Light and Form: A Case Study

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First Principles

"The first great consideration is that life goes on in an environment, not only in it, but because of it, through interaction with it."

John Dewey, Art As Experience

There is little doubt that texture, surface, extension, value, and color are in one sense basic categories of physical phenomena, constituting in essence a fundamental stratum of experience and the sensible world. Modern psychology and epistemology, however, cohere in saying that this stratum is not the sense world of everyday, the primary datum of the functioning societal member. Neither is the abstract world of the physicalist’s concepts an everyday world. What is given in our day-to-day life is neither very abstract, nor very concrete, but a sort of functionally-bound middle world of norms and stereotypes.

It takes the disciplined seeing characteristic of foundational training in the arts to drive this bourgeois view of physical reality back to elemental sense data. Just as it requires the supremely abstract language of mathematics and the rarified “experience” of modern scientific experimentation to drive that same view off-center in the direction of abstraction. The first exercises of a program of design education begin to perform the former rôle.

Value: Light and Form

Light assembles form. Light dissolves form. Value is reflectance, a measure of the reflection of light incident on a surface, the means by which we visually comprehend our physical environment. To perceive nuance in value is to (be enabled to) perceive nuance in physical form.
In the “grain” of the nerve endings of the retina, the grain of the photographic film and paper, the raster of the television screen we find the archetypes of communication systems which by their own inherent structure transform the image data of reflected light and leave their own characteristic mark on the communicated image.

Luminous Flux

Light is that portion of a broad spectrum of environmental energy to which our eyes are sensitive. James J. Gibson describes it as a luminous flux washing over our sentence within which we learn to discriminate the invariant structure of our surroundings. Our interest in our surroundings, while typically vital, is also not infrequently casual—a lively form of disinterest in which curiosity, fascination, and absorption play as large a part as ascertainment and judgment. Within, we learn to read the invariants in the flux of energy for information which they hold for us in our ongoing transactions with our environs. Perceiving is a diviner’s act wherein everything is charged with portent.

"...[T]here is information in light for the perception of surfaces, is there information for the perception of what they afford? Perhaps the composition and layout of surfaces constitute what they afford. If so, to perceive them is to perceive what they afford. This is a radical hypothesis, for it implies that the ‘values’ and ‘meanings’ of things in the environment can be directly perceived. Moreover, it would explain the sense in which values and meanings are external to the perceiver..."

"The theory of affordances is a radical departure from existing theories of value and meaning. It begins with a new definition of what value and meaning are. The perceiving of an affordance is not a process of perceiving a value-free physical object to which meaning is somehow added in a way that no one has been able to agree upon; it is a process of perceiving a value-rich ecological object. Any substance, any surface, any layout has some affordance for benefit or injury to someone. Physics may be value free, but ecology is not."

James J. Gibson, The Ecological Approach to Visual Perception

Perception is Active...

"...Perceiving is an act, not a response, an act of attention, not a triggered impression, an achievement, not a reflex."

James J. Gibson, The Ecological Approach to Visual Perception

Though the environment provides a barrage of stimuli, and our sensory makeup manages to receive some part of them, perception is not a passive absorption of stimuli. It is an active, out-reaching faculty, constantly employed in making sense of things. As such it is dynamic, ever-changing, even when the stimuli are not. Sensory-deprivation promotes wild and disorienting hallucinations, not tranquility or blank repose.

...and Whole

From the earliest moment in a child’s development that experimental techniques can reliably isolate, the world is being treated holistically, as patterns seen entire, not laborious summations of bits and pieces of discrete stimuli. Locke’s was wrong; perception begins with genera, then proceeds to differentia, given time, and need, or interest. More to our point, the world is being engaged as one which is pregnant with signification, apprehended directly.

Quality

"...[Q]uality is not a property which...[a] thing...possesses in addition to its other properties. It is something which externally demarcates it from...[other things]...and which internally pervades, colors, tones, and weights every detail and every relation of the work..."

John Dewey, "Qualitative Thought"

Environmental attentiveness and thought means, therefore, the capacity for qualitative thought. Most particularly, it means something other than, something more subtly shaded than, thoughts about shape as such. The “gestalt” by means of which we read and assess our environment (for quite practical purposes) typically involve complex, multi-sensual appeals to our reciprocal capacity to apprehend them. Selective attention certainly plays a role, but we attend to something as portent, as an affordance for us, addressed to us, meant for us, and flowing into our future. We decide whether a storm is imminent, whether a field is fallow or abandoned, whether a building complex is under construction or derelict, whether the person with whom we are conversing is trustworthy, whether the situation on the night urban street, or on the subway car is threatening or benign, whether our spouse is vexed with us. And we make these and other similar decisions about circumstances which are fraught with quality, apprehended as
quality, pondered and judged as quality, routinely, daily, continuously.

Synesthesia

It is crucial to remember that our sentence is multidimensional, and that we are mobile creatures. So much of the attention of the design world and design pedagogy has been given over, unquestioningly, to vision as foremost of the senses that a few corrective moments at the outset are in order.

It was the astronomer Kepler who, in 1604, first realized the true function of the retina—that it is the screen on which an image from the lens is formed. This hypothesis was tested experimentally by Scheiner, in 1625. He cut away the outer coating (the sclera and the choroid) from the back of an ox’s eye, leaving the retina revealed as semi-transparent film—to see an upside-down image on the retina of the ox’s eye.

R. L. Gregory, Eye and Brain

We teachers still often victimize ourselves and new generations of design students by the false analogy drawn between the camera and human visual perception. James J. Gibson deftly unmasks this uncritical and insufficient analogy: what internal watcher in one’s head, using what other set of eyes, attends to the projection screen of the retina?

Human grasp of form is a mosaic of partial truths, significant portions of which have been presented, over time, and singly, as the evidence of several senses. Form is grasped as (to make a purely visual analogy) the Egyptians (seemingly) grasped human form; each component in its most strong, best Gestalt, yet the totality not conforming to a single, coherent, spatial-visual form. We see a cloud, which approximates in its giveness a singular impression of form. Perhaps the strongest aspect of its form is a rounding, or swelling, or bellying out of a major portion. We might not notice at all those respects in which our “cloud” (is the event really encompassed in its manifold and elusive characteristics by our naming?) is not dealt justice by the swelling forth of the main body of the form.

In the middle-world of day-to-day perception, where our interest in events is dominated by a casual instrumentalism, we typically stitch together (cobble together) as a bricolage bits and pieces of several (probably quite incompatible) Gestalts—each cognizing a component of the form—and these Gestalts are not restricted to imagery of a visual nature—we reach for and heft the weight of the inapproachably vast and insubstantial form of a cloud-bank with our mind’s hands; enabled by a synesthesia based on sight we sense a virtual weight and solidity.

How much more comprehensively like the thing in its fulsome concrete-ness are these complex, whole grasping than those of a picture (say, a drawing) and the purely visual sense. The whole project of perception gets skewed by the draughtsman’s sudden restriction: “Use only static sight, and static sight cues, to read it all.” Of course we flounder, given such a requirement that all our form knowing be poured out through this one, as yet technically undeveloped, vehicle.

Untangling the Skein

Consider then the achievements which are represented in M. C. Escher’s “Three Worlds” the artist presents the viewer with the image of a puddle in the woods; it is late autumn; the surface of the puddle reflects the barren branches of the surrounding forest trees; fallen leaves rest on the surface of the water; several fish swim in the puddle below the water’s surface. Yet graphically and presentationally all three worlds are given in the same field of graphic devices, superimposed on one another, occupying the same (graphic) space and time. A veritable palimpsest of overlaid, simultaneous, interacting, and yet distinct visual cues.

Try drawing the quality of transparency, or reflectivity. Try sculpting, as the ancients did so well, one marble surface which yet encodes the distinct and interdependent surface morphologies of a Rubble torso, a diaphanous garment, and transient qualities imparted to both by gravity and wind. Or just try reading an X-ray. One has to learn to see, certainly, but the environmental content which the language of sight must express is not from vision alone. Vision’s task is the concretization in visible form of a complex of environmental knowings issuing from many sensible sources.

Discriminatory Skills

The pedagogical task begins where the student always begins, in medias res. Education proceeds from there to untangle and articulate this complex web of environmental knowings, constructing from that
embedded, engaged beginning a newly disciplined visual sense, a self-conscious visual sense which is (more) adequate to serve as the primary channel of communication and inquiry about environing issues, for oneself and for others.

What is most basic in a design education is to quicken the student's interest in the physical environment, and to encourage attending to phenomena by sharpening powers of discrimination.

The physical world is a well-spring of delight and mystery. Faithful attention ensures limitless rich perceptions, unending possibilities. Faithful attention provides its own intrinsic reward. Faithful attention, simple and modest as it may seem as an agenda, is quite sufficiently ambitious, both as a beginning, and as a cultivated attainment.

To see a World in a grain of Sand
And a Heaven in a Wild Flower
Hold Infinity in the palm of your hand
And eternity in an hour

William Blake

Attention and Discrimination in Light and Form: An Elementary Project "Cluster"

“Vivid contact with compelling phenomena” is an insufficient guideline to direct classroom activities. Base experiences must be both rich and selective. Enchantment demands richness; clarity depends on limits. The experiential limits established for the following studio work are severe. The associated exercises structure and differentiate perception of nuance within this limited milieu.

Each student is asked to search for and collect a series of black and white photographs (they are steered toward high-quality published [offset lithography] reproductions). From this pool of candidates of their choosing they are advised on the selection of one deemed suitable for the coming work. Guidelines: a highly imageable subject-matter, preferably a portrait; an image which is technically superb, even in its available reproduction; an image which is (transportable, which can be brought into the studio. Scale is important, as is resolution, and a comprehensive, well-defined grey scale. Harder to describe, outside the context of the student’s pool of choices, are such intangibles as character, mood, expression, yet the student is sensitive to these attributes. They are felt, if not cognized, and will prove invaluable in the course of subsequent work. They will direct the technical investigation, keeping it on course. They are, quite literally, the subject matter.

The remaining studio work (on this project) concentrates on developing skills at reading differences in the value structure of the chosen image, analyzing these differences, categorizing or typifying them, exploring them through deliberately contrived manipulations (making the differences different), and reconstituting them in some transformed manner, quickening the students’ sensitivity to the expressive (i.e., the qualitative, portent-laden signifies) qualities which they now embody.

Procedure

Using an acetate overlay on the original photograph, each student reduced the continuum of greys in the photograph to a stepped gradient analogous to a topographic map. Varying gradients were mandated, from stark black/white, to as many as five intermediary values.

The “iso-lines” of value thus obtained were enlarged (photocopy or transparency projector), and the image colored, typically using grey-scale markers for an economy of time while the judgments were tentative and the discriminatory skills fledgling.

Numerous revisions, some global, some focal, were required before the character of the original photograph was reestablished.

Some classes presented their refined value analyses in gauache, and repeated the problem, working from a still-life under controlled light instead of from a photograph.

Others were required to devise a system for encoding the visual data in the original analysis, “digitizing” it, and then reconstituting that data on a (far) larger scale.

Other intrinsic contents toward which attention may be directed are the ones of resolution or “grain” of the decoding and encoding, contrast (the rate of change of value in the steps replacing the original gradient, the absolute values assigned to the relative values in the image, or the relative position and extent along that theoretical continuum of the grey-scale of the image, whether given or made.
Inherent Problems

Run the problem, or some aspects of it, once, and you're mesmerized by the intrinsic power of the imagery. Run it several times, in several variations, and you begin to uncover the deep structure of the problem. In particular, you begin to see the utterly predictable difficulties with which each new group of students will inevitably wrestle, the misperceptions to which they will inevitably fall victim, the triumphs of perception that will enable them to turn their frustrations into love and pride and power.

1. The relational nature of perception

The human perceptual apparatus, in common with that of other organisms, is attuned to reading local change in circumstances—contrast, in a word. There must be a change in stimulus for our sentient structures to be engaged, our attention to be directed, and messages sent by the sense organs to the resident
CPU. In Gibsonian terms, we read through the flux to perceive the underlying invariant structure of environment. But flux, or change, is the vehicle which reveals the stable, which makes invariance visible.

What we read directly though are not absolute stimuli (a sound of just such and such a pitch, a color of just such and such a hue, or intensity, or value, a texture of just such and such an absolute roughness). We read local (i.e., essentially adjacent) differences in the stimulus field. A grey which registers as dark in one part of an image, though the same absolute reflectance as a grey seen in another part of the same image, may yet appear there as a significantly lighter (or darker) grey because of a ground of darker (or lighter) values in which it is locally embedded.

2. "Nested" values

Set the students immediately to work with a task they understand as that of drawing boundaries around zones which contain an essentially homogeneous value—one in which they are (at any given moment) unable to perceive differences. They will dutifully and diligently carve up the organized continuum of values constituting the intelligibility of that image into a patchwork quilt of bounded, unrelated shapes—a kind of English landscape of independent holdings.

It is not immediately evident that the darkest regions of a field are contained like pools within the next darker zones, just as the most brilliantly illuminated are enveloped by a darker "shade of pale."

3. To see is to operate, to learn is to do:

For the students to discriminate changes, those changes must be presented to vision simultaneously, as changes in, from, or toward some present reference. Visual memory is notoriously unreliable but the intrinsic capacity for visual discrimination within a present field surpasses nearly every need. Student choices, or preferences, while authentic, may yet be maudlin or banal. They, like we, are circumscribed by past experience. We have learned that fact and don't place overmuch value on what we presently prefer. They must be led to understand that taste, and preference, and opinion, are all malleable, and that it is part of the larger function of education to free the sensibilities from the unreflecting and uncritical tyranny of circumstance. To pose the problem is easy. What is needed, pedagogically, is an operational instrument of value in the classroom with which to address the problem.

I use a simple device. Each student is required to produce a structured set of contrived variations in their work. These are then read (again to use Gibsonian terms) for the qualities of communication and expression they afford. To know whether a "choice" is to be preferred, the student must demonstrate, concretely, an awareness of that larger field of possibilities within which the choice is being exercised.
Discernment is educable, and rarely fallible. A lust for broadened perceptual horizons can typically be kindled, an aptitude for discovery quickened. Skill in the generation of fields of possibility sufficiently rich to permit discernment to be demanding in its judgments and pointed in its preferences is a harder discipline to acquire. Still, like discernment, skills of inquiry can be acquired; passion for the novel in experience is transferable; the need for the continual education of perception is communicable. Indeed, the disease analogy is apt. Desire to learn, founded on belief in the adequacy of one’s own (developable) sensibilities, spreads like contagion in proximity. The close quarters of a studio provide a fertile medium for ideas and values in germ.

4. To see is to decide is to design:

(Value) zones have edges. Their perimeters have character. As bounded entities they have shape. Shape has expressive power.

As the students move from a (seemingly) strictly analytic mode to a synthetic or constitutive one, making new images from the elements discerned as structure in the given ones, they discover that, while the quality of their outcome is founded on the quality of their initial data, that data is in itself insufficient to obtain expression.

The “imageability” of the image is dependent on new decisions of a qualitative and imaginative nature regarding shape and character of contour, factors not given in their analysis of values per se. Where they first saw only the refinement of a skill in visual discrimination, they now discover the unavoidable necessity of an act of the imagination, an act of design.

Guiding Structures

The problem structures that have gradually emerged to deal with these generic difficulties originated as patch-work fixes addressed to emergencies in the studio—tin cans over rat holes, so to speak. Not to say off-hand, or ill-considered. Just that I had no way of prefiguring exactly where so many would have such difficulty that the problem ‘cluster’ would require a local and specific guiding structure. Analogous perhaps (in structure, if not significance) to Piaget’s discovery that children who had difficulty learning the left-hand right-hand distinction were children who had never crawled as infants; the simple expedient of teaching them to crawl in elementary school is sufficient remedy for the problem.

So most of the sub-sets and sub-routines that have evolved over the years were fixes for perceptual and conceptual problems inherent in the activity of students—coming-to-know, not evident aspects of the subject matter itself. Simply put, I knew no way to adequately anticipate these problems before the fact, and accordingly no way to fix them, except through the agency of attentiveness and wits in the face of that ever-changing emergency which is studio teaching.

Sufficient Richness

I find it impossible to engage a class with a problem that fails to engage me as well. It is not enough to believe that the subject matter or the skill or the issue is of such fundamental importance that every student of the field must undergo it. An unalloyed sense of duty carries only so far. More accurately put, teaching guided simply by a sense of duty fails in that larger mission of teaching; teaching that only occurs obliquely, by example; teaching that the life of the mind is an intrinsically rewarding life; that
ideas, especially ideas about things, are rightfully objects of passion; that being alive to the moment, and being underway is everything.

The treasures each new class of novel sensibilities thinks to bring back from that land of vision and the imagination are more than ample incentive to undertake to visit there once again.

New Opportunities

The present discussion is not intended to document past achievements per se, nor to recommend this activity as a classroom Best Project candidate. It simply indicates, against the background of some examples of past student work in this once chosen problem arena of the development of Discriminatory Skills, another instance of the extraordinary classroom promise of the computer.

Students don’t learn to perceive nuances (i.e., learn to discern, or discriminate) within a field, or quality, or phenomenon, unless they have some means to operate on that field, to transform it in some way, to explore how operational differences transform the field qualitatively. Dewey described the condition of a sentient organism as consisting of doing and undergoing in alternation. The conditions for intelligence interpose reflection in this sequence before doing begins again.

Any designer or teacher of design knows that physical ideas are cumbersome to work with, and that qualitative thinking is labor intensive. Labor-saving devices should always be welcomed. No purpose is served in design education by busy-work (the Arabs colorfully refer to it as “donkey” work), or by onerous tasks laid on as a form of hazing—the Parris Island model of studio pedagogy. Free the students from all unnecessary tedium, empower them to explore broadly, with exactitude, and with an economy of means, and one enables scope and substance of learning that should leave the teacher being taught.

These next examples of past student work are presented to parallel instances from recent research (and current studio applications) with image-processing software. Together they sketch the kinds of operations, traditional and electronic, which are accessible to contemporary teachers and students of design working in the problem arena of Light and Form. The work with the electronic media is represented to students as yet another means to explore the same basic issues. Hand (eye) work is as intrinsic to the intelligent use of electronic tools as to traditional ones, and the students move between the two modes with facility on the basis of need or curiosity.
The computer imagery (Figures 17 through 23, following pages) required about 45 minutes to generate, based on a single image scan, and another 30 minutes to format and print. Needless to say, the handwork by students took far longer.

Appropriate Technologies

I am not building a case to replace careful, thoughtfully planned work with electronic shortcuts. Rather, I facilitate the acquisition of basic discernment with powerful tools, and let the handwork proceed from this educated base. You empower the work, you empower the students, and you earn the students' trust that you are not burdening them with unnecessary drudgery.

Many of our fathers (mine was one) learned to drive on cars that had to be hand-cranked, that had separate lever settings for the choke, the throttle, and the advancement or retardation of the spark, and that required double-clutching for every up or downshift. The handbrake was on the running-board. Certainly each new generation of drivers does not need to begin with the horse-less carriage. Address age-old problems with up-to-the-minute, yet appropriate technologies. Careful teaching can avoid false dichotomies.

Garbage In, Garbage Out

The quality of the base data is crucial for all subsequent work. That this data is basic, and that it is functionally and logically primary, should not mislead one into thinking it comes first. It is attained slowly, tentatively, by dint of attention, and the hard work of exploration and testing.

Nor can the need for quality in the initial photographic image be overstated. Technical quality is necessary but insufficient. Expressive power, the means by which the image seduces the eye and the imagination, is clearly essential to initial motivation. Perhaps less obvious is its role in directing inquiry and securing an ongoing sense of achievement. Recognizability ties at a first level, mood, or quality, or expression runs deeper (i.e., is dependent on more elusive objective attributes). Too hard, or too soft, too warm, too cool, too melancholy, too pensive enough may not be refined analytical terminology, but the students' sense of what they use these terms to denote becomes finely honed.
Figure 10: Value separations; acetate tracing over photo

Figure 10 (above) is a refined value separation (isolines of value determined by eye, and hand-drawn with 0.1 mm. Ø technical pen on acetate). Figure 11, a-d (above right), which seems the derivative set, is operationally and conceptually prior and was undertaken first, as an assignment, to clarify the "nested" character of successive value sets or regions. This exercise, which is essentially a controlled variation in the thresholds set between regions the eye will consider predominantly dark and those predominantly light, has proven fundamental to establishing a good (i.e., nuanced and coherent) value separation.

The Economy of Typification

Discrimination is directed by operations which yield controlled differences. Systematic variation using hand (and eye) techniques alone is too cumbersome a process to expect any but the most motivated of students to apply conscientiously to an entire image. The time invested in doing so is disproportionate to the educational benefits derived. Selection of critical or representative portions of an image makes the task more manageable. The lesson learned is generic and transfers to other tasks.
Figure 12: Representative portrait (black and white photo) chosen by a student for subject matter in the value analysis exercise.

Figure 13: Acetate tracing identifying zones of equivalent value in the photo. (Lines are isolines of constant value). Exercise of visual discrimination and judgement.

Figure 14: Area initially selected for required resolution and contrast variations (see following page). Final area is smaller yet (see inner set of lines in tracing at right, Figure 15).

Figure 15: Acetate tracing of selected area, showing isolines as determined by the student. Inner set of lines reflect the final choice of a zone to enrich for the resolution and contrast variations (next page).

The inner set of lines in Figure 15 define the region selected for the work on the following page, in which contrast and the degree of reduction of the original values are systematically varied. The value variations are equivalent to changing the number of values in a posterized image, and represent a kind of resolution, not of datum size, or location, but of the fineness of discrimination applied to it.
Variation: Prelude to Expression

Each student was required to produce the set of nine variations illustrated above: variation in contrast; high, medium, and low; simultaneous variation resolution (not pixel size, but number of values identified), equivalent to choosing the number of steps in the posterization of an image.

The greatly reduced scope (the use of a small recognizable feature as a representative of the whole) was to enable each student to conduct a rigorous set of variations in these two variables without an inordinate amount of "busy work."

Once sensitized to the expressive qualities resulting from varied contrast ranges and resolutions, the students were then prepared to make intelligent choices from among these and related possibilities for the final presentation of their value analyses.
Figure 17: Yousuf Karsh: Portrait of composer Kurt Weill, 1946

Figure 18, a-h: (right) Variations in threshold setting: the “edge” between light and dark.

In Medias Res

For the purpose of demonstration we must take the scanned image as a given, as if it were the original. Scan resolution is far below the grain of the photograph, or the screen resolution of the offset lithograph; the output resolution of the laser printer is far below as well. One cannot consider that one actually manipulates Karsh’s photograph.
Posterization

A technically "good" black and white photograph contains a clear, brilliant white, a rich, vivid black, and a full range of greys in between. It presents a continuum of value or reflectances.

Posterization replaces the continuum with a series of discrete changes occurring at distinctly drawn thresholds.

This second set of transformations approximates what a student can obtain using the threshold settings in the preceding transformations as contour limits (iso-lines of value).

One obtains a second kind of "resolution" of the image: not the amount of light which floods it, or the acuity with which the information-changed luminous flux is registered on a retina or film plane, but the number of gradations of value that are used to construct the image.

Resolution

Resolution can be thought of as a measure of the absolute information content of an image.

It is difficult to ensure that the student experiment with the consequences of these changes without authoritarian measures...

Resolution varies directly with labor, and with ease of imageability. The motivated students, enchanted with their chosen images, far overshoot the mark. They will take pride in the finished work, certainly. But they will be exhausted, and therefore resistant to the criticism of the "I wonder what would happen if..." variety.

The poorly motivated ones see in low resolution only the opportunity for an easy out, and fail to distinguish between a small number of pieces of information, and the exactitude with which those pieces, and their inter-relationships, have been determined. Laziness tends to be all-pervasive.
Contrast and Range

Few things have as much qualitative impact on expression as variations in contrast and value range.

To encourage the students to carry out sufficient explorations of possibility to enable them to see these differences for themselves, and to choose intelligently from among them, requires extensive persuasion, or trickery, or an autocracy of manner that is hard for this teacher to muster.

Here the electronic media can prove invaluable; the facility with which changes can be made and variations generated is, of course, obvious. The import of this economy for the generation of perceptually significant visual data cannot be overstated.

The eye and the hands are still intimately involved in electronic processes, and the objective here remains the education of vision.
Input/output

Most image-processing software allows the user to assign arbitrary relations between the base (input) value data and its output definition. For instance locations that registered as a middle grey in the scan (and in the original) may be coded to receive a very different value as screen or printed output.

Two of the more obvious reassignments are represented in the images above, producing images familiar to persons with photographic darkroom experience. Figure 22a is a simple inversion of the value relationships, while 22b is generated graphically by drawing a new graph of the input/output relationships.
Artificial data

NASA has amazed the world with computer-aided enhancements of the resolution of images sent back from far distant objects. If the inherent characteristics of a camera lens, for instance, degrade an image in certain measurable and predictable ways, then it is within the realm of possibility that algorithms can be developed which compensate for these patterns of degradation.

The net result (we presume) is equivalent to an enhancement of the quality of the primary data.

The images at left play at the game of a manipulated discrepancy between quality of primary data, and quality of output as well.

Image data stored at a resolution of 30 dots per inch (d.p.i.) has been reassigned a resolution of (Figure 23a) 75 d.p.i., and (Figure 23b) 150 d.p.i.). But there is no enhancement of information. Instead, the given data is spread around over a larger field of potential resolution. The result is a kind of averaging of the data, and the visual equivalent to blurring the image, throwing the lens out of focus, or the well-known draughtsman’s trick of squinting.

What is of interest, therefore, is the hint that such phenomena as the scattering of light within a dispersing medium (dense fog, water, petroleum jelly on a lens surface, etc.) or the out-of-focus qualities of sunlight through trees, or poorly focused lenses, can be studied for their own distinctive visual characteristics.

Commencement

Traditionally, courses of study conclude with a ritual of beginning anew. The term for these ceremonies, commencement, seems appropriate here. New tools generate new curiosities, because they open new possibilities in the area of the questions one can entertain. One may be confident that the computer will open, rather than shut off, inquiry in the problem cluster here called “Light and Form.” The further possibilities presented here so sketchily do not begin to exhaust the pedagogical potential of the computer in this one problem area.
Notes:


2 If any intellectual prejudice has dogged Western civilization as stubbornly (and as perniciously) as "logocentrism," it is that stereognosis, shape-knowing, is a higher form of knowing than is our apprehension of other attributes of a situation.

3 The comment is technical, not aesthetic. Is there spatial isomorphism between referent and representation or not? Isomorphism was deliberately violated by the Cubists, and perhaps by the Egyptians. The violence done by the untutored, which is the present subject, is, apparently, unintentional. *I certainly* do not mean that the work of the ancient Egyptians is uniformed or incoherent.

4 Too casual, that is, to demand of us either rigorous concretization or abstraction and their attendant reductions.

5 Contemporary research on the localization of brain function has determined that the areas of the brain responsible for the shape-knowing of the human face and physiognomy are distinct from those responsible for the stereognosis of abstract (particularly geometric) forms. These findings are corroborated by findings in the pathologies of perception. Cf. *The Man Who Mistook His Wife for a Hat,* by Oliver Sacks. By using the face as subject matter for this problem, one enlists the powerful inbuilt ally of an inimitable capability of human perception; it's simply much easier for students to recognize for themselves when they've "got it right!"

6 Cf. George A. Miller, "The Magical Number Seven, Plus or Minus Two."

7 The scanning was done using an Apple One-Scanner ® through Ofoto ® scan software. Default settings were used (brightness, contrast, threshold, etc.). Scan resolution was set at 300 d.p.i., print resolution at 150 d.p.i. The scan was saved as a TIFF image.

The file was reopened in Adobe Photoshop ®. The raw scan image was rotated for alignment, the photo's edges cropped (approximately) to the original borders of the photograph. The image was resized to an overall height of 5.5" (from the book "original" of 9.75"). All subsequent manipulations were derived from this image file as base data.