THE DYNAMICS OF SHAPE

Design Quarterly 64

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In this special issue of DESIGN QUARTERLY Dr. Rudolf Arnheim, noted author and professor of the psychology of art, treats the psychology of perception as it applies to the field of design.

In his commentary, illustrated by more than fifty examples from the fields of architecture, industrial design, interior design and engineering, Dr. Arnheim discusses the active *visual forces,* the *visual dynamics* perceived in looking at design objects. While many of these principles have been put forward in his book, *Art and Visual Perception,* here for the first time they are applied to the analysis of design objects.

Frequently we are at a loss if asked to justify why we think a certain product is better than another. Rational explanations of why a product is good are mostly based on its functional aspects: does the product work, does it do the job?; or based on emotional response: is it elegant, strong, graceful? Although quality, safety and durability are usually the guiding elements in any design study, visual factors seldom become a prime criterion.

According to Dr. Arnheim, shapes can be analyzed in detail by describing their forms in terms of geometry, size, quantity, location, etc. Yet, beyond such objective characteristics, there are *visual forces* which expand and contract, push and pull, rise and fall, advance and recede. He contends that these *visual forces* determine meaning and expression in art and design. It is essential for the architect and designer to be aware of these *dynamics of shape.* This is especially important because the technological factors involved in producing an object increasingly limit and influence its shape. The designer must consider anew the qualities inherent in a curve, a straight line, etc. and realize the fundamental difference between convex and concave, or positive and negative shapes. Dr. Arnheim observes that we cannot be forced to accept something visually merely because it works technically. This establishes the necessity for further study and conscious evaluation of these *visual forces.*

For the sake of clarity, we did not select only "good design" examples, although many of the illustrations show some of the best in the field of design. A study of the *visual forces* which Dr. Arnheim demonstrates must remain uninfluenced by the aesthetic conflicts which arise when we see a 1959 model Chevrolet together with Frank Lloyd Wright's Kaufmann House at Bear Run.

In presenting Dr. Arnheim's views on *The Dynamics of Shape,* DESIGN QUARTERLY hopes to continue its role of enlarging the scope of design and fostering the understanding of disciplines related to design.

P.S.

Two tall cubes stand on the ground. To the mathematician these are two solids and a plane, to be accounted for by measurements and relations among measured quantities. There are height, breadth, and depth; there are right angles and parallels. Each building shares a rectangular surface with the ground. The mathematician's account relies entirely on immobile elements, and his description remains static even when it refers to the ratios between these elements, because a ratio merely divides one size by another. We are presented with the anatomy of shape. The information is useful; but anatomy deals with the dead body. It does not speak of life.

In contrast to such a passionless survey, what does the architect see? What is the artist's view of shape? What indeed does the average pair of eyes see? Most answers to these questions cannot be simple. But one answer is simple and fundamental. It says that all perceived shapes are dynamic, and that all relations among such shapes are equally dynamic. Good architects know this, and allusions to the principle appear constantly also in writings on art; but it has not been recognized as a basic fact of vision. Books on the psychology of perception ignore it. And yet, dynamics is the very life of what we see.

To the builder or engineer, the tall cubes are not static. They do more than touch the ground, they press it and grip it. A building's many floors are not monotonous repetitions because each floor adds more weight and calls for more strength to keep the tower standing on its base, to steady it against the wind. The vertical is not an arbitrary spatial direction but the one that will keep the bulk of the pressure within the bounds of the building. The power of man and machine raises the tower, in opposition to the pull of gravity. To the builder and the engineer, the cube on the ground and in open space is a pattern of physical forces.

The World Trade Center, New York, N.Y., designed by Minoru Yamasaki and Assoc., to be completed in 1970

The one simple point that will be made in this commentary on a set of photographs is that when the eye looks at an object it, too, is presented with a pattern of forces. By no means is this visual pattern identical with the physical stresses that concern the engineer, but there are parallels. In the visual field, just as in the physical, a vertical force pulls downward. In the drawings of the geometrician there is no difference between moving upward and moving downward. In visual space the difference is fundamental. We say that visual space is anisotropic, that is, the directions within it are not interchangeable.

Why is it so difficult for the giant cubes to look their size? Because mere size is not dynamic; size is a matter of measurable quantity. Visual greatness, on the other hand, results when the eyes see an object grow — grow beyond its surroundings. A cubic shape does not favor such an experience. The cube keeps the physical stresses under cover. The eye travels across an expanse of uniformity. Nothing changes and therefore nothing grows. Whatever sense of climbing or height may be conveyed by the sight derives from perspective distortions and the awareness of distance, not from the shape of the building itself.

The character of many shapes is profoundly influenced by the dynamic difference of up and down. A bowl rests on its foot and opens like a flower to receive and to contain what pours into it from above. The bowl is open, passive, feminine. Turn it upside down, and nothing has changed, if you listen to the geometrician. To him, the invisible stream of energy pervading the visual field does not exist. Perceptually, however, this dynamic medium changes every aspect of the shape. The turned-over bowl becomes a rising cupola which grips, covers, and protects the space it hides. It is closed, active, masculine and rests on its rim or hangs by its foot. All forces have been reversed.

Bowls, designed by Herbert Krenchel, 1953

Lamps, designed by Carl Fagerlund, 1959

Objects, shaped by nature or by man, tend to conform to the anisotropy of space. Like trees or the human body, two of Carl Fagerlund's lamps are symmetrical horizontally, but asymmetrical vertically. They are covers, containers of a radiant energy that spreads mostly downward and sideways. These lamps dominate the space underneath, and their tapering form tends to be read from the top down as a crescendo directed toward the open mouth. Define these objects as mere truncated cones, and you reduce live things to their anatomy. The anatomy of shape offers nothing but the vehicle of visual dynamics, which alone determines expression and meaning.

Compared with the two more traditional lampshades, the one on the right startles like an apparition. This lamp, because of its symmetry in the vertical, is untouched by the pull of gravity. The dynamic space of the visual field appears suspended around an island of weightlessness.

This is a very modern effect. During the last century or so, painting and sculpture have liberated themselves increasingly from the anisotropy of visual space. The forms in a modern painting tend to float weightlessly in the frame. A similar effect is harder to achieve in sculpture, which dwells in physical space, in the company of things proclaiming the pull of gravity. That it can be done is seen most clearly in Richard Lippold's diaphanous constructions which radiate in all directions, suspended like chandeliers.

In architecture, visual weightlessness is even more difficult to obtain because buildings are seen as the bases and containers of human bodies and other objects. Even so, modern design obtains startling effects. The facade of the building on I. M. Pei's *Kips Bay Plaza* is nondirective and in suspension, except for the overall horizontality of the large rectangle and the counterbalancing verticality of the windows. The eyes drift freely yet restlessly, and on their return to earth, with its trees, lampposts, fences and pedestrians, they are shaken out of a dream.

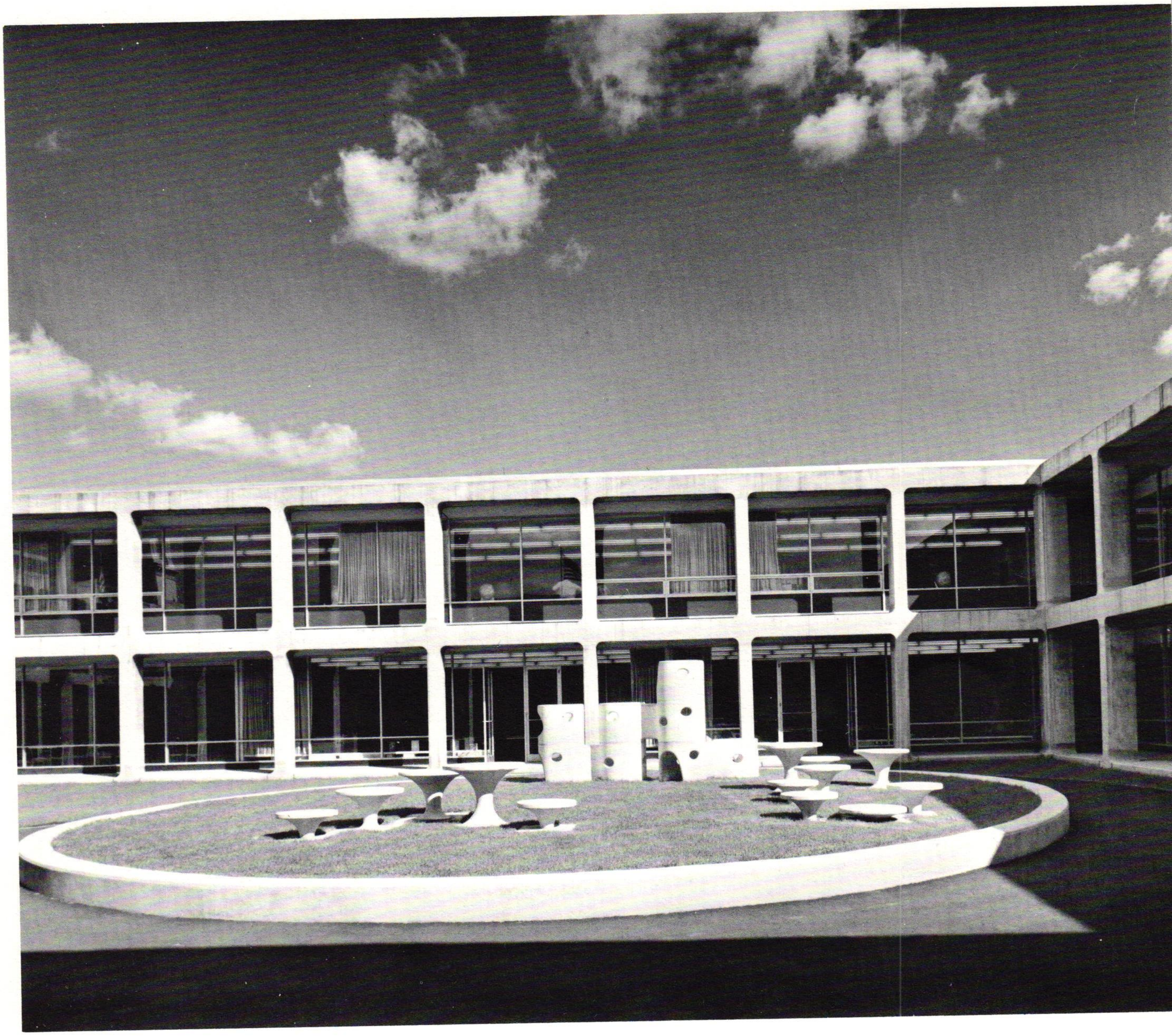
Is it a dream of liberation or of disorientation? The two-story grid around the inner court of Skidmore, Owings and Merrill's *Harry A. Conte School and Community Center* is not only outside of space but also outside of time. In suspending the visual interplay between load and support, the design eliminates the dramatic play of forces, and it is by the play of forces that architecture reflects action. The verticals and horizontals are here almost equal in function, and the relation of up and down is as tensionless as that of right

Kips Bay Plaza, New York, N.Y., designed by I. M. Pei & Assoc., 1961

and left. What made the architects strive for this neutrality, which seems to be separated from the human business going on behind the impassible screen, in the real spaces between ceilings and floors? Has the effect simply been carried over from the neutral and empty space on the drawing board? Or is it a legitimate contribution to the modern denial of weight, thereby satisfying a need of contemporary man?

One of the early symptoms of this denial was Mies van der Rohe's Brno chair. One can ignore the new dynamics of this design and say that it deprived the traditional chair of one of its essential elements, namely, its back legs. Perhaps we still perceive the new chair as an amputation of the old one: the uncanny miracle of the invisible support, the paradoxical lack of normally indispensable limbs. Or have we learned to

Harry A. Conte Elementary School and Community Center, New Haven, Conn., designed by Skidmore, Owings & Merrill, 1963-64



Left: Brno chair, designed by Mies van der Rohe, 1930

reorganize the pattern of visible forces in accordance with what happened to the physical ones? The sense of sight is helped by what we observe when somebody sits down on the Mies chair. The seat swings, and immediately the sustaining base of support is transferred to an unexpected and inconspicuous location — the bend between the horizontal arm-rest and the vertical leg. The Mies chair is a visual pun. Viewed as an accompaniment of the seated person, it has its central weight located along back-rest and seat. From this center sprout the secondary limbs, the arms and legs. This diagram of forces is borne out visually by the heaviness of back and seat and the slightness of the metal limbs, but it is refuted by the absence of the posterior support. A slight swing, and we see the hub of the pattern of forces transfer to the steel curve. From this new center issue two metal arms, holding the seated person aloft as a father lifts his child. The arms must now be read the opposite way. The passive V-shape of back and seat is counterbalanced by the active curve of the steel ribbons. Sitting has become uplift.

But does this view work? Does the eye succeed in paralleling the pattern of physical forces? Can it reinterpret sitting as cantilevered hovering? Can it "see" the tenuous steel frame as the powerful upholder of conspicuous human weight? Whether or not the design is valid depends on the answer to these questions. The sense of sight can indeed adapt itself to such reorganizations of dynamics. But it cannot be bullied into acceptance on the mere strength of what works physically. The dynamics has to be convincing visually.

When it does convince us, the effect is indeed spectacular. To be held aloft instead of simply being prevented by a seat from dropping to the floor is an "uplift" of considerable consequence. Resembling the principle of the Mies chair in intent, but less revolutionary as a solution, is the reversal of dynamics in the chair leg. By making the single leg rise smoothly from the base, the designer invites the eye to read the support upward as though it were the stem of a flower or wine glass. This creates a paradoxical lift.

Below: Table and chairs, designed by Eero Saarinen, 1957

U.S. Airforce Academy Library Staircase, Colorado Springs, Colo., designed by Skidmore, Owings & Merrill, 1963

Spiral Staircase at A. Jespersen & Son, Copenhagen, Denmark, designed by Arne Jacobsen, 1956

Instead of being burdened by the weight of the seated person, the leg raises its load with the effortless grace of a good athlete.

The spiral staircase is a forerunner of this visual reversal. For centuries it has been curling upward and has thereby liberated the eye as well as the body from earthbound existence. But even though it spiralled through empty space, the steps of the staircase were usually grounded on a solid base, promising safety during the ascent. Now, a staircase can spurn such reassurance. The Jespersen design redefines the dynamics of the steps. Traditionally, steps were elevated segments of the ground floor; this kept their horizontality dynamically neutral. But now, transformed into wedges shooting outward from a central column, the steps treat their task of supporting weight almost casually. They poise the human figure as though on the palm of a hand. The pressure from above has been reduced to a minor force. The cantilever, in other words, transforms vertical forces into horizontal ones.

The devaluation of gravity becomes most evident when the architect is given the freedom to play. For the purposes of the *Johnson Pavilion* at the New York World's Fair, the auditorium, a container for a large crowd and a successor to the ancient arena, hovers in mid-air, not only physically but visually. The lentil shape of the auditorium has no contact with the ground while the decorative frame of arches, deliberately frail, anchors the flighty container rather than supporting it. Fountains jet their water upward from below. And in the neighboring *IBM Pavilion,* hydraulic motion bears out the visual effect of a similarly-shaped container. The seated audience is actually lifted into the auditorium while the announcer hovers in space like the herald angel.

Cubic shape, we noted earlier, does not convey the sense of growing. However, in spite of its uniformity, such a shape is not without dynamics.

Right: Johnson Wax Golden Rondelle, New York World's Fair, designed by Lippincott & Margulies, Inc., 1964

Below: I.B.M. Information Machine, New York World's Fair, designed by Charles Eames - Eero Saarinen & Assoc., 1964

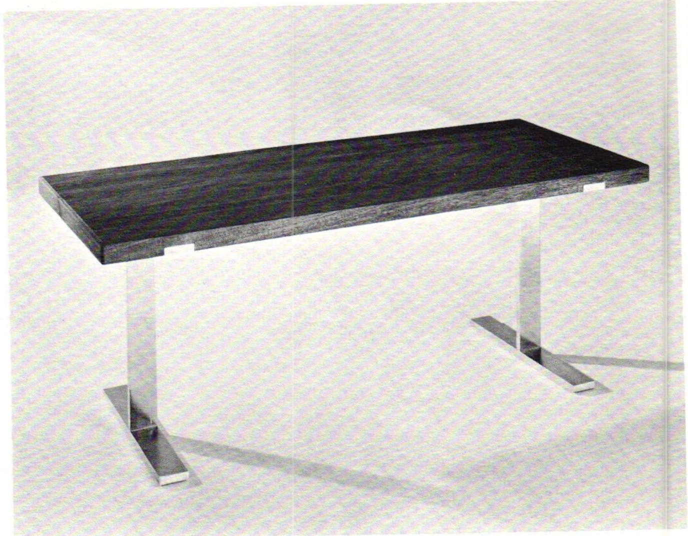
Below: I.B.M. People Wall, New York World's Fair, designed by Charles Eames - Eero Saarinen & Assoc., 1964

Architects must always have felt that a rectangle moves along its greater axis. Narrowness will increase this effect, as shown by the vertical strips of wall and window in Saarinen's Morse College dormitories. Beyond a maximum of narrowness, however, the effect declines. For example, a flagpole rises less forcefully. This is so because the dynamics of the rectangle derives from the tension between length and width; it is the dynamic counterpart of an arithmetical ratio. Tension, not extension, creates visual movement, and without width the tension of straight shape is greatly reduced.

Straightness is stubborn and uncompromising. It encourages parallelism because parallels are multiplications of each other's identity; but any change of angle endangers the connection. Straight lines which cross each other have no tendency to weld at the crossing point. This creates a permanent problem in the use of the right angle, a basic element of design. The Helicon Company's simply-shaped table has rectangles moving in the three dimensions of geometrical space. The harmony among these elements is limited to parallelism. Otherwise, they are interrelated only by counterpoint; the eye is entertained by the antagonism of directions. The unity of the whole relies on the balancing of highly self-contained parts.

The same balance of opposites unifies the verticals and horizontals of the *Verrazano Bridge.* But the span, in its stubborn straightness, races through the gates of the towers like an automobile, and the equally straight towers take no notice of their physical contact with the span. This lack of visual touch among supporting and supported elements presents the eye with a bothersome inconsistency.

Morse College Dormitories, Yale University, New Haven, Conn., designed by Eero Saarinen, 1962



Right: Table, designed by Robert Benham Becker, 1959

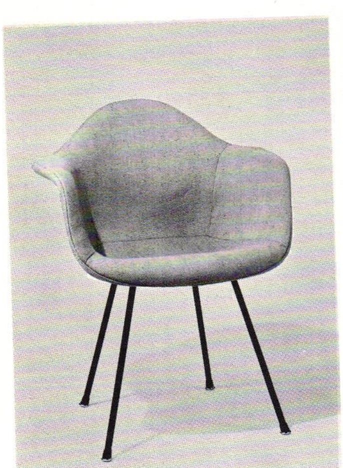
Verrazano Narrows Bridge, New York, N.Y., designed by Amman & Whitney, 1964

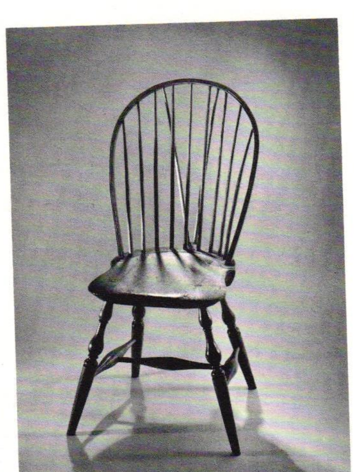
In the past, capitals and bases were used to keep columns from seeming to pierce the ceiling and the floor. Their modern descendants possess no such safeguard. Granted that the visual effect of penetration is often in accord with what happens technically in steel construction. However, this effect, too, must be reinforced visually. Otherwise the equally reckless straightness of the horizontal plane cuts paradoxically through the column by which it is punctured.

Right: Carpenter Center for the Visual Arts, Harvard University, Cambridge, Mass., designed by Le Corbusier, 1963

One Charles Center, Baltimore, Md., designed by Mies van der Rohe, 1962-63

Left below: Chair, designed by Charles Eames, 1950
Right below: Windsor chair, Rhode Island, circa 1700



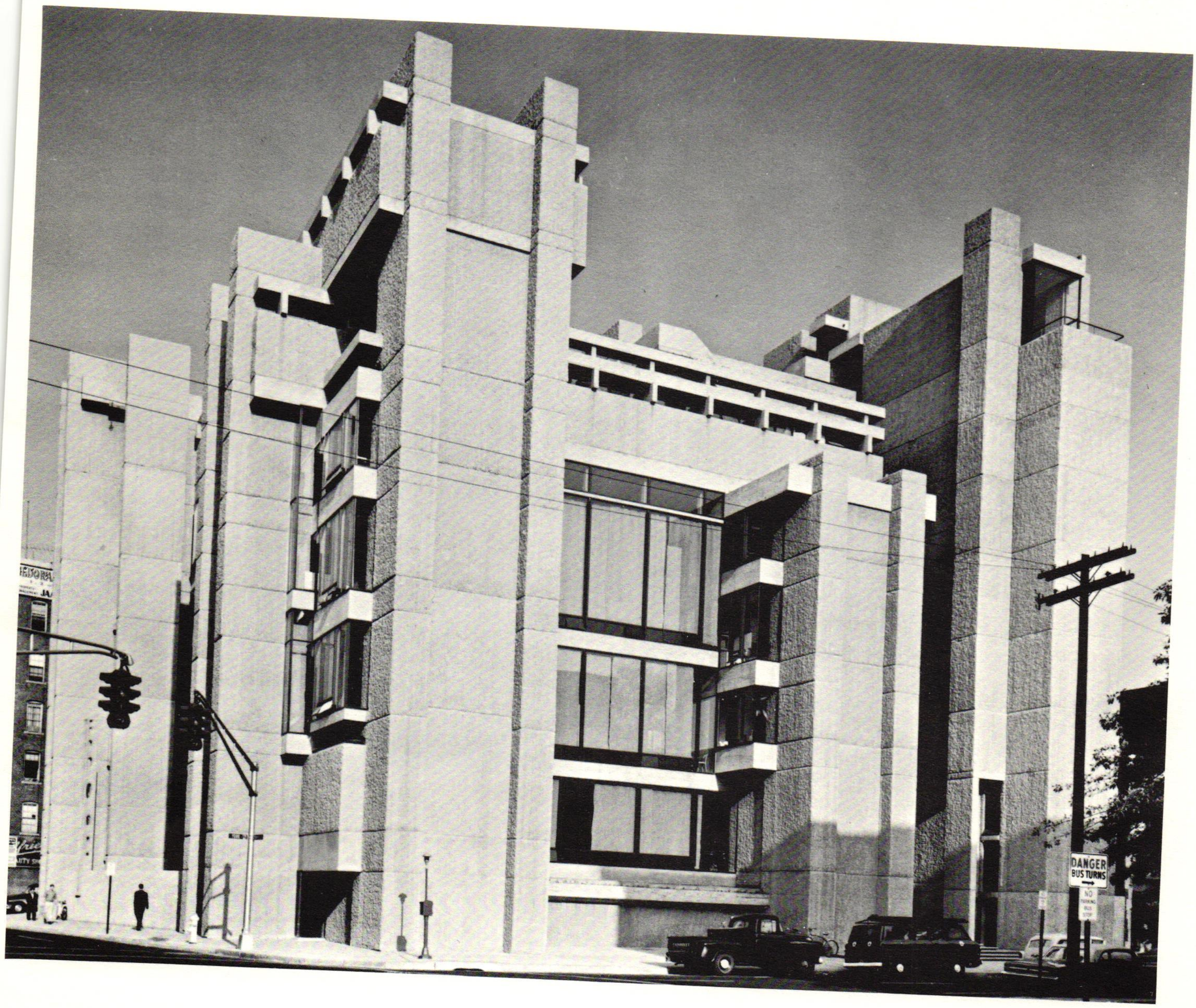


The problem is reduced when the outside of the building reveals the framework, in which the steel columns, as a part of the structural skeleton, cross the horizontal partitions. On the other hand, the problem is aggravated rather than solved when the columns fail to fit the grid of the wall so that the lack of visual relation is perceived as a disturbing break of continuity as seems to be the case in Mies van der Rohe's *One Charles Center.*

When the legs of the Eames chair streak upward without a visible bend, their straightness punctures the seat. Also the inability of straight lines to fuse visually with other shapes endangers the unity of the design. Glancing back in this connection at the old Windsor chair, we realize that its turned legs were no mere "decoration." Apart from the lively dynamics produced by the swellings, the tapering at the upper end indicates visually that the leg, while penetrating the seat, comes to an end. This leg has run its course; whereas a straight leg never ends.

If an architect senses that the angles between straight shapes tend to look like crossings, he can make positive use of this perceptual property by composing a building as a network of interpenetrating cubes. The units of Paul Rudolph's *School of Art and Architecture* at Yale University look as though they were fitted together like a Japanese wood construction. The right-angled connections become crossings, at each of which the colliding units penetrate one another. The relative weights of these units are carefully chosen to tell at every crossing which cubic volume has the right of way while the other yields. This purely visual interplay of forces breaks the continuity of the building's outer skin and transforms the physically inert mass into a three-dimensional web of vertical and horizontal units. In addition, the eye perceives these units not as rigidly connected but as sliding through each other. This creates an extraordinary sense of mobility and freedom. The obstinacy of straightness is used as a virtue.

Below: School of Art and Architecture, Yale University, New Haven, Conn., designed by Paul Rudolph, 1964

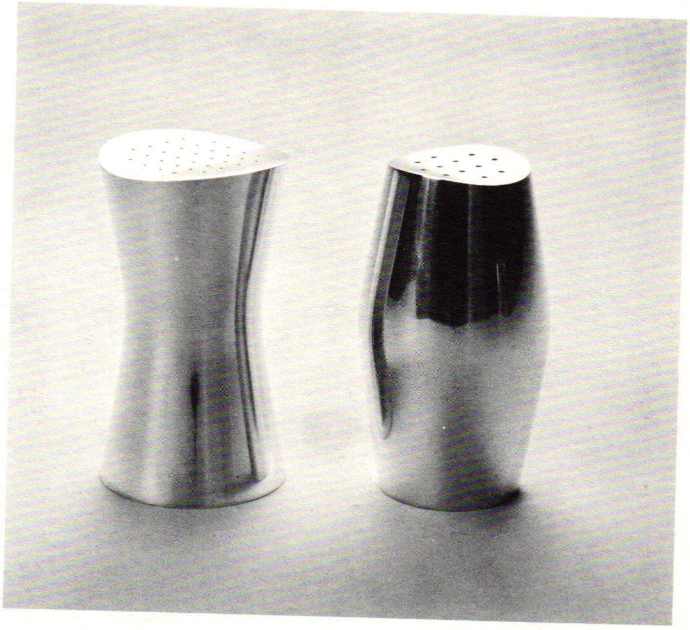


Barcelona Chair, designed by Mies van der Rohe, 1929

To preserve the simplicity of straightness, but to mitigate its rigidity by the interplay of verticals and horizontals was the task that absorbed the painter Piet Mondrian during his years of maturity. Within the limits of this task he succeeded. But life is not truly reflected by shape until we admit curvature. What accounts for the vitality of curves? As long as we ignore dynamics, the best answer we have to offer is that curves recall the organic: the roundness of fruit, the swelling of muscle. But such indirect associations do not explain the immediate appeal of curvature. Dynamically, a curve is a deviation from straightness. When a single force is left alone, it pursues a straight path. Straight paths, as we have seen, cross each other without reacting to each other. The curve, on the other hand, tells of the interplay of forces among objects and within a single object.

Mies van der Rohe's Barcelona chair is supported by two handsome curves. One, holding the back, simply sustains the rate of its curvature throughout. The other, nimbler and more graceful, changes direction. To the eye, a curved object speaks of having been bent, being bent, and being about to bend. Furthermore, the life of any curve is enhanced by its ambiguity. The curved object can be perceived as bending by its own initiative or as being bent by an outer power. Thus the upper swing of the S-curve can look as though the steel ribbon adapted itself voluntarily to the demands of the seat or as though it yielded to the pressure from above. More subtly, this response is understood as a combination of both versions, that is, as a sensitive countermove to outer stress. At the same time, a curve is ambiguous as to its direction. The large back curve of the chair can be read as a support, forced to give up its straightness under the pressure of the weight of the seat with its human load. Or, the same curve can be perceived as straightening out and thereby actively raising the seat. Here again, the subtlety of the dynamics is in the combination of yielding and lifting. The curve brings to mind the virtues of an organism in its alertness and flexible response.

The interaction of inner force and outer force is particularly meaningful when an object is to be characterized by its shape as a tool of man. Geometrically, Hans Henriksen's salt and pepper shakers are simply a pair of complementary shapes, the one concave, the other convex. They come to life when we acknowledge their dynamics. The salt shaker's dignified corpulence derives from the expansion of internally generated forces.



Salt and pepper shakers, designed by Hans Hendricksen, 1953

Grown by its own central impulse, it actively conquers the space it occupies and seems to displace and squeeze it. The human hand can only surround this convex shape and passively savor its prepossessive strength. Conversely, the pepper shaker yields to the grip. The hand is given a chance to enjoy its own power. Thus the designer imparts significant human overtones to the practical operations of holding the objects, and the contrasting attitudes which the two objects invite in the person handling them enrich the geometric complementarity of their shapes.

Because a curve adapts one direction to another, it can serve as a mediator between the horizontal and the vertical. Paul Rudolph's parking garage is not perceived as a web of penetrations as is his Art and Architecture Building. Here the curves slide over the right-angled crossings and create the continuity of an unbroken skin. The crescendo shape of the piers makes them grow upward and blend into the horizontal slabs of the floors. This introduces the element of time. The geometric difference of direction between vertical and horizontal is interpreted as a sequence, an event — similar to what happens in organic growth, for instance, when the upright trunk of a tree branches out sideways into the limbs. The curve expresses visually the continuity of growth.

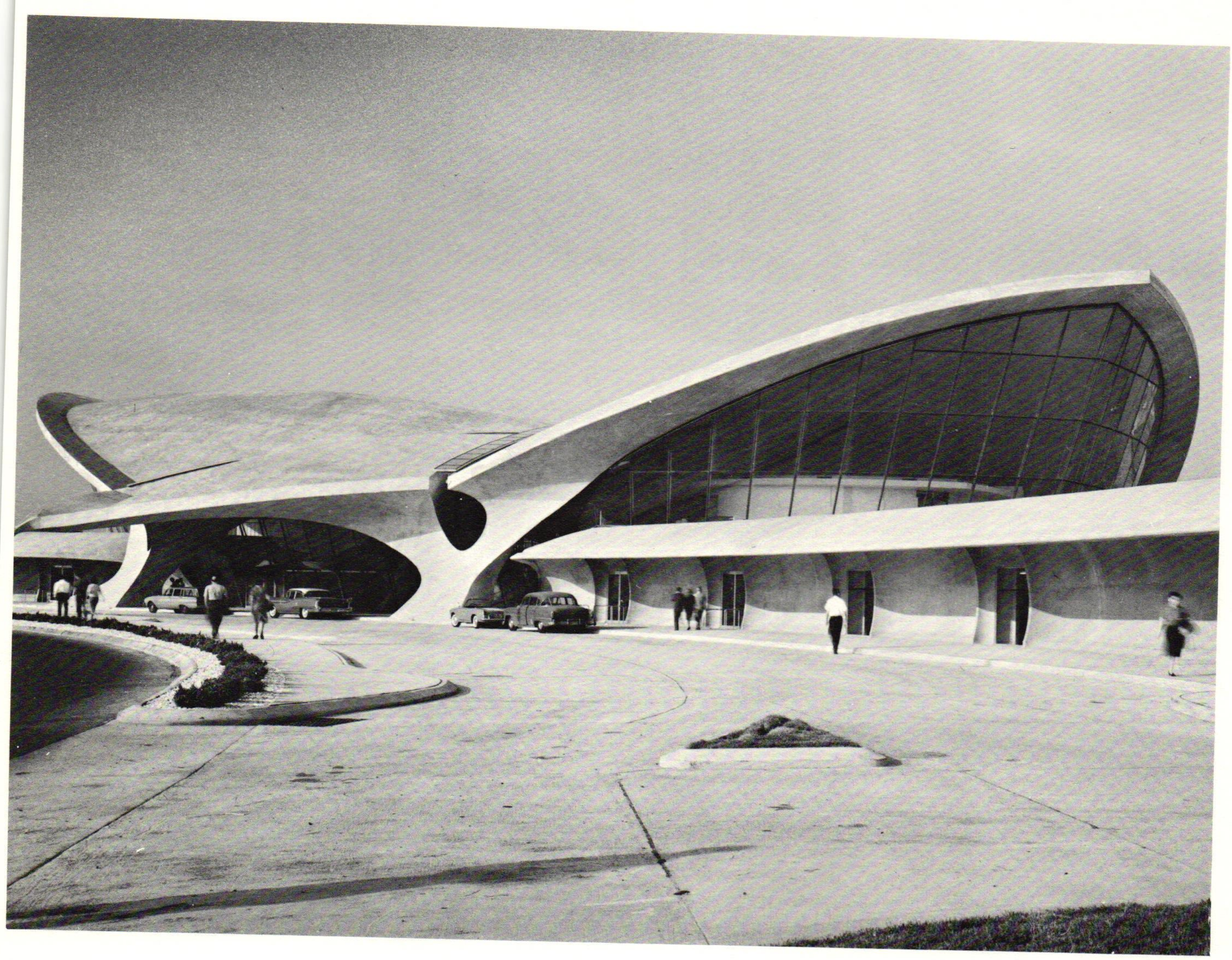
Some critics may say that this effect is achieved by cheating, because concrete is not sensitive and flexible as the shape imposed on it would make it appear. It is a characterless and inert substance, willing to be pressed into any form. Such an accusation misses the point. The architect creates for the eyes a pattern of forces that need not tally with the physical forces inherent in the material and the structure, and in fact it never does.

Temple Street Parking Garage, New Haven, Conn., designed by Paul Rudolph, 1964

The dynamics displayed to the eyes must be compatible with the practical function of the building; but we must not ask: are the exuberant curves of Saarinen's *TWA Terminal* functional? No architectural shape is sufficiently determined by function. What we need to know is whether this spectacle of swinging shapes can be developed without constraint, as a sort of ideological superstructure, from the practical and psychological purposes of the airport. Does the visual form of the building reflect the experience of persons about to take flight or returning to earth from the air? Does it suitably guide and modulate this experience? Shall the traditional notion of a haven or port, made visually secure by verticals and horizontals, be abandoned in favor of a transformation of stable matter into a play of wings and of fossilized air currents frolicking unhampered in empty space? This is a philosophical and aesthetic question, to which the notion of functionalism contributes little.

Pier Luigi Nervi believes that the freedom of design, which must respect physical function but is not determined by it, is a temporary luxury. As the physical requirements increase, the range

T.W.A. Terminal, Kennedy International Airport, New York, N.Y., designed by Eero Saarinen, 1961



Four Level Highway Interchange, Fort Worth, Texas,
Texas Highway Department, 1958

of suitable shapes from which the designer can choose shrinks more and more. A horse-drawn carriage could put up with almost any shape; a supersonic jet plane cannot. Nervi, inspired by a romantic trust in the wisdom of nature, hopes and expects that this convergence of physical requirement and aesthetic form will compellingly produce beautiful design. Will it? The curves of the four-level highway interchange at Fort Worth must be largely determined by the needs of automobiles moving at high speed. Here, then, physical forces control shape. Is the result beautiful? The pattern of interweaving curves is perhaps as attractive as certain natural forms, as for example, the vascular system of the human body or the ramifications one admires in photographs of electric sparks. But, like many complex natural forms, the pattern lacks visual order and meaning because it has not been organized by the eye.

The relation between aesthetic form and physical requirement may be illustrated by the example of a simple Japanese bamboo ornament. When the wooden strips are bent they assume the shape of curves derived from the molecular structure of the wood, that is, from a particular ratio of flexibility and coherence. However, these curves do not determine the shape of the ornament, which is invented and controlled by a craftsman's sense of form. In realizing this form, the craftsman respects the curves offered to him by the physical properties of the bamboo; but it is he who uses them to express a particular elegance of winding, turning, contracting and expanding, made readable by the balance and order of the whole.

Shape serves to unify the appearance of an object but also to define its parts. This is another of the principles usually discussed without reference to dynamics. I see one undivided object — for example, an apple — or another made up of parts, for example, a casserole consisting of a round container and a straight handle. The color and

Manipulation of bamboo, Kanagawa Prefecture, Japan

Covered Casserole, designed by Kay Bojesen, 1951

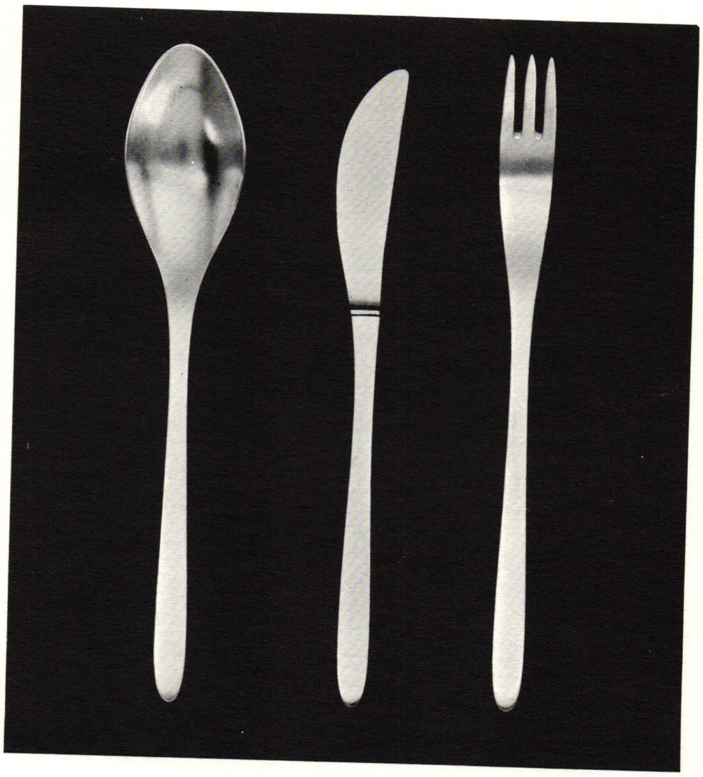
Couch, designed by Mies van der Rohe, 1931 texture of the material may help to unify what belongs together and separate what is to be kept apart. Lid and bowl are made of the same metal, from which the ivory handle detaches itself visually. Distinctions of shape may illustrate distinctions of function. All this is true but does not go beyond the addition and subtraction of pieces.

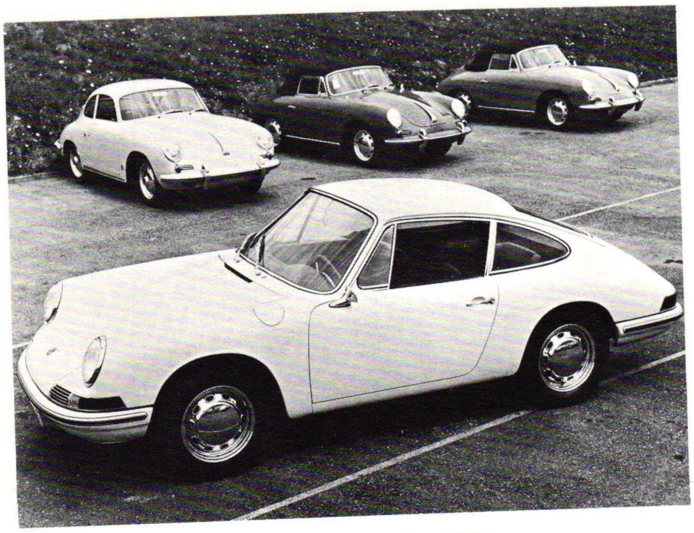
Dynamically viewed, the couch by Mies van der Rohe is almost amusing because of the neat separation of its parts. The self-contained cylinder of the pillow does not give an inch to the equally complete leather slab of the mattress. It is a world of uncompromising coexistence, in which each element contributes only by what it is, not by what it gives.

The insistence on self-contained parts reminds us of the workings of the intellect and of language as an intellectual tool. Language is made up of defined separate units and builds statements by the relations deriving from the combination of these units. The German set of flatware aims at this almost intellectual neatness. Each function — scooping, cutting, gripping — is represented by a fairly complete geometrical element, and the free movement of visual forces is essentially confined to the realm of each element: the hollow bowl of the spoon, the lyre shape of the tines, the rectangular handle. Interaction among the parts relies here on parallelism, common axes, contrast, comparison, etc. The Danish set reflects a different mentality. The total shape predominates. Forces circulate freely through the entire object. Rather than being built up of parts, a primary whole differentiates into separate functions secondarily. Here we are not reminded of the intellect but of the organism. The tool seems to have grown like an embryo. Its organs may look as though they were not yet clearly divided or as though they felt tempted to surrender their particular character and function excessively to the unity of the whole. Giving may endanger being.

Place setting, designed by Voss, 1955

Place setting, designed by Arne Jacobsen, 1960





Porsche, designed by Ferdinand Porsche, 1964

A slight dizziness, welcome or unwelcome, results from the underplaying of differentiation. The metal shell of the modern automobile fuses the basic spatial dimensions of the cube — top and bottom, left and right, front and back — into a continuous, highly complex shape, almost intangible, because there is nothing to hold on to, and inaccessible, because the door is only an inconspicuous slit. Like the members and organs of the human body, the functional units of the car are hidden under an overall skin over which eye and hand glide voluptuously. A sophisticated subtlety of mind is needed to understand the structure of such an object by its appearance. From a tool the car has developed into another person — an independent organism which must be comprehended, served, worshipped and adapted to.

Marina Towers, Chicago, Ill., designed by Bertrand Goldberg Assoc., 1962-63

The predominance of all-inclusive shape may develop into a monopoly. The cylinders of the *Marina Towers* are so compelling in their simplicity that the open galleries at about a fourth of the total height fail to subdivide the structure visually into the section of garage rings at the bottom and that of the scalloped apartment floors above. Subdivision calls for more than an interruption of shape. The coherence of the whole must be actively opposed by a coherence of the parts. The resulting tension among the antagonistic patterns is needed to produce subdivision. In the Marina Towers, the deviations from the uniform cylinder shape — that is, the interruption of the vertical outline and the change of pattern — may look like flaws that should not be there.

The very opposite procedure can be observed in Le Corbusier's *Carpenter Center.* This building gives the impression that the architect conceived the whole by fitting together variously shaped volumes. As these volumes interpenetrate, the windows serve to distinguish them by texture: vertical strips for the drum, oblique gills for the upper studios, glass blocks for the tower of the staircase. Here the dynamic theme is that of a dramatic collision, in which incompatibles are made compatible by a miraculously obtained unification of the whole — a principle explored earlier in the century by the Cubist painters.

Physically, a maximum of subdivision is obtained when the parts are separated by empty space. Perceptually, however, such gaps can be bridged. The connection will be quite stable when, as in the chair by George Nelson, the shapes continue each other smoothly across the lacuna. The more self-sufficient and complete the units and the less evident the relation between them, the more strongly will the object resist the eye's effort to unify it. The resulting tension has been exploited by the sculptor Henry Moore in his reclining figures composed of two or more separate blocks. If successful, the visual integration is experienced as a victory of mind over matter — a forcing together of what is actually separate. Nelson's two-part chair is hardly intended to match this exalted experience; but the witty antagonism of unity and duality plays its part in the visual interest aroused by the piece of furniture.

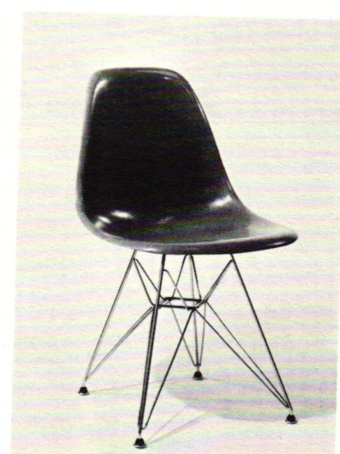
Parts not resembling each other sufficiently may refuse to fit into a compositional whole. In such a case, the effect is not tension but decomposition of the object. This destroys the dynamics because only the parts of a unified whole can interact within a common pattern of forces. The Eames chair poses the problem of how much difference of shape and material can be overcome by a compositional framework.

In a broader context, we must ask how much

Carpenter Center for the Visual Arts, Harvard University, Cambridge, Mass., designed by Le Corbusier, 1963

Left below: Chair, designed by George Nelson, 1958

Right below: Chair, designed by Charles Eames



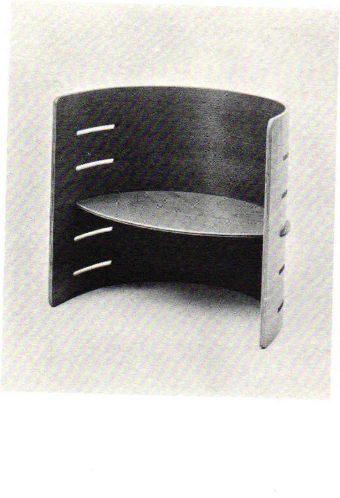
difference in form and meaning can be integrated in one environment. Can a modernized version of feudalistic Renaissance architecture in the inner court of the *Detroit Institute of Arts* accommodate the expressionist pronouncements on labor and industry by Diego Rivera? Can the combination of both serve, in turn, as a frame for sculpture ranging from Rodin to Marini and the kind of functional furniture that, as we noticed above, must cope with a strong internal dissonance in itself? Do these riches add up to the kind of exhilarating synthesis of alien elements from which some civilizations have drawn so much vitality, or are they lost in an atomized setting in which no enlivening spark flies from object to object?

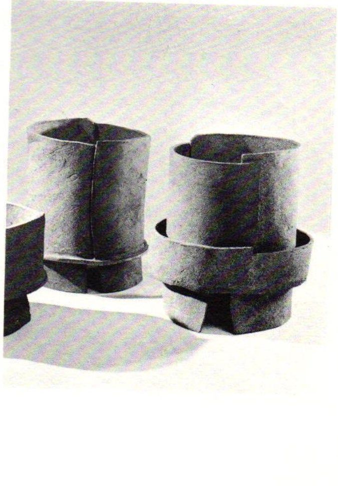
When separate functions are served by one unified form, the corresponding visual expression also replaces the subdivision with a unitary theme. For example, when the sides and lid of a container fuse into a sphere, the corresponding dynamic pattern fuses the expressive themes of containing and covering into one concentric act of enclosure. Similarly, when the walls and roof of a building merge in a tent or dome, the two functions are reinterpreted by a new synthesis. This is particularly significant in houses of worship not intended to contain the godhead but to point to it with a heavenward gesture. How to reconcile worldly gathering and transcendental orientation is a permanent problem in church architecture. The triangular theme of the *Airforce Academy Chapel* by Skidmore, Owings and Merrill resolves this spatial conflict in favor of the vertical pointer. No ceiling responds to the horizontal plane of the floor, and the remnants of the perpendicular walls are fitted into the zigzag variations of the triangular profile. Whereas in the IBM World's Fair pavilion the audience rose hydraulically, the chapel of the young airmen tends to skyrocket past its congregation. The validity of this depends on whether this all-encompassing movement uplifts the spirit or prevents the mind from collecting itself in contemplation.

Detroit Institute of Art, Detroit, Mich., chairs and table designed by George Nelson, 1962

When the back and the sides of a chair are merged in one curved sheet of plywood, the effect is that of an interrupted circular enclosure. Roundness is the one shape that shuns all subdivision. Its dynamics tends to be centric; that is, forces of expansion radiate from the middle, and forces of constriction converge towards it. David Weinrib's stoneware planters break the concentric integrity of the container by preserving the slabs of which it is built. The visible bending of what was straight and the loose superposition of the slabs overlays the circular symmetry with a spinning rotation, thus intensifying the dynamics without losing the closure.

Above: U.S. Airforce Academy Chapel, Colorado Springs, Colo., designed by Walter Netsch, Skidmore, Owings & Merrill, 1963



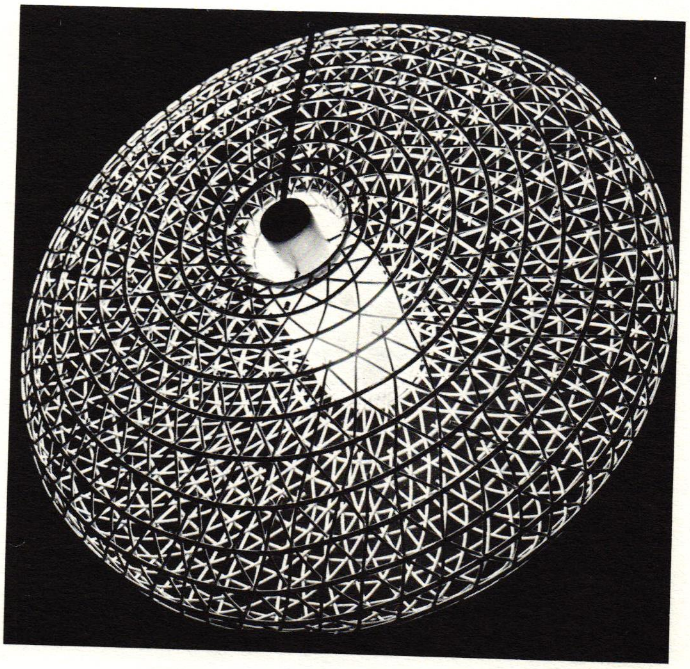


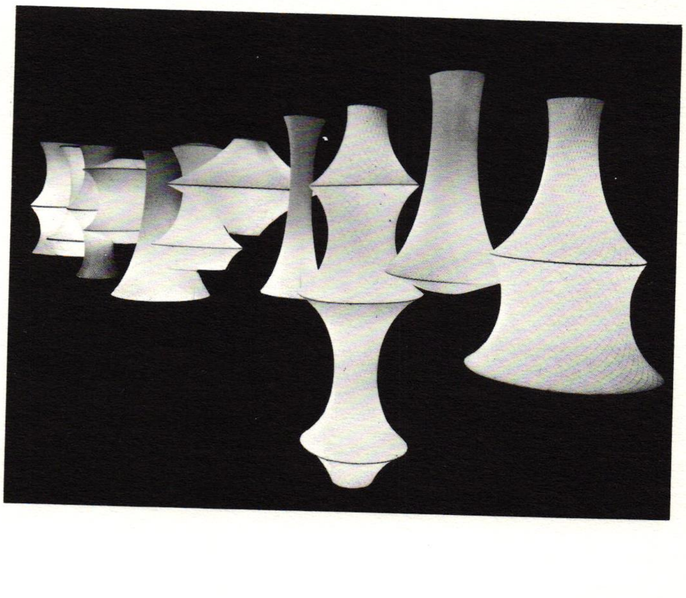
Right: Chair designed by Kristian Vedel, 1957

Far right: Planters, designed by David Weinrib, 1958

By a similar device, Frank Lloyd Wright changes the cylinder or inverted cone of a rotunda into a spiral. The floor space is reduced to an outer shell surrounding an inner court. This shell assumes the function of a one-dimensional track, and the track is made continuous by the elimination of the separate floors. The subdivision of the floors has given way to a sliding descent. Instead of a rather static accumulation of rings, *The Solomon R. Guggenheim Museum* embodies a rotation. The visitor does not roam through an immobile storehouse of art, but is carried along a path which introduces the dimension of time into the architecture itself. The visit is not an exploration of space but a sequence of events. The museum has become a guide.

The exclusivism of roundness can be counteracted by other means. Viewed from the campus side, Wright's Arizona auditorium may look as impregnable as the Castel Sant'Angelo in Rome. On the opposite side, however, the shell is interrupted by arches, and glass walls allow light to pass through. Visual shape is not subject to the alternative of closedness and openness. It can be closed and open at the same time. The arches of the auditorium create a closed cylinder without making it opaque. Nathan Shapira's geodesic wicker structure produces the visual effect of the lamp's continuous ellipsoid from a loose web of sticks. Paradoxically, the inside is exposed without any interruption of the outside.





Left: The Solomon R. Guggenheim Museum, New York, N.Y., designed by Frank Lloyd Wright, 1959

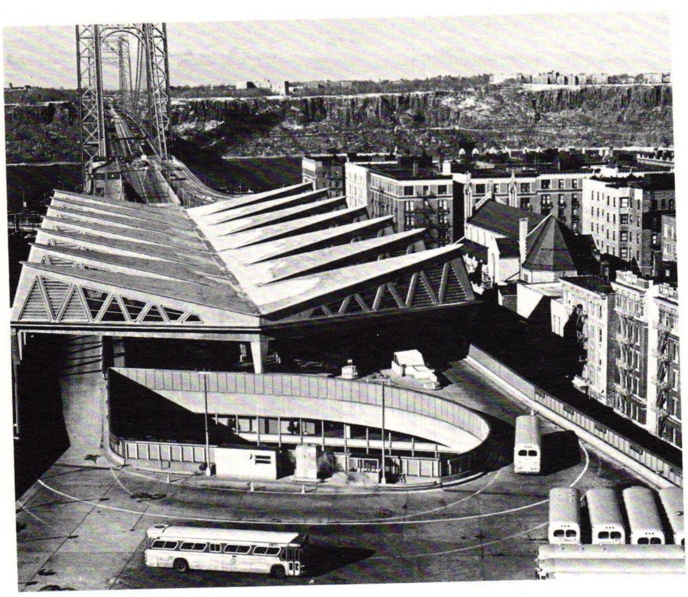
Top right: Grady Gammage Memorial Auditorium, Arizona State University, Tempe, Ariz., designed by Frank Lloyd Wright, 1964

Center right: Lamp, designed by Nathan Shapira, 1954

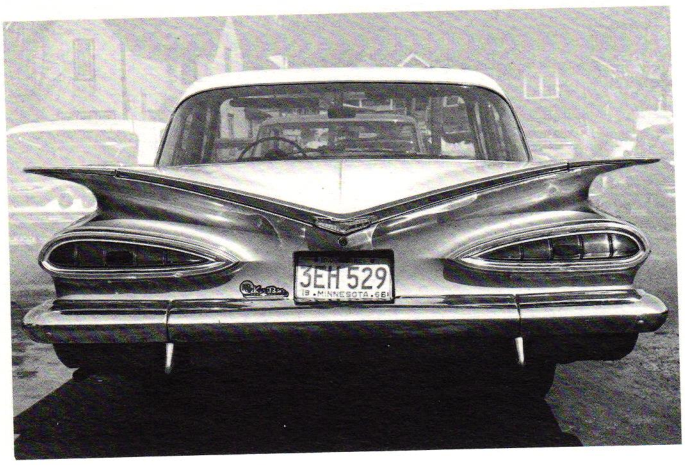
Bottom right: Light, designed by George Nelson, 1959

Transparency is a refined entertainment of the eye. It denies the solidity of matter in the full presence of the material object. The film director Fritz Lang once depicted the vision of a madman by having the entire furniture of a room built of glass. On our table tops of glass, teapots and cups rest securely on the nothingness of empty space — a Surrealist feat of madness, which attempts to dematerialize the world. When such an attempt is constructive, it replaces, one might say, matter with energy. George Nelson defines a lamp as a source of radiance by turning the convexity of the container into its opposite. He exploits the dynamic ambiguity of convex shape, which looks passively squeezed in the center but conquers space actively with its outgoing rims.

Left: Lotus and Tulip Chairs, designed by Estelle and Erwine Laverne, 1959



Left center: George Washington Bridge Bus Station, New York, N.Y., designed by Pier Luigi Nervi, 1963



Left bottom: Chevrolet, 1959, Company Design, General Motors

In such examples, the material object is redefined dynamically as a focus of outgoing radiance. The Laverne chairs play down the functions of container and support. They look as though they were in a constant state of flying apart – like the expanding universe, an incautious philosopher might be willing to say. Similar tendencies can be observed elsewhere. The roof of Pier Luigi Nervi's bus station is composed of wedges that move from the central spine outward. These wedges diminish, in the conventional form of arrows, from the broad base to a point, or inversely, open up like the sectors of a fan. Viewed in elevation, the building is capped by an inversion of the traditional pitched roof, which collects the cubic volume while directing it upward. Here, the roof dispenses and disperses energy, whose central container is almost immaterial: the ridgepole lies in a depression.

The lamented tailfins of American automobiles tried to counteract the constrictive form and function of the container. Like Nervi's roof, the posterior wings of the Chevrolet model rise from a central depression; they disavow the trunk and force even the tail lights into the dynamic shape of a lateral crescendo.

The Kaufmann House (Fallingwater), Bear Run, Pa., designed by Frank Lloyd Wright, 1938

The prototype of such centrifugal dynamics in modern architecture is, of course, Wright's Kaufmann house in Bear Run. To describe the building statically as an arrangement of variously proportioned and oriented slabs would mean to miss the essence of its visual appearance. Seen from the side of the waterfall, the house consists of cubic units rushing in various directions. The explicit reference to the moving waters is hardly needed to make us realize that the building cannot be understood as a volume, or a stack of volumes, but only as a pattern of forces.

A typical modern building, such as the *Tyrone Guthrie Theatre* in Minneapolis, leaves the geometrician with an infinity of pieces. It can only be grasped perceptually. We acknowledge the virtual presence of the all-encompassing cube, nonexistent in the physical world, but hinted at visually by the many edges and strips, paraphrased by vertical and horizontal planes at various levels, constantly punctured but never abandoned. It is a shape created entirely by the eye, coherent because of its unity but transparent because of its openness, filtering the light of day through a multiplicity of broken planes and holes and sending forth its own light at night through an equally intricate manifold of openings. Instead of an inert envelope separating the architectural solid from empty space, there is an interplay of many forces and counterforces, dipping into space, receding, piercing, stopping at momentary barriers.

Tyrone Guthrie Theatre, Minneapolis, Minn., designed by Ralph Rapson, 1963

Designers, architects, and artists are doing their best to transform inert shape into visual dynamics. In the natural sciences, matter is redefined as energy. The psychologist, exploring the human personality, discovers that he is not dealing with a set of faculties but with the interaction of mental tendencies. It is time to recognize that what our senses perceive is not an arrangement of things but a field of forces.

ABOUT THE AUTHOR

Rudolf Arnheim was born in Berlin, Germany, 1904. He studied at the University of Berlin at the Psychological Institute under the Gestalt psychologists Max Wertheimer, Wolfgang Köhler, and Kurt Lewin, and received his Ph.D. in 1928 with a dissertation on the experimental psychology of visual expression. From 1933-38 he was associate editor of publications at the International Institute for Educational Film (League of Nations) in Rome, Italy. In 1940 he emigrated to the U.S.A. and is now an American citizen.

Dr. Arnheim received a Guggenheim Fellowship for work in the psychology of art, 1942-43. Since 1943 he has taught psychological theory and the psychology of art at Sarah Lawrence College and at the New School for Social Research, Graduate Faculty, New York City. Dr. Arnheim has lectured throughout the United States and was a Fulbright lecturer at Ochanomizu University in Tokyo, Japan, 1959-60. In the fall of 1964 he was Visiting Professor at the Carpenter Center for the Visual Arts, Harvard University, which position he will resume this year. He is also president of the Division on Psychology and the Arts of the American Psychological Association, 1965-66.

Dr. Arnheim is well known for his writing in the field of the psychology of art. Besides extensive essays for numerous publications, he has written *Art and Visual Perception,* published in 1954 by the University of California Press. Other books by Rudolf Arnheim include *Film as Art* (1957), *Picasso's Guernica: The Genesis of a Painting* (1962), and *Toward a Psychology of Art: Collected Essays* (1966).

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