FIGURE 1: THE DESIGN PROBLEM

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Although most of Dr. Papanek's work has been in product design, his background includes architecture and anthropology. He has taught or chaired departments at universities in Canada, the U.S., Denmark, Sweden and England. In recognition of his work to create a closer understanding between the impoverished Third World and technologically advanced countries, he has been nominated for the Alternative Nobel Prize. In 1981 he received the ICSID/Kyoto Honours Award for his development of a conmmunications device for the governments of Tanzania and Nigeria. He has also been senior design consultant to Volvo of Sweden, to the government of Papua New Guinea and to a medical lighting firm in Australia. Since 1981 he has been permanent J.L. Constant Distinguished Professor at the School of Architecture and Urban Design at the University of Kansas in Lawrence. Dr. Papanek is the author of *Design for Human Scale*, and co-author of *Nomadic Furniture*, *Nomadic Furniture 2* and *How Things Don't Work.*

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–*Design* Magazine

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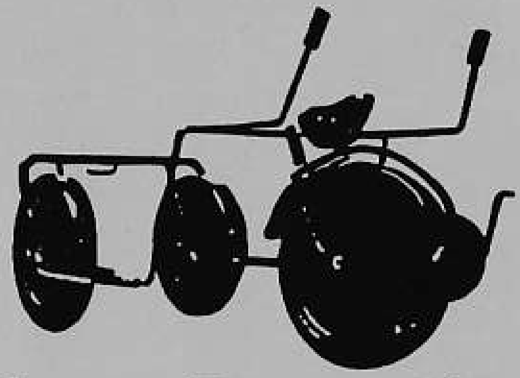
Design for the Real World

Design for the Real World

Human Ecology and Social Change

Second Edition
Completely Revised



Victor Papanek

"Thoroughly provocative."
—*Time*

7
Rebel with a Cause:
Invention and Innovation

When you make a thing, a thing that is new, it is so complicated making it
that it is bound to be ugly.
But those that make it after you,
they don't have to worry about making it.
And they can make it pretty, and so everybody can like it
when the others
make it after you.

PICASSO (as quoted by Gertrude Stein)

The most important ability that a designer can bring to his work is the ability to recognize, isolate, define, and solve problems. My own view is that designs must be sensitive to what problems exist. Frequently the designer will "discover" the existence of a problem that no one had recognized, define it, and then attempt a solution. The number of problems, as well as their complexity, have increased to such an extent that new and better solutions are needed.

At this point I should like to do three things: to attempt to explain why it is becoming critically important to encourage innovation, to define what is meant by creative problem solving, and to suggest specific methods.

The word creativity has become trendy over the last two decades, opening the door to a strange collection of absurdities. On my desk lies a paper entitled "Creative Aspects of Pre-Colombian Pottery." It sheds a good deal of light on pottery and might be of compelling interest to any pre-Colombian potter now working—however the dry scholarly dissection of thinking processes assumed by its author are of little help in the process of innovation. A university in southern California offers a course under the title "Remedial Creativity 201"! The mind boggles. Shelter magazines, addressing themselves to bored, middle-class housewives, consistently feature articles on "Creative Closets," "Creative Barbecue Pits," or "Twenty Creative Ways of Cooking a Country-Style Quiche." Brushing this trendy misuse of the word creative aside, we need to examine what creativity really is.

Our ways of thinking can be divided into various modes. There is *analytical* thinking (How long will it take me to drive from here to there, assuming a heavy rainstorm and stopping for lunch?). We engage in *judgmental* thinking (Which of these three steaks looks rarest?) and *routine* thinking (Given a specific temperature for the tempering of a steel alloy, what thickness is required to hold up a bridge?). In this last thinking mode we are encouraged to look up the correct answer at the back of some technical manual.

Routine thinking is a process that seems to go with the territory of being an engineer. This may be the reason why I have been retained to teach two-day seminars in "Creative Problem-Solving Techniques" to industrial engineering companies in the United States, Finland, Germany, and England for many years. Other professions seem less routinized in their problem-solving behavior.

And finally there is *creative* thinking. This seems to occur in three different ways. There is the sudden, momentary insight—the "spark of genius"—that sometimes comes to us in a blinding flash of revelation. Neither psychologists nor the innovators themselves have a clear explanation of this process.

We have a good deal of documentation for the second way

of finding a new solution: the discovery that comes to us in a dream. Scientific literature is filled with descriptions of this process: a researcher trying hard to develop a new insight, going to sleep and awakening with a lucid solution clear in his mind. This mechanism too is not understood, my own conviction is that such revelations are *intuitive*, that is: a marshalling of facts awaiting synthesis on a subconscious or preconscious level.

We are here concerned with the third mode: a systematic, solution-directed search for a new way of doing things.

Arthur Koestler has explored such acts of innovative thinking in his *Insight and Outlook* (1949) and later expanded this into possibly his most rigorous and definitive work *The Act of Creation*. Koestler finds similarities between humor and wit (through comic simile), "the art of discovery" (through analogous thinking), and the "discovery of art" (through metaphor). In each case he has established that the new insight occurs through an act of *collision*. He has named these moments of discovery as the "HaHa!, AhHa!, and Ah . . . !" reaction (as shown in the diagram below).

His working definitions of the creative act are excellent:

"The creative act consists in combining previously unrelated structures so that you get more out of the emergent whole than you put in."

Or:

"Perceiving of a situation or idea in two self-consistent but mutually incompatible frames of reference or associative contexts."

To meet problems in a new and creative way has been part of the biological and cultural endowment of our species for millions of years. But, as we live in a society that places a high

"Haha-aha-ah" curve. After Arthur Koestler.

value on conformity, our creative responses have been blunted or stifled—frequently an innovative reaction will be dismissed as mere eccentricity.

Although the ability to solve problems has been an inherent and desirable trait throughout human history, mass production, mass advertising, media manipulation, and automation are four contemporary trends that have emphasized conformity and made creativity a harder ideal to attain. In the twenties, Henry Ford, attempting to reduce the price of his cars through standardized production methods, is reputed to have said, "They [the consumers] can have any color they want as long as it's black." Through curtailing color choices, the price of individual automobiles was lowered by some $95, but consumers had to be persuaded that black is a desirable color.

This spirit of conformity has accelerated at an amazing rate. The demands on the individual to conform come from all directions: not only do the national, state, and local governments understandably enforce certain standards of behavior, but there are pressures from neighbors in suburban areas, conformist trends in school, at work, in church, and at play. What happens if we are unable to operate in so aggressively conformist an environment? We "blow our top" and are taken to the nearest psychiatrist for help. The first thing this specialist in human thought and motivation may want to say to us (if not in so many words) is "Well, now, we must *adjust* you." And what is adjustment, if not another word for conformity? This is not to argue for a totally nonconformist world. In fact, conformity is a valuable human trait in that it helps to keep the entire social fabric together. But we have made our severest mistake in confusing *conformity in action* with *conformity in thought*.

Extensive psychological testing has shown that the mysterious quality called "creative imagination" seems to exist in all people but is severely diminished by the time an individual reaches the age of *six*. The environment of school ("You mustn't do this!" "You mustn't do that!" "You call that a

drawing of your mother? Why, your mother only has *two* legs." "Nice girls don't do things like that!") sets up a whole screen of blocks in the mind of the child that later inhibits his ability to ideate freely. Of course, some of these prohibitions have social value: moralists tell us that they help the child establish a conscience; psychologists prefer to call this the formation of the superego; religious leaders call it a sense of right and wrong, or soul.

However, society can go to amazing lengths to create greater conformity and protect itself from whatever the current mainstream is pleased to call "deviants." In 1970 Dr. Arnold Hutschnecker suggested in a memo to President Nixon that all children between the ages of six and eight be tested psychologically to determine if they *might* have the kind of tendencies that would turn them toward becoming criminals later in life. The underlying suggestion was that some of these children be tranquilized heavily and maintained in that condition, much as millions of elderly patients in retirement homes are kept under sedation to ease the work of the nursing staff.

Too many blocks can effectively stop problem-solving. (These blocks will be examined in detail later in this chapter.) The wrong kind of problem statement can also block effective solutions. The saying "Build a better mousetrap and the world will beat a path to your door" is a case in point. What is the real problem here, to *catch* mice or to *get rid of them*? Suppose my city is overrun by rodents, and I *do* invent a better mousetrap. As a result I may have ten million captured mice and rats to contend with. My solution may have been highly innovative; it was the original problem statement that went wrong. The real problem was to *get rid* of mice and rats. It might be far better to broadcast an ultrasonic or subsonic beam over every radio and television set for a few hours, which, while harmless to other living creatures, would sterilize all rats and mice. Some weeks later the rodents would be gone. (This raises the ethical question as to whether rats and mice should be permitted to watch television.) It would raise the environmental question to what extent some small rodents are important links in the ecosystem.

However, most problems requiring immediate and radical new solutions lie in areas that are quite new.

Chad Oliver, in his science-fiction novel *Shadows in the Sun*, says

> . . . he had to figure it out for himself. That sounds easy enough, being one of the familiar figures of speech of the English language, but Paul Ellery knew that it was not so simple. Most people live and die without ever having to solve a totally new problem. Do you wonder how to make the bicycle stay up? Daddy will show you. Do you wonder how to put the plumbing in your new house? The plumber will show you. Would it be all right to pay a call on Mrs. Layne, after that scandal about the visiting football player? Well, call up the girls and talk it over. Should you serve grasshoppers at your next barbecue? Why, nobody does that. Shall you come home from the office, change into a light toga, and make a small sacrifice in the backyard? What would the neighbors think?
>
> But—how do you deal with a Whumpf in the butter? What do you do about Grlzeads on the stairs? How much should you pay for a new Lttangnuf-fel? Is it okay to abnakave with a prwaatz?
>
> Why, how silly! I never heard of such things. I have enough problems of my own without bothering my head with such goings on.
>
> A Whumpf in the butter! I declare.
>
> *A situation completely outside human experience . . . .*

We live in a society that penalizes highly creative individuals for their nonconformist autonomy. This makes the teaching of problem-solving discouraging and difficult. A twenty-two-year-old student arrives at school with massive blocks against new ways of thinking, engendered by some sixteen years of miseducation, a heritage of childhood and pubescence of being "molded," "adjusted," "shaped." Meanwhile our society continuously evolves new social patterns that

promise a slight departure from the mainstream but without ever endangering the patchwork of marginal groups that make up society as a whole.

First we must understand the psychological aspects of problem-solving. While no psychologist or psychiatrist can yet point to the exact mechanics of the creative process, more insights are becoming available. We know that the ability to generate new ideas freely is a function of the unconscious and that it is the associative faculty of the brain that is at work. The ability to come up with many new ideas is inherent in all of us, regardless of age (with the exception of senility and anility) or so-called IQ level (always excepting true morons). However in being able to associate freely, multidisciplinary abilities are indispensable. The quantity of knowledge, the quality of memory and recall can also enrich this process. All this helps to look at things in new ways. A new way of looking at things can be enhanced enormously through a thorough understanding of a second language. For the structure of each language gives us different ways of dealing with and experiencing realities.

It is perfectly reasonable to say "I am going to San Francisco" in English. The same statement can be made in German ("Ich gehe nach San Francisco"), but it makes no sense linguistically. In German a qualifier must be added, for instance: I am *flying* to San Francisco, I am *driving* to San Francisco. In Navajo and the Eskimo languages such statements must be even more specifically qualified to make sense: "I (alone, or with two friends, or whatever) am driving (sometimes I will drive, sometimes my friend will drive) (by cart, by sled) to San Francisco (then I will return and my friend will drive on)." By bringing more than one language to bear on a problem, we obtain depth.

If we are forced to wear a temporary eye patch, we have to drive more carefully: our depth perception is gone, since we see the landscape from one vantage point only. To view the road (or a problem) in full depth, we have to look at it from two different observation posts simultaneously. Optically both eyes together perform this service—this is also the principle of a range-finder on a camera. Intellectually the morphological and structural differences between two languages provides us with two similar vantage points, permitting us to use triangulation in viewing a problem. Whether the language studied is German, Finnish, Swahili, music, Fortran, or Basic matters little.

We can list the inhibitors that keep us from solving tasks in new and innovative ways. They are:

1. Perceptual Blocks
2. Emotional Blocks
3. Associational Blocks
4. Cultural Blocks
5. Professional Blocks
6. Intellectual Blocks
7. Environmental Blocks

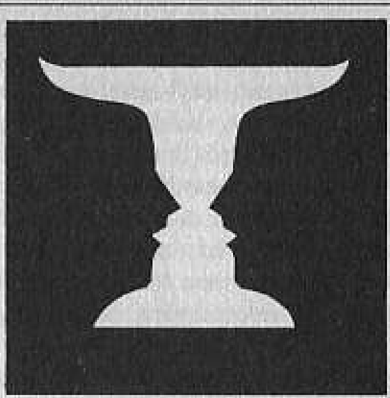
Each can be explained simply through examples.

1. *Perceptual Blocks*: As the name implies, these inhibitors lie in the area of perception. A tone-deaf person labors under perceptual blocks when trying to hear music, with a deaf person the block has become total. There are scores of such physical blocks, from color blindness, astigmatism, and strobismus to true blindness or hysterical aphasia. These blocks lie well beyond the scope of this book. But consider the fairly familiar figure opposite.

Some people see a white goblet against a black background. Others see the profiles of two black people against a field of white. (It is interesting to note in this figure-ground-relationship problem that American blacks tend to see the second interpretation first.) No matter: *all* people can see either picture.

The second illustration is less familiar. The majority of people can identify a pretty young woman, dressed in a style of around 1890, wearing a motoring veil, and with her face provocatively turned away.

The simultaneous image of a mean old witch is less appar-



Perception problem in figure-ground relationship. After Koffka.

Old Hag—Young Girl? A classical figure in perception.

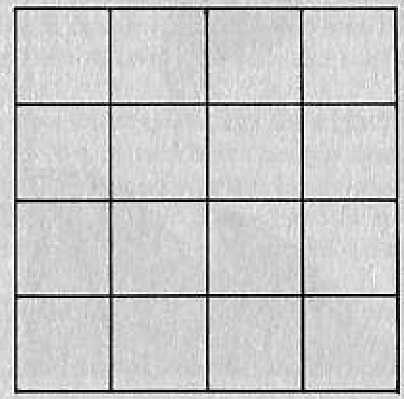
ent, and many people have to struggle before recognizing her. Now what was a black choker around the young girl's throat has become the uncompromisingly mean mouth of the witch. The young beauty's left ear and her snub nose have turned into the eyes of the old hag. (It seems that people discover what they want to see more easily.)

Again both pictures are visible to everyone but only *ad seriatim*. While anyone, once having recognized both images, can flip back and forth between them at will, it takes a good deal of training to be able to view both images *simultaneously*.

When asked how many squares are in the figure below, the majority of people say sixteen. A few, counting the encompassing "meta-square," will see seventeen.

Actually there are thirty squares of various sizes, but it's *easier* to just recognize seventeen.

2. *Emotional Blocks*: In a society that values conformity, people readily learn that "you don't stick your neck out," and "you don't rock the boat." A simple experiment will convince the reader that emotional pressures are strong in group situations. Ask a group of twenty-five or thirty people if any of



How many squares?

them does bird-watching as a hobby. Eliminate these bird-watchers, and then ask the remaining people: "How many of you can identify or differentiate among thirty different birds?"

Few if any hands will be raised in assent. The fact of the matter is that most normal six-year-olds recognize between thirty and thirty-five birds; most adults can easily differentiate or identify sixty or more, as the following list of sixty will show.

Chicken	Flamingo	Penguin
Owl	Goose	Eagle
Duck	Parrot	Parakeet (Budgerigar)
Woodpecker	Swallow	Hummingbird
Pheasant	Seagull	Peacock
Cornish Game Hen	Stork	Kingfisher
Raven	Pelican	Sandpiper
Swan	Robin	Sparrow
Cardinal	Kiwi	Quail
Blackbird	Crow	Cockatoo
Dodo	Hawk	Nightingale
Pidgeon	Tucan	Ptarmigan
Vulture	Heron	Bluebird
Lyrebird	Emu	Cormorant
Finch	Lark	Albatross
Grouse	Dove	Puffin
Guinea Fowl	Jay	Starling
Egret	Wren	Condor
Bittern	Ostrich	Falcon
Canary	Turkey	Kestrel

Individuals in a group audience are under a great emotional pressure. They don't "stick their neck out," afraid that they may be asked to identify some unusually exotic bird. It is an excellent example of emotional blocks at work.

3. *Associational Blocks*: Associational blocks operate in those areas where psychologically predetermined sets and inhibitions, often going back to our earliest childhood, keep us

from thinking freely. A well-known experiment will illustrate this point.

In one of our Eastern colleges a five-foot-long steel pipe, one-and-one-half inches in diameter, was fixed into the concrete floor of a laboratory, with twelve inches of the pipe below floor level and four feet stuck straight up. A ping-pong ball was then inserted into the pipe, so that it would rest at the bottom, five feet from the top. A miscellaneous collection of tools, utensils, and gadgets was placed in the room. One thousand students were introduced into the room one at a time—each was asked to find some method for getting the ping-pong ball out of the pipe. The attempts to solve the problem were as various as the students themselves: some tried to saw through the pipe, which proved too strong; others dripped steel filings on to the ping-pong ball and then went "fishing" for it with a magnet, finding that the magnet would adhere to the pipe wall long before it could be lowered all the way down. Others tried to raise it with a wad of chewing gum on a string, but the ball would inevitably drop off. To stick a series of soda straws together and try to "suck" it up also proved impossible. Sooner or later almost all of the students, 917 out of 1,000 (a respectable performance indeed) found a mop and a bucket of water in a corner, poured the water into the pipe, and floated the ball to the top. This, however, was only the control group.

A second series of 1,000 students were then asked to solve the problem again; conditions remained unchanged with one exception. The bucket of water was removed, and the psychologists substituted an antique rosewood table on which a finely cut crystal pitcher of water, two glasses, and a silver tray rested. Only 188 out of the second group succeeded. Why? Because nearly eighty percent of this group failed to "see" the water. The fact that a crystal pitcher standing on a rosewood table is more noticeable than a pail in a corner is obvious. Still, the second group failed to make the associational link between water and flotation. The associational connection was much more difficult to make with the handsome pitcher

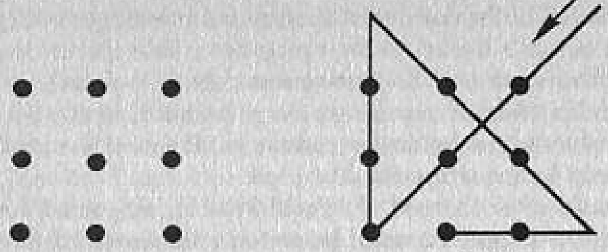
than with the bucket, even though we normally don't pour water out of a bucket to float ping-pong balls either.

A third version of the test removed *both* the pail of water and the pitcher. A suprisingly large number, nearly 50 percent, of these (male) undergraduates still solved the problem correctly by urinating into the pipe.

Shortly after the end of World War II, Raymond Loewy Associates designed a small home fan and succeeded in making the action truly noiseless. To their consternation, consumer response forced them to introduce a new gear into the fan that would give off a slight sound: the average American associated noise with cooling action and felt that a totally noiseless fan did not provide enough cool air.

4. *Cultural Blocks*: As the name implies, these are imposed upon an individual by his cultural surrounding. And in each society a number of taboos endanger independent thinking. The classic Eskimo nine-dot problem, which can befuddle the average Westerner for hours, is solved by Eskimos within minutes, since Eskimo space concepts are quite different from ours. Professor Edward Carpenter explains how the men of the Aklavik tribe in Alaska will draw reliable maps of small islands by waiting for night to close in and then drawing the map by listening to the waves lapping at the island in the dark. In other words, the island's shape is discerned by a sort of aural radar. We are sometimes confused by Eskimo art, for we have lost the Eskimo's ability to look at a drawing from all sides simultaneously.

While living with an Eskimo tribe some years ago, I received magazines through the post. I found that my Eskimo friends would form a circle around me, while I looked at pictures or read. Neither in igloo nor hut *was there any jostling for positions*. My friends could read (or view pictures) as easily and quickly upside-down or sideways as if "correctly" positioned by nonEskimo standards. I noticed that those Eskimos living in cabins would frequently hang pictures upside down or sideways. (Norman Rockwell covers from the *Saturday Evening Post* were a favorite, being story-telling illustrations.)



The Problem: The Solution:

The Eskimo Nine-dot Problem

Nonlinear, aural space perception imposes fewer vertical and horizontal limitations on the Eskimos' world-view. Carpenter has suggested that this may account for the immediate ease Eskimos exhibit in working with electronic devices.

It seems to me that this is a species-specific survival characteristic in the far North. I have accompanied Eskimo hunting parties, which, after the hunt, headed across fifty or more miles of featureless terrain to return to their group of igloos. There was seemingly no visual differentiation between snow-laden sky, the snow falling, or the covered ground itself. To miss the igloos by even 200 feet would have resulted in death from exposure. But both my friends and their sled dogs reacted to minute stimuli of changing moisture and wind and

Eskimo print: "Spirits (*Tornags*) Devouring Foxes." Author's collection.

invariably found the way back to the encampment. (Eskimos are equally astonished by our ability to cross Bloor Street in Toronto or Times Square in New York.)

A design problem involving cultural blocking was stated by a client of mine (a manufacturer of toilet bowls) as follows: while the average American changes his automobile every two-and-a-half years, gets a new suit about every nine months, buys a refrigerator every ten years, and even changes his residence about every five years, he never buys a new toilet bowl. If one could design the sort of bowl that would make people want to trade in their old one, industry would benefit. At first sight this seemed a phony job, calling for artificially created obsolescence. And two answers would immediately come to the mind of the "stylist." The "Detroit approach": possibly providing the bowl with tailfins and vast chrome ornamentation. Another would be the "toilet bowls are fun" approach: imprinting the surface with, say, little flowers or birds. But intelligent research soon showed that *all toilet bowls are too high* (medically speaking). Ideally, people should assume a lower, squatting position when using a toilet. After much research, a new, lower bowl was designed and built. In spite of the obvious medical and sanitary advantages, in spite of the fact that now a real reason existed for buying new toilet bowls, the design was rejected. The manufacturer felt that the cultural block in the public mind was too great and that it would be impossible for him to advertise his new and better product. It can be shown that this was a true U.S. *cultural* block: my design was eventually produced by a subsidiary company and advertised in the press in the Nordic countries, where it sold well and provided a prototypal object for other manufacturers. By 1982 I noticed that the majority of Northern European toilet bowls had followed suit. (This is fully illustrated and well described in Luigi Bearzotti's article: "W.C." in *Ottagono*, No. 73, June 1984, Milano, Italy.)

Cultural taboos about elimination processes have made other developments difficult: toilet tissue is made of paper that uses enormously large quantities of water in its manufacture.

For reasons now obscure, rolls of toilet paper are a given width. By reducing this by one inch, millions of gallons of water would be saved daily in the manufacturing process, without cutting down on the function of the tissue. Yet this is another idea that is ecologically sound but has gone begging.

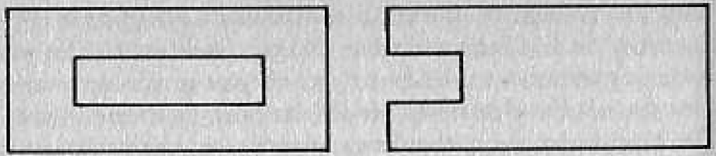
Whenever the concept of recycling body wastes is brought up (for instance in a discussion of space capsules or space stations), people become disturbed. (It is useful to remember that, on Liferaft Earth, everything we breathe, drink, eat, wear, or use, has gone through billions of digestive systems since the planet was first formed.) Cultural blocks about this affect our thinking; our thinking affects our acts. We think of streams and lakes as "polluted by urban wastes"; we use words like "sludge" and "solid waste" and are appalled to find that our water sources are "poisoned" by human excrement. We are confused (as with the better mousetrap mentioned earlier) about whether we want to get rid of excrement or just separate it from our drinking supply.

The entire field of *anaerobic and aerobic digestion* has received more study, research, and application. Major scientists are involved in rigorous work with methane-generating processes. In the early seventies only occasional paragraphs appeared in *The Whole Earth Catalog* about solitary British eccentrics who manage to power their automobiles from chicken droppings, alerting the public about the gigantic energy sources that can be mined from our bodily processes of putrefaction, digestion, and waste-making. Now research technology has developed a prime-energy convertor that, by using anaerobic digestion systems, can make a house independent of external connections. In 1973, looking through the newspapers of communes and alternative societies, I thought it pathetic that much of their gear (transformers, pumps, high-fidelity components, light generators, projectors) still had to plug in somewhere. The use of biological recycling for energy has now made true independence possible.

By 1969 much of this had already been proven experimentally. Dr. George W. Groth Jr. maintained 1,000 pigs in confinement on his farm near San Diego, California. The pig manure operates a ten-kilowatt war-surplus generator, which provides all the electricity needed for both light and power. The liquid manure pit has been capped, and the sewer gas is tied to a gas engine. Hot water from the engine's cooling system runs through 300 feet of copper tubing coiled inside the pit. A temperature of between 90 and 100 degrees Farenheit is maintained, which provides the best temperature for maximum "digestion." A tiny pump, running off the fan-belt pulley, circulates the water. A complete digestion cycle takes about twenty days, but, once the process is an ongoing one, it is also continuous. Besides providing electric power, the system has virtually no odor and attracts no flies. Finally, the manure at first breaks down into simple organic compounds like acids and alcohols. Ultimately, as there is no air, it breaks down into water, carbon dioxide, and methane gas. Experiments of this sort have also been tried in Europe, Asia, Africa, and Latin America.

By 1983 methane digesters are working in communities and farms all over the world. It seems clear that this design strategy is giving us a way of using human and animal waste by converting it into power sources and recycling what is left. (But even now it is curious that what little has been written about it has appeared mostly in technical journals, the underground press, and alternative life-style papers where cultural blocks are less inhibiting.)

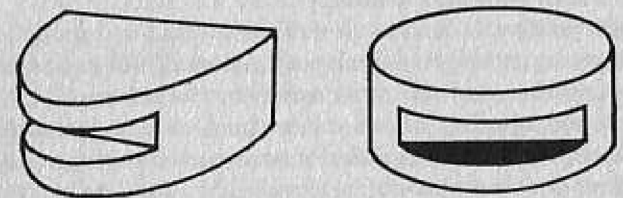
5. *Professional Blocks*: Sometimes, specific professional training may establish truly crippling blocks. When shown the front elevation and the right side elevation of an object (as shown) and asked to draw a correct plan view or perspective, architects, engineers, and draftsmen usually fail at a higher rate than people untutored in these fields. Finding the correct solution to this problem can also teach us *how* we solve problems. Both answers shown are correct. It is possible to diagnose how a solution was reached: either through a species of creative analysis or through sudden insight (depending on



Object Visualization Problem

which answer is given). The reasoning behind answer number one runs somewhat as follows: "The right side elevation is wrong; it should be a center section. I must therefore find a figure where the theoretical center section and the right side elevation are identical. After selecting an equilateral triangle as the answer, I see that the front edge will show up as a line in the front elevation. By rounding this off, the line disappears and the problem is answered correctly." The second answer is equally correct but, mathematically speaking, much more elegant. It is discovered through sudden insight and intuition.

Needless to say, the particular professional block that keeps people from answering this problem correctly (using either solution), lies in their assuming a false, ninety-degree relationship, and visualizing the figure as being rectangular or square. "Rectangularity" or "squareness," then, is the basic block that the solver himself has built into the problem.



Object Visualization Solutions

Professional blocks can also be illustrated by the following anecdote: Two engineering students are finishing their graduate work at MIT. One evening John visits Michael in his rooms and is amazed to see an entire wall covered by a huge "attribute-listing" chart. This chart lists the names of various young ladies, Joan, Cheryl, Mary, Jennifer, and so forth, along the left margin. The top line lists attributes: "has money," "cooks well," "good-looking," "intelligent," "trained in engineering," "good in bed." To John's questions, Mike replies: "I've been asked to start teaching at Stanford, and I felt this would be a good time to get married. So I've listed all the young women I know with their attributes and—true to engineering tradition—have put check marks across significant correlations." John is impressed and, noticing that one young woman in particular has accrued most of these distinctions, says, "I guess you'll marry Mary?" "No," replies his friend fastidiously, "you see, *I don't like her!*" Michael overcame his professional block.

6. *Intellectual Blocks*: Over-intellectualization frequently keeps us from recognizing the nub of a problem and makes it difficult to choose the best method for reaching a solution.

Arthur Koestler cites the following puzzle:

> At sunrise one morning a Buddhist priest begins to climb a holy mountain. There is only one narrow path that spirals its way to a meditation chamber at the top. The priest interrupts his upward path frequently to rest, to meditate and pray. Being elderly it takes him the entire day to reach the summit. There he spends several days in meditation and fasting. He starts his way down, again at sunrise, walking more briskly this time and with fewer and shorter rests.
>
> Is there *a spot* along the path that the priest will occupy at precisely the same time of day in both trips? Answer yes or no.

Answers to this simple puzzle are usually equally divided between yes and no. The correct answer of course is yes. It is interesting to note that those who have opted for the negative fight furiously and irrationally on behalf of their solution. In this case, the intellectual interest lies in *how* the problem was solved. By far the simplest way is to mentally add a second priest and collapse time into one day. Visualize *two* priests—one at the bottom and one at the top—both starting their journey at the same moment (sunrise). It is obvious that at some time and at some point they will meet along this single path, regardless of each other's speed. This point is the spot along the path, the time of meeting is the time. The answer is yes.

You may have chosen a visual image as your method of thinking. In that case you probably also solved it. One can equally well imagine a plot on a graph of each priest's position as a function of time. The two graph lines will have to intersect at a common time and position.

If you chose verbalization, you probably failed. Even after knowing the "visual solution," if you again think about it in a verbal manner, the problem will become confusing and obscure.

Here is another example of an intellectual block:

> Envisage a large piece of paper the thickness of a sheet of typewriter paper. Fold it in half in your imagination, resulting in two layers. Now fold it once again (having four layers) and continue folding it over upon itself fifty times. How thick would the 50-times-folded paper be?

In reality it is impossible to fold any piece of paper (regardless of size or thickness) fifty times. But for the sake of this problem, imagine you can do it.

Most people guess "two to three inches."

The correct answer is approximately 50,000,000 miles, or more than half the distance from the earth to the sun. The *first fold* gives a stack two times the original thickness. The *second* results in two by two the original thickness; the *third*, two by two by two times the original thickness. If you are somewhat mathematically inclined, you will see that the answer to the problem is 2^{50} times the thickness of typing paper, and 2^{50} is about 1,100,000,000,000,000.

Solving this problem *visually*, as with the priest on the sacred mountain, you would fail. It is impossible to correctly envisage fifty folds. *Verbalization* also leads to difficulties. If you are familiar with "*doubling problems*," you saw that the answer would be enormously large but could still not place a correct value on it. In this case the best strategy is mathematics.

7. *Environmental Blocks*: From Proust's cork-lined room to the noise of the editorial office at the *Washington Post* is a major step. Environmental blocks, that is, the extent to which the environment influences your problem-solving behavior positively or negatively, differ from person to person. My twelve-year-old daughter can do rigorous exercises in mathematics while listening to symphonic music. My older daughter, Nicolette, writes and edits training manuals in an environment that must be completely quiet and peaceful. Personally I find that I operate best with phones ringing, frequent interruptions, and a great deal of visual distraction. (This may be based on my having started my writing career as a reporter for a busy morning paper.)

You are best able to determine yourself the ideal environment for problem solving in your case.

These points will recapitulate what has been established so far:

1. With constant pressure toward less individualism and greater conformity forced upon our society by mass advertising, mass media, mass production, and automation, the ability to solve problems in new and unexpected ways is becoming increasingly rare.
2. In a fast-accelerating, increasingly complex society, the designer is faced with more and more problems that can be solved only through new basic insights.
3. Design graduates leave our schools with some know-how, a great many skills, and a certain amount of aesthetic sensitivity but with almost no method for obtaining any basic insights.

4. They find themselves unfit to solve new problems because of perceptual, emotional, associational, cultural, professional, intellectual, and environmental blocks. These blocks are the direct result of the constantly accelerating rat race toward conformity and so-called adjustment.
5. This race is not only inimical to all true design creativity but, in a wider sense, violates the very survival characteristics of the human species.
6. The various blocks are not inherited parts of the personality structure but rather learned, limiting, and inhibiting factors.

Our job then becomes one of establishing methods of doing away with these blocks. Although it is difficult to make a definitive list, since there is enormous overlap between different methods, I shall list eight:

1. Brainstorming
2. Synectics
3. Morphological Analysis
4. Sliding Scales
5. Bisociation
6. Trisociation
7. Bionics and Biomechanics
8. Forcing New Thinking Patterns

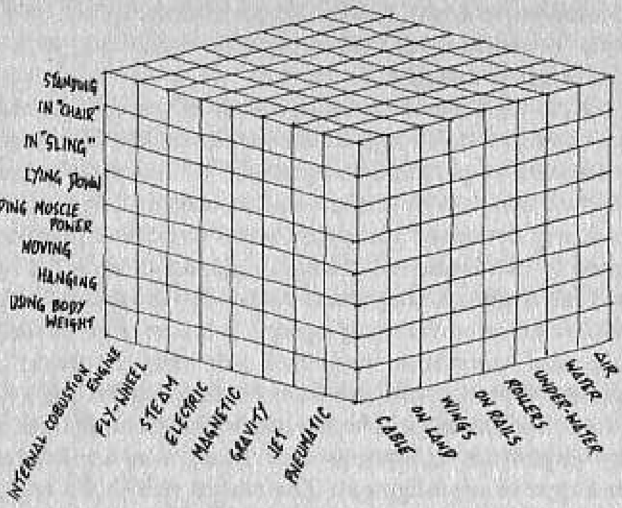
1. *Brainstorming*: This is probably the most widely known problem-solving method. The emphasis in a brainstorming team is on *quantity* of ideas rather than quality. The team members are asked to *suspend their judgment sense* during the actual working session. A team of six to eight people can be randomly assembled within an organization; the problem is then explained, and they then sit around a table trying to generate as many ideas as possible and list them regardless of merit. The theory behind the concept is simple. It is assumed that if only *one* solution to a problem exists, the originator will always feel protective towards it. Should it later prove

unworkable, he or she will be blocked from contributing new insights by unconsciously attempting to merely ring variations on the original thought.

Since no idea can be prejudged, an enormous quantity of ideas is generated. To a problem statement like "How can we increase sales of personal computers?" a team will frequently contribute 300 to 400 unevaluated concepts. These ideas are then slowly processed through a series of criteria (also brainstormed by the team) until final implementation. It is significant that brainstorming was invented by Alexander Osborne, of BBD & O, an advertising agency. Because of its advertising background, the system lends itself primarily to solving "soft" problems, that is, problems in behavior, marketing, or motivation. Technical problems tend to be encumbered by so many important limitations that these very considerations form a type of prejudgment. The reader will find a complete explanation of brainstorming in Sidney Parnes' *Creative Behavior Guide Book* (New York: Charles Scribner's Sons, 1967).

2. *Synectics*: William J.J. Gordon developed this second team problem-solving method while leading the Invention Research Group for Arthur D. Little. A synectics team, unlike brainstorming, requires a strong team leader; furthermore, team membership is permanent, and the members of the team are carefully chosen to represent at least two disciplines each. Synectics works best with technical and scientific problems and is much more rigidly structured than brainstorming. I have worked with synectics modes in Cambridge, Massachusetts; since this system is closely tied to biology, I have given some examples in the following chapter. Those interested are referred to Bill Gordon's *Synectics* (New York: Harper & Bros., 1961), or, for a less self-serving analysis, George Princes's *The Practice of Creativity* (New York: Macmillan/Collier Paperback, 1978).

3. *Morphological Analysis*: This system, unlike brainstorming and synectics, is a method of *individual* problem-solving. Morphological analysis is a good deal simpler than its pretentious name. Developed by a West Coast advertising guru, it



Morphological-analysis Matrix

consists of a three-dimensional graph in the form of a cube (as shown).

Since each of the three parameters consists of eight small squares, forming a larger square of 64, the entire construct results in a sort of super-cube containing 512 boxes. The late Professor John Arnold gave an example of using it to provide a new concept for personal transportation. In our illustration I have chosen power source, medium in which the vehicle operates, and gross means of locomotion.

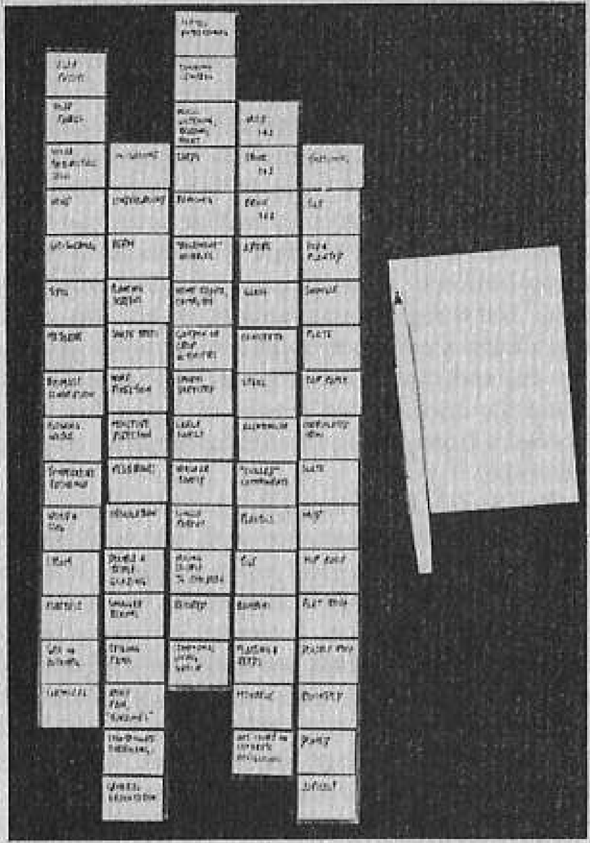
If we now look at each of the 512 boxes resulting from the conjunction of the three parameters, we find a series of "solutions." Some of these will unavoidably be duplications of already existing systems: a steam-driven device, running on rails with seated passengers—in other words, a railroad. In another box we will find a jet-propelled device operating under water with people reclining on couches. This yields us an idea for high-speed underwater transportation. Another cube

generates the suggestion for a fly-wheel-powered vehicle with people standing up in it and operating on a hard surface. Seemingly this gives us still another new approach. Later research will show that this system is in use for buses in Switzerland—nonetheless it may force an American transportation designer to think in new and unfamiliar ways.

From the above it will be clear that this is no more than the externalization of a sort of memory aid, a sort of "paper computer." But there is one advantage: we still are completely unable to design a computer *with a random hunting circuit.* Until we do, and that prospect seems unattainable now, we need to use the associational powers of the brain in selecting useful answers from among the 512 possibilities contained in the super-cube.

4. *Sliding Scales:* I developed this *individual* problem-solving system out of my impatience with the small number of possibilities that morphological analysis offers. It is another "paper computer," although it happens to be made of wood. As shown in the illustration, it consists of twelve tally-sticks that move in grooves against one another, somewhat in the manner of an old-fashioned slide-rule. Using peel-off labels it is possible to insert twenty or so different limitations of a problem in architecture or design on each stick, with all of the limitations still confined to just *one* general area. This might be material, process, or whatever. Sliding the individual sticks up or down, it is then possible to read a line across. This will yield twelve combinations out of a possible 240 juxtapositions (as shown in the photograph on page 176).

But wait. The unit shown is but *one* out of eighteen identical ones (each of which consists of twelve tally sticks—each stick has twenty or so further parameters written in). These other seventeen devices each stand for major design considerations, such as economics, social consequences, aesthetic criteria, and safety factors. These eighteen boards, each with 240 juxtapositions, hang next to each other in a vertical file. By working all eighteen boards and reading not only the linear



Sliding scales, arranged to solve an architectural problem. Photo by John Charlton.

solution on each board but also *reading through all eighteen three dimensionally*, we are looking at nearly 4,400 possible combinations.

Sliding scales give a much larger choice than morphological analysis. Although useful in searching for problem solutions, they are still fairly unwieldy. Both systems are basically "paper computer" checklists, and rely on a guiding, goal-directed, and selective brain to make choices. Unfortunately the sheer mechanics—simple as they are—get in the way.

Finding all such systems cumbersome, I have spent a good deal of time trying to develop a simple and elegant way of turning the brain to solution finding (and problem finding) with no mechanical intrusions. I also felt that the number of ideas obtained should be unlimited—as it is in normal intensive thinking—rather than arbitrarily tied to 512 or 4,400 possibilities.

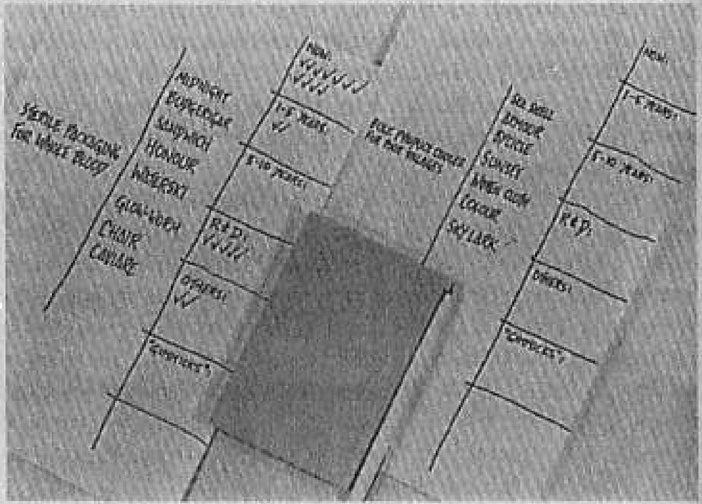
Arthur Koestler's theory of bi-association (the engineered collision between two incompatible sets of ideas) was explored by him and myself in the years since his original publication of *Insight and Outlook*. Through meetings and letters we refined the phrase to *bisociation*. Over the last ten years I have both practiced and taught my bisociation technique, which seems to fill my original prescription for an elegant system without mechanical distraction.

5. *Bisociation*: The individual problem-solving method is best explained through an actual example. A simple chart is shown, with the object to be designed listed to the left of the vertical line. To the right six or seven "response words," that is, nouns arbitrarily picked from a dictionary or provided by a coworker, are written down. *It is important that these nouns not be connected in the designer's mind with the object under design consideration.* To organize the solutions discovered, these are arranged under headings on the extreme right of the page. Classifications I normally use are:

NOW (a product or system that can be made immediately)
2-5 YEARS (a concept not quite ready for immediate production)
5-10 YEARS (an answer leading to long-range product or system planning)
R & D (a solution that sounds reasonable, the feasibility of which may have to be determined by the Research & Development department)
GIMMICKS (Sometimes an idea results that has nothing to do with the product itself but rather develops a new merchandising gimmick.)

OTHERS (Frequently ideas may emerge that don't solve the specific design problem at all. Nonetheless they may be innovative answers to problems beyond the scope of the inquiry and may be developed for other clients.)

Let's see how it works in practice. Below are typical bisociation forms. The one on the right at the start of the problem, the same form on the left upon completion:



Two bisociation charts. Photo by John Charlton

The object chosen to be designed is a chair. The response words offered are ventriloquist, sex, eagle, orchid, bicycle, sunset, and ice cream.

It will now be my task to bring the concept of chair-to-be-designed into an artificial and forceful collision with each of the response words in turn. The technique used is a sort of free stream-of-consciousness flow.

> Chair/Ventriloquist: ventriloquists use dummies . . . window-display dummies . . . figures in a wax museum . . . back to window dummies . . . they used to be made of papier-mâché

> . . . kids use papier-mâché in nursery school . . . in chair design compound curves can be achieved only with difficulty in mass produced plastic shells . . . here's the idea: we can construct an enormously comfortable easy chair for normal use, or even for a specific subgroup such as severely handicapped people . . . by using a chicken wire armature we can create any compound curve configuration we want to, wet newspapers and glue (papier-mâché) can be worked in over the armature . . . We can now make one-of-a-kind individual chairs easily for the first time in history (the wire and papier-mâché shell can be covered with foam and fabric in a conventional manner). Enter under NOW.
>
> Chair/Sex: a delightful activity . . . Freud's "prime determinate" . . . pleasure . . . pregnancy . . . pregnant women . . . pregnant women's stomachs expand . . . they go back to "normal" after delivery . . . here's the idea: since seating comfort depends on positional changes, we can design a continuously yet randomly expanding and contracting back portion of a chair. This can be done hydraulically or mechanically. Enter under NOW for chairs; enter under R & D for dentists' chairs and under OTHERS for seats in automobiles, buses, trains, and aircraft.
>
> Chair/Eagle: the eagle is a national symbol . . . it is also a bird of prey . . . prey . . . pray . . . . No redesign has been done on church seating, including prayer stalls. Enter under NOW . . . but I want to continue . . . back to bird . . . when birds sit on a telephone wire, they don't fall off when they go to sleep, why? . . . as their leg muscles relax with the onset of sleep, their bones and claws lock . . . as they wake up, musculature takes over before bones unlock . . . . This can become a locking and unlocking swivel base for chairs. Enter under NOW.
>
> Chair/Orchid: orchids are flowers . . . flowers are beautiful . . . this morning I saw a magnificent Bonsai . . . cut flowers . . . flowers are plucked . . . an enormous amount of money and research has been expended to make auditorium and classroom chairs that stack . . . the problem is with the leg structures . . . . Here comes the solution: why not have the seat-back terminate in a single leg? Classroom or auditorium flooring could be built with one-and one-half-inch holes; chairs

could be plucked . . . plugged . . . into the floor as needed, into any configuration, and unplugged again. Floor receptacles for chair legs, one and one-half inches in diameter, would be 36 inches apart and could be closed with a stopper when not in use. Since this demands architectural predesign, enter under 2-5 YEARS.

Chair/Bicycle: bicycle seats still needlessly uncomfortable . . . simple redesign is possible using new ergonomic data. . . enter under OTHERS . . . . Here comes a second idea: a bicycle seatlike "perch" could provide excellent temporary seating for assembly line workers. Enter under NOW.

Chair/Sunset: great beauty . . . changing colors . . . some of the beauty of sunsets caused by pollution . . . particulate matter in the air . . . spots . . . the leopard does not change his spots . . . but the chameleon does . . . How? . . . melanic deposits in the epidermic layer rise to the surface, depending on background coloration . . . this can be done in plastics through the insertion of encapsulated pigments . . . If phototropic, a variably colored or changing color chair would result. Enter under R & D.

Chair/Ice Cream: ice cream is chilly . . . cold . . . hot . . . warm . . . the technology of electric blankets can form the surface of a chair easily . . . Less than pennies a day can give us warm easy chairs and sofas, reducing heat needs in a living room. Since warmth rises the chair will keep occupants comfortable. A timely idea: enter under NOW and R & D.

A balance sheet will show that I have developed nearly a dozen new and original ideas—most of them patentable—in less than six minutes. This is an idea flow of better than one new idea every thirty seconds!

The best thing about bisociation is the fact that it can be learned in the length of time it has taken you to read about it. The reason is fairly simple: *all* of our minds work this way nearly *all* the time when hunting for ideas. All that this bisociation technique accomplishes is to *externalize* the process by making a list. Without the list, the mind tends to wander, seeking more beguiling images than a new chair.

If you try this out, and it doesn't work for you the first time, just substitute seven different response words.

One final note: it is possible to feed your design concept through this list a second time. Our first solution was chair/ventriloquist leading to a compound curved papier-mâché chair design. We can now take this entire concept and start again at the top:

Compound Curved Chair/Ventriloquist: ventriloquist . . . dummy . . . sits on ventriloquist's lap . . . small . . . child-sized . . . handicapped children . . . . Here comes the idea: a clinical and adjustable chair for retarded children. It can be made of a number of sections (each in comfortable curved configurations). These can then be plugged together in a limitless number of combinations, each of which caters to the specific handicap and body size of one particular child. Enormously individualized clinical seating through a type of mass production. Enter under NOW.

And so forth.

This is an elegant system, which I have used, without exception, on everything I have designed for more than a decade.

6. *Trisociation*: This variation of sliding scales and bisociation uses my icosahedral dice. (An icosahedron is a regular solid with twenty faces, each an equilateral triangle.) A series of parameters can again be established; as under morphological analysis or sliding scales various concepts can be assigned to colors of dice and to numbers from zero to nine (twice on each die). One roll of *three* dice yields 8,000 forced associations, one roll of *four* dice gives 160,000 possibilities.

7. *Bionics and Biomechanics*: It has been explained that many of the ideas and methods in synectics come from the field of biology. The reader will also have noticed that many of my bisociational "triggers" in the example given above came from the field of nature. In my opinion the use of biological prototypes in design is profoundly justified. The entire following chapter is given over to this concept.

8. *Forcing New Thinking Patterns*: By repeatedly facing students and young designers with problems far enough removed from everyday reality so as to *force* them into entirely new thinking patterns (new cortical associations), by constantly pointing out to them the nature of the various blocks, it is possible to help them realize their creative design potential. By forcing them into solving problems that have never been solved before, problems that lie outside normal human experience, a habit pattern is slowly established, a habit pattern of solving problems without the interference of blocks (since, with problems removed from everyday experience, blocks cannot operate), and these habit patterns are then carried over into the solving of *all* problems, familiar or not.

What constitutes a totally new problem, outside all previous human experience? If we are asked to design some fabulous animal unlike any we are familiar with, we will probably end up with something possessing the body of a horse, the legs of an elephant, the tail of a lion, the neck of a giraffe, the head of a stag, the wings of a bat, and the sting of a honeybee. In other words, we have really put a lot of familiar things together in a totally unworkable, unfunctional, unfamiliar way. This is *not* solving a problem. If, on the other hand, we are asked to design a bicycle for a man with three legs and no arms we can now solve a specific functional problem, far enough removed from any previous experience, to become valuable in this context.

It was my good fortune to study and assist the late Professor John Arnold at M.I.T. Arnold pioneered in this field with students in engineering and product design. Most famous of his problems is probably the Arcturus IV project: here the class is given voluminous reports regarding the inhabitants of the imaginary fourth planet in the Arcturus system, as well as the planet itself. An extraordinarily tall, slow-moving species descended from birds, these mythical inhabitants possess many interesting physiological characteristics. They are hatched from eggs, possessed of a beak, have birdlike, hollow bones, with three fingers on each hand and three eyes, the center one

of which is an x-ray eye. Their reaction speed is almost ten times as slow as that of human beings; the atmosphere they breathe is pure methane. If a class is now asked to design, say, an automobilelike vehicle for these people, totally strange, new limits for design are immediately established.

Obviously a gasoline gauge is unnecessary, since the Arcturians can always see through the gas tank with their x-ray eye. What about a speedometer? Top speed will have to be around eight miles per hour because of their slow reaction speed. Perceptually, however, such a people would experience the gradations of speed (up to eight miles per hour) much as we experience the speed range in our own automobiles. The answer here then seems easy: subdivide a speedometer dial. But what kind of a numerical system would people use who have three fingers on each hand and three eyes: decimal, duodecimal, binary, sexagesimal? As these vehicles will be built on earth and exported to Arcturus IV, should they use a standard gasoline engine shielded against a methane atmosphere, or must a new type of engine, specifically designed to operate optimally in methane, be designed? What of the overall shape of the vehicle? Should it be egg-shaped (a simple and sturdy form when aerodynamics are of no importance), or would the egg be the worst possible shape in terms of vehicular safety because the Arcturians would perceive it, psychologically speaking, as a return to the womb, lulling them into a false feeling of security? Maybe our design consideration then becomes one of a shape as unlike an egg as possible—a difficult order to fill indeed!

Arcturus IV is just one of many problems evolved by Professor Arnold, and, from this all-too-brief analysis of some of the possible approaches to it, it will be seen that, while fantastic and science fictional in content (especially three years before *Sputnik*), it is a serious approach to creative problem solving.

It can be seen from the foregoing that the "how" in teaching design creativity must consist largely of establishing a milieu in which new approaches can flourish. But schools tend to preserve the cultural *status quo*, by disseminating whatever mass of data is currently acceptable as "truth." Education rarely concerns itself with the *individual* human brain; rather, the tremendous variation in human minds is taken into account only as something to be flattened out so that the particular curriculum or theory in vogue at the moment can be "sold" with minimal effort. We have failed to recognize that discovery, invention, original thought are culture-smashing activities (remember $E = mc^2$?) whereas so-called education is a culture-preserving mechanism. By its very nature, education, as it is now constituted, cannot sponsor any vital new departures in any facet of our culture. It can only *appear to do so* to preserve the sustaining illusion of progress.

One of the major problems is that "newness" often implies experiment, and experiment implies failure. In our success-oriented culture, the possibility of failure, although an unavoidable concomitant of experiment, works against the matrix. The history of progress is littered with experimental failures. This "right to fail," however, does not absolve the designer from responsibility. Here, possibly, is the crux of the matter: to instill in the designer a willingness to experiment, coupled with a sense of responsibility for his failures. Unfortunately, both a sense of responsibility and an atmosphere permissive of failure are rare indeed.

A more ideal creative design environment will consist of habituating designers and students to work in areas where their many blocks and inhibitions cannot operate, and this will imply a high tolerance level for experimental failure. Furthermore, it must mean the teaching and exploring of basic principles that, by their nature, have no immediate application. This calls for a suspension of belief in ready answers, and in the glib, slicked-up kitsch that characterizes most of the design work coming out of schools and offices.

We need not journey to Arcturus IV to face designers and students with something completely outside their familiar experiences. All we have to do is to design for the poor, the sick, the elderly, the disabled. For while designers have addressed

themselves to the fads of the middle and upper bourgeoisie, we have lost sight of the fact that a very substantial part of our population is discriminated against in design.

I am questioning, then, the entire currently popular direction of design. To "sex-up" objects (designers' jargon for making things more attractive to mythical consumers) makes no sense in a world in which basic need for design is very real. In an age that seems to be mastering aspects of form, a return to content is long overdue.

Much of what is suggested throughout this volume in the way of alternative areas for attack by designers also has the useful quality that it will be new to designers and students alike. If (within the meaning of this book) we do that which seems right, we will also develop our ability to see things in a new way and to do things that are new.