What Is Design?
A Definition of the Function Complex

The wheel's hub holds thirty spokes
Utility depends on the hole through the hub.
The potter's clay forms a vessel
It is the space within that serves.
A house is built with solid walls
The nothingness of window and door alone renders it usable.
That which exists may be transformed
What is nonexistent has boundless uses.

All men are designers. All that we do, almost all the time, is design, for design is basic to all human activity. The planning and patterning of any act toward a desired, foreseeable end constitutes the design process. Any attempt to separate design, to make it a thing-by-itself, works counter to the fact that design is the primary underlying matrix of life. Design is composing an epic poem, executing a mural, painting a masterpiece, writing a concerto. But design is also cleaning and reorganizing a desk drawer, pulling an impacted tooth, baking an apple pie, choosing sides for a backlot baseball game, and educating a child.

Design is the conscious and intuitive effort to impose meaningful order.

It is only in recent years that to add the phrase “and intuitive” seemed crucial to my definition of design. Consciousness implies intellectualization, cerebration, research, and analysis. The sensing/feeling part of the creative process was missing from my original definition. Unfortunately intuition itself is difficult to define as a process or ability. Nonetheless it affects design in a profound way. For through intuitive insight we bring into play impressions, ideas, and thoughts we have unknowingly collected on a subconscious, unconscious, or preconscious level. The “how” of intuitive reasoning in design doesn’t readily yield to analysis but can be explained through example. Watson and Crick intuitively felt that the underlying structure of the DNA chain would express itself most elegantly through a spiral. Beginning with this intuition, they began their research. Their instinctive precognition paid off: a spiral it is!

Our delight in the order we find in frost flowers on a window pane, in the hexagonal perfection of a honeycomb, in leaves, or in the architecture of a rose, reflects man’s preoccupation with pattern. We constantly try to understand our ever-changing highly complex existence by seeking order in it. And what we seek we find. There are underlying biological systems to which we respond on levels that are often unconscious or subconscious. The reason we enjoy things in nature is that we see an economy of means, simplicity, elegance, and an essential rightness there. But all these natural templates, rich in pattern, order, and beauty, are not the result of decision making by mankind and therefore lie beyond our definition. We may call them “design,” as if we were speaking of a tool or artifact created by humans. But this is to falsify the issue, since the beauty we see in nature is something we ascribe to processes we often don’t understand. We enjoy the beautiful red and orange tones of maple leaves in the autumn, but our enchantment is caused by a process of dissolution, the death of the leaves. The streamlining of a trout’s body may be aesthetically satisfying to us, but for the trout it is a means for swimming efficiency. The profound beauty of spiral growth patterns found in sunflowers, pineapples, pine cones, or the arrangement of leaves on a stem can be explained by the Fibonacci sequence (each number is the sum of the two previous members: 1, 1, 2, 3, 5, 8, 13, 21, 34 …), but for the plant the arrangement serves only to improve photosynthesis by exposing a maximum of its surface. Similarly, the beauty we find in the tail of a peacock, although no doubt even more attractive to a peahen, is the result of intraspecific selection (which, in the case cited, may ultimately prove fatal to the species).

Intent is also missing from the random-order system of a pile of coins. If, however, we move the coins around and arrange them according to size and shape, we impose our intent and may produce some sort of symmetrical alignment. A symmetrical-order system is a favorite of small children, unusually primitive peoples, and some of the insane, because it is so easy to understand. Further shifting of the coins will produce an infinite number of asymmetrical arrangements that require a higher level of sophistication and greater participation on the part of the viewer to be understood and appreciated. While the aesthetic values of the symmetrical and asymmetrical designs differ, both can give ready satisfaction since the underlying intent is clear. Only marginal patterns (those lying in the threshold area between symmetry and asymmetry) fail to make the designer’s intent clear. The ambiguity of such “threshold cases” produces a feeling of unease in the viewer. There are an infinite number of possible satisfactory arrangements of the coins. Importantly, none of these is the one right design, though some may seem better than others.

Shoving coins around on a board is a design act in miniature because design as a problem-solving activity can never, by definition, yield the one right answer; it will always pro-
duce an infinite number of answers, some “righter” and some “wronger.” The “rightness” of any design solution will depend on the meaning with which we invest the arrangement.

Design must be meaningful. And “meaningful” replaces such semantically loaded expressions as “beautiful,” “ugly,” “cute,” “disgusting,” “glamorous,” “realistic,” “obscure,” “abstract,” and “nice,” labels convenient to a bankrupt mind when confronted by Picasso’s “Guernica,” Frank Lloyd Wright’s “Fallingwater,” Beethoven’s “Eroica,” Stravinsky’s “Le Sacre du Printemps,” Joyce’s “Finnegan’s Wake.” In all of these we respond to that which has meaning.

The mode of action by which a design fulfills its purpose is its function.

The American sculptor Horatio Greenough first stated that “form follows function” in 1739. His phrase became a battle cry for the architect Louis Sullivan roughly 100 years ago and was restated as “form and function are one” by Frank Lloyd Wright. Both statements have contributed to a seeming divorce between that which works well and that which is beautiful. The implication in “form follows function” is that as long as the functional requirements are satisfied form will follow and seem pleasing. Others have put the cart before the horse and misread these statements to imply that “ideal” form will always work well.

The concept that what works well will of necessity look well has been the lame excuse for all the sterile, operating-room-like furniture and implements of the twenties and thirties. A dining table of the period might have a top, well proportioned in glistening white marble, the legs carefully nurtured for maximum strength with minimum materials in gleaming stainless steel. But the first reaction on encountering such a table is to lie down on it and have your appendix extracted. Nothing about the table says: “Dine off me.” Le style international and die neue Sachlichkeit have let us down rather badly in terms of human value. Le Corbusier’s house la machine à habiter and the packing-crate houses evolved by the Dutch de Stijl movement reflect a perversion of aesthetics and utility.

“Should I design it to be functional,” the students say, “or to be aesthetically pleasing?” This is the most often heard, the most understandable, and yet the most mixed-up question in design today. “Do you want it to look good or to work?” Barricades are erected between what are really just two of the many aspects of function. A simple diagram shows the dynamic actions and relationships that make up the function complex.

It is now possible to go through the six parts of the function complex and to define each of its aspects.

The function complex. The Yin-Yang monad appears at each of the six aspects, indicating the soft-hard, feeling-thinking, intuitive-intellectual mix, which determines each of these six evaluative criteria.
Method: The interaction of tools, processes, and materials. An honest use of materials, never making the material seem that which it is not, is good method. Materials and tools must be used optimally, never using one material where another can do the job less expensively, more efficiently, or both. The steel beam in a house, painted a fake wood grain; the molded plastic bottle designed to look like expensive blown glass; the 1967 New England cobbler's bench reproduction ("worm holes $1 extra") dragged into a twentieth-century living room to provide dubious footing for martini glass and ashtray—these are all perversions of materials, tools, and processes. And the discipline of using a suitable method extends naturally to the field of the fine arts as well. Alexander Calder's "The Horse," a compelling sculpture at the Museum of Modern Art in New York, was shaped by the particular material in which it was conceived. Calder decided that boxwood would give him the specific color and texture he desired in his sculpture. But boxwood comes only in rather narrow planks of small sizes. (It is for this reason that it traditionally has been used in the making of small boxes.) The only way he could make a fair-sized piece of sculpture out of a wood that only comes in small pieces was to interlock them somewhat in the manner of a child's toy. "The Horse," then, is a piece of sculpture, the aesthetic of which was largely determined by method. The final piece was done in walnut at the request of one of the museum's patrons.

When early Finnish and Swedish settlers in what is now Delaware decided to build, they had at their disposal trees and axes. The material was a round tree trunk, the tool an axe, and the process a simple "kerf cut" into the log. The natural result of this combination of tools, materials, and processes was a log cabin.

Paolo Soleri's desert home in twentieth-century Arizona is as much the result of tools, materials, and processes as the log cabin. The peculiar viscosity of the desert sand where Soleri built his home made his unique method possible. Selecting a mound of desert sand, Soleri criss-crossed it with V-shaped channels cut into the sand, making a pattern somewhat like the ribs of a whale. Then he poured concrete in the channels, forming, when set, the roof-beams of the house-to-be. He added a concrete skin for the roof and bulldozed the sand out from underneath to create the living space itself. He com-

completed the structure by setting in car windows garnered from automobile junkyards. Soleri's creative yet honest use of tools, materials, and processes was a tour de force that gave us a radically new building method.

Dow Chemical's “self-generating” styrofoam dome is the product of another radical approach to building methods. The foundation of the building can be a twelve-inch-high circular retaining wall. To this wall a four-inch-wide strip of styrofoam is attached, which raises as it goes around the wall from zero to four inches in height, forming the base for the spiral dome. On the ground in the center, motorized equipment operates a spinning boom, with an operator and a heat welding machine. The boom moves around, somewhat like a compass drawing a circle, and rises with a spiraling motion at about three feet a minute. Gradually it moves in towards the center. A man sitting in the saddle feeds an “endless” four-by-four-inch strip of styrofoam into the welding machine, which heatwelds it to the previously hand-laid styrofoam. As the feeding mechanism follows its circular, rising, and ever-diminishing diameter path, this spiral process creates the dome. Finally, a hole thirty-six inches in diameter is left in the top, through


Medical clinic designed using seven interlinked styrofoam domes, Lafayette, Indiana.
which man, mast, and movement arm can be removed. The hole is then closed with a clear plastic pop-in bubble or a vent. At this point the structure is translucent, soft, and entirely without doors or windows. The doors and windows are then cut (with a minimum of effort; in fact the structure is still so soft that openings could be cut with one's fingernail), and the structure is sprayed inside and out with latex-modified concrete. The dome is ultralightweight, is secured to withstand high wind speeds and great snow loads, is vermin-proof, and inexpensive. Several of these fifty-four-foot-diameter domes can be easily joined together into a cluster.

Under the leadership of the designer/mathematician Steve Baer, groups of young people built "Drop City," a commune near Trinidad, Colorado. In 1965, Steve Baer developed a new geometry called Zornes. Domelike forms are based on polyhedra and polygons; however, in a Zome, the polyhedra are pulled or "stretched"—a sort of topological rubber geometry. From 1965 to 1981 Zornes were built with foundations of fieldstone, concrete, or wood. The skeletal outline of the dome was then constructed of wooden two-by-fours. For the covering "skin" of the building, Steve Baer and his friends went to automobile graveyards and cut triangular segments out of the tops of junked cars or station wagons with axes. These were then nailed in place and painted or enameled.

Drop City, which still exists as this is being written, provides a sort of postindustrial example of vernacular building. Its design authenticity is marred by dubious craftsmanship, rust, and some neglect. Nonetheless, it provides still another example of a new kind of building that is based on method: the interrelationship between material, tool, and process.

All these building methods demonstrate the elegance of solutions possible with a creative interaction of tools, materials, and processes.

Use: "Does it work?" A vitamin bottle should dispense pills singly. An ink bottle should not tip over. A plastic-film package covering sliced pastrami should withstand boiling water, yet open easily. Because in any reasonably conducted home, alarm-clocks seldom travel through the air at speeds approaching five hundred miles per hour, streamlining clocks is out of place. Will a cigarette lighter designed like the tailfin of an automobile (the design of which in turn was copied from a fighter aircraft of the Korean War) give more efficient service? A ballpoint pen shaped and colored like a pickle and made of a creepily yielding plastic is a tawdry perversion of design for use. On the other hand, look at some hammers: they differ in weight, material, and form according to use. The sculptor's mallet is fully round, permitting constant rotation in the hand. The jeweler's chasing hammer is a precision instrument used for fine work on metal. The prospector's pick is delicately balanced to add to the swing of his arm when cracking rocks.

The results of the introduction of a new device are never predictable. In the case of automobiles, a fine irony developed. One of the earliest criticisms of the car was that, unlike "old Dobbin," it didn't have the sense to find its way home whenever its owner was incapacitated by an evening of genteel drinking. No one foresaw that mass acceptance of the car would put the American bedroom on wheels, offering everyone a new place to copulate (and privacy from supervision by
parents and spouses). Nobody expected the car to accelerate mobility, thereby creating the urban and exurban sprawl and the dormitory suburbs that strangle our larger cities; or to sanction the killing of 50,000 people per annum, brutalizing us and making it possible, as Philip Wylie says, "to see babies with their jaws ripped off on the corner of Maine and Maple"; or to dislocate our societal groupings, thus contributing to our alienation; or to put everyone from sixteen to sixty in permanent hock to the tune of $150 a month. In the middle forties, no one foresaw that, with the primary use function of the automobile solved, it would emerge as a combination status symbol and disposable, chrome-plated codpiece. But two greater ironies were to follow. In the early sixties, when people began to fly more and to rent standard cars at their destination, the businessman's clients no longer saw the car he owned and therefore could not judge his style of life by it. Much of Detroit's Baroque exuberance subsided, and the automobile again came closer to being a transportation device. Money earmarked for status demonstration was now spent on boats, color television sets, and other ephemera.

The last irony is now upon us: with carbon monoxide fumes poisoning our atmosphere, the electric car, driven at moderate speeds and with a cruising range of only 100 miles, reminiscent of the turn of the century, has made a comeback as a city transportation device in Sweden and Great Britain between 1978 and 1984. Since individual transportation devices still fulfill an important need in large rural sections without public transport, much experimentation is going on in 1984. This has resulted in fleets of post office vans, taxis, or delivery vehicles being fitted out with methane conversion systems; hydrogen powered cars; and vehicles powered by natural gas converters. The automobile provides an interesting case history: in nearly 100 years it has changed from useful tool to gas-guzzling status symbol and finally to a device the use of which pollutes the environment and destroys irreplaceable natural resources.

Detroit is in complete disarray. More than one million workers in the automobile and automobile-connected industries have been laid off, and stockholder’s dividends have dried up. There are wild fluctuations in the world’s available oil supplies and consequently in gasoline prices. Although gasoline seems again to be more readily available in 1984, the new escalations of the Iraqi-Iranian War may turn the tap off at any time. Add to this mass unemployment, coupled with high prices, and it is understandable that U.S. consumers are choosing subcompact cars from Japan and other countries. Although carmakers in the United States have valiantly tried to market their own small cars, as this is being written whole new series of these automobiles have just been recalled for serious design faults, engineering errors, and manufacturing mistakes. (According to the Associated Press in August 1983, the Consumer Safety Division is attempting to get General Motors and others to recall eight-and-a-half million X, J, and K subcompacts manufactured between 1979 and 1983.) Since the first edition of this book nearly one-third of Detroit’s cars have been recalled.

Need: Much recent design has satisfied only evanescent wants and desires, while the genuine needs of man have often been neglected. The economic, psychological, spiritual, social, technological, and intellectual needs of a human being are usually more difficult and less profitable to satisfy than the carefully engineered and manipulated “wants” inculcated by fad and fashion.

People seem to prefer the ornate to the plain as they prefer daydreaming to thinking and mysticism to rationalism. As they seek crowd pleasures and choose widely traveled roads rather than solitude and lonely paths, they seem to feel a sense of security in crowds and crowdedness. *Horror vacui* is horror of inner as well as outer vacuum.

In clothing the need for security-through-identity has been perverted into role-playing. The consumer can now act out various roles by appearing caparisoned in Naugahyde boots, pseudomilitary uniforms, lumberjack’s shirts, various types of “survival gear,” and all the other outward trappings of Davy
Crockett, a Foreign Legionnaire, Cossack Hetman, or John Wayne. All these furry parkas and elk-hide boots are obviously mere role-playing devices, since climate control makes their use redundant. In a society concerned with physical fitness, enormous design improvements have been made in jogging shoes (beginning with Adidas and Puma in Germany), and most athletic clothes have been improved or even newly invented. But fake-outdoorsy fashions have grown even more rapidly as people frantically try to tell others whom they would like to be.

Nearly twenty years ago the Scott Paper Company introduced disposable paper dresses for 99 cents. In 1970 I was disgusted by the fact that such paper party dresses were selling for between $20.00 and $149.50, whereas increased consumption might have dropped the price to less than 50 cents. But during the intervening years the functional need for paper clothing was discovered: we now accept paper gowns routinely in hospitals, clinics, and doctor's offices, and disposable paper clothing is used extensively in clean rooms for computer assembly and space hardware.

Greatly accelerated technological change has been used to create technological obsolescence. The enormous proliferation of electronically improved telephones during the last two years makes that case clearly. A mail-order house in New England sends out four forty-two-page catalogs a year that list telephones only. Here are phones that will automatically dial by responding to your voice stating the name of the person you wish to call, phones with built-in automatic dialers, answering services, microrecorders and speakerphones, hand-held computers that can be preset to dial your seventy-two most favorite numbers anywhere in the world without your having to push buttons or turn dials, telephones that will automatically dial your local fire station (being plugged into smoke detectors) even when you're away from home, and much else. The economy of the marketplace, however, is still geared to a static philosophy of "purchasing-owning" rather than a dynamic one of "leasing-using," and pricing policy has not resulted in lowered consumer cost. If a television set, for instance, shows enough technological improvements to make it worthwhile to replace it from time to time, then routine leasing arrangements (as in England) or much lower purchase prices should reflect this. Instead important values of real things have been driven out by phony values of false things, a sort of Gresham's Law of Design.

**Telesis:** "The deliberate, purposeful utilization of the processes of nature and society to obtain particular goals" ([Random House Dictionary](#), 1978). The telesic content of a design must reflect the times and conditions that have given rise to it and must fit in with the general human socioeconomic order in which it is to operate.

The uncertainties and the new and complex pressures in our society make many people feel that the most logical way to regain lost values is to go out and buy Early American furniture, put a hooked rug on the floor, buy ready-made phony ancestor portraits, and hang a flintlock rifle over the fireplace. The gas-light so popular in our tract housing areas is a dangerous and senseless anachronism that only reflects an insecure striving for the good old days by consumer and designer alike.

Our thirty-five-year love affair with things Japanese—Zen Buddhism, the architecture of the Ise Shrine and Katsura Imperial Palace, haiku poetry, Hiroshige and Hokusai blockprints, and music of koto and samisen, lanterns and sake sets, green tea liqueur, and sushi and tempura—has been used to sell imported artifacts to consumers who disregard telesic aptness.

By now it is obvious that our interest in things Japanese is not just a passing fad or fashion but rather the result of a major cultural exchange. As Japan was shut off for nearly 200 years from the Western world under the Tokugawa Shogunate, its cultural expressions flourished in a pure (although somewhat inbred) form in the imperial cities of Kyoto and Edo (now Tokyo). The Western world's response to an indepth knowledge of things Japanese is comparable only to the
European reaction to things classical, which we are now pleased to call the Renaissance.

It is not possible to just move objects, tools, or artifacts from one culture to another and then expect them to work. Exotic decorative accessories or art-objects can be translated in this way, but their value seems to lie precisely in the fact that they are exotic—in other words, seen in an unfamiliar context. When cultures truly intermingle, then both cultures are enriched and continue to benefit one another.

But it is not possible to just take everyday objects and without regard to context expect them to work in a different society. The floors of traditional Japanese homes are covered by floor mats called tatami. These mats are three by six feet in size and consist of rice straw closely packed inside a cover of woven rush. The long sides are bound with black linen tape. While tatami mats impose a module (homes are spoken of as six-, eight-, or twelve-mat homes), their primary purposes are to absorb sounds and to act as a sort of wall-to-wall vacuum cleaner that filters particles of dirt through the woven surface and retains them in the inner core of rice straw. Periodically these mats (and the dirt within them) are discarded, and new ones are installed. Japanese feet encased in clean, socklike tabi (the sandal-like street shoe, or geta, having been left at the door) are also designed to fit in with this system. Western-style leather-soled shoes and spike heels destroy the surface of the mats and also carry much more dirt into the house. The increasing use of regular shoes and industrial precipitation make the use of tatami, difficult enough in Japan, absolutely ridiculous in the United States, where high cost makes periodic disposal and reinstallation ruinously expensive.

Beginning around 1980 a number of importers of tatami mats have sprung up in Oregon, California, and New England in order to sell tatami through advertisements in Sunset magazine. *A Japanese Touch For Your Home*, by Koji Yagi, published for the American Society of Interior Designers by Kodansha International of Tokyo, New York, and San Fran-
nels, clip-on swivel sets for hospital beds) might not only clear up the astoundingly large back inventory of sets in warehouses, but also create new markets.

To television as furniture or equipment we must add television as jewelry. Dick Tracy's wristwatch television from the comic strip of the forties and fifties was turned into reality by Panasonic late in 1983. Sony has designed their Watchman: a flat minitelevision roughly the size of four checkbooks stacked on one another. Listening is done through headphones, as with Sony's Walkman minicassette player. And Sinclair Electronics in England has unveiled its portable television set with a picture the size of a postage stamp. Thus we see television moving into a new associational area. With consumer electronics becoming smaller, miniaturized, and finally microminiaturized, we can expect many objects to reclassify themselves as they shrink in size. But while the manufacturers and their designers may manipulate associational values, we have to look at the objective results: a television set with a stamp-sized screen has an image that is too small to see. While listening to wrist-television on earphones or to a Sony Walkman may carry associations of portability, lightness, or personal adornment, the net result is impaired hearing. And with a bathroom scale that announces one's weight in an alluring contralto or a pleasing baritone voice (synthesized, of course), the associational value pushed is sexiness and gadgetry rather than anything that has to do with health, fitness, weight, or bathrooms.

At a time of economic insecurity, the misassociation most heavily pushed by manufacturers and sales departments is status combined with gimmickry. The best example from the 1983/1984 Christmas Catalog by Diners Club is a solid gold telephone, selling for a mere thirty thousand dollars.

The influence of media advertising has become so powerful as to act as a great equalizer, turning the public into passive consumers, unwilling to assert their taste or discrimination. A picture emerges of a moral weakling with an IQ of about 70, ready to accept whatever specious values the unholy trinity of

Motivation Research, Market Analysis, and Sales has decided to inculcate in him. In short, the associational values of design have degenerated to the lowest common denominator, determined more by inspired guesswork and piebald graphic sales charts than by the genuinely felt wants of the consumer.

Some associations are shared by everyone, and this can be simply demonstrated. If the reader is asked to choose which one of the figures below he would rather call Takete or Maluma (both are words devoid of all meaning), he will easily call the one on the right Takete (W. Koehler, Gestalt Psychology).

Most associational values are universal within a culture and frequently are based on the traditions of that culture. These values come from unconscious, deep-seated drives and compulsions. The totally meaningless sounds and shapes shown above can mean the same thing to most of us. There is an unconscious relationship between the expectations of the spectator and the configuration of the object. The designer can manipulate this relationship. This can enhance the "chairness" of the chair and at the same time load it with associational values: elegance, formality, portability, the sense of fine woods crafted well, or what-have-you.

Aesthetics: Here dwells the traditional bohemian artist. A mythological figure, equipped with sandals, lover, garret, and
easel, pursuing dream-shrouded designs. The cloud of mystery surrounding aesthetics can (and should) be dispelled. The dictionary definition, "a theory of the beautiful, in taste and art," leaves us not much better off than before. Nonetheless we know that aesthetics is a tool, one of the most important ones in the repertory of the designer, a tool that helps in shaping his forms and colors into entities that move us, please us, and are beautiful, exciting, filled with delight, meaningful.

Because there is no ready yardstick for the analysis of aesthetics, it is simply considered to be a personal expression fraught with mystery. We know what we like or dislike and let it go at that. Artists themselves begin to look at their productions as autotherapeutic devices of self-expression, confuse license and liberty, and forsake all discipline. They are often unable to agree on the various elements and attributes of design aesthetics. If we contrast the "Last Supper" by Leonardo da Vinci with an ordinary piece of wallboard, we will understand how both operate aesthetically. As "pure" art, the painting was a source of inspiration, delight, beauty, catharsis ... in short, a communication device for the Holy Church at a time when a largely preliterate population was exposed to few pictorial representations or graphic stimuli. But the "Last Supper" also had to fill the other requirements of function; aside from the spiritual, its use was to cover a wall. In terms of method it had to reflect the material (pigment and vehicle), tools (brushes and painting knives), and processes (individualistic brushwork) employed by Leonardo. It had to fulfill the human need for spiritual satisfaction. And it had to work on the associational and telesic planes, providing reference points from the Bible. Finally, it had to make identification through association easier for the beholder through such traditional symbols as the racial type, garb, and posture of the Savior.

Earlier versions of Christ's last supper, painted during the sixth and seventh centuries, depicted Christ lying or reclining in the place of honor. For nearly a thousand years, the well-mannered did not sit at table. Leonardo da Vinci disregarded the reclining position followed by earlier civilizations and painters for Jesus and his Disciples. To make the "Last Supper" acceptable to Italians of his time on an associational plane, Leonardo seated the crowd around the table on chairs or benches. Unfortunately the scriptural account of St. John resting his head on the Savior's bosom presented an unsolvable positioning problem to the artist, once everybody was seated according to the Renaissance custom.

On the other hand, the primary use of wallboard is to cover a wall. But an increased choice of textures and colors applied by the factory shows that it, too, must fulfill the aesthetic aspect of function. No one argues that in a great work of art such as the "Last Supper," prime functional emphasis is aesthetic, with use (to cover a wall) subsidiary. The main job of wallboard is its use in covering a wall, and the aesthetic assumes a highly subsidiary position. But both examples must operate in all six areas of the function complex.

The six parts of the function complex are informed by the past: experience and tradition. But Januslike the function complex also faces the future. The ongoing dimensions of what we design, make, and use lie in the consequences. All of our tools, objects, artifacts, transportation devices, or buildings...
have consequences that reach out into such diverse areas as politics, health, income, and the biosphere.

It has already been shown that the mere choice of material that is plastic and not biodegradable can have far-reaching consequences for the environment. The process of manufacturing may lead to immediate pollution problems, such as the acid rain denuding forests in Canada, New England, and the Scandinavian countries: this poisonous precipitation is caused by factory chimneys spewing pollutants in the Chicago-Gary area and the Ruhr and Saar valleys. Long-range pollution is making itself felt only now: the Environmental Protection Agency has so far identified 140,000 toxic waste sites in North America—the direct result of arbitrary dumping of chemicals, waste, and factory effluvia.

Falling property values in two of the worst dump-site areas, the Love Canal in New York and Times Beach in Missouri, demonstrate clearly the economic consequences when afterburners and postmanufacturing filtration systems are not designed—to say nothing of health problems and genetic damage caused by improperly designed storage barrels for toxic waste.

The design of gas-guzzlers has tied American consumers (and hence their government) to the whimsical foreign policies of oil exporting nations that are frequently unstable—a clear case of political consequences following the design act.

"Urban renewal" and "slum clearance" projects have verticalized ghettos into monolithic highrises that have had enormously damaging social consequences to people forced to live in them. Suicide, alienation, aggression, rape, murder, heavy drug use, and other departures from sexual norms have followed each urban renewal project. (Peter Blake, Form Follows Fiasco. Boston: Little Brown and Company, 1979; Victor Papanek, Design for Human Scale. New York: Van Nostrand Reinhold, 1983.)

The self-assertive greed of corporations has given us strips of quick-food restaurants in every town or sizable village in the United States. The societal and social consequences are clear: a destabilization of the family, new eating patterns that
quarreling over where to dump atomic matter that comes from the relatively minor research and applications performed in hospitals and clinics. A whole series of science-fictional proposals are being seriously studied. This includes storing nuclear waste products in underground caves, dumping demonstrably imperfect barrels containing such wastes in the oceans, or even firing atomic garbage into space. In the ten years until 1983, newspapers and magazines were full of articles describing the complete inadequacy of any existing storage method—and meanwhile the nuclear waste pile rose. It is a fact that we have no present safe means of storing nuclear waste products.

Similar frightening statistics can be drawn from toxic waste storage; these are discussed at length in another chapter.

Designers often attempt to go beyond the primary functional requirements of method, use, need, telesis, association, and aesthetics; they strive for a more concise statement: precision, simplicity. In a statement so conceived, we find a degree of aesthetic satisfaction comparable to that found in the logarithmic spiral of a chambered nautilus, the ease of a seagull’s flight, the strength of a gnarled tree trunk, the color of a sunset. The particular satisfaction derived from the simplicity of a thing can be called elegance. When we speak of an elegant solution, we refer to something that reduces the complex to the simple:

Euclid’s Proof that the number of primes is infinite will serve as an example. Primes are numbers that are not divisible, 3, 17, 23, and so forth. One would imagine as we get higher in the numerical series, primes would get rarer, crowded out by the ever-increasing products of small numbers, and that we would finally arrive at a very high number, which would be the highest prime, the last numerical virgin. Euclid’s Proof demonstrates in a simple and elegant way that this is not true and that to whatever astronomical regions we ascend, we shall always find numbers that are not the product of smaller ones but are generated by immaculate conceptions, as it were. Here is the proof: Assume that P is the hypothetically highest prime;