space-time problems

Social conditions, the arts, sciences, the development of an industrial technology with prefabrication, new materials and new processes are the determining factors to realize the new architectural development. From them the architect and planner will draw inspiration and factual knowledge, resulting in a changed conception of space. Every great period in human civilization organically creates its particular spatial conception. Though such space conceptions were utilized in the construction of shelter, they were also frameworks for the articulation of visual arts, play, dancing, lighting; in fact, for the mastery of life in every detail.•

The history of articulated space, the special space conceptions of different periods, have been determined by the grasp of one, two, three or more dimensions.

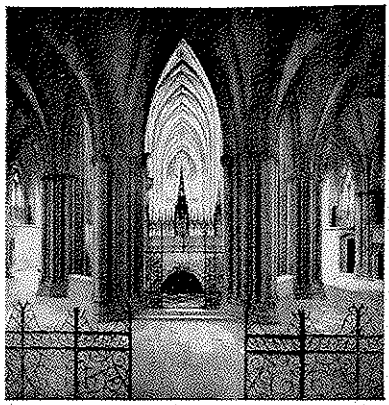


Fig. 331. The Cathedral in Metz
Such a dome was the work of generations into which they put their best. This illustration shows a rich space articulation starting out with the wrought iron gates continuing with numerous space cells into the far distance of the nave, amplified by the repeated and disappearing arches in the perspective

The magnificence of the Egyptian temple could be comprehended by walking through a basically one-dimensional straight line, the sphinx alley, leading towards its facade.

Later the Greek architects of the Acropolis designed a two dimensional approach to the temple so that the visitors had to move through the Propylaen, between the Erechteion and Parthenon, around the colonnades toward the main entrance.

The gothic cathedral also applied this concept most intriguingly to the interior. The spectator was placed in the midst of the nave, vaults, balcony and choir, and became the center of coordinated space cells of all directions.

The renaissance and the baroque brought man into closer contact with the inside and outside of the building. Apart from the "hanging gardens" of Semiramis and the Moorish-Spanish architecture, these were man's first attempts to integrate building and nature, not merely fit building into its surrounding. In our age of airplanes,

• *See the "space" chapter of "the new vision".*

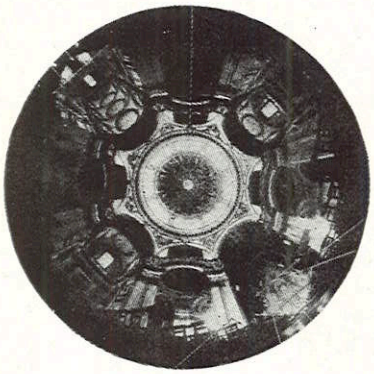


Fig. 332. St. Paul's Cathedral, London, 1936
A composite perspective (fisheye view)

architecture is viewed not only frontally and from the sides, but also from above—vision in motion. The bird's-eye-view, and its opposites, the worm's and fish-eye-views, have become a daily experience. Architecture appears no longer static but, if we think of it in terms of airplanes and motor cars, architecture is linked with movement. The helicopter, for example, may change the entire aspect of town and regional planning so that a formal and structural congruence with the new elements, time and speed, will manifest itself.

Already the great spans of large airplane hangars require a new departure for space articulation since the columns, which former architecture used as a most effective means in modulating and articulating space, have been eliminated. But the problem of space articulation in contemporary architecture is a simple affair in comparison with the complex problems of planning for a new space comprehension caused by the infinite acceleration of speed.

rendering motion (space-time) on the static plane

Motion in space can be grasped if its reality is perceptible through the senses. Difficulties arise only if illusionistic motion has to be perceived, as in the cubist paintings which rendered objects as if the spectator were moving around them.

Fig. 333. Charlotta Rudolph, 1925
Action photograph of the dancer Palucca
An early motion study of a sequence of "frozen" instantaneous movements

These interpretations of vision in motion denote not only an artistic achievement but also an important practical step in visual perception as well as in the skill of rendering. The mass construction of war planes, for instance, called for complex working instructions. But the workers could not comprehend their tasks through references contained in the customary blueprints. Factories had to resort to new methods of visualization called "production illustration" mainly derived from the findings of contemporary painters, photographers and motion picture men, all of whom tried to translate the space-time sequence of production into a visually perceivable language. In this way a speeding up of the work was accomplished. This process is only in its infancy. Photomontage, superimpositions, diagrams, explosion, phantom, x-ray, cut-away techniques, stroboscopic motion projections and other combinations may enlarge its scope tremendously.

speed

Motion, accelerated to high speed, changes the appearance of the objects and makes it impossible to grasp their details. There is clearly recognizable difference between the visual experience of a pedestrian and a driver in viewing objects. The motor car driver or airplane pilot can bring distant and unrelated landmarks into spatial relationships unknown to the pedestrian. The difference is produced by the changed perception caused by the various speeds, vision in motion. To prove this Jean Carlu, the eminent French poster designer, made an experiment in 1937. He mounted two posters on two conveyor belts which moved at different speeds. The one poster, made by Toulouse-Lautrec around 1900, was moved at six to seven miles per hour

Fig. 334. Henri Toulouse-Lautrec, 1864-1901
Painting

(approximately the speed of a horse and buggy); the other, a contemporary poster, was moved at fifty miles per hour (the speed of an automobile). Both posters could be read easily. Then Carlu accelerated the speed of the Toulouse-Lautrec up to fifty miles per hour, and at this speed the poster could be seen only as a blur. The implications are obvious. The artist, architect, advertising and display man, must count with the quickly moving vehicles requiring a new orientation toward spatial organization and communication. A new viewpoint in the visual arts is a natural consequence of this age of speed which has to consider the moving eye. (And what an improvement it would be if the signmakers of streets and highways were also aware of this fact.)

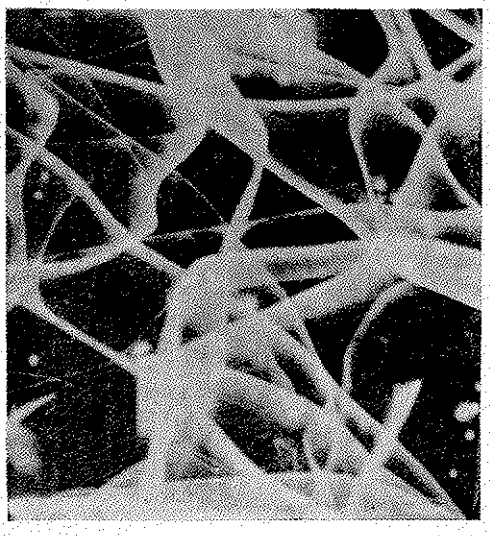


Fig. 335. John H. Stickell, 1942
Action photo of a bomber in a searchlight hunt
With an open camera shutter, the film recorded this picture of a flight over Germany. The broad waves are searchlights hunting the moving plane. The waves result from the combined movements of the lights and the diving of the bomber. The dots are anti-aircraft batteries firing at the plane

Jean Labatu (Princeton University) had the task of preparing effective outdoor advertising for a factory site half a mile long, situated along a highway with heavy motor traffic. Studying the problem, he found that the required water displays, fountains, light, even the shape of the pool which had to mirror the buildings, had to be related to the speed, that is, the rapidly changing position of the spectator at the wheel. On the basis of calculations as to time and vista, he suggested a "time facade". It consisted of continuous mobile light and water displays placed so that they could be perfectly seen in 30 to 60 seconds, the time it took a car to drive along the site at 30 to 60 miles per hour. Such an approach translates the static meaning of advertising into a kinetic process, "shooting at a moving target".

Photography, motion pictures, the speed studies of futurism and cubism handled such aspects intuitively, anticipating the vision in motion of a motorized world long before an actual need existed for a new visual education based upon scientific standards. Safe air travel, for instance, is greatly dependent upon the skill and visual alertness of pilot and navigator. Their vision in motion—especially at landing—the flashquick ability to identify small details within vast areas, has to be conditioned to the new validities of speed since even radar or other mechanical equipment can fail.

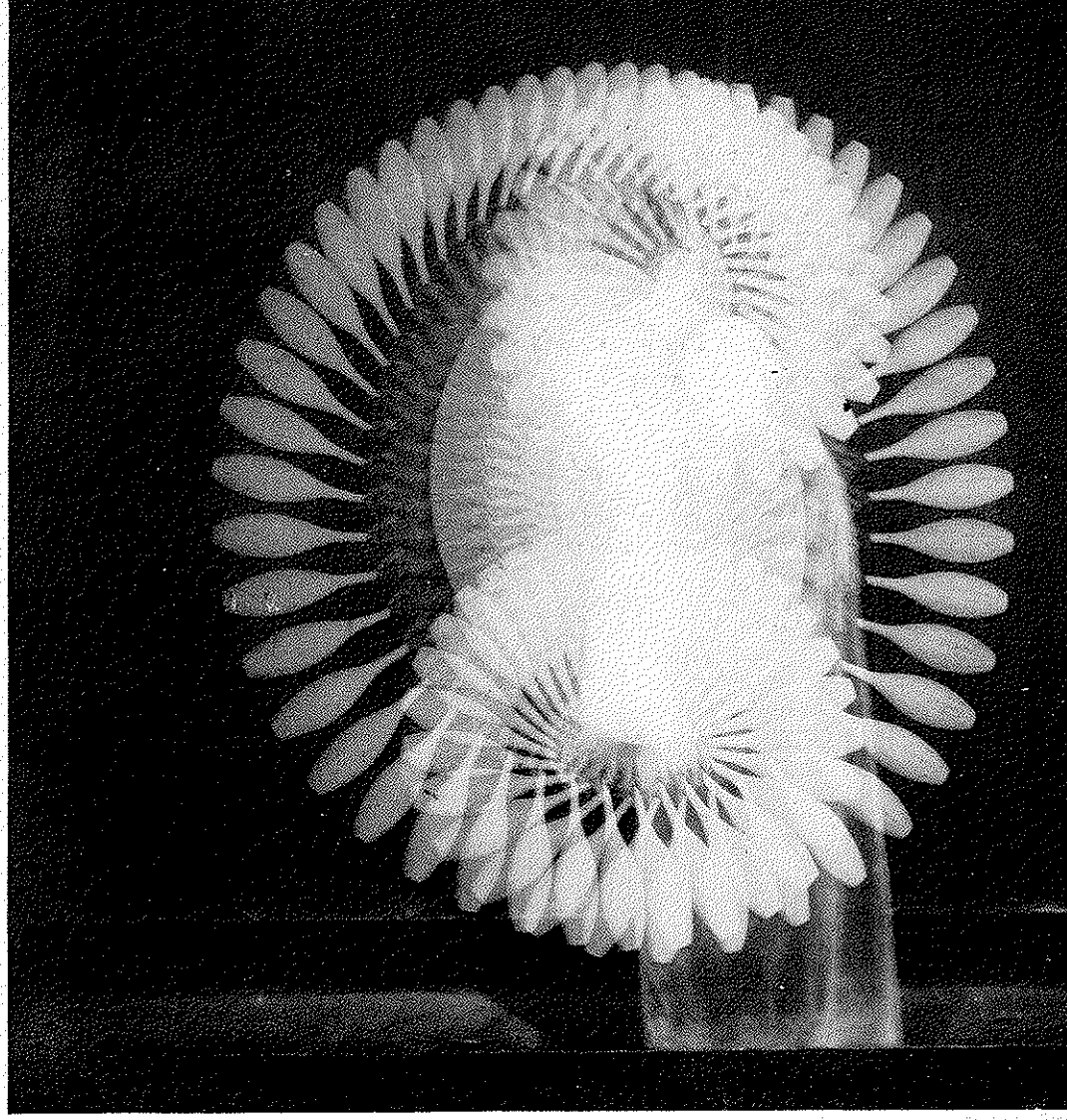


Fig. 336. Harold Edgerton, 1937
Indian club exercise
In such a stroboscopic photograph the velocity of the motion can be read through the various distances between the single shots of the club, since they all have the same time measurement of exposure

analysis of speed

Speed itself can become the subject of a visual analysis. We know of innumerable photographic shots of arrested motion such as sport scenes, jumps and dives. On the other hand we can observe slowly unfolding buds, moving clouds taken at intervals; similarly the effect of time exposures of moving objects on streets and merry-go-rounds. Experiencing speed that can be arrested, rendered, stretched and compressed, in short, articulated, we can state that we have possession of it, that we are approaching a new vocabulary of space-time.

Harold Edgerton (M.I.T.) found a new way to render speed in stroboscopic photography.• The relationship between the velocities of the dissected movements gave him the clue to improving the action of golfers, turbines, spinning wheels and various kinds of machinery. These pictures are juxtaposed details of frozen move-

From the manifest of the futurist painters, 1912:
"Indeed, all things move, all things run, all things are rapidly changing. A profile is never motionless before our eyes, but it constantly appears and disappears. On account of the persistency of an image upon the retina, moving objects constantly multiply themselves; their form changes like rapid vibrations, in their mad career. Thus a running horse has not four legs but twenty, and their movements are triangular".

• *Thomas Eakins, American painter, when collaborating with E. Muybridge in recording speed, made similar photographs as early as 1881-84 as Charles Bregler reported in the "Magazine of Art", January, 1943.*

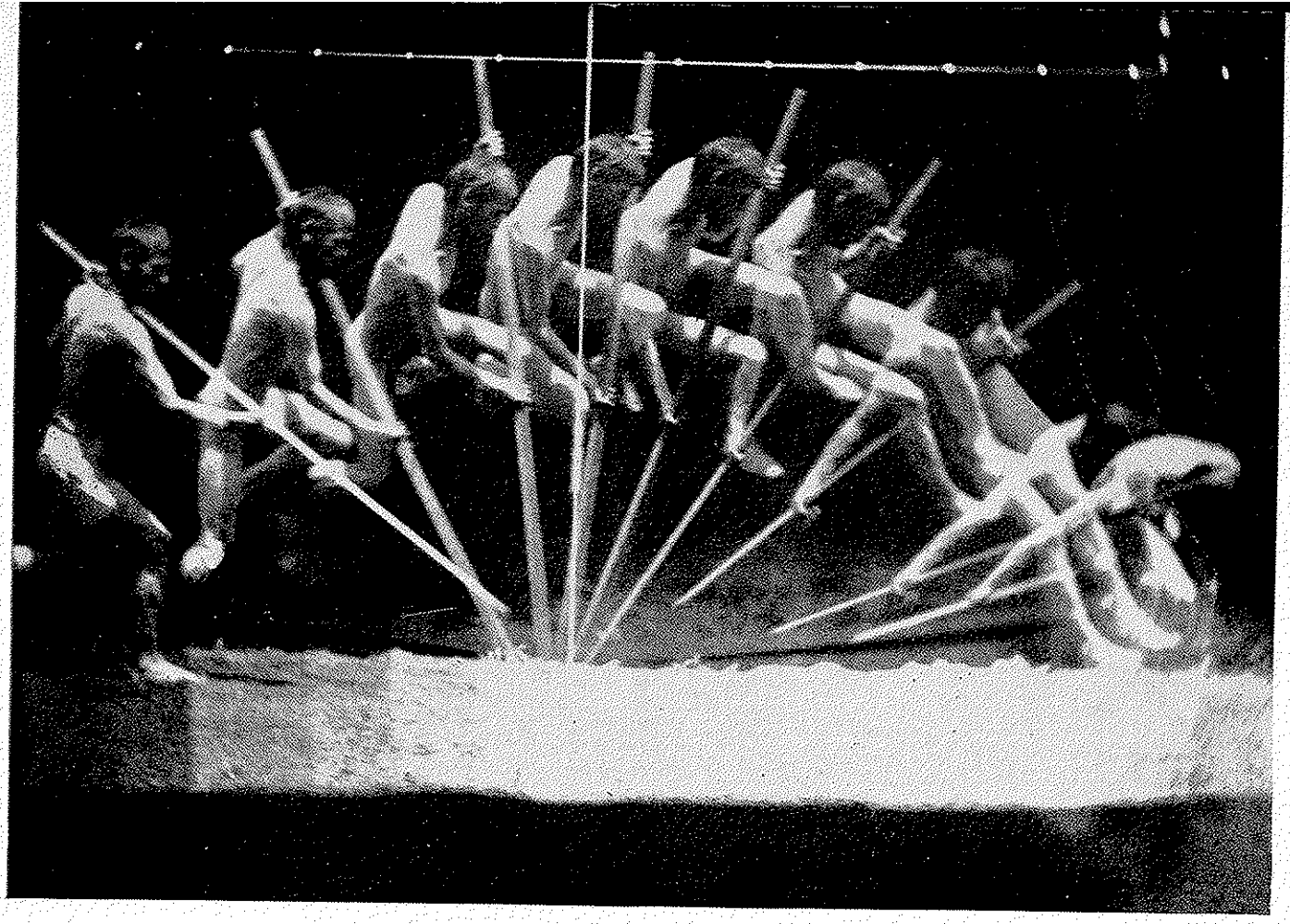


Fig. 337. Thomas Eakins, 1881-1884
Action photo
Although we generally consider the futurists' attempts to render motion as the earliest, the truth is that even the spectacular motion photographs by Professor Edgerton (1937) are preceded by the work of Muybridge, and almost literally by Muybridge's collaborator, Thomas Eakins

ments analyzable and in relationship to each other and the whole cycle of motion. They clearly show that space-time can not only be articulated but also employed as a means of expression. These speed photographs are of more recent date, but they are astonishingly similar to futuristic paintings. In fact, they are their exact repetitions: e.g., "Dog on the Leash", 1912; "Speed", 1913, both by Balla; "Nude Descending the Stairway", 1912, by Marcel Duchamp. They all show the same juxtaposition of frozen movement.

The problem of futurism is similar to that of cubism. The difference is that cubism takes to motion as a means of better grasp of the object in space; futurism is interested in motion for the sake of motion. Although both used superimpositions, most of the futurist paintings seem merely a new naturalism beside the spatial sophistication of cubism.

Fig. 338. Umberto Boccioni, 1911
The power of the street
Boccioni said about this picture in an exhibition catalog, March 1912, (Sackville Gallery, London): "The tendencies, dynamic power, life, ambience, anguish, which one experiences in the city; the crushing sense of modern bustle"

Around 1910 the futurists had begun to emphasize movements, saying, "The world's splendor has been enriched by a new beauty—the beauty of speed. . . . ." "We shall sing," they continued, "of the man at the steering wheel. . . . Who can still believe in the opacity of bodies since our sharpened and multiplied sensitiveness has penetrated the obscure manifestations of the medium? Why should we forget in our creation the double power of our sight, capable of giving results analogous to those of the x-rays?" Umberto Boccioni in "Power of the Street", 1912, projected such a double power of sight and such a fusion of the manifold elements of a street,

Fig. 339. Marcel Duchamp, 1912
Nude descending the stairway

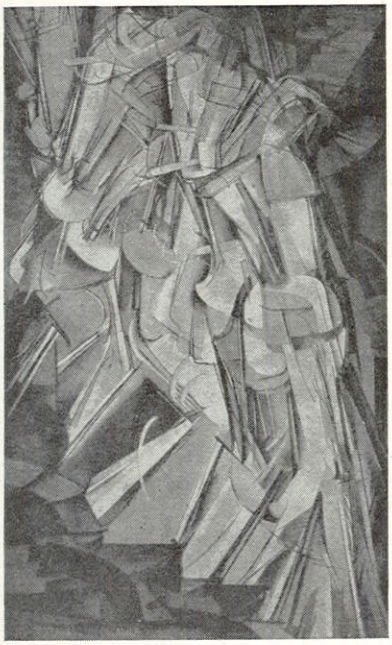


Fig. 341. Carlo D. Carra, 1911
The funeral of the anarchist Galli
The futurist painting, attempts the rendering of a motion dynamics. The "dramatic intrepretation of the scuffle between the cavalry and the proletariat"

Fig. 342. Pablo Picasso, 1936
Guernica (mural)
This picture translates the anger and desperation about the Nazi bombing of Guernica into a plastic demonstration. Besides the symbolic significance of the painting (the bull stands for fascism, and the horse turning around in pain for the loyalists), it is the motion of the figures itself which conveys the real meaning

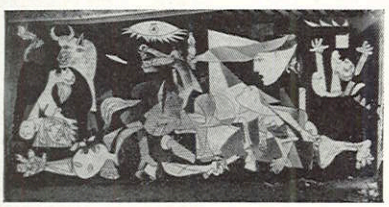


Fig. 340. Herbert Matter, 1941
Figure in movement

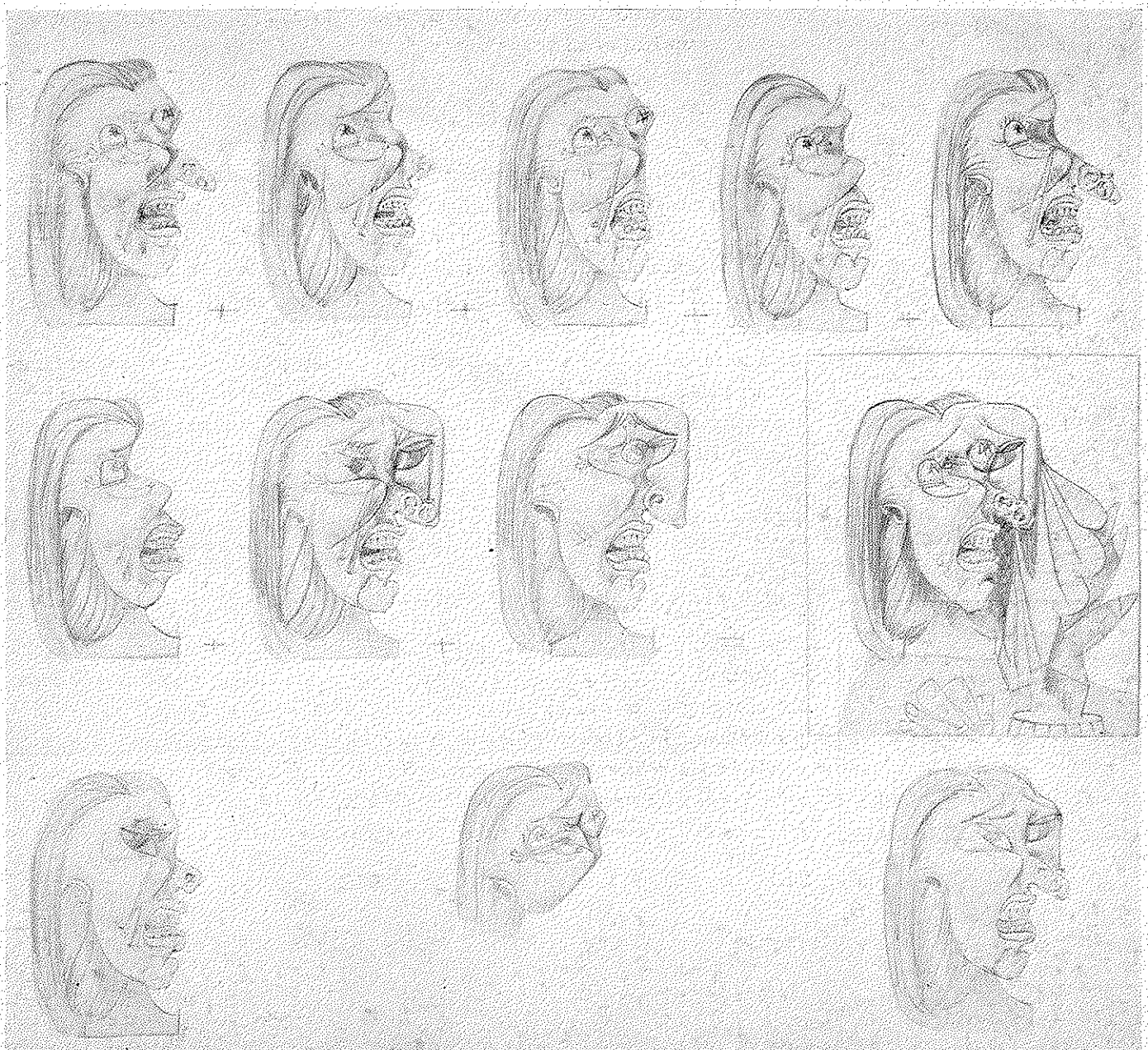
into one simultaneous, expressive representation. Pablo Picasso did the same in the mural of the bombing of Guernica, the Basque city. The painting is a monument of human torment and a powerful symbol of the agony of the heroic Spanish loyalists. Visiting him in 1937, before the painting was placed in the Spanish Pavilion at the Paris World's Fair, he said that he had attempted to render "*the inside and outside* of a room simultaneously".

Among the Guernica studies which Picasso made there are a number of drawings which record not only the space-time visualization of the successive changes of physical motion, but also the psychological space-time, the emotional metamorphosis caused by horror in the doomed creatures.

Fig. 343. Pablo Picasso, 1936
Sketch for Guernica mural (etching, second stage)

In the old arts, horror was usually rendered through the distortion of the facial muscles, distortion of the open mouth, by enlarged and protruding eyeballs. Picasso intensified this approach by moving and distorting the usually immovable and undistortable elements of the body, such as the eyes, ears and nose. In "Guernica" he shifted the eyes away from their normal position; he turned the ears upside down. In the studies for the mural he transformed the eye into a cup and the lower eyelid into a saucer from which tears poured. He exposed the tongue of a screaming, horror-stricken victim as a flame, at other times as a dagger to signify despair. In one of these studies he showed a dozen variations of a face, changing the profile of a young mother under the impact of unspeakable suffering—into the distorted, crumbled features of an old woman. This was done through interweaving the features of a panicky, quickly aging, hideous creature, each expression growing out of the other without breaking the oneness. The same etching, if looked at upside down, solved the enigma by displaying the deteriorated, piggish visage of Hitler,

Figs. 344 a, b, c, d, e, f, g, h, i, j, k, l O
The face opposite is a psychological space-time study expressing the horror of bombing. A young matron changes into an old woman with the distorted features of a terrified creature. The pencil sketches charting the changes are by Robert Santmyers, student of the Institute. Turning the large etching upside down, one sees Hitler's caricature topped by a frightening headgear.



Figs. 345-346. Harold Edgerton, 1940
Multiflash of the "Martels", an acrobatic team
The photograph at the right records the sequence of movement in superimposed flashes. The girl, thrown into the air by the acrobat, is caught by him. Observe in the closeup on the left the position of the man's eyes. Through the superimpositions of the various phases of movement, the eyes in his "faces" appear in strange distortion, similar to the eyes of the Picasso etching for the Guernica mural (see pages 250-251). Here again distortion equals motion (see figs. 151, 152, 153, 156, 157, 236, 275, 276, 277b, 279, 283)

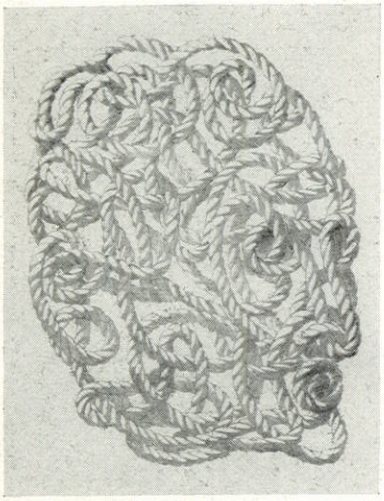


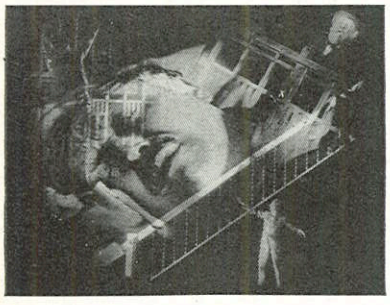
Fig. 347. Xanti Schawinski, 1945
Pluralistic head

the cause of the bestial destruction. The old technique of the trashy "double image" postcards was used here with unusual subtlety to make the psychological space-time as transparent as an x-ray photograph.

transparency and light

The passion for transparencies is one of the most spectacular features of our time. In x-ray photos, structure becomes transparency and transparency manifests structure. The x-ray pictures, to which the futurist has consistently referred, are among the outstanding space-time renderings on the static plane. They give simultaneously the inside and outside, the view of an opaque solid, its outline, but also its inner structure. They have to be studied to reveal their meaning; but once the student has learned their language, he will find them indispensable. In my pictures I have tried to follow this line of space-time articulation by painting on waterclear, transparent plastics, introducing direct light effects, mobile reflections and shadows, indicating a trend away from the static pigmentation of surfaces toward a kinetic "light painting". The problem is only how to control these colored "light paintings" with the same precision as the painter of yesterday controlled the effects of his pigments. (Figs. 189, 203, 205, 213-215, 356)

Fig. 348. Dream
Superimposition of the different scenes from a motion picture



photographic practice

Different space and time levels usually appear in photographic rendering as superimpositions. The reflections and transparent mirrorings of the passing traffic in the windows of motor cars or shops are one example. Mirroring means in this sense the changing aspects of vision, the sharpened identification of inside and outside penetrations. In such renderings there is a blending of independent elements or events into a coherent whole. Superimposition of photographs and distortion by reflection, as frequently seen in motion pictures, can be applied as a new visual language to represent dreams, acting as a space-time symbol, even synonym.

Fig. 349. L. F. Ehrke and Dr. C. M. Slack, 1941

Man shaving (x-ray photograph)

Photograph taken at 1/1,000,000 of a second in the Westinghouse Research Laboratories, Bloomfield, New Jersey.

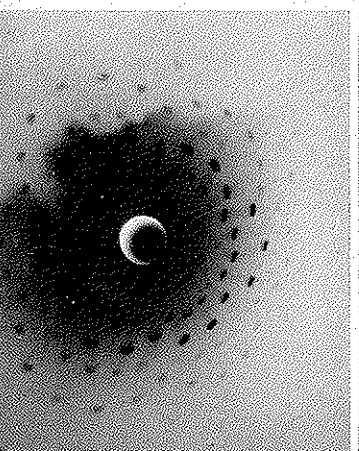
The electric razor was going full-speed, its tiny motor making 116 revolutions per second. Pictures may be made of larger motors, even though covered with heavy metal. Note the ring on the finger, the watch, the glasses, and the sharply defined mechanism of the razor

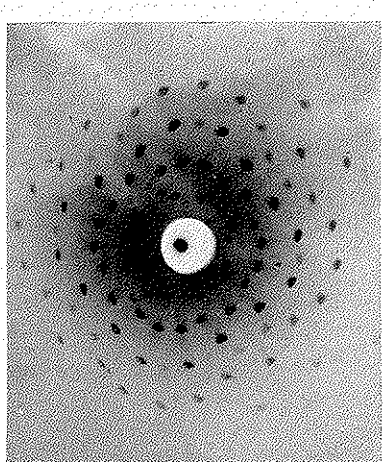
Fig. 350. Jellyfish

The transparent body discloses the shape, surface as well as the inside structure

Figs. 351 a, b. Prof. Laue, 1929

Atom structure of metal (x-ray photograph)





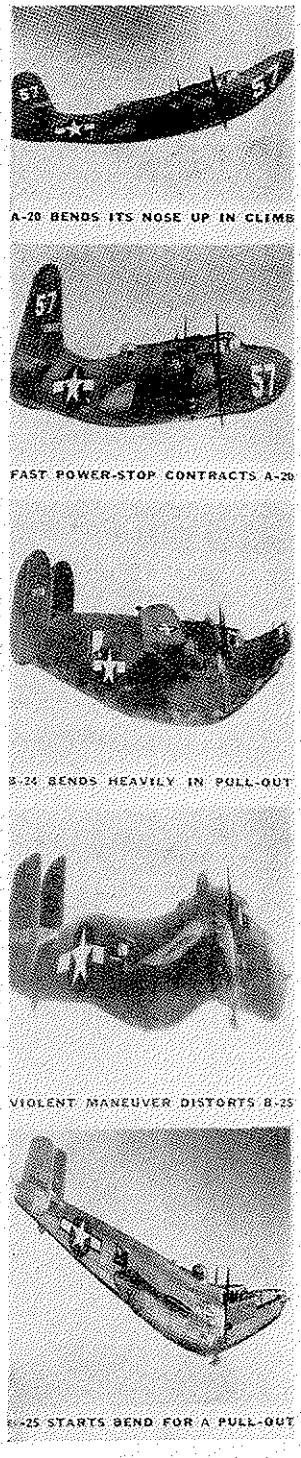


Fig. 358 a, b, c, d, e.
Distortion diagrams for the novice pilot who has to learn the reaction of the machine to all his manoeuverings in the air. Here again: **distortion equals motion**

Photomontage has a similar connotation. The final effect is a synopsis of actions, composed of originally unrelated space and time elements juxtaposed and fused into a unity. (Figs. 287-291, 387, 389, 390)

A cameraless picture (photogram) can also be understood as vision in motion since it is a diagram of the motion of light, creating the space-time continuum which literally is the photogram.• (Figs. 238-254, 388)

symbols

This type of analysis may help to find visual symbol values for space-time experience. Such a symbol is the spiral. It revolves from the outside to the inside with constant ascent. Inside and outside are simultaneously seen.

The smoke diagram of a skywriter-plane, the drawing or light tracks of motion studies (Figs. 4, 156, 157, 191, 327, 330), the various ways of distortion, such as the curved edge of bent plastic sheets and wire structures (Figs. 306, 312, 314-317, 320, 329, 357), transparency (Figs. 181, 189, 203, 205, 211-215, 350, 356) (light penetrates matter) and inter penetration (Figs. 216, 354, 355) have also space-time connotation.

By future research such phenomena will help to clear and shortcut communicational needs on the plane of intellectual-emotional fusion.

mobile architecture

Mobile architecture is space-time reality. Automobiles and trains can be viewed as mobile buildings. That is, should be so viewed. Unfortunately, they are still largely designed with the traditional principles of static architecture, a more or less obsolete superstructure erected upon a new type, the mobilized base. The notion of sending a "house" to sea, as in the luxury liner, is simply imposing the past upon the present.

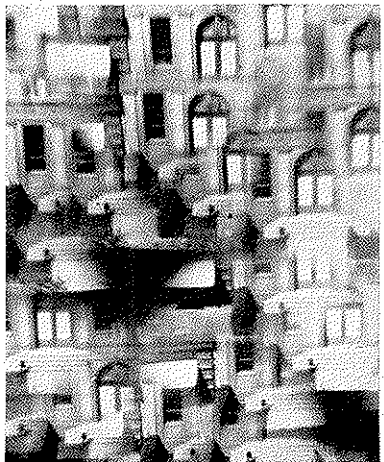
The bare fact that in this country from 600,000 to 800,000 families live today on wheels in trailers must influence all architecture.

Among the exhibits at the 1939 World's Fair in New York was a "poetic" scene.

• *James Joyce captured this delicate quality, this becoming, in a passage of "Ulysses"; "a very short space of time through very short time of space."*

Fig. 357. Hans Finsler, 1925
Chocolate mixing machine
The moving mass of soft chocolate forms a twisted shape (distortion equals motion)

Fig. 360. Albert Renger-Patzsch, 1924
"Architecture"
Distortion achieved by using a prism in front of the lens



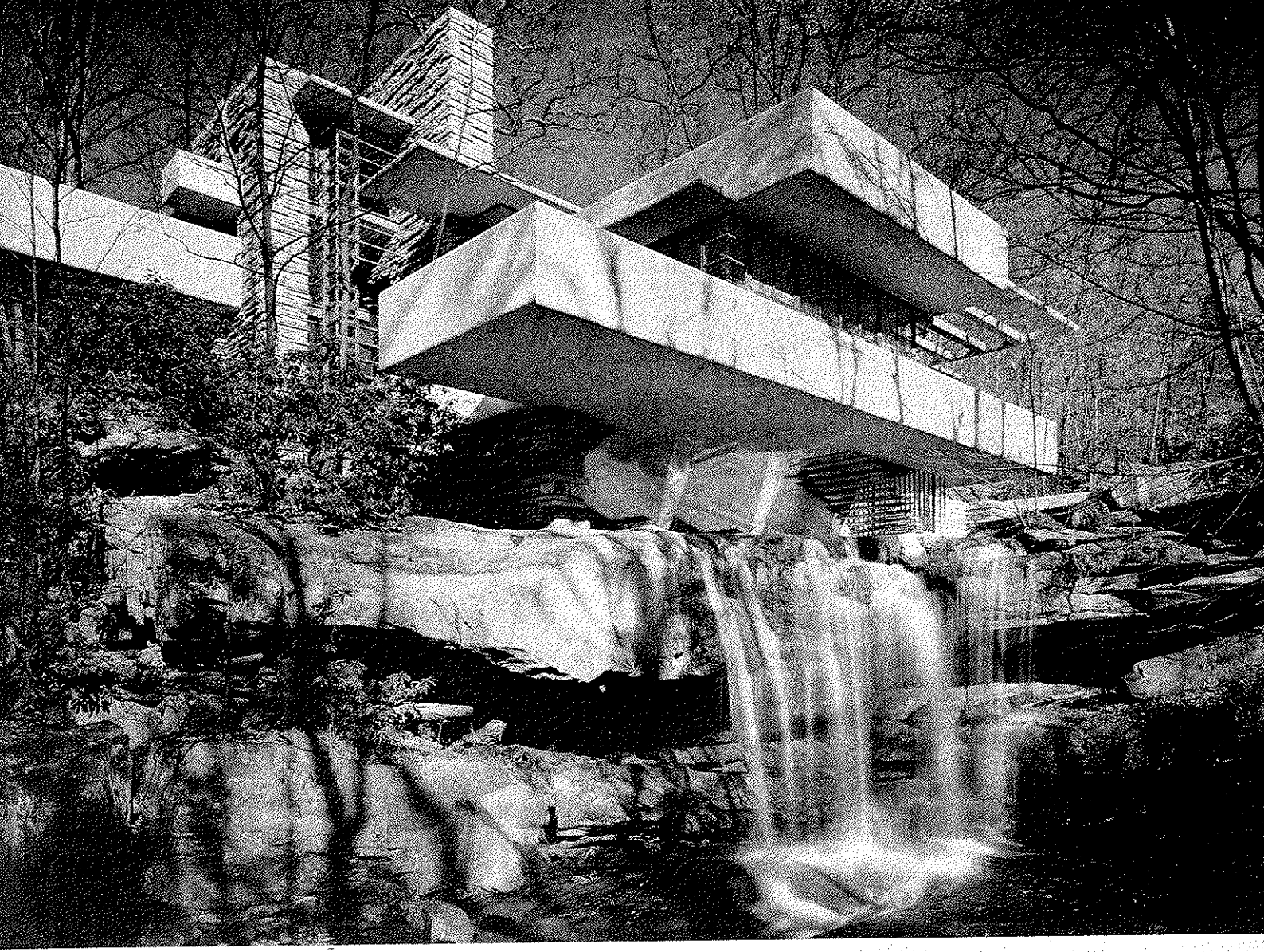


Fig. 361. Frank Lloyd Wright, 1937
The Kaufmann house at Bear Run, near Pittsburgh
In its unusual conception, courageous use of reinforced concrete, this building is one of the masterpieces of contemporary architecture

In the light of the full moon the silhouette of a big building was visible. Then majestically the sun rose and suddenly a whole wing of the building moved on rails down to a trailer-truck and drove away.

Gropius and Wagner are advocating demountable, movable houses for future cities. There are projects not only of movable but of moving houses too; sanitariums, for example, turning with the sun.•

The architecture of Frank Lloyd Wright, especially the strongly cantilevered Kaufmann house at Bear Run, near Pittsburgh, shows more similarity to an airplane than to traditional buildings. To live in such a house creates the sensation of being in an airplane, giving an emotionally freer relationship to the surroundings. Such

• *The house of the future should have movable eaves which, by power, would protrude or move back according to the stand of the sun in the different seasons. This would be a new type of horizontally moving, solid awning.*

buildings may be disturbing to a few unimaginative people, who probably would be even more aghast at the plan of Professor J. D. Bernal of Cambridge, England, to construct houses whose walls are produced by compressed air, by rotating air streams or opaque gases. These walls would provide perfect insulation. Arthur Korn built a rubber factory in Berlin in 1930 where he used a pressed air curtain to prevent bad odor penetrating adjoining rooms. Such an air curtain may be used in the future as a kitchen door.•

The question then arises: why should one live between stone walls when one could live under the blue sky between green trees with all the advantages of perfect insulation?

Some contemporary buildings with their undivided, gigantic windows already allow transparency and thus the unhindered view of everchanging surroundings, since the seasonal shifts at least visually enter the rooms as in the house Gropius, Lincoln, Massachusetts. Another house designed by Richard Neutra (California) makes nature a part of the vestibule by means of a garden growing simultaneously "inside and outside" divided only by a large glass wall. A restaurant in Berlin, a cinema in Zurich and a night club—of all things—just outside of New York have movable roofs so that the starlit sky can become the ceiling. By interpenetrating nature and man-made structure, the old idea of synthesis has been at least approximated.

• *The driver's cabin in a Diesel locomotive is aerodynamically designed so that a vacuum created by the high speed around it acts as a strong insulation for the window shields against flying dirt, rain and snow.*
In 1927 in Zurich I suggested for cinema publicity to the architects Moser and Steiger a gas curtain onto which motion pictures could be projected through which the public could pass. This gaseous curtain could also, chameleon-like, change colors.

Fig. 363. Walter Gropius and Marcel Breuer, 1938
The Gropius house in Lincoln, Massachusetts

Fig. 362. Richard J. Neutra, 1941
Residence of John Nesbitt, Brentwood, California
The entrance with lily pond, continues through a glass wall into the interior, accomplishing a delightful unity of man-made structure and nature. The mirror set at 90 degrees to the transparent wall enhances the visual richness

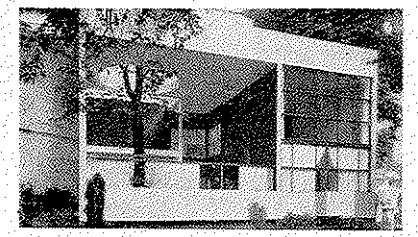


Fig. 364. Le Corbusier, 1925
A housing unit executed as the exhibition pavilion of the magazine, "L'Esprit Nouveau", at the Paris Exposition of Decorative Arts
The conservative exposition committee, not very enthusiastic about the participation of Le Corbusier, assigned to him a site full of trees, stipulating that none could be cut down. He turned this shortcoming into a virtue, erecting his building around a tree, demonstrating the idea that architecture and nature could be more thoroughly fused

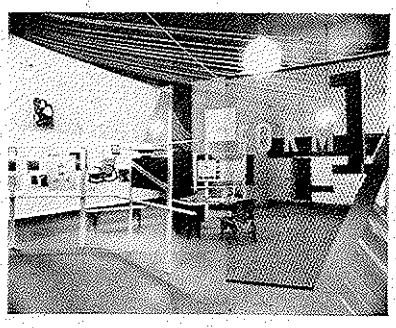


Fig. 365. O Students of the Institute of Design, Chicago, 1945
Exhibition of the faculty, "Form One"
In the new exhibition techniques, virtual walls play a great role. They are often made from string, wire, and wire mesh

exposition architecture, display, theater, dance

In Paris in 1925 Le Corbusier built an exposition building for his "L'Esprit Nouveau". The trees on the site had to remain, thus he incorporated one of the largest trees into his pavilion fusing "the inside and outside" into a new unity. Frank Lloyd Wright allowed a tree to grow through the balcony of the Kaufman house at Bear Run. The greatest attraction of the Edinborough (1938) exposition was a restaurant where guests on the second floor could sit under blooming trees which penetrated the ceiling of the first floor.

In expositions, structural and practical limitations can be dismissed more easily than in a permanent type of architecture. Indeed, starting with the London Crystal Palace, through the Paris exposition of 1889 with its Eiffel Tower, to the expositions of our day in Berlin, Paris, Moscow, Barcelona, Stockholm, Milan, Chicago, San Francisco, New York, a more or less imaginative world did come true—the embodiment of projects which were conceived by the great "dreamers" of mankind, the creative architects, artists and designers who dared to use the potentialities of the new materials of a new age. Their temporary structures can be understood more in the way of laboratory experiments than as a panorama of dissociated units. Such architectural experiments on a large scale may signalize a spatial order in which neither single structures nor large spans of openings will play the most important part, but rather the relationships of neighboring units, the harmonious and functional distribution of buildings and free spaces, the right proportion between shelter, recreation, leisure and production areas. "World Fairs" could be in the future community affairs from which the curse of trashy sensationalism will be lifted; where it will be understood that nothing more important can be done in life than search for the biologically "better ways".

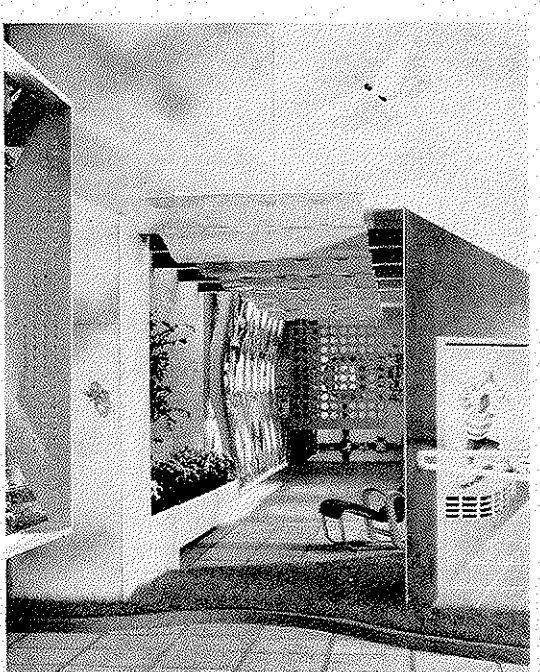
Attempts toward a new type of space articulation are embedded in the most advanced solutions of the pioneering young architects in North America, Brazil, Holland, Switzerland, Finland and Sweden. They have already humanized the technological advances even though, for the time being, they work mainly for a privileged clientele.

The fact that their efforts are not as yet generally accepted and only hesitatingly employed for slum clearance and public housing is more an indictment of traditional-minded administrations, ignorant of the people's requirements, than a criticism of the new direction.

The public accepts technical processes and new inventions more readily when they affect only details of the living standard; the acceptance becomes more difficult if they seem to cause radical changes in habits. And yet many inventions, appearing at first as casual improvements for a few, paved the way to a complete transformation of everyone's life. Examples are telephone, telegraph, automobile, airplane, refrigeration and radio. They—of course—must be understood as the utilization of new materials and new potentialities, not for their technological sake but in the direction of a more functional and biological use.

Fig. 366. ○ L. Moholy-Nagy and Marcel Breuer, 1936
Model of an exhibition with offices and stage for fashion shows and cinema performances
The main requirement of an exhibition is activity flow, effective visual demonstration and easy communication

Fig. 367. MARS (Modern Architectural Research Group) Exposition in London, 1937
This detail shows a porch, synthesizing the elements of architecture and nature



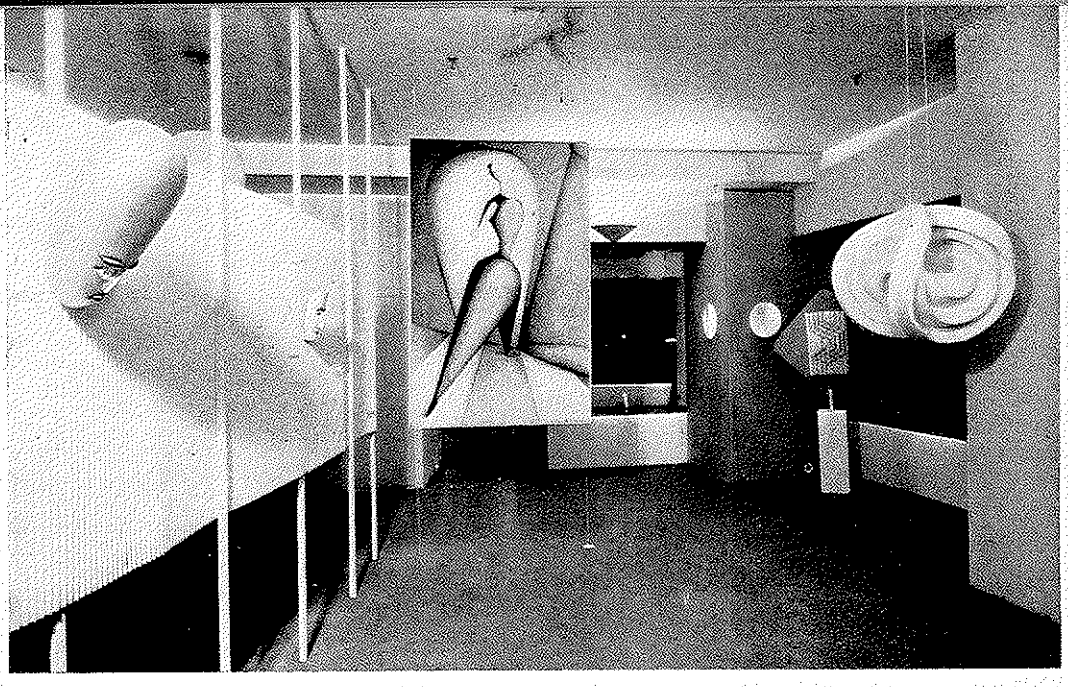


Fig. 369. Herbert Bayer, 1937
Exhibition of the Bauhaus, in the Museum of Modern Art, New York

Fig. 370. Herbert Bayer, 1945
The exhibition of the Container Corporation of America for modern advertising
The structure was designed as a knock-down solution for easy packing, transportation and assembly

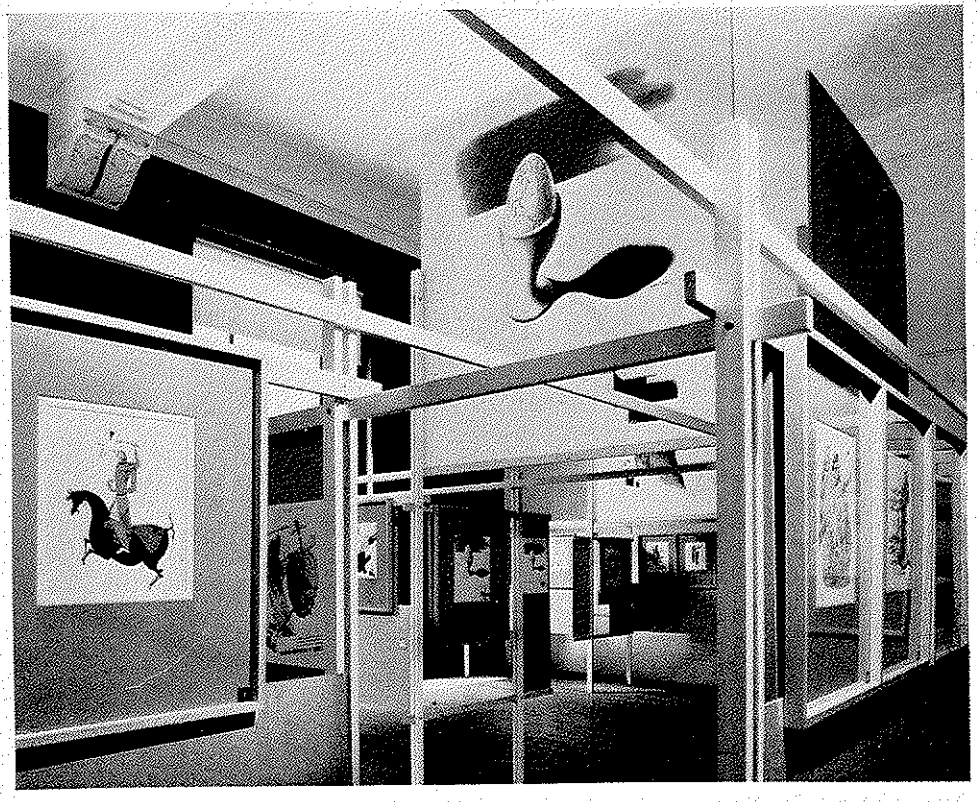


Fig. 368. Aino and Alvar Aalto, 1939
The exposition pavilion of Finland at the New York World's Fair
With high, undulated and inclined walls, the Aaltos introduced the baroque richness of a monumental pipe organ into the room, a solemn framework for the manifold wood products of their country

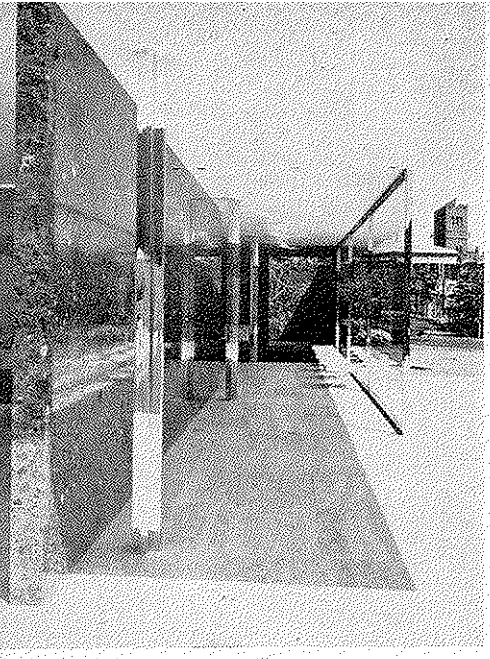


Fig. 371. L. Mies van der Rohe, 1929
Pavilion of the German Reich of the Worlds Fair in Barcelona, Spain
Corridor at the front composed of green marble and crystal plate glass walls; the ceiling was supported by chromium-plated cross-shaped steel beams.
Marble was for a long time ruled out by the modern architects as an element of obsolete architecture. The same was the case with wood. Today these materials are reconsidered. One of the first among modern architects to take up marble has been Mies van der Rohe.

Advertising, as usual, quickly adopts new ideas. Advertisers, having no inhibitions regarding classical rules, already use light, for example, as "building material". With light, architecture itself can be changed. With light one may pull together walls and windows or break them down into small units. With neon or other lights a completely different building outline can be created overnight in place of the actual structure. In the future, light—monochrome and multicolored—will play an essential part in architecture. The plan for a science museum in Paris by Jourdain-Nelson already foreshadows the use of such elements. These will carry in their wake also the solution of the old problem of relating painting, sculpture and architecture. But only a new insight into this problem can promise a full integration of all visual expression (including television) with the structural demands.

Step by step the necessary changes are coming. But even the most modern architecture of the static type is only a transitory step toward the future architecture of kinetic character. Space-time is now the new basis on which the edifice of future thoughts and work will be built.

Fig. 372. Maxwell Fry, 1937
Exhibition room for electrical appliances
The railing of the circular stairway is used as a display case. An impressive use of transparent material in a limited space.

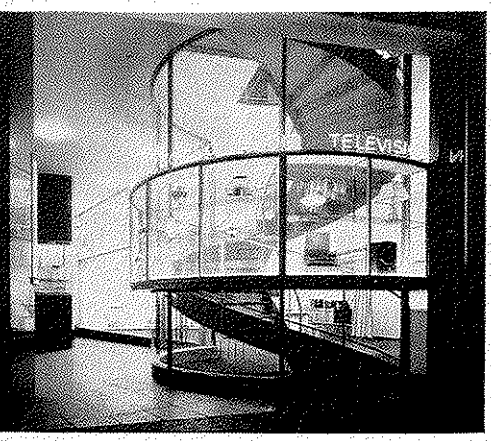
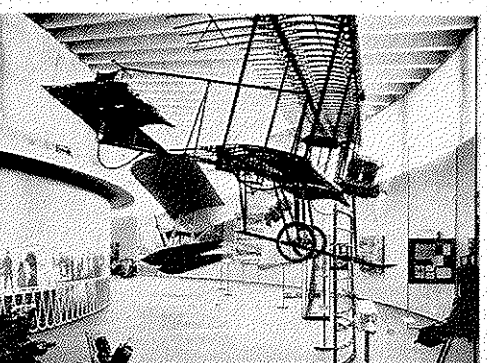


Fig. 373. Banfi, Belgioioso, Rogers and Peressutti, 1934
Aeronautical exhibition in Milano
In the foreground is an early Caproni and Gabardini seaplane.



It would be logical to assume that these ideas, particularly the powerful developments of modern architecture, have influenced the concept of stage design. But strangely enough, neither theater nor movie settings yet show the slightest inclination toward a really new space conception, although the new ways of handling space are so full of visual excitement and emotional tension that their use would mean not only an adaptation to contemporary spirit but also box office success.

The reason for the lack of a "contemporary" stage design is that the present theater is a remnant of the renaissance—a box in which to create an illusion of reality! There is little hope for a new space concept on the stage as long as this "box"—with only the front side open—is maintained. Revolutionaries of the stage—Meyerhold, Kiesler, Piscator—have been fighting for a long time for an open-space theater like an arena.

The open-space stages of Greece and the Middle Ages, on which the actors' relationship to each other and to their audience could be observed transparently, showed a foretaste of the tendencies prevailing in the space articulation of modern architecture. The new trends, originating mainly in new materials and constructions which were introduced by the industrial revolution will also bring to the theater greater flexibility. A combination of the existing mechanical devices and future light technique will make a revolution of the stage inevitable. This revolution will create the new setting for verbal articulation as well as for the dance which is space-time visualization through the human body.

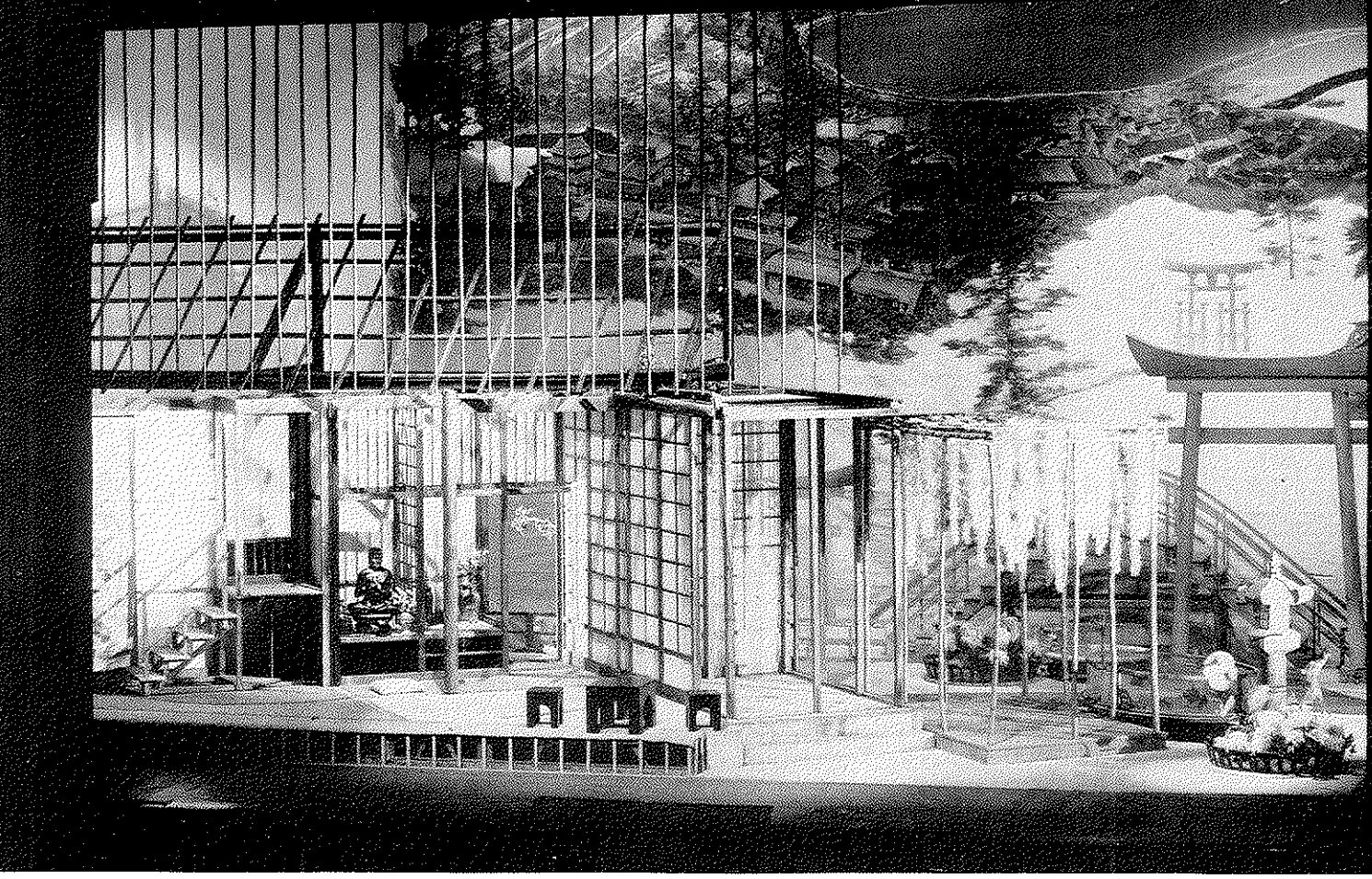


Fig. 374. O L. Moholy-Nagy, 1928
Scene from "Madame Butterfly"

One of the most important means of expression for the stage designer is light. The traditional theater designer generally worked with dispersed light, without any shadow. But light without shadow is lifeless

In order to achieve the richest play of shadows, in all my theater work I have tried to dissolve the straight and plain surfaces into curved planes, and have used skeleton walls which cast open, not solid shadows. This "Butterfly" was designed for a stage which allowed a quick change of scenery by moving it at the end of the act to one of the side-stages (the "wings") and rolling in a new set from the other side. This facility made possible the building of a double-set, comprising the middle stage and one wing. This allowed a change of scene before the eyes of the public. During the "garden aria," for instance, while the middle stage was rolled away into the left wing the singers moved right in the garden. This created the illusion of a long walk since the set previously in the right "wing" was brought to the center

As a backdrop, a gigantic photomontage (a composite picture of Japanese landscape, with a large cutout for the bay) was used. Behind it, on the cyclorama colored lighting effects, from dawn to sunset, were projected

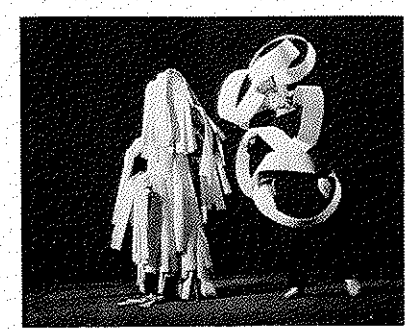


Fig. 375. Xanti Schawinski, 1936
Paper costumes for dancers used as kinetic "light modulators"

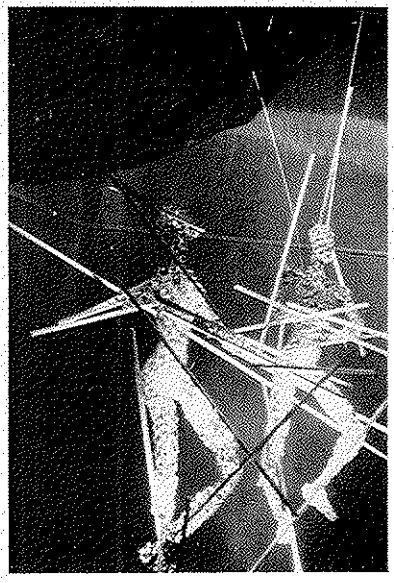


Fig. 376. Xanti Schawinski, 1936
Costumes for still-dancers

An amplification of spatial relationships the dancer produces. An anthropomorphic utilization of the "virtual volume"

space-time?

Since "space-time"• may be a misleading term, it especially has to be emphasized that space-time problems in the arts are not necessarily based upon Einstein's theory of relativity.•• This is not meant to discount the relevance of his theory to the arts. But artists and laymen seldom have the mathematical knowledge to visualize in scientific formulae the analogies to their own work. Einstein's terminology of "space-time" and "relativity" has been absorbed by our daily language. Whether we use the terms "space-time", "motion and speed", or "vision in motion", rightly or wrongly, they designate a new dynamic and kinetic existence freed from the static, fixed framework of the past. Space-time is not only a matter of natural science or of esthetic and emotional interest. It deeply modifies the character of social ends, even beyond the sense that pure science may lead to a better application of our resources.

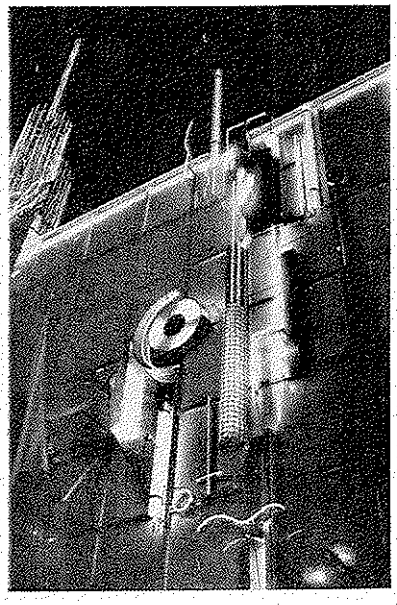


Fig. 377. Yoshio Watanabe, 1938
Ginza Palace, Tokyo
This three-dimensional light advertising forecasts a more conscious use of illumination and its space articulating quality in the future

History furnishes us with a good example of this. When the European cities consolidated into political and economic units and dethroned to a certain extent the regime of the feudal lords, the space concept was suddenly invaded and challenged by a new element: time. Where heretofore only space, the acreage of land owned, had basically determined economic and social values, the artisan and the merchant, the two pillars of city life, built their wealth on the time they had to put into jobs, the time they could buy from others to work for them, the time it took to bridge the distance in moving goods from the place of production to the place of consumption. Time (speed) became the most important competitive factor in production, transportation and sale. With the introduction of accelerated time, a new kinetic dimension was added to the static existence.

Space or space-time experience is not merely the privilege of exceptionally talented persons. It is a biological function, as important and as common as the experience of color, shape and tone. Its connotations are numerous. There is, for example, the hope that it will help in grasping future problems and vistas, enabling us to see everything in relationship, that it will furnish us with the right concept of cooperation and defense against aggression, where again space and time are inseparably intertwined.• • •

• *The book by Dr. S. Giedion: "Space, Time and Architecture" (Harvard University Press, 1942) will help greatly in understanding this concept, though I am approaching the problem not so much from the point of view of architectural structure as from that of social implications.*

•• *The relativity theory states: The speed of light is constant; it is the absolute speed in the universe. However, motion of objects can only be measured relative to another motion. Time is a coordinate of space. It is the "fourth dimension"—a physical measurement. Electricity and gravity combined account for all solid matter and matter and energy are interchangeable terms. This latter thesis led to the forecast of Einstein that the atom can be split thereby releasing immense energies.*

• • • *Even the soapbox orators have already adopted the new term: "The Japanese changed Pearl Harbor from a place to a date." Another example: the submarine finds its target by radio wave sent out and reflected back, indicating distance by time. The "instantaneity" of this measurement of space with a time factor makes it totally different from the way in which one used to measure, say, the distance from New York to Chicago as "ten days".*

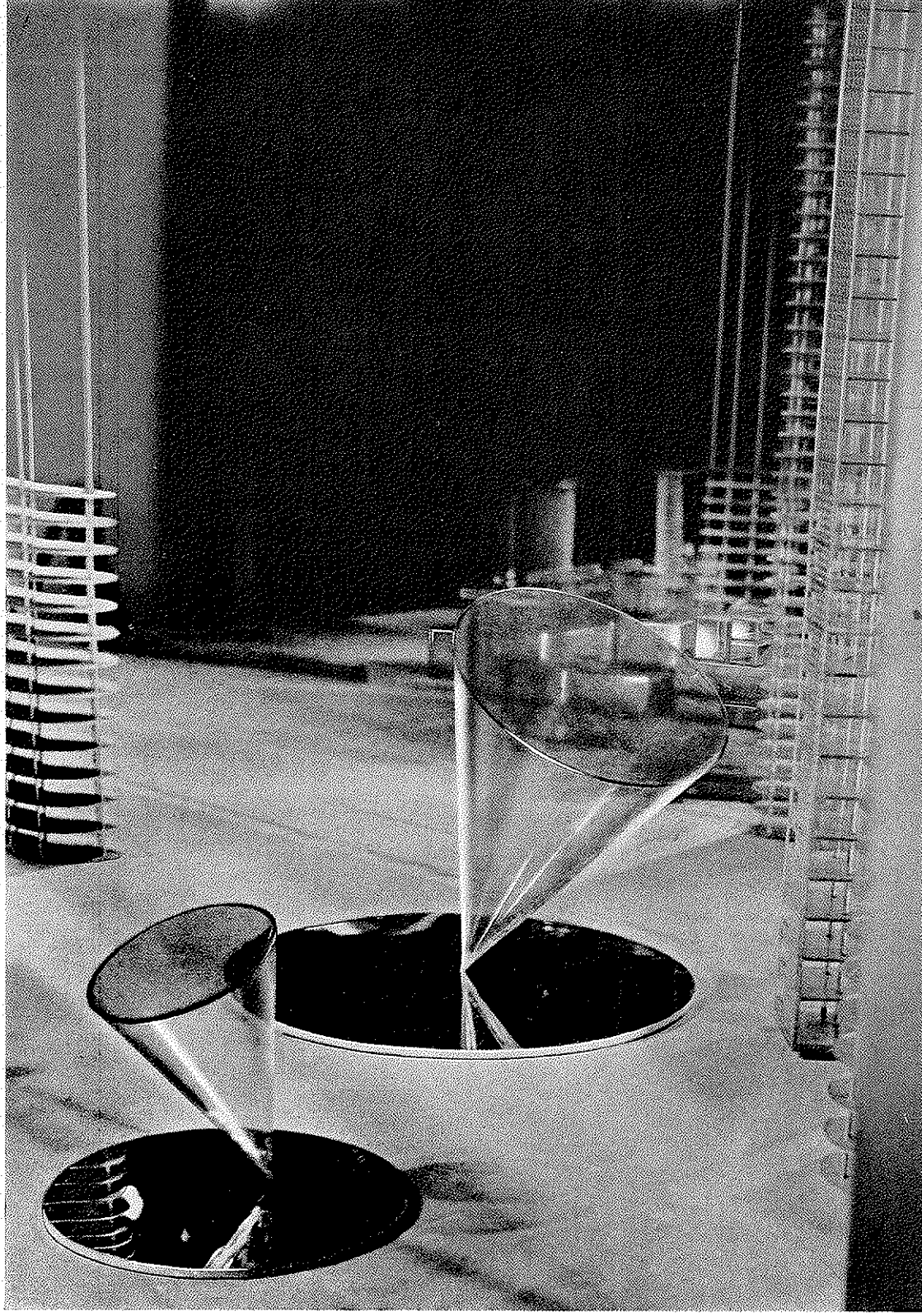


Fig. 378. O L. Moholy-Nagy, 1936
Special effects for "Things to Come" by H. G. Wells, London Film
This same set with the revolving cones, photographed with multiplying prism, produced so rich a visual result that the editor of the film did not dare to use it

"America's greatest achievement so far has been in the field of pure 'time-problems'. 'Time is money'. America has sufficient space. The result has been a dominating appreciation of time. . . .
"Europe—on the other hand—always faced the opposite problem: space. Time seemed eternal. The European architecture is a clear indication of this space-feeling. The architectural understanding you can find in Europe—the appreciation of form and space—is unknown in America. What appeals to the American in the European monuments is the historic element—time. Form means very little. What is going on in Europe at the present time—what is behind the interest for America—American production, American method is—I believe—a new understanding of time as an essential element of life. Final aim: Time—Space.
"America has only developed the 'time-faculty'. The finest intelligence has been working with time-problems. Communications. Autos. Elevators. Railways. Moving-pictures. And first of all: Production. Efficiency: time-saving" (K. Lönberg-Holm in "i 10" No. 15, Amsterdam, 1928)

It is enough to understand one example of logistics to grasp its ever growing significance. The military strategist has to estimate the kind of warfare likely to be waged in a particular area. His plans have to include the maintenance of a precise number of pieces of artillery in that particular theater of war. For that it will be necessary to organize and coordinate the production of factories and transportation means to maintain the pipeline (the normal flow of estimated need of full units) including the anticipated damage by enemy attack upon shipping, as well as to estimate normal wear and tear. Further, for these guns there is a need of special instruments which may wear out before the guns themselves. Then there is the problem of maintenance, and possible damage or loss by enemy action in actual battle; plus the varying type of ammunition required. Also, the right personnel must be available when and where needed, not only the combatants who serve the guns but also mechanics to provide necessary repair and replacement. An immense amount of detail has to be visualized. This is a vast and complex manipulation of men, raw material, clerical work, production and transportation of which the peculiar characteristic is that it is a process of constant change since the absorbed material continually has to be replaced. Though all this as a reality functions more or less perfectly, its exact rendering for the purpose of study and quick reading would entail an imagination and inventiveness yet missing. In fact, no *visual technique* exists yet which could convey to the public the complicated nature of these transactions in a simple, legible form. But this has to be found if planning for the destruction, which is war, shall yield a lesson for the planning of peace and the common good.

The more people understand and master this type of "thinking in relationships" the easier it will be to realize social planning and a better living. "Vision in motion" is a tool to render the complexity of these processes as simply as the economist attempts in his field when he speaks about all this as a matter of man hours, that is, operations measured by time.•

We are heading toward a kinetic, time-spatial existence; toward an awareness of the forces plus their relationships which define all life and of which we had no previous knowledge and for which we have as yet no exact terminology. The affirmation of all these space-time forces involves a reorientation of all our faculties.

Space-time stands for many things: relativity of motion and its measurement, integration, simultaneous grasp of the inside and outside, revelation of the structure instead of the facade. It also stands for a new vision concerning materials, energies, tensions, and their social implications.

This conception is still unpredictable in its consequences for the improvement of the affairs of mankind though the artist as well as the designer already experi-

• *Jack Pritchard (London) indicated the use of the "man-hour" as an effective "rendering" of this type of logistic planning.*

In order to read multi-relationships simultaneously, scientists use nomographs. A nomograph is a diagram of scientific or mathematical laws which are expressed by equations with any number of variables.

In a nomograph the lines or curves are so arranged that any straight line drawn across the diagram intersects the lines or curves at points which satisfy the equation for which the diagram was made.

A true nomograph must be read by means of a straight edge, a compass, two sides of a triangle, or any conceivable curve or line which serves as the key to the diagram. F. T. Mavis, in "The Construction of Nomographic Charts", calls the nomograph "a grapho-mechanical computing device."

The nomograph makes it possible to read simply, rapidly and accurately in one diagram any number of variables which would otherwise have to be expressed by many graphs.

The nomograph is also called an alignment chart or a nomogram.

The main principles of nomography were developed by Philbert M. d'Ocagne in France about 1890. D'Ocagne was the first to use the terms "nomography" and "nomogram".

ment with it on a new level of consciousness. The designer has to think in terms of integrated processes of materials and production, sales, distribution, financing and advertising; the contemporary artist consciously or intuitively tries to express the substance of his specialized field as the result of forces in space and time and to integrate it with the social reality. He prepares a new and creative vision for the masses, and with it a new orientation for a healthier life plan. But in order to benefit society, the artist's work must penetrate everyone's daily existence.

As a reminder of the atomic age, here is the model of the chemical structure of a material.

Fig. 378a. Power puzzle

This is a chemist's model of the hydrogen and carbon atoms in one type of hydrocarbon molecule. Gasoline is a mixture of hundreds of different kinds of hydrocarbons —each with its own molecular structure and each with its own special way of behaving inside a gasoline engine