new conception of human nature which eliminated Original Sin; the French and Americans had revolutions which upset ancient social structures; God became a less personal being for many; and writers began to claim energy as a legitimate part of human life instead of depicting it as a source of sin and danger. Then, in the nineteenth century, the process was accelerated, and many writers—Blake, Coleridge, Shelley, Mill, Carlyle—feared the loss of energy (depression, enervation, lifelessness, alienation) more than anything else. Perhaps the sight of new machines, manmade but clearly more powerful than human beings, or the loss of individuality by people newly crowded into cities, or the new realization that what had been considered the eternal power of nature could be destroyed, all helped to create a new fear, that human beings were losing energy and were sinking into a dull, depressed sameness.

At any rate, energy itself became a major subject of nineteenth-century poetry. Blake, more than anyone else, celebrated it by name, without metaphorical disguise: “The Marriage of Heaven and Hell” attacked the Christian idea “that Energy, called Evil, is alone from the Body, & that Reason, called Good, is alone from the Soul,” and declared three new metaphysical principles which define a new energy, both divine and inherent in the body.

1. Man has no Body distinct from his Soul; for that called Body is a portion of Soul discerned by the five Senses, the chief inlets of Soul in this age.
2. Energy is the only life, and is from the Body; and Reason is the bound or outward circumference of Energy.
3. Energy is Eternal Delight.
Blake did not here associate the idea of energy with any particular image from the natural or supernatural world, but anticipated the techniques of some recent writers who have tried to enact or embody energy in the sheer form of their work by violating every expectation of what a poem should look and sound like—mixing prose and poetry, jokes, aphorisms, puzzles, and refusing to provide either a narrative or a rational structure in which a reader could feel secure.

Other romantic poets called the divine energy of the natural world by other names, like Spirit or Power, and described it by means of metaphor. Wordsworth’s Spirit in “Tintern Abbey” is like a stream that flows through the world; Shelley’s Power in “Mont Blanc” is like water in a more menacing form, a glacier; both Coleridge, in “The Eolian Harp,” and Shelley, in “Ode to the West Wind,” say that divine energy is like the wind. Obviously, neither wind nor water is a true source of energy, since both are moved by other forces—gravity, the heat of the sun. Yet neither gravity nor the sun is an important subject of poetry, since they are less directly experienced than wind and water, both of which can move through the world without destroying it.

Later in the nineteenth century, when people had lost faith in the romantic idea of Spirit, energy assumed a new form in poetry. Two poems which clearly suggest energy without binding it to one metaphor are Whitman’s “The Dalliance of the Eagles” and Browning’s “Meeting at Night,” both short, intense, sexually indirect, and imagistically explosive. The Whitman poem is quoted first.

_Skirting the river road, (my forenoon walk, my rest,) Skyward in air a sudden muffled sound, the dalliance of the eagles, The rushing amorous contact high in space together, The clinching interlocking claws, a living, fierce, gyrating wheel, Four beating wings, two beaks, a swirling mass tight grappling, In tumbling turning clustering loops, straight downward falling, Till o’er the river poised, the twain yet one, a moment’s lull, A motionless still balance in the air, then parting, talons loosing, Upward again on slow-firm pinions slanting, their separate diverse flight, She hers, he his, pursuing._

Sex is the cosmic force which replaces Spirit for Whitman; he has broken through the clichés of romance in the poem by choosing an unexpected subject—birds, instead of young human lovers—and has suggested energy through clear and unusual verbs. The poem is not metaphorical, as romantic poems were, because the eagles are an example of energy, not an analogy.

Browning writes about human beings, not animals, but also suggests energy with words that refer to actions rather than to objects.

_The gray sea and the long black land; And the yellow half-moon large and low;_
And the startled little waves that leap
In fiery ringlets from their sleep,
As I gain the cove with pushing prow,
And quench its speed in the slushy sand.

Then a mile of warm sea-scented beach;
Three fields to cross till a farm appears;
A tap at the pane, the quick sharp scratch
And blue spurt of a lighted match.

And a voice less loud, through its joys and fears,
Than the two hearts beating each to each!

These two poems are short enough to be read as unstructured, pure bursts of energetic images. They contain no metaphysics, no abstractions; they demand that the reader supply his own knowledge of sex as one of the forms of human energy. They suggest that energy is a property of the physical world, not a part of divinity or spirit.

Energy is located in a new place in some twentieth-century literature—in the words themselves. In "Vorticism," one of the great manifestos of twentieth-century art, Pound compared poetry to mathematics and claimed that images have power as elements of an equation rather than as references to the powers in the external world. Energy was certainly his standard of value:

The image is not an idea. It is a radiant node or cluster; it is what I can, and must perforce, call a VORTEX, from which, and through which, and into which, ideas are constantly rushing. In decency one can only call it a VORTEX.

For him, the best art—vorticist art—was the most intense, and intensity existed in the words alone. Such theories have gained many followers among both poets and fiction writers in the twentieth century; they are a return to a kind of idealism because they deny energy to matter and attribute it to nonmaterial entities, if words can be called entities. Pound and his followers sought for energy as avidly as Blake could have wished, perpetually intensifying the search. But whether words can in fact carry the burden which they have been given remains very doubtful to me.

Judith Weissman: Overview

The most insightful comment in the discussion that followed the six talks on images of energy was that the missing science was economics. Questions of many sorts demanded economic answers. The first, rather heated, question from the audience was why the intellectuals had snobbishly sidestepped issues like solar energy, which ordinary people care about; the primary answer was that many of the energy images mentioned derive from an economy of waste and that it is to the economic advantage of the powerful to keep the world addicted to oil. Economic thought also answers a very different question—whether Rousseau broke away from the traditional image of bodily energy as dangerous because he saw the body as a machine. In fact, he demystified sexual passion by analyzing it economically and concluding that human lust would be a perfectly manageable feeling if it were not artificially intensified by the sexual marketplace. What
was needed to illuminate much of the discussion was indeed economics, though not current economic jargon about interest rates, stock-market trends, and rates of productivity. The missing economic theories (now often relegated to philosophy departments) were theories centered on the idea of human labor and the unjust distribution of wealth.

Although labor was mentioned, particularly in connection with architecture, it was a distinctly peripheral topic. Both the speakers and the audience avoided talking about it just as resolutely as the members of advanced industrial societies try to avoid doing it. Literature suggests psychological or sexual energy; psychiatrists study the emotions associated with energy, not how energy produces goods; graphic designs are supposed to minimize the human effort required to read a page; the important images in architecture are the expressive forms of the completed buildings. The images in the talks devoted to these subjects are bound by no laws; the mind can imagine energy in any form. The strictly scientific talks were short on images and long on formulas; Dennis and his blocks are a very distant analogy for energy, not an image of it. And their main message is clear: laws govern energy. If some phenomenon seems anomalous, then some piece of information is missing, or some theory is wrong. Our understanding of natural phenomena may advance or improve, but the phenomena themselves do not. They have to work in consistent ways. No one can alter the number of Dennis’s blocks, and no one can change the amount of energy we get from the sun or the processes by which living things use it. Although we may find new ways to use plants—perhaps to make oil, as was suggested—we cannot change the laws of energy. The idea of human labor might connect the nonscientific talks with the purely scientific ones by reminding us that no human endeavor is exempt from physical laws. Thought cannot take place in an unfed brain; feelings and emotions are inseparable from the body; our buildings cannot be built, like Camelot, to music.

Labor is the basis of the economy which determines many of our values and images. Chic forms of exercise produce nothing; no one thinks of carpentry and bricklaying in terms of energy. And the people who have time for tennis and jogging are precisely those who have been liberated from the need to earn their daily bread by physical labor. We are deluded by advertising into believing that labor will go away (also the goal foreseen in orthodox Marxist theory). Recently on television I saw an advertisement for frozen food (Stouffer, owned by Nestlé, but that’s another essay) promising women freedom to do what they really wanted—swimming, sailing, tennis, all very energetic and slimming activities. Since when does frozen food grow on trees? What about the energy needed to keep it frozen after it is grown and picked and prepared and packaged by energy in the form of human labor? The preparation of food and the care of children have always been done by human beings; like the slow small processes of respiration, such images are not associated with the glamour of energy. They require real energy, however, and those women who have freed themselves from such jobs in order to pursue energy in the form of leisure activities have merely passed the work on to other people, probably other women, either household servants or factory workers.

The rich have always enjoyed sports while the poor provided labor.
The difference now is that we—for all of us at the university have many of the privileges of wealth—now think less about the working classes, who are hidden in factories, while their labors appear as new cars and mysteriously packaged foods, our liberation. The working classes do not impinge on the image-making minds of the elite. Their absence is profoundly symptomatic of the way in which the image of energy has changed in recent years. Two thousand years ago Plato, who called energy passion, said in the Republic that passions were to the individual what the laboring classes were to the state. Laborers provide the material energy for a society; passion provides the physical energy for a human being. His analogy was still alive for Shakespeare, perhaps even for Pope. But now, if energy is the highest property of mind and spirit, the analogy does not work. So labor and laborers disappear from our images.

In spite of our images, economic laws still work. Either people or fuel-burning machines still have to provide labor for any human product. Perhaps of all the works of art mentioned in the colloquium, the pyramids most demand to be connected with labor; they are not just images of energy but the products of an almost unthinkable amount of human energy, very probably unwilling energy. And the goal of some recent architecture, to design buildings which will demand little human energy to build—doesn’t it carry as a corollary a greater demand for energy to maintain these buildings as livable structures? I have read that the heavy stone walls of some old buildings, hard to erect and long lasting, need little insulation. Perhaps it is possible for a building to be easy to construct, durable, and energy efficient; but so far the decreasing expenditure of human labor in architecture and other forms of production has precipitated the voracious demand for fossil energy which has determined the current state of world politics.

And to question even more fundamental presuppositions: What if we didn’t need many new buildings? What if our public buildings lasted for centuries? What if the population were not growing? What if people lived together in groups larger than the nuclear family? Would we need so many houses? Our images of energy are inseparable from words like progress and from the assumption that everything had better keep changing—our cars, our houses, our selves. If architects really do start to make buildings again which will endure, like the buildings of the distant past, perhaps they will begin a return to an older way of life; perhaps they will also bring some old images of energy back to our culture.

All the nonscientific images of energy in the colloquium come from what is called Western civilization—hierarchical, industrial, wasteful, fragmented. No one would advocate a simple retreat by a hundred or five hundred or a thousand years to a hierarchical, wasteful, fragmented nonindustrial society; the earth suffers less when many human beings slave for the few, but humanity suffers more. Probably we cannot return to our biologically natural state of hunter-gatherers, though that is the one state in which people destroy neither each other or the earth, a state without architecture, agriculture, or accumulation. We—on both sides of the Iron Curtain—call such people uncivilized and destroy them wherever we find them, in Cambodia, El Salvador, Vietnam, Afghanistan. The best image I can think of for the feeling of advanced civilization toward peasant or tribal cultures is
Milton’s Satan looking at Adam and Eve in the garden, enraged and envious. Of course no culture is truly Edenic any more, except perhaps the Tasadays and the Pygmies; but our wish to transform primitive cultures smacks of Satan’s inability to see anyone live without suffering like his own.

Naturally the people who are on top in our society fear solar power—because it is the one possible road back to a culture that exploits neither man nor nature, where the ease of some is not dependent on the oppression of others. This possibility of peace is not the Eastern philosophy which one person suggested as a possible alternative to the Western images of energy presented in the six talks. What we call Eastern philosophies have belonged to elite classes who depended on the labor of the lowly; I am talking about the unphilosophical way of life of tribal or peasant cultures, cultures that live by tradition. Such cultures violate the principle which one member of the audience discovered as the unifying basis of the six talks—that they all included the idea of direction. Only the physicist’s talk suggested a circular or enclosed image of energy; and yet that is the way traditional cultures view human activity and human history. We have been taught that life without progress is worthless, that such people have no lives worth considering—and meanwhile we are progressing toward extinction.

None of this is particularly original; at the end of the nineteenth century Ruskin and Morris attempted to imagine a just society based on the reintegration of the laborer and his work and a new aesthetic which included both the energy of production and the expressive energy of finished objects. It is obvious from both the six talks and the discussion afterwards that Ruskin and Morris have had little influence on the way people now think about energy. They are too reactionary for Marxists, too practical and political for spiritual and counterculture types, who depend on the existence of an affluent, industrial society to scorn and sponge off. They do not offer supernal liberty because they always remember the limitations of the human body and hold as an idea the liberation of the working classes from their oppression by the leisure classes—and so they are out of fashion.

Imaginary energy is in fashion. One participant brought up Nietzsche’s suggestion that the true philosopher carried dynamite in his words; Nietzsche, along with other kindly souls like de Sade, is a great favorite of a school of avant-garde writers and thinkers who follow Bataille, Lacan, and Foucault into the tumultuous frontiers of Language and Thought—a world of energy that is alleged to exist in pure mind. Nietzsche’s philosophical dynamite is radically different from what Marx meant in the last of his theses on Feuerbach, when he said that philosophers should change the world. Marx’s world is a material one, and his philosophers should incite people to action on behalf of the workers of the world—human labor, once again. What is Nietzsche’s dynamite supposed to blow up? Christianity, the religion of slaves? The depressing ideals of democracy and equality so degrading to the great men of the world? Nietzsche and his followers all express a grotesque perversion of romanticism, a frantic concoction of fantasies to which people attach an inordinate amount of emotion, sometimes even what amounts to a religious faith. Here is a very recent passage of avant-garde fiction by a very minor epigone of Nietzsche’s, Raymond Fisher et al.: Images of Energy Published by SURFACE, 1981
Federman:

One could imagine that it happened this way:
in the beginning
words scattered
by chance
and in all directions! Uncontrolled energies!
Wild lines of words would have crossed the sheets of paper
obeying only their own furor.

I do not believe words can do a thing. Feelings, thoughts, ideas, exclama­tions, can pass through words from one mind to another—but without minds, firmly encased in matter, words are nothing.

"Uncontrolled energies," "furor"—this is the intellectual's version of pyramid power and the zooming spaceships of Star Wars, magically accelerating to the speed of light in seconds, even though it is impossible, even theoretically, to accelerate from a standstill to the speed of light in less than years. Delusions about energy have been finding acceptance in many minds, both educated and uneducated, in recent years. Perhaps because science has become extremely specialized and encoded in mysterious language, perhaps because in some high schools not carrying a switch blade is enough to earn a student a diploma, perhaps because brains go lazy on too much television, science and scientific ways of thought are no longer part of ordinary discourse. When we look at other cultures we say with confidence that instincts, emotions, or wishes cannot tell people how forms of energy operate: we know that the Chinese are wrong to believe that sexual energy gets depleted and that only a lunatic would see himself as the repository of a mysteriously destructive form of supernatural energy. There is no more reason to give any credence to Nietzsche's dynamite or Federman's uncontrolled energies than to the Chinese superstition. Blake was wrong when he said that everything capable of being believed is an image of truth; plenty of ideas which are ardently believed are out-and-out falsehoods—and right now a lot of those falsehoods have to do with newly idealized energy. It is quite a job explaining to an intelligent adult that there is no way that a pyramid-shaped hollow structure can sharpen a razor blade; it is even harder and infinitely more necessary for some brave soul to explain to the United States Congress that deregulation is not going to produce any more oil and natural gas, because they exist in finite quantities, cannot be created geologically in anything like a human lifetime, and that these facts cannot be affected by anyone's economic system. And what rebuttal can be made to the fantasy that words on the page contain furor and uncontrolled energies?

Surely the human body is the unspoken element here too. Dreams of superhuman power—eternal youth, enormous strength, the ability to fly—are ancient ones; but I do not think that any culture has despised their opposites—age, weakness, sickness—as ours does. In a culture where age brings no rewards, it is pathetically natural that the quest for eternal energy has been intensified to the point of insanity. Nietzsche, of course, was extremely sick and weak when he dreamed up his supermen and philosophical dynamite; but even the youngest and healthiest person is still vulnerable and mortal. Mortality is particu­larly terrible for people who have lost old hopes for eventual immortality in God's heaven and who are tantalized and frustrated by endless ex-
hortations to produce energy forever. What can follow but delusions and rage? *Furor* and *dynamite* are words for angry, destructive energy.

Anger, rather than sex, may be the form of energy which those psychiatric patients who fear their own explosive power may feel. Sex between consenting people does not hurt anyone; it is anger that can kill. *Anger* is another word that never came up in the colloquium on energy; the magazines in supermarkets do not advocate anger as they advocate energy in other forms. And at this point I return again to the hostility of Western, industrial, alienated cultures to uncivilized people; a part of Freudian theory which no one mentioned is that civilized people are always discontent because they live controlled and repressed lives. That is nothing new: Achilles and Jeremiah were discontent. What is new is the combination of ancient discontent and the recent delusion that unlimited energy is ours to create, in ourselves and in the material and spiritual worlds. It is a deadly combination.