AESTHETICS: IGNORE AT OUR PERIL

Author: Amelia Amon
Delivered to the American Solar Energy Society
June 2003

ABSTRACT

We, as a species, have evolved our response to beauty: order, pro-portion, balance, as a tool for survival. Stronger, perhaps, than our rationality or ethics, our instinctual love of beauty may still be our best hope for preserving our natural environment. How can we, renewable energy practitioners, appeal to this emotional response to form? Are there objective principles we can use to design equipment and systems? Do these principles cross cultural boundaries, for installations in developing countries?

Using aesthetic principles postulated by a team of eminent neuroscientists in the Journal of Consciousness Studies in 1999, I will describe how these principles can be applied to the design of renewable energy systems and installations. Contained are brief explanations of the cognitive theory followed by practical examples for 1. peak shift effect, 2. binding or grouping, 3. isolating elements, 4. contrast ex-traction, 5. puzzles and problem solving, 6. Use of metaphor, and 7. symmetry and harmony.

1. PRINCIPALS OF AESTHETIC EXPERIENCE

There have long been theories of art and beauty, but recently neuroscientists have started to develop a "science of art", a neurological theory of aesthetic experience. V.S Ramachandran, Director of the Center for Brain and Cognition, and professor of neurosciences and psychology at the University of California, San Diego, has proposed principles of aesthetics, based on the way the brain processes information (1). Though still controversial, these phenomena seem to hold up in laboratory testing as well as from evolutionary and cultural observations.

The basis for this line of exploration is that the eye-to-brain communication mechanism incorporates a visual "short-hand" that allows us to make decisions on where to focus in less time than it would take to process every detail as a separate nonspecific event. Thus, forms that are clear and visually striking are physiologically more appealing. Many of these aesthetic principles pertain to the design and installation of renewable energy systems. Here I will address those that seem to have most relevance to emerging energy technologies.

1.1 The Peak Shift Effect

One principle, called the peak shift effect, exaggerates one aspect or essential feature to amplify the viewer's reaction to a design. It can be seen as caricature, the art of removing the average visual qualities to focus on the unique characteristics. This can be done in different modalities such as form, color, depth, and motion.

On a primitive neurological basis, this effect is well-known in animal discrimination learning. If rat is taught to discern a rectangle from a square, and rewarded for choosing the rectangle, it will have a more pronounced response to a longer, skinnier rectangle. Once it has learned the principle of rectangularity, it shows increased recognition for the more extreme example.

Another example from the animal kingdom, from which our perceptual responses evolved, can be seen in seagull chicks. These young birds peck at their mothers' beaks for food, using the distinctive red spot near the tip for recognition. Surprisingly, they will have the same pecking response to a disembodied beak or a brown stick painted with a red dot. It was later shown that a very long, thin stick with three painted red stripes will illicit an elevated pecking response from a seagull chick, even though it doesn't have the appearance of a mother gull's beak. The chick's neurons are wired for survival, and so produce an immediate, strong response which is more functional under normal feeding conditions than a slower assessment of its mother's actual beak (1).

In this same way, our visual system jumps to conclusions, allowing a pre-rational response to a given stimulus. By accenting a distinctive feature of an installation, we can set off these visual triggers to elicit a positive (or negative) reaction. Physiologists have shown that our brains have specialized modules for visual modalities such as form, color, depth, and motion, hence our visual perception is an integration of simultaneous assessment and comparison. The peak shift effect can be produced in any one or more of these modalities.

For example, the striking iridescent blue of multi-crystalline photovoltaic panels can be accentuated to catch the viewer's eye. I put this principle into effect in my

solar fountain for the Cooper-Hewitt, the National Design Museum of the Smithsonian Institution. The custom photovoltaic array was set into translucent reflex blue fiberglass pans. The mimicked hues of blue light shining through accented the shimmering nature of the cell surface.

The organic form of this fountain was maximized by repeating similar curves on the overhanging shield and base. The impression is of a continuously rounded natural form, in spite of solid, unyielding materials.

Of course, it is the movement of water that captivates the audience of a fountain and will generally have a calming influence. From an evolutionary standpoint, this attraction to the movement of water probably runs stronger and deeper than almost any other easily achievable visual effect.

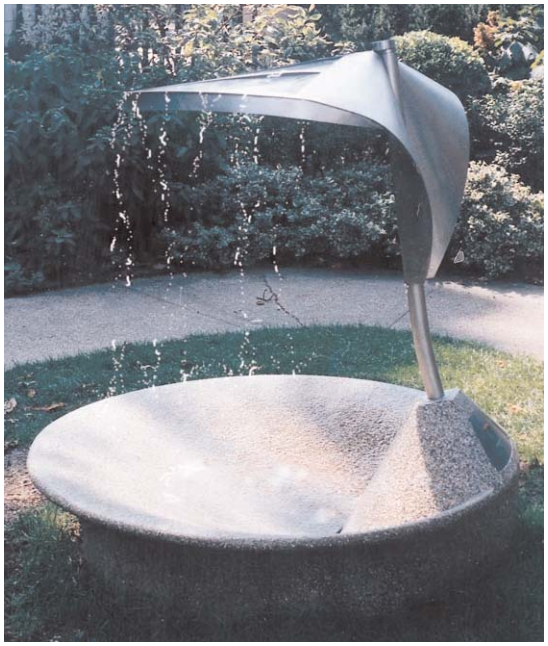

Fig. 1: Solar Fountain at the Cooper-Hewitt Design Museum

Peak shift might also be accomplished in renewable energy installations by exaggerating features such as the height or taper of support poles. The size, extreme proportions, and changeable motion of wind generators give them the potential to be a striking visual statement, if carefully sited. It may be worthwhile to bring in an artist or design advocate to help guide those decisions when trying to convince communities and zoning boards to accept a local wind installation. It was suggested, at a recent renewable energy conference, that we might increase public acceptance of wind turbines by calling them monumental kinetic sculptures with an energy by-product.

The dramatic angles necessary for solar gain in high latitudes can make an eye-catching statement that also serves to orient us directionally. Trackers moving in concert over time can be employed to intrigue the viewing public. In a recent installation for the International Brotherhood of Electrical Workers (IBEW) in Trenton, NJ, I placed the trackers in a semi-elliptical arrangement, and tied the poles together with a long sweep of stainless steel tubing, incorporating their sign and logo, which light up after sunset. The impressive sixty foot curve is echoed in the staggered heights of the trackers themselves and set off by the gently sloping grade of the site. Flowering bushes follow the curving path to add color and soften the transition from ground to vertical poles.

1.2 Grouping or Binding

Grouping or binding, being able to immediately see correlations between similar objects, is very satisfying to our human brain. This tendency, also known as a Gestalt process, is one of the main functions of 'early vision', the ability to discern and delineate objects in the visual field. Scientists believe there may be direct links in the brain between the visual processes that discover such correlations and the limbic system which give rise to pleasurable reward sensations associated with feature binding. It's the feeling of "aha" one gets when a group of random splotches is focused in as a recognizable face, animal, or something in our memory mapping.

Once we've picked out the object in question, this reinforcing mechanism makes it difficult to not hold on to that image, or to once again see it as a random field. As with other aesthetic sensitivities, an immediate feedback system for finding clues for identifying known entities, such as a food source, mating opportunity, or danger, is vital to ensure survival response, given the limited attentional resources of the brain and the myriad representations competing for neural space at any given time (1).

Again, designers can produce this effect in the different visual modalities of color, form, depth, and motion. An interactive solar exhibit, SolSpherica, designed and produced for Liberty Science Center in Jersey City, NJ, in collaboration with Wendy Brawer of Modern World Design, NYC, includes several distinct features representing scales of energy usage; from home, to community, to earth, to the galaxy. To pull these separate units together, I used a consistent color palate of turquoise and sunny yellow. This was reinforced with a consistency of materials and form, with elliptical, somewhat bulbous shapes, repeated use of stainless

steel tubes and cylinders for structure, and a circular slightly domed floor of recycled rubber to define the boundaries of the exhibit. The floor also represents a compass face, to locate the exhibit objects, and by comparison, the observer, by the four cardinal direction points. The effect is a unified statement, which can later be cognitively parsed into separate activity areas.

Fig. 2: Solspherica at Liberty Science Center

1.3 Isolating Elements

Isolation, or the removal of unnecessary visual information, is another way to send a clear message to the brain's imaging centers. Because there are constraints on attentional resources that the brain can allocate to any one of the visual modules, isolating and enhancing one area (such as line, form, or color) allows the viewer to direct more attention to one source of information. This amplifies the limbic (or emotional, prerational) centers, thus reinforcing the satisfaction felt. This is why, counter-intuitively, a line drawing can sometimes convey information more strongly than a full-color picture. Because only boundaries are shown, the mind can respond with more immediacy, without having to process superfluous details.

Ramachandran and Hirstein theorize one reason for the artistic skill seen in early cave paintings, similar in ways to those created by today's autistic children, to be the result of more direct access to the early vision modules of the brain as a result of being less "concept driven". Obviously, less is more when you want to generate quick mental processing and response. An added incentive is that the evolved human imagination can fill in the missing information, often enhancing reality with our innate creativity.

Renewable energy technologies can readily take full advantage of the isolation principle of aesthetic design. The simple, flat planes of photovoltaic panels lend themselves to pleasing perception in one modality. When locating them on a roof or structure, it's important to consider their relationship to the other elements of the site, as well as their directional orientation for optimum power. Minimizing external wiring and consolidating equipment storage will help with the overall impression. Grouping similar photovoltaic panels and maintaining the height/width orientation of the rectangles will produce easier home owner and neighborhood acceptance, even on a pre-cognitive level.

The stark, easily recognizable profiles of wind generators exemplify the isolating principal of aesthetics. Perhaps this is why we intuitively paint them in gray tones, from white poles to black blades (for rapid ice removal). These minimalist approaches to their exterior decoration, with careful siting, have the best potential to increase their popularity.

Distributed generation presents increased hope for urban and rural landscapes that are not cluttered by the ubiquitous electric wires we try to block out of our consciousness. We've all had the experience of taking a photograph of a landscape or installation. Later, when we look at the image we thought we saw, we see, instead, a large electric pole or drooping wires blocking our view. The human mind effectively eliminates information not considered crucial or rewarding from memory. Part of the effort of the renewable industry could be to further improve the quality of our local environments by minimizing visual clutter.

1.4 Contrast Extraction

Contrast extraction is similar to isolation of elements, in that redundant information is discarded to reinforce an immediate impression. We know, instinctively, that the borders separating objects are the places of most interest to our attention and reaction centers. Cells in the retina, in relay stations in the brain, and in the visual cortex respond mainly to edges, but not to homogenous surface colors. Attraction to contrast can be exploited across many visual modalities, including luminescence (dark to light), color, and motion (1).
Though these principles are considered in terms of aesthetic experience, they could just as easily be used to discern that which will be jarring or unaesthetic. Often, when bringing a new technology to an indigenous culture, the innovation is simply dropped into the environment in the most technically expedient manner. The visual effect is immediately recognizable as high contrast. The sometimes unfortunate outcome is that

the recipients of the benefits of the technology don't feel a sympathy or compatibility with the equipment. So how do we integrate renewable energy installations with cultures that have evolved over thousands of years? The solution is not likely to be quick or easy.

As with any community project, we should look to the local population for ideas and insight, because only they fully understand their own cultural requirements, native materials, and local conditions. This process involves extensive communication, openness to compromise, and allowing the time for consensus; areas that are seldom budgeted into renewable energy development. Arguably the most significant long term benefit is local investment in the project, which will greatly increase the commitment to maintenance, and correspondingly, the life expectancy of the system.

I've seen this phenomena in the small pocket gardens of New York City, as well as when traveling through rural India. Though cultural differences are extreme, some aesthetic responses may predate our learned biases. Our challenge, as an emerging industry, is to appeal to people on rational, sensory, and cultural levels. In the 6BC Community Garden, lengthy stakeholder discussion led to the location of photovoltaic panels on top of a suitable grape arbor. The array lets enough light through to produce healthy vines and still provides enough power to run a pond pump and security lighting after dark. The added task of cutting back the grape vines was the eventual trade off for a consensually-concluded unobtrusive installation.

Contrast can undoubtedly be used as an visual enhancement. In an early prototype for a window sill battery recharging unit, I contrasted a sleek, black amorphous photovoltaic lid with a slightly rough recycled scrap wood base. A visceral pleasure is received when two materials set-off each other's qualities by contrast. Use of indigenous materials for a PV structure could have this same effect if sensitively planned, located, and fabricated with attention to details.

1.5 Puzzles and Problem-Solving

Almost converse to the other principles, the mind's attention is drawn to visual puzzles or problem-solving. A perceived incongruity, which can not be automatically processed, will attract the eye repeatedly as the brain searches for resolution. The allure of the 'peekaboo' effect is paradoxical, in that it causes the visual system to struggle for understanding and therefore hold the focus. Ultimately, it can lead to the satisfying, aha response, also found in the peak shift effect, but presumably after concentrated effort.

Sculptures that seem to defy the laws of physics are examples of this phenomena. Again, for our purposes of promoting alternative energy technology, the effect can be advantageous or off-putting. An example where the effect is dramatic is the large solar cube at the Orange County's Discovery Science Center in Santa Ana, CA by Solar Design Associates, in which a 135 foot tall geometric space frame cube seems to balance on one corner, with one entire cube face a thin film photoelectric skin appropriately angled at 50° to maximize visual impact along with solar gain (2).

This same brain-puzzling effect might not work so well if the overwhelming impression is precarious or dangerous. As practitioners of an emerging technology, we always want to ensure our installations appear safe, durable, and structurally-sound, at the very least. Dramatic effects should be carefully considered within those constraints.

The function or utility of a renewable energy demonstration product can also present a paradox. The 'Solar Freeze', an ice cream vending cart powered by photovoltaics, designed by my company Alt.Technica, Ltd., intrigues people because it is cooled by the sun. Four 30 watt lightweight, unbreakable panels charge an onboard battery to supply energy to a 24 volt direct current compressor to maintain 0 degrees in a super-insulated 5 cubic foot freezer compartment. Children and adults enjoy and remember this valuable teaching tool (and delicious frozen treats).

1.6 The Use of Metaphor

Fig. 3: Solar Sapiens Streetlight in Austin, TX.

Another higher level artistic effect is that of visual metaphor. This also incorporates visual puns, allegories, and the use of humorous juxtaposition. Metaphor is usually thought of as a linguistic device for effective communication, the comparison of two concepts or qualities that are recognized independently of each other. Recent theories of how the brain works portray metaphor or symbolic relationship as one of our most basic cognitive mechanisms for economically (in terms of neural attention) encoding the world.

Classifying objects into categories is vital for survival, e.g. prey vs. predator, edible vs. inedible, male vs. female. Seeing similarities between disparate entities is an essential step in the formation of mental judgments. Like the visual effects previously mentioned, metaphor taps into the limbic reward system that gives us the feeling of satisfaction when we 'get it'. It can be used to capture and compare the essence of objects, qualities, or ideas.

The Solar Sapiens streetlight (fig. 3) was designed as a collaboration between Alt. Technica and Kevin Conlin of Solarcraft, Inc. of Stafford, TX, who produced several for Austin Energy. Conlin's original concept was to incorporate the gesture of a person triumphantly raising a photovoltaic panel over a luminous fixture 'head' into an attractive, practical streetlight. The merging of these two elements and anthropomorphism of the technology seem to bring a smile of surprise and recognition on initial viewing.

Solar Design Associates' "Sun Flowers" are a superb example of the use of metaphor in solar design. This installation of multiple solar trackers uses color, the bright yellow of flower petals; movement, the phototropism of trackers and flowers; scale and location; scattered on an open field, to make the appealing comparison between a technological application and a commonplace, light-hearted blossom.

1.7 Symmetry and Harmony

The importance of symmetry and harmony, abundant in the natural environment, should not be ignored in our list of aesthetic principles. From an evolutionary standpoint, most biologically significant objects — predator, prey, or mate— are symmetrical, so symmetry recognition may serve as an early-warning system to grab attention for further processing. It has been shown experimentally, that both humans and animals prefer symmetrical mates, presumably because it indicates health and vitality.

This is not to say that all installations should be symmetrical, but when in doubt, symmetry is a safe place to start. Balanced proportions also fit well in much of the built environment, can be easily processed, and are not generally challenging to the observer.

There are myriad forms of harmony in nature. One of the most well-known is the Golden Ratio or Golden Section, represented by the Greek letter, Phi. This ratio, approximately 1: 1.618, is based on the Fibonacci sequence, in which each number of the sequence is determined by adding together the previous two: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55,…and on. The ratio of adjacent numbers in sequence approaches the golden section proportion. This progressive proportion can be seen in the spiral shapes of shells, the spiral growth patterns of pine cones and sunflowers, the proportions of fish, and the Divina Proportione of the human body as famously illustrated by Leonardo da Vinci in 1509 (3). There are many excellent books and articles explaining this phenomenon. Suffice to say it has been shown to be a preferred proportion across many centuries and diverse cultures (4).

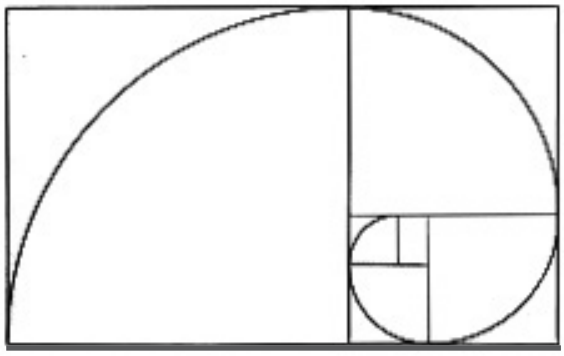

Fig. 4: The Golden Section Spiral

An interesting exercise would be to take the rectangular proportions of all the photovoltaic manufacturers standard models to see how they compare to the Golden Ratio. It may be a subtle way to increase the public's willingness to see solar panels installed on their roofs.

SUMMARY AND CONCLUSIONS

"When I am working on a problem, I never think about beauty, I think only of how to solve the problem. But when I am finished, if the solution is not beautiful, I know it is wrong." –R. Buckminster Fuller

This paper is meant as a beginning, to look into ways we might increase the popular appeal of renewable energy technology. Understanding some of the methods

or short-cuts that the brain uses for visual processing may give us input on how to design dynamic, inspiring installations. Alternatively, these principles can also help to avoid unexpected negative reactions to our best efforts.

The first principle, called peak shift effect, exaggerates one aspect or essential feature to amplify the viewer's reaction to a design. Grouping or binding, the ability to immediately see correlations between similar objects, creates satisfying brain responses. The third principle isolates a single element, which allows us to pick out significant features in a crowded environment. Contrast is another pleasing stimulus that can enhance our dimensional perception. Problem-solving, or employing a simple brain puzzle, can be used to create a more tantalizing impression, as can the use of metaphor. Symmetry and harmony are often used to define the beauty we see in our natural environment.

Our species' innate love of beauty underlies our most crucial personal decisions, from what to buy to where to live. Retailers, real estate salesmen, and marketers know well how to manipulate these basic instincts. It's time for our industry to go beyond technical proficiency and moral arguments to address the cultural appeal of what we have to offer. I hope to initiate an interdisciplinary discussion on how we can use basic aesthetic principles to integrate photovoltaics and wind generators into urban and natural landscapes to create a more beautiful, sane energy future.

REFERENCES

(1) V.S. Ramachandran and W. Hirstein, The science of art: A neurological theory of aesthetic experience. Journal of Consciousness Studies vol. 6, 1999

(2) "Architectural Icon with Power", Environmental Design & Construction , February 2001

(3) Kimberly Elam, Geometry of Design, Princeton Architectural Press 2001

(4) Mario Livio, The Golden Ratio, Broadway Books 2002