THE CULTURE OF

TIME AND SPACE

1880 – 1918

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6

THE NATURE
OF, SPACE

In an autobiographical sketch Einstein recalled two incidents from his childhood that filled him with wonder about the physical world. When he was five years old his father showed him a compass. The way the needle always pointed in one direction suggested that there was "something deeply hidden" in nature. Then at twelve he discovered a book on Euclidean geometry with propositions which seemed to be about a universal and homogeneous space.[1] These early memories embodied two opposing views about the nature of space. The

traditional view was that there was one and only one space that was continuous and uniform with properties described by Euclid's axioms and postulates. Newton defined this "absolute space" as at rest, "always similar and immutable," but the action of the compass suggested that space might be mutable, with orientations that varied according to its contents. The quivering needle pointed to the north pole and to a revolution in physics.

New ideas about the nature of space in this period challenged the popular notion that it was homogeneous and argued for its heterogeneity. Biologists explored the space perceptions of different animals, and sociologists, the spatial organizations of different cultures. Artists dismantled the uniform perspectival space that had governed painting since the Renaissance and reconstructed objects as seen from several perspectives. Novelists used multiple perspectives with the versatility of the new cinema. Nietzsche and José Ortega y Gasset developed a philosophy of "perspectivism" which implied that there are as many different spaces as there are points of view. The most serious challenge to conventional space came from physical science itself, with the development in the early nineteenth century of non-Euclidean geometries.

Geometry is the branch of mathematics most directly concerned with the nature of space and with the properties of points, lines, planes, and objects in it. Euclid stated without proof certain axioms and postulates that seemed self-evident and from them derived other theorems by deductive logic. His geometry was of two and three dimensions, and for over two millennia it was considered to be the only true geometry of real space. Kant assumed that its propositions were necessarily true and about the world, hence synthetic judgments *a priori*. At the beginning of the nineteenth century it lay at the heart of classical physics and Kantian epistemology. But in the course of that century other geometries challenged the idea that Euclid's was the only valid one. Crucial to it was the Fifth Postulate: that through a point in a plane it is possible to draw only one straight line parallel to a given straight line in the same plane. The non-Euclidean geometries replaced the postulate with others and modified the rest accordingly. Around 1830 the Russian mathematician Nicholai Lobatchewsky announced a two-dimensional geometry in which an infinite number of lines could be drawn through any point parallel to another line in the same plane. In his geometry the sum of the angles of a triangle is less than 180 degrees. In 1854 the German

mathematician Bernhard Riemann devised another two-dimensional geometry in which all triangles had angle sums greater than 180 degrees. Riemann's space was elliptical; that of Lobatchewsky was hyperbolic. These alternative surface spaces contrasted with the flat planar surface of Euclid's two-dimensional geometry in which the angle sum of a triangle is exactly 180 degrees. By the end of the century other mathematicians had developed geometries for all kinds of spaces—a doughnut, the inside of a tunnel, even a space like a venetian blind.[2]

The parallel postulate was a weak point in Euclid. As early as 1621 Sir Henry Savile identified it as a blemish in the system, and to many mathematicians thereafter it did not seem sufficiently self-evident to warrant acceptance without proof. It is therefore ironic that Lawrence Beesley, in his account of the sinking of the *Titanic*, referred to the law of parallels as if it were a symbol of order in the natural world. From a lifeboat he described the beauty of the ship at night, marred by the "awful angle" made by the level of the sea with the rows of porthole lights. "There was nothing else to indicate she was injured; nothing but this apparent violation of simple geometrical law—that parallel lines should 'never meet if produced ever so far both ways.'"[3]

If the spaces of non-Euclidean geometry were not bewildering enough, there were other new spaces that could not be accounted for by any geometry. In 1901 Henri Poincaré identified visual, tactile, and motor spaces, each defined by different parts of the sensory apparatus. While geometrical space is three-dimensional, homogeneous, and infinite, visual space is two-dimensional, heterogeneous, and limited to the visual field. Objects in geometrical space can be moved without deformation, but objects in visual space seem to expand and contract in size when moved different distances from the viewer. Motor space varies according to whatever muscle is registering it and hence has "as many dimensions as we have muscles."[4] In a similar manner Mach defined visual, auditory, and tactile spaces that varied according to the sensitivity and reaction times of different parts of the sensory system. These spaces constituted the physiological foundation for the "natural" development of geometrical space. Symmetry has a bodily source, and the positive and negative coordinates of Cartesian geometry derive from the right and left orientation of our body. Our notion of surface comes from the experience of our own skin. "The space of the skin," Mach wrote, "is the analog of a two-dimensional, finite, unbounded and closed Riemannian

space." Terms for basic units of measurement such as "foot" and "pace" reveal anatomical origins, and thus "notions of space are rooted in our physiological organism."[5]

Speculation that there are two- and three-dimensional spaces other than the one described by Euclid and that our experience of space is subjective and a function of our unique physiology was disturbing to the popular mind. Perhaps the most famous critic of these notions was V. I. Lenin, who, in *Materialism and Empirio-Criticism* of 1908, cried "enough" to the proliferation of spaces, to the "Kantian" notion that space is a form of understanding and not an objective reality, and to "reactionary" philosophies such as those of Mach and Poincaré. Like a man trying to hold down a tent in a wind, Lenin raced about defending the objective, material world in absolute space and time that he believed to be the foundation of Marxism and which, he feared, was threatened by recent developments in mathematics and physics. It is an embarrassing performance by a man straining in a field beyond his expertise, but it gives a sense of the concrete implications and political overtones of this seemingly abstract thought.

Lenin began the chapter on "Space and Time" with a statement of the materialist position: there is an objective reality in which matter moves in space and time independently of the human mind. This is in contrast with the Kantian view that time and space are not objective realities but forms of understanding. He conceded that human conceptions of space and time are "relative," but this relativity moves toward the "absolute truth" of objective reality. Mach's statement that space and time are "systems of series of sensations" was "palpable idealist nonsense." He labeled "absurd" Mach's speculation that physicists might seek an explanation for electricity in a space which is not three-dimensional, and he reaffirmed the orthodox position: "Science does not doubt that the substance it is investigating exists in three-dimensional space." He tossed off Poincaré's famous anticipation of the relativity of time and space and then criticized that "scrupulous foe of materialism" Karl Pearson, who had written that time and space are "modes under which we perceive things apart." The kind of thinking that denies the objective reality of time and space is "rotten" and "hypocritical."[6]

Lenin engaged in this polemic because he believed that the reputation and political effectiveness of the Bolshevik party were at stake. When an article appeared in *Die Neue Zeit* (1907) about certain Bolsheviks who had embraced a Machist philosophy and compromised

orthodox Marxism, Lenin decided to attack publicly to define the Bolshevik position and show that Machism was simply an aberration of certain individuals in his party, one manifestation of a general disease of doubting material reality that was infecting modern society as a whole and that could break out in any political party.[7] In the concluding paragraphs Lenin singled out the prominent Bolshevik philosopher A. Bogdanov, who had argued for the social relativity of all categories of experience in *Empirio-monism* (1904–1906). Bogdanov had written that time, like space, is "a form of social coordination of the experiences of different people." Such relativistic idealism undermined materialism and the belief that there is one and only one real framework of time and space in which the events of all cultures take place. According to Bogdanov, Lenin charged, "various forms of space and time adapt themselves to man's experience and his perceptive faculty."[8] This formulation contradicted Lenin's materialism in two respects. The reference to a plurality of spaces challenged the universality of a single space, and the suggestion that these various forms of space and time "adapt" to man's experience identified Bogdanov with the genetic epistemology of both Mach and Poincaré.

While Lenin was combating the social relativism of Bogdanov, a far more important theory of relativity was being developed by Einstein. Efforts by physicists to fit the negative findings of the Michelson-Morley experiment into the body of classical physics were like those of a squirrel trying to bury a nut in a tile floor. Lorentz hypothesized a dilation of time for the beam of light traveling in the direction of the "ether current" just enough to reconcile the experiment with absolute time. George Fitzgerald suggested a similar compromise to hold on to absolute space. He hypothesized that the arms of the apparatus in the experiment actually contracted in length in the direction of the ether flow just enough to compensate for the longer time that the light should take to travel with and against the current as compared with the beam of light that traversed the same distance across and back. Einstein scrapped the Fitzgerald contraction together with the Lorentz dilation and proposed relativity instead. In the special theory of 1905 space was redefined as a quasiperspectival distortion. The contraction was not a real change in the molecular construction of the apparatus but a distortion created by the act of observing from a moving reference system. This perspectival effect differed from ordinary perspective because it was not due to optics and would occur no matter how far the object observed in

motion was from the observer. The relative velocity of the object and viewer was the crucial factor, not the distance between them. With Einstein's explanation no absolute meaning could be given to the concept of the actual length of the apparatus or of the space it occupies. Length is not in anything; it is a consequence of the act of measuring. Thus absolute space has no meaning. In 1916 Einstein explained: "We entirely shun the vague word 'space,' of which, we must honestly acknowledge, we cannot form the slightest conception and we replace it by 'motion relative to a practically rigid body of reference.' "[9] With the general theory of relativity the number of spaces increased beyond calculation to equal the number of moving reference systems of all the gravitational fields generated by all of the matter in the universe. In 1920 Einstein summed up boldly: "there is an infinite number of spaces, which are in motion with respect to each other."[10] Fortunately Lenin was too busy making a revolution to take notice.

While physical scientists were trying to come to terms with the heterogeneity of abstract space, natural scientists began to investigate the relation between the structure of living organisms and their spatial orientation. In 1901 the Russian physiologist Elie de Cyon published an article on the "natural" foundation of Euclidean geometry based on results of experiments that he had been conducting for over twenty years on the physiological origins of experiencing space.[11] His hypothesis was that the sense of space is rooted in the semicircular canals of the ear. Animals with two canals experience only two dimensions and those with one canal are oriented in one. Humans experience three dimensions because they have three canals set in perpendicular planes, and three-dimensional Euclidean space corresponds to the physiological space determined by the orientation of these canals. From these experiments Cyon concluded that the sense of space is not inherent and that Kant's theory that it is an *a priori* category of the mind was wrong. Only the semicircular canals are inherent, and our sense of space derives from them and remains dependent upon them. The boldness of these claims, particularly the attack on Kant, triggered a good deal of scholarly criticism,[12] but Cyon was undaunted and continued to extend his theory. In 1908 he argued that the sense of time also was dependent upon the semicircular canals.[13] The following year his results were incorporated into a classic of theoretical biology, Jacob von Uexküll's *Umwelt und Innenwelt der Tiere.*

Uexküll asks the biologist to set aside everything that he takes for

granted in his own world—nature, earth, heavens, objects in space—and focus on only that part of the environment that a particular organism can actually experience. Although all animals live in the same environment, they have their own surrounding world (*Umwelt*). Each species responds to the outer world in its own way, and that response creates its special inner world (*Innenwelt*). The lower animals react to stimuli directly, and only higher animals with some organ of sight develop a proper sense of space. Their brains recognize the surrounding world not merely by direct contact but are also able to mirror objects and spatial relations in the environment. This mirror world or counterworld (*Gegenwelt*) differs with each type of nervous and muscular system. Thus the inner worlds, surrounding worlds, and counterworlds vary with the "building plans" of each animal and constitute different senses of space.

Uexküll modified and extended Cyon's theory to the entire animal kingdom and concluded that the sense of space of all animals, however rudimentary, varied with their unique physiology. Each had special dimensions, even the space sense of one-celled animals. The amoeba's space was a limited one, but he reconstructed it in great detail and characterized it as a "most lively work of art." His appreciation of the creative force generated by the needs and structural patterns of animals led him to a critique of Darwin's theory of natural selection. "It is not true, as people are accustomed to think, that nature compels the animal to adapt, but on the contrary, the animal forms its nature according to its special needs."[14] Among the throng of worlds and living spaces, he speculated, there may also be higher worlds of greater dimensions that we are unable to see, as the amoeba is unable to see the stars in our sky.

This reminder that there are complete worlds with distinctive spatial orientations scattered all along the phylogenetic scale challenged the egocentrism of man. Another challenge came from social scientists. Adventurers and scholars had long sailed about the earth and dug into its crust to find out about other societies, but they always reconstructed them in the uniform space of the modern Western world, never imagining that space itself might vary from one society to another as much as did kinship patterns and puberty rites. Durkheim's arguments for the social relativity of space and its heterogeneity were part of his general theory of the social origin of basic categories of experience.[15] In *Primitive Classification* he challenged the theory, attributed to Sir James Frazer, that social relations are based on logical relations inherent in human understanding. He argued the

opposite—that logical categories derive from social categories, space being one of them. To illustrate he described the Zuñi Indians who divided space into seven regions—north, south, east, west, zenith, nadir, and center—which derived from social experience and in which all objects belonged. The wind and air belonged to the north, water and spring to the west, fire and summer to the south, earth and frost to the east. Different birds and plants belonged to specific regions as did the energies of life. The north was the region of the pelican and crane, the evergreen oak, force and destruction. He concluded that their space was "nothing else than the site of the tribe, only indefinitely extended beyond its real limits."[16] Space is heterogeneous in two senses: it varies from society to society, and within societies such as the Zuñi it has different properties in different regions.

In *The Elementary Forms of the Religious Life* Durkheim elaborated on the heterogeneous nature of space, again as part of a general theory of the social origins of the categories of thought. If space were absolutely homogeneous, he argued, it would be useless to coordinate the varied data of sensuous experience. To identify things in space it must be possible to place them differently—to put them above and below, right and left—and so in every society space is heterogeneous. But there is a collective sense of these unique spaces, shared by all member of a society, hence they must have a social origin; and there is evidence that these spatial classifications are structurally similar to social forms: "There are societies in Australia and North America where space is conceived in the form of an immense circle, because the camp has a circular form; and this spatial circle is divided up exactly like the tribal circle, and is in its image. There are as many regions distinguished as there are clans in the tribe, and it is the place occupied by the clans inside the encampment which has determined the orientation of these regions."[17] Durkheim believed that there was a multitude of such spaces about the surface of the globe, differing from each other like patterns of Oriental rugs.[18] In Germany another social scientist unearthed a plurality of spaces buried in time.

Spengler believed that different cultures had a unique sense of space (as well as time) manifested in a symbolism that embraced every aspect of life. This sense of space or extension is the "prime symbol" of a culture, inherent in political institutions, religious myths, ethical ideals, principles of science, and the forms of painting, music, and sculpture. But it is never conceptualized directly, and it is

necessary to interpret many aspects of a culture to grasp its particular notion of extension. The infinitely extended space of the modern "Faustian" era is but one of several in which the great cultures of history have been staged.

The Egyptians conceived of space as a narrow path down which the individual soul moves to arrive at the end before ancestral judges. Their most distinctive constructions are not buildings but paths enclosed by masonry. Reliefs and paintings are done in rows and lead the beholder in a definite direction. In Chinese culture space is also a path that wanders through the world; but the individual is led to his ancestral tomb by nature, by "devious ways through doors, over bridges, round hills and walls," not by rows of stones like the Egyptians. Greek space was dominated by a sense of nearness and limit. The universe was a cosmos, a "well-ordered aggregate of near and completely viewable things" covered by the corporeal vault of heaven. Its government was a clearly circumscribed city-state; its temples, finite structures formed about a center, enclosed by a colonnade. Classical art had "closed" figures with sharply bounded surfaces, and the predominance of the body brought the eye from the distant to the "near and still." Its statues, like its buildings, were clearly delimited, with no suggestion of the infinite or unbounded, and it produced a geometry of regular, closed figures that were the ideal forms of the earth and heaven.[19]

Spengler's account of space in the modern era expands with an exuberance that parallels his thesis—that the prime symbol of the Faustian soul of the modern age is limitless space. Faust's restless striving, the soaring of Gothic cathedrals, and the proliferation of geometric spaces reflect this sense of infinity. Modern music such as Wagner's *Tristan* liberates the soul from material heaviness and sets it free to move towards the infinite. He concludes with a cannonade of evidence for the modern era's sense of the limitlessness of space: "the expansion of the Copernican world picture into that aspect of stellar space that we possess today; the development of Columbus's discovery into a worldwide command of the earth's surface by the West; the perspective of oil painting and of tragedy-scene; . . . the passion of our civilization for swift transit, the conquest of the air, the exploration of the Polar regions and the climbing of almost impossible mountain peaks."[20]

The proliferation of geometrical and physical spaces had a great effect on mathematics and physics but did not generally influence

thinking in other areas. The exploration of the experience of space of the amoeba, the Zuñis, and the ancient Egyptians was important to some natural and social scientists but made little stir outside their respective disciplines. However, the multiplication of points of view in painting had an impact far beyond the world of art. It created a new way of seeing and rendering objects in space and challenged the traditional notion of its homogeneity.

The depiction of space in painting reflects the values and fundamental conceptual categories of a culture. In the Middle Ages the importance of persons and things in heaven and earth determined their size and position in space. With the introduction of perspective, objects were rendered to scale according to their actual size and were located in space to reproduce the relations of the visible world.[21] In 1435 the Florentine painter Leon Battista Alberti formulated the rules of perspective that were to govern painting for four hundred and fifty years. He intended to help painters create a unified pictorial space in which God's order, the harmony of nature, and human virtues would be visible. Samuel Edgerton has observed that this formulation of perspective was a "visual metaphor" for the entire Florentine world at that time: its politics were just coming under the authority of the Medici oligarchy; there was a growing rationality in banking and commerce that relied on mathematical orderliness and utilized the system of double-entry bookkeeping; the Tuscan hills were terrassed with neat rows of olive trees and parallel strings of grape vines, all controlled by a centralized land management; proportion and orderliness were valued in every area of culture and were expected to regulate decorum and dress.[22] Although there were occasional variations or intentional violations of the rules of perspective, they governed the rendering of space in art until the twentieth century. Then, under the impact of the Impressionists, Cézanne, and the Cubists that perspectival world broke up as if an earthquake had struck the precisely reticulated sidewalks of a Renaissance street scene.

When the Impressionists left their studios and went outside to paint, they discovered a new variety of points of view as well as shades of color and light. They broke Alberti's rule that the canvas should be placed precisely one meter from the ground, directly facing the subject, and positioned it up and down and at odd angles to create new compositions. They moved in and out of the scene, and the frame ceased to be the proscenium of a cubed section of space that it had traditionally been. Daubigny carried to an extreme their

rejection of the fixed point of view when he painted from a houseboat as it rocked at anchor or actually sailed along the Seine. With these new points of view the Impressionists abandoned the scenographic conception of space.[23]

However varied the scope and angle of Impressionist space, it was essentially one space as seen from one point of view. Cézanne was the first to introduce a truly heterogeneous space in a single canvas with multiple perspectives of the same subject. In *Still Life* (1883–1887) a large vase is reconstructed from two points of view with the elliptical opening more rounded than a strict adherence to scientific perspective would allow and gaping fuller than the opening of the other vase standing next to it on the same flat surface in the same plane. In *Still Life with a Basket of Apples* (1890–1894) the corners of the table are seen from different vantage points and grafted together to create balance with the other shapes. His *Portrait of Gustave Geoffroy* (1895) combines a frontal view of the seated subject with an aerial view of the table before him on which open books are lying with almost no perspectival foreshortening. This optically impossible mixture of points of view enabled Cézanne to show all that he wanted of the man and his work and at the same time conform to the requirements of composition. Cézanne was enamored of the shape of Mont Sainte-Victoire and painted it hundreds of times. By using different perspectives for different parts of the landscape he gradually pulled it out of the distant background toward the foreground until in the later paintings it loomed large as a symbol of his lifelong fascination with form and space. His landscapes broke ground for modern art as he gouged out quarries and cleared trees to make the terrain of Aix-en-Provence conform to his artistic needs.

Cézanne's primary commitment was to the composition of forms on the flat surface of the canvas; conventions for accurately rendering volume and depth were secondary.[24] While most painters had tried to create an illusion of three-dimensional space, Cézanne accentuated the flatness of the picture surface and frequently violated the rules of perspective in deference to it. He never entirely abandoned the techniques for showing depth but compromised them when necessary. And so he broke up consistent linear perspective with multiple perspectives, he violated aerial perspective in landscapes by painting objects in the distance as bright or brighter than those in the foreground, and he occasionally chipped off a piece of pottery when overlapping would interfere with his overall design. He sought to reconcile the properties of volumes in three-dimen-

sional space with the two-dimensionality of the picture plane, and his paintings vibrate from the tension. He also wanted to fuse perceptions and conceptions—the way we see things from a single point of view and the way we know them to be from a composite of several views. Experience tells us that the opening of a vase is circular, but when viewed from the side we see it as an ellipse. Cézanne combined the two perceptions visually with multiple perspectives.

These daring innovations were possible only for someone with a sharp sense of space. Cézanne's unique sensitivity to the effect of slight shifts in point of view is revealed in a letter to his son of September 8, 1906: "Here on the edge of the river, the motifs are plentiful, the same subject seen from a different angle gives a subject for study of the highest interest and so varied that I think I could be occupied for months without changing my place, simply bending more to the right or left."[25] Subtle differences in form and perspective that most painters would not notice occupied Cézanne—fascinated him—for months. He wrestled with them until, as Merleau-Ponty believed, he created "the impression of an emerging order, of an object in the art of appearing, organizing itself before our eyes."[26] He "realized" objects in space as they take form, as the eye darts about the visual field and hovers around things until they are identified in space and integrated into our world of experience. For Cézanne an object in space was a multitude of creations of the seeing eye that varied dramatically with the most minute shifts in point of view.

One of the great fallacies of historical reconstruction is the characterization of events as transitional. The work of Cézanne is one of the most fully realized corpuses in the history of art, and it is particularly misleading to view it as a transition to modern art. Nevertheless the important innovations he made in the rendering of space—the reduction of pictorial depth and the use of multiple perspective—were carried further by the Cubists in the early twentieth century and have therefore come to be viewed as transitional. The Cubists repeatedly expressed their debt to Cézanne and used his techniques to create even more radical treatments of space. Their use of multiple perspective also shows a strong similarity to the cinema, which broke up the homogeneity of visual space.

Like modern art, the cinema offered some new and varied spatial possibilities. Theater viewers saw action in the same frame, from a single angle, and from an unchanging distance in a space that was stationary and uniform from beginning to end. But the cinema could manipulate space in many ways. The frame could be changed by

moving the camera or changing the angle of the lens. The point of view or distance from the action could be shifted with different camera positions, and the space in view could move continuously with a pan. The multiplicity of spaces produced by these camera techniques was augmented by editing, which made it possible to shift quickly between points of view and break up spatial coherence even further.[27] The cinema also showed places around the world to which the audience rarely had access. In 1898 a Viennese physician made a film of a surgically exposed pulsating heart. The camera also looked into the interior space of the human body by means of the new x-rays. An article of 1913 on "The Widening Field of the Moving-Picture" described the "Roentgencinematography" of a radiologist at Cornell Medical College who made a film from a succession of x-rays of a mixture of bismuth subcarbonate and buttermilk as it passed through the intestines.[28]

The two pioneers of Cubism, Picasso and Braque, incorporated the innovations of Cézanne and the cinema and brought about the most important revolution in the rendering of space in painting since the fifteenth century. They abandoned the homogeneous space of linear perspective and painted objects in a multiplicity of spaces from multiple perspectives with x-ray-like views of their interiors. Picasso's first Cubist work, *Les Demoiselles d'Avignon* (1907), showed two figures in frontal pose but with noses in sharp profile. The seated figure has her back to the viewer but her head is seen from the front. Delaunay's Cubist *Eiffel Tower* (1910–11; Figure 5) is assembled to suggest the ubiquity of the tower in Parisian life. Houses from different parts of the city are clustered under and about its base like gifts under a Christmas tree. Their windows peer at it from all sides, even from inside it. The lower section is shown from a corner and the ironwork of the rear is perched on the side to indicate both the airiness of the structure and that it can be seen from all directions. Part of the tower has been taken out and upper sections collapsed toward the base to suggest its height. The tower was a particularly good subject because it really could be seen from anywhere and symbolized the Cubist objective to rearrange objects as seen from multiple perspectives.

One explanation for multiple perspective was that it enabled the Cubists to transcend the temporal limitations of traditional art. In 1910 the essayist Roger Allard described the Cubist painting of Jean Metzinger as "elements of a synthesis situated in time."[29] The following year Metzinger explained that Cubists have "uprooted the

Fig. 5. Robert Delaunay, *Eiffel Tower*, 1910–11.

prejudice that commanded the painter to remain motionless in front of the object, at a fixed distance . . . They have allowed themselves to move round the object, in order to give, under the control of intelligence, a concrete representation of it, made up of several successive aspects. Formerly a picture took possession of space, now it reigns also in time."[30] In 1913 Apollinaire commented that Cubists have followed scientists beyond the third dimension and "have been led quite naturally . . . to preoccupy themselves with new possibilities of spatial measurement which, in the language of the modern studies, are designated by the term: the fourth dimension."[31] There was a popular interest in the fourth dimension in France at that time, which might have inspired the Cubists.[32]

In addition to rendering multiple points of view, the Cubists also revised the traditional concept of depth. Formerly artists conceived of painting as the representation of an object in three-dimensional space, but modern artists rejected the notion that art was supposed to represent anything. Rather it must be what it is—a composition of forms on a flat surface. In 1900 the art critic Maurice Denis announced this essential characteristic of modern art: "a picture—before being a war horse, a nude woman, or an anecdote—is essentially a flat surface covered with colors assembled in a certain order."[33] This flattening was accomplished by the Cubists in part by multiple perspective but also by multiple light sources, the reduction of aerial perspective, and the breakdown of discrete forms and consistent overlapping. All of these techniques can be seen in Braque's *Still Life with Violin and Pitcher* (1910; Figure 6). The violin is broken up and shown from several points of view. Color is limited to shades of white, black, and brown, and there is no aerial perspective. The wild overlapping suggests forms and depth, but it is impossible to determine exactly what forms in what depths. The light source is ambiguous and casts shadows in different directions, but the fold of paper at the top throws a distinct shadow to the left while the illusionistic nail casts one to the right. This contradiction further interrupts a consistent sense of depth. There is another ambivalence about two- and three-dimensional space with the molding on the wall, which indicates depth clearly at one corner but then breaks into the flatter composition of the rest. The Cubists, like Cézanne, never entirely abandoned depth but reduced it, creating tensions between the world of three dimensions that was their inspiration and the two-dimensionality of painting that was their art. The *trompe-l'oeil* nail is a symbol of this creative tension. It is the most unambiguously three-dimen-
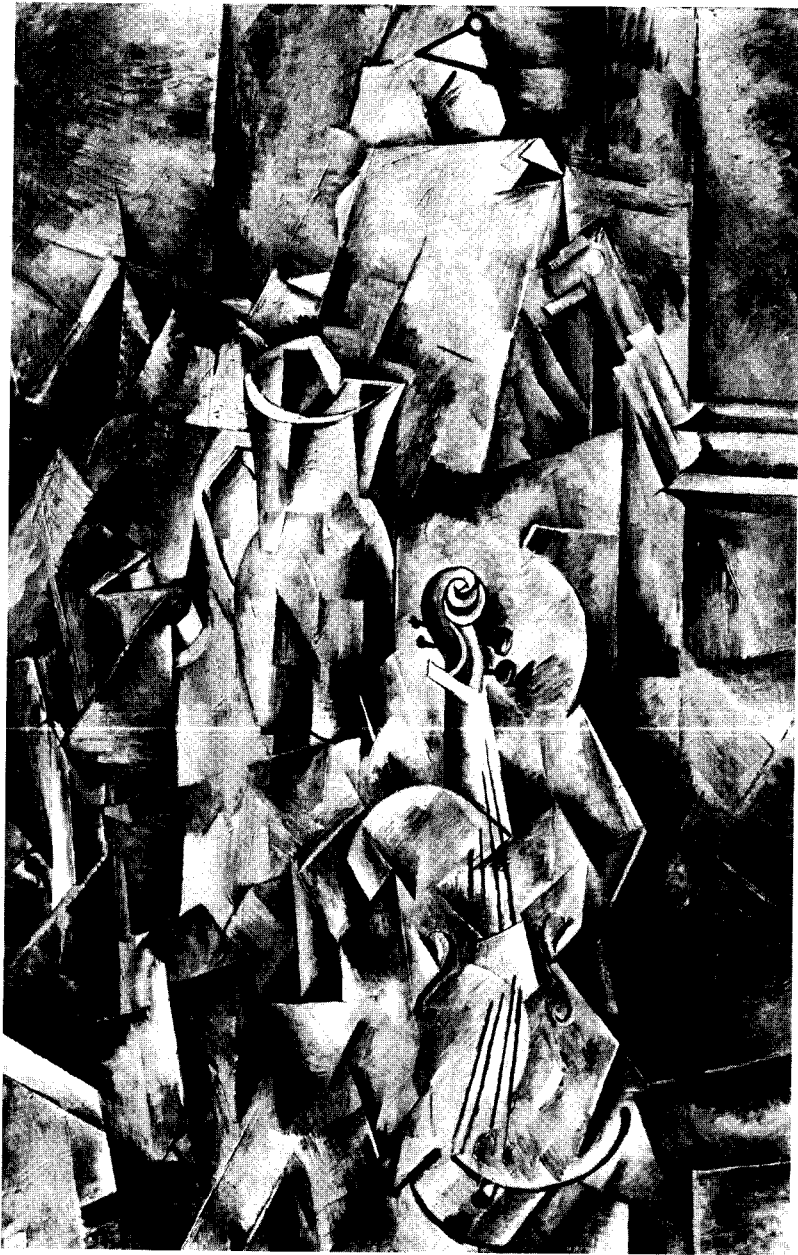
Fig. 6. Georges Braque, *Still Life with Violin and Pitcher,* 1910.

sional object in the painting and is represented clearly with an identifiable light source, but it also contradicts the illusion of depth by proclaiming that the painting *is* flat and could be nailed to the wall like a piece of paper. It is a stake in the heart of the third dimension of painting.

The Cubists' break with the space of traditional art was the subject of an essay of 1912 by Gleizes and Metzinger. They argued that the convergence technique of perspective records only visual space, but to establish pictorial space the artist must react to the world, as does the viewer, with all of the faculties. "It is our whole personality which, contracting or expanding, transforms the plane of the picture. As it reacts, this plane reflects the personality back upon the understanding of the spectator, and thus pictorial space is defined—a sensitive passage between two subjective spaces." Modern art is no longer content with slavishness to the rules of scientific perspective. "The worth of river, foliage, and banks, despite a conscientious faithfulness to scale, is no longer measured by width, thickness, and height, nor the relations between these dimensions. Torn from natural space, they have entered a different kind of space, which does not assimilate the proportions observed." That different kind of space must no longer be confused with "pure visual space or with Euclidean space." It is the space of all of the faculties and emotions and, if it is to be linked with any geometry, it would be a non-Euclidean geometry such as Riemann's.[34]

The proliferation of perspectives and the breakup of a homogeneous three-dimensional space in art seemed to many to be a visible representation of the pluralism and confusion of the modern age. As early as 1923 Picasso tried to defend his achievement from such forced juxtapositions: "Mathematics, trigonometry, chemistry, psychoanalysis, music and whatnot, have been related to Cubism to give it an easier interpretation. All this has been pure literature, not to say nonsense, which has only succeeded in blinding people with theories."[35] This is an important reminder that Cubism came out of pressures and challenges within art. Nevertheless Cubism did influence, and was influenced by, other developments. Chronophotography and cinema no doubt had some effect, however indirect, on the way Cubists rendered space and sought to give a sense of the development of an object in time as a construction of successive points of view. X-ray must have had something to do with the Cubist rendering of the interior of solid objects. In spite of Picasso's warning, critics continued to draw parallels between Cubism and a number of

other cultural developments. Fritz Novotny suggested that the "alienation of objects from reality" in Cubism was symptomatic of a culture that affirmed the "unreality of place" and that was plagued by nihilism.[36] Siegfried Giedion linked Cubism with a new sense of the many-sidedness of moral and philosophical issues.[37] Pierre Francastel saw Cubism as a reflection of the fragmented space of the modern age.[38] Max Kozloff saw a connection with the relaxation of rules of grammar where words are run together as in the writing of Joyce.[39] Wylie Sypher stressed its similarity to the shifting perspectives of the new cinema and used it as a metaphor for the modern "world without objects."[40]

Painters and novelists faced contrasting challenges in reproducing the dimensions of experience. Painters, limited to a single instant, used multiple perspective to portray objects as they came into view in time. Writers, limited to a series of single settings, used multiple perspective to depict different views of objects in space. Proust and Joyce used the technique in several ways.

While riding in a carriage Marcel was moved by the sight of the twin steeples of the church of Martinville, which continually changed position as he approached them along a winding road. His description of the shifting steeples is a literary analog of a Cubist painting.[41] His account of successive views of a sunrise seen through the windows of a speeding train made the connection with painting directly: "I was lamenting the loss of my strip of pink sky when I caught sight of it afresh, but red this time, in the opposite window which it left at a second bend in the line, so that I spent my time running from one window to the other to reassemble, to collect on a single canvas the intermittent antipodean fragments of my fine scarlet, ever-changing morning, and to obtain a comprehensive view of it and a continuous picture."[42] In addition to such multiple perspectives of objects viewed over a relatively short time, there is another proliferation of space in Proust that is produced over long stretches of time by the action of feelings on the settings of important events. After many years Marcel returned to the Bois de Boulogne to try and recapture the pleasures of his childhood. But all was changed. The carriages were replaced by motor cars; the women wore different hats. Space itself, he realized, was as malleable as the objects in it: "The places that we have known belong now only to the little world of space on which we map them for our convenience. None of them was ever more than a thin slice, held between the contiguous impressions that composed our life at that time; remembrance of a particular form is but regret for a particular moment; and houses, roads,

avenues are as fugitive, alas, as the years."[43] Spaces are subject to changing perspectives, thoughts, and feelings and suffer the unceasing transformation of things in time.

We have already observed in a discussion of simultaneity how Joyce reconstructed events, such as those in the "Wandering Rocks" episode, from a number of points of view in order to give a fuller sense of them. He also envisaged a multiplicity of coexisting universes of different dimensions. Bloom reflects on the size of his universe and sees it as one of an infinite number enclosed within one another as in a set of Chinese boxes. He thinks of the star Sirius 57,000,000,000,000 miles distant, 900 times as large as the earth, and then of the nebula of Orion in which 100 of our solar systems could be contained. He then considers the infinitesimally small universes around him, "the incalculable trillions of billions of millions of imperceptible molecules contained by cohesion of molecular affinity in a single pinhead" and "the universe of human serum constellated with red and white bodies, themselves universes of void spaces constellated with other bodies." In the final account of his hero, Joyce mocks the convention of giving a precise, single location of action. Bloom is in bed next to Molly and telling her about his day: "Listener S.E. by E.; Narrator, N.W. by W.: on the 53rd parallel of latitude, N. and the 6th meridian of longitude, W.: at an angle of 45° to the terrestrial equator."[44] Here the relative position of the two lying head to foot is identified by means of this incongruous navigational jargon, which ironically brings to mind the impossibility of knowing the precise location of bodies in space. We know their exact location on earth, but where is the earth? Moreover, even if we did know that, Joyce implied, it would not reveal the crucial information about place. Odysseus's Mediterranean, Bloom's Dublin, his bed at 7 Eccles Street are not the essential settings, because the real action takes place in a plurality of spaces, in a consciousness that leaps about the universe and mixes here and there in defiance of the ordered diagraming of cartographers. Edmund Wilson has interpreted these shifting perspectives as part of a general movement in European culture. "Joyce is indeed really the great poet of a new phase of human consciousness. Like Proust's or Whitehead's or Einstein's world, Joyce's world is always changing as it is perceived by different observers and by them at different times."[45] Thus the two most innovative novelists of the period transformed the stage of modern literature from a series of fixed settings in a homogeneous space into a multitude of qualitatively different spaces that varied with the shifting moods and perspectives of human consciousness.

In geometry and physics, biology and sociology, art and literature attacks were launched on the traditional notions that there is one and only one space and that a single point of view is sufficient to understand anything. Sometimes the historical record is generous and supplies abundant evidence for a cultural change. In this period it also supplied an interpretation of that change with the philosophy of "perspectivism."

After Nietzsche left the university he began to criticize the narrowness of academic thinking—a Platonism that denied the validity of knowledge acquired through the senses, a positivism that was blind to the inherent subjectivity of knowledge. Scholars, he wrote, "knit socks for the spirit."[46] He came to life in the clear air outside the academy, and like the Impressionists who discovered a world of new colors *en plein air*, he found new philosophical topics and a fresh poetic language with which to write about them. In opposition to the positivists' belief in the truth of objective facts, he insisted that there are no such things, only points of view and interpretations, and he urged philosophers "to employ a *variety* of perspectives and affective interpretations in the service of knowledge." This philosophy was called "perspectivism," and in 1887 he proclaimed its method.

> Henceforth, my dear philosophers, let us be on guard against the dangerous old conceptual fiction that posited a "pure, will-less, painless, timeless knowing subject"; let us guard against the snares of such contradictory concepts as "pure reason," "absolute spirituality," "knowledge in itself": these always demand that we should think of an eye that is completely unthinkable, an eye turned in no particular direction, in which the active and interpreting forces, through which alone seeing becomes seeing *something*, are supposed to be lacking; these always demand of the eye an absurdity and a nonsense. There is *only* a perspective seeing, *only* a perspective "knowing"; and the *more* affects we allow to speak about one thing, the *more* eyes, different eyes, we can use to observe one thing, the more complete will be our "concept" of this thing, our "objectivity." But to eliminate the will altogether, to suspend each and every affect, supposing we were capable of this—what would that mean but to *castrate* the intellect?[47]

We must look at the world through the wrong end of the telescope as well as the right one, see things inside out and backwards, in bright and dim light. In this philosophy spaces proliferate with points of view.

In the twentieth century perspectivism was formalized by the

Spanish philosopher José Ortega y Gasset. Rationalists argue that there is one and only one truth that can be grasped by factoring out the errors that arise from viewing things from subjective points of view. Rejecting this approach, Ortega formulated his own theory of perspectivism in 1910: "this supposed immutable and unique reality ... does not exist: there are as many realities as points of view."[48] In 1914 he made perspective into the stuff of reality: "God is perspective and hierarchy; Satan's sin was an error of perspective. Now, a perspective is perfected by the multiplication of its viewpoints."[49] The rationalist position maintained the homogeneity of space, and Ortega countered that there were as many spaces in reality as there were perspectives on it. In a manifesto for the first issue of the journal *El Espectador* (1916), he reaffirmed the validity of the individual point of view. Reality is perspective. The war itself, he suggested, was brought about by a narrow-mindedness among nations that failed to see the larger context of their actions. People must react against this "exclusivism" and develop a broad outlook that embraces a multitude of perspectives.[50]

In a lecture on the historical significance of Einstein, Ortega linked perspectivism and the general theory of relativity and maintained that the coincidence of their publication in 1916 was a sign of the time. The two doctrines signified a breakdown of the old notion that there is a single reality in a single, absolute space. "There is no absolute space because there is no absolute perspective. To be absolute, space has to cease being real—a space full of phenomena—and become an abstraction. The theory of Einstein is a marvellous proof of the harmonious multiplicity of all possible points of view. If the idea is extended to morals and aesthetics, we shall come to experience history and life in a new way."[51] He also suggested ethical and political consequences. The peace broke down in Europe because each nation was fixed in a narrow outlook. The British "white man's burden," the French *"mission civilisatrice,"* and the German *"deutsche Kultur"* were but different points of view on the same landscape, but each nation viewed its own as the only true one.

Ortega once described perspectivism in terms applicable to Cubism: "The truth, the real, the universe, life ... breaks up into innumerable facets and vertices, each of which presents a face to an individual."[52] His philosophy itself reflected many others. He was influenced by, or noted parallels to, Riemann, Lobatchewsky, Mach, Einstein, Uexküll, Proust, and Joyce and shared their restlessness with conventional notions about the sanctity of a single space or point of view. He challenged what he felt to be an arrogance deeply

embedded in Western culture, an egocentrism that believed that one point of view—be it that of a mathematician, philosopher, or nation—was alone correct. Knowledge progresses and cultures advance as the diversity of concrete experience is allowed to be heard. The world is understood by the observer who localizes reality "in the current of life which flows from species to species, from people to people, from generation to generation and from individual to individual, gradually possessing itself of more and more universal reality."[53] There is danger that such a philosophy of perspective can become a runny, undisciplined pluralism, an excuse for having no point of view at all, but in this period it provided a corrective to the epistemological and aesthetic egocentrism that had dominated Western culture for so long.

Durkheim's theory of the social relativity of space gave weight to societies outside the Western world, and even Spengler was able to appreciate the broad range of achievements of cultures based on a different sense of space. Ortega's philosophy of perspectivism in its social and political implications lined up clearly on the side of pluralism and democracy against monism and monarchy. It implied that the voices of many, however untrained or chaotic, are a desirable check on the judgment of a single class, a single culture, or a single individual. Even Nietzsche, who had contempt for democracy and who railed against the leveling effect of the masses, understood that the overman must achieve transcendence through a continual struggle, and hence dialogue, with the masses. Zarathustra repeatedly returned to the masses, even though he was always misunderstood and continually threatened by contact with them. Although these various arguments on behalf of the heterogeneity of space did not always address themselves to the social and political terms of social equality versus social privilege and democracy versus monarchy, they form part of a general cultural reorientation in this period that was essentially pluralistic and democratic.

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A second major issue raised about the nature of space was its constituency.

The traditional view that space was an inert void in which objects existed gave way to a new view of it as active and full. A multitude of

discoveries and inventions, buildings and urban plans, paintings and sculptures, novels and dramas, philosophical and psychological theories, attested to the constituent function of space. I will refer to this new conception as "positive negative space." Art critics describe the subject of a painting as positive space and the background as negative space. "Positive negative space" implies that the background itself is a positive element, of equal importance with all others. The term is somewhat unwieldy, but it is accurate and suggests the historical sense of the developments in this period, since it implies that what was formerly regarded as negative now has a positive, constitutive function.

One common effect of this transvaluation was a leveling of former distinctions between what was thought to be primary and secondary in the experience of space. It can be seen as a breakdown of absolute distinctions between the plenum of matter and the void of space in physics, between subject and background in painting, between figure and ground in perception, between the sacred and the profane space of religion. Although the nature of these changes differed in each case, this striking thematic similarity among them suggests that they add up to a transformation of the metaphysical foundations of life and thought.

From the time of Democritus scientists had believed that the stuff of the world was composed of solid bits of matter. In 1897 J. J. Thomson announced his discovery of some even more basic "corpuscles" out of which the elements were built, and developed a model of the atom with these corpuscles (eventually called electrons) orbiting around a nucleus.[54] The Thomson atom was thus largely empty space, and it wiped out the classical distinction between the plenum of matter and the void of space. By 1914 a book about atoms explained that matter had a "spongy" consistency and was "prodigiously lacunary."[55]

In 1876 William Clifford, the English translator of Riemann, formulated a theory that matter and its motion were manifestations of the varying curvature of space. He hypothesized that matter was the location of curvatures in space analogous to "little hills" on a flat surface; "that this property of being curved or distorted is continually being passed on from one portion of space to another after the manner of a wave"; and "that this variation of the curvature of space is what really happens in that phenomenon which we call the motion of matter."[56] In 1898 the American philosopher Hiram M. Stanley identified a trend among physicists of seeing all things as different

states of energy. For them space was not an epistemological form but a product of the struggle for existence among the opposing forces that might displace it. Stanley concluded that space is "not full of things, but things are spaceful."[57] This adjectival form emphasized the active and constituent function, but most nineteenth-century physicists could not conceive of attributing physical functions to space, so they posited a medium called ether, pervading space, which transmitted electromagnetic phenomena like wireless waves and x-rays. A book on the wireless maintained that there is "nothing absolutely solid in nature" and that it is possible for a medium to penetrate all things.[58] Wells's Time Traveller was able to avoid collision with the solid objects that occupied the places through which his machine moved by slipping through the interstices of intervening substances. Another science-fiction writer imagined a "Y-ray" that could increase the spaces between matter to allow one solid body to pass through another.[59] Thus space constituted a large portion of matter, and the medium that was thought to pervade it played an active role in the transmission of energy.

Physical space came fully to life with Einstein's field theory. In 1873 Clerk Maxwell hypothesized that electricity and light travel in waves through fields like those around magnets. Fifteen years later Heinrich Hertz developed instruments to propagate electromagnetic waves through a vacuum, but he, like Maxwell, could not imagine how the wave could oscillate in nothing and so clung to the theory of an ether. Even after the Michelson-Morley experiment failed to detect an ether, physicists continued to spin theories to accommodate the mechanical model for the propagation of waves through a medium of ponderable matter. Einstein boldly abandoned that model. His special theory removed the idea "that the electromagnetic field is to be regarded as a state of a material carrier. The field thus becomes an irreducible element of physical description, irreducible in the same sense as the concept of matter is in the theory of Newton." In Newton's mechanics a particle of light moves through empty and static space. In Einstein's mechanics everything is in movement throughout the field at the same time, and space is full and dynamic and has the power of "partaking in physical events."[60] According to the new physics the universe is full of fields of energy in various states, and space can be thought of to be as substantial as a billiard ball or as active as a bolt of lightning.

The history of architecture is the history of the shaping of space for a variety of political, social, religious, or purely aesthetic reasons.

Greek temples and theaters, Roman basilicas and baths, Byzantine churches, Romanesque and Gothic cathedrals, Renaissance and Baroque palaces, each style had a distinctive sense of space unique to its period and self-consciously created by architects schooled in its respective artistic conventions.[61] However, around the turn of the century architects began to modify the way they conceived of space in relation to their constructions. Whereas formerly they tended to think of space as a negative element between the positive elements of floors, ceilings, and walls, in this period they began to consider space itself as a positive element, and they began to think in terms of composing with "space" rather than with differently shaped "rooms." Although this change was essentially a rethinking of the nature of architectural design, it was facilitated by three inventions that liberated architects from many structural requirements for illumination, load-bearing, and ventilation and made it possible to sculpt interior space freely.

There was an enormous increase in the use of artificial illumination even before the introduction of the electric light: between 1855 and 1895 an average household in Philadelphia increased its use of illumination twenty times.[62] But this came mostly from burning oil or gas and imposed great architectural limitations. The invention of the gas mantle in the 1880s eliminated the soot, but even so the electric light bulb quickly came to dominate the market and by the mid-nineties began to revolutionize architecture and interior design. It was cooler and cleaner than gas and could be placed almost anywhere, so architects could build with whatever natural light they desired or eliminate it completely.

In 1892 the French engineer François Hennebique increased the load-bearing strength of reinforced concrete by replacing the iron rods with steel and bending them near the supports. He used it in his own house to support a tower that cantilevered four meters out from the building. The French remained leaders in the development of concrete architecture until the First World War; their fascination with the new material culminated in the monumental Maginot Line. Reinforced concrete enabled architects to fling dramatic new forms all over Europe and America in the early twentieth century, and since it could be poured into molds, there was no end to the unusual shapes or spaces that could be created.[63]

A fully air-conditioned building controls temperature, cleanliness, humidity, and circulation of air. There is some controversy about which building was the first to have all four, but it came into

being some time between 1903 and 1906. Reyner Banham identified the Royal Victoria Hospital in Belfast (1903) as "the first major building to be air-conditioned for human comfort," because the entire plan was adapted to environmental considerations. Stuart W. Cramer coined the term "air-conditioning" in lectures and patents filed in 1904–1906. But the crucial invention was the dew-point control system for humidity regulation that Willis Carrier patented in 1906.[64] Liberated from the necessity of providing structural openings for ventilation, architects could open or close spaces at will.

With the flood of industrial goods in the nineteenth century, Europeans lost their sense of the dignity of space and rooms were cluttered with knickknacks and mementos, bird cages and aquariums, ornate picture frames, moldings, drapes, and overstuffed furniture. Large interior spaces were thought to be a sign of incompleteness or poverty. As Siegfried Giedion observed, these fashionable interiors "with their gloomy light, their heavy curtains and carpets, their dark wood, and their horror of the void, breathe a peculiar warmth and disquiet."[65] Around the turn of the century, as Art Nouveau designs crawled everywhere, there was a movement among interior designers and architects to clean up the gobbledygook in rooms and the excessive ornamentation on exteriors. In an article of 1895 the British architect Charles Voysey expressed disgust with the "motley collection of forms and colors with which most rooms are crowded."[66] He criticized the clutter and eclecticism of nineteenth-century taste and appealed for flat surfaces and simple, functional structures. In Germany, Friedrich Naumann praised ships, bridges, railway stations, and market halls as the new buildings of a machine age that had "no stuck-on decoration, no frills."[67] In a famous essay of 1908, "Ornament and Crime," the Austrian designer Adolf Loos argued that erotic cave drawings, bathroom graffiti, and architectural ornamentation were manifestations of the same primitive impulse that in the contemporary world leads to degeneration and crime. He concluded that "the evolution of culture marches with the elimination of ornament from useful objects."[68]

The Dutch architect Hendrick Berlage subdued ornament on the Amsterdam Stock Exchange building that he constructed between 1890 and 1903. He articulated his aesthetics of unadorned design in 1905, and in 1908 commented on the excessive concern for ornamentation in earlier times: "The nineteenth century forgot to build from the inside out; it was an architecture of façades that sacrificed reality to appearance." Architecture must recognize its true pur-

pose as an "art of space." The primary subjects of architecture are not so much walls and ceilings as the spatial enclosures created by them.[69] This conceptual shift was presented even more forcefully in the writings and buildings of Frank Lloyd Wright. His Larkin Soap Company building in Buffalo (1904) was essentially a single room closed to the outside. Wright himself identified its role in the history of architecture. It was "the original affirmative negation" that showed "the new sense of 'the space within' as reality." His interior spaces were carefully designed to conform to human needs and were to be the rationale for the entire structure. Space was the basic element in Wright's architectural design of Unity Temple (Oak Park, Illinois, 1906), which had a simple cubical interior that was visible on the outside of the building constructed with simple blocks of cement and an unadorned concrete slab roof. He explained that his initial conception was "to keep a noble ROOM in mind, and let the room shape the whole edifice." Although this account used the more traditional architectural terminology that conceived of space in terms of rooms, the sense of it was modern, as Wright went on to make a bold historical claim about his conception of the positive function of space: "The first conscious expression of which I know in modern architecture of the new reality—the 'space within to be lived in'— was Unity Temple in Oak Park. True harmony and economic elements of beauty were consciously planned and belong to this new sense of space-within . . . In every part of the building freedom is active. Space [is] the basic element in architectural design."[70]

This reference to a sense of freedom evoked by the space of a building echoed the aesthetic theory of the German philosopher Theodor Lipps and its application to architecture by the British architect Geoffrey Scott. In 1903 Lipps argued that our bodies unconsciously empathize with architectural forms. We feel free when there are no external constraints on our bodily movements, and buildings with large open spaces offer that freedom.[71] In 1914 Scott elaborated an "architecture of humanism" based on this theory. Architects project human feelings into a building, and it in turn impresses viewers with an immediate physical response. We feel uncomfortable in a room fifty feet square and seven feet high, because it constricts our sense of freedom. Heretofore architects have neglected the importance of space in their art. "The habits of our mind are fixed on matter. We talk of what occupies our tools and arrests our eyes. Matter is fashioned; space comes. Space is 'nothing'—a mere negation of the solid. And thus we come to overlook it." Architec-

ture is the one art form that deals with space directly. Painting can depict space, poetry can form an image of it, music can offer an analogy, but only architecture can actually create it. "To enclose a space is the object of building; when we build we do but detach a convenient quantity of space, seclude it and protect it, and all architecture springs from that necessity. But aesthetically space is even more supreme. The architect models in space as a sculptor in clay. He designs his space as a work of art." Scott summarized the striving of a generation of architects to recognize the constituent function of space.[72]

The crowding of interior space by objects in rooms was matched by a growing crush of people, vehicles, and buildings in cities; urban planning arose to deal with the problem. All the different proposals conceived of space as a positive, constitutive factor in urban planning. Reinhard Baumeister and Joseph Stübbens oriented their designs to the needs of traffic and cut large arteries through cities to accelerate the flow.[73] Ebenezer Howard, who pioneered the modern "garden city" idea, planned cities around areas of greenery. Camillo Sitte insisted that the rhythmic distribution of spaces in pleasing and functional patterns should be the top priority. He argued that urban spaces should be enclosed to give them a definite shape. He also criticized the horror of empty space that repeatedly led planners to put statues and monuments in the center of town squares. His model was the open plazas of medieval towns that functioned as market or meeting places, and his motto was to "keep the middle free."[74] While most interior decorators, architects, and city planners felt that their principal decision was where to place solid objects, others, like Voysey, Berlage, and Sitte, reversed that priority and sought to utilize the aesthetic potential of space itself.

Changes in stage design conformed to the same lines. In the 1890s the German designer Adolphe Appia abandoned painted backdrops and created "rhythmic" spaces with sculptured architectural forms and dramatic chiaroscuro lighting.[75] In England Gordon Craig carried the ideas of Appia further toward making the stage a positive space.[76] He also eliminated the deceptive orchards and arcades on painted backdrops and recomposed the space with drapes, screens, and simple geometric forms. As painters rejected the illusionistic perspective of traditional art, Appia and Craig eliminated the illusions of depth created by traditional stage design. Accompanying these simplified stage designs were simplified costumes, stripped of excessive ornament in the manner of Loos's interiors and Berlage's

façades. The stage must be adorned only with light, shadow, and nonrepresentational sets that merely accented the space in which actors moved.

National festivals in Germany in this period were staged in spaces around national monuments where masses of people could sing and dance. Earlier designers had provided a space for national worship in the form of cemeteries around monuments, but this period saw an evolution "from dead to a living space, one which was taken up not by graves but by living people acting out their national liturgy."[77] George Mosse identified the emergence of such a "living" space around the Kyffhauser monument, completed in 1896. Erected to celebrate the hundredth anniversary of the Battle of Leipzig, the Völkerschlachtdenkmal, completed in 1913, included both a cemetery to memorialize the past and a large open space on which to hold national festivals that made the monument come alive.[78]

Sculpture provided the most graphic and explicit affirmation of positive negative space. In Boccioni's *Development of a Bottle in Space* (1912) the bottle spirals out of a pool of silvered bronze into space that itself coils into the solid form (Figure 7). In a manifesto Boccioni announced that Futurists will create masses "in such a way that the sculptural block itself will contain the architectural elements of the sculptural environment in which the object exists."[79] Space is no longer a setting for the subject but a constituent element of the work that the sculptor must model.

A more dramatic use of positive negative space occurs in the sculpture of Alexander Archipenko, who created figures with concaves and voids. He reversed the traditional notion that space was a frame around the mass, that sculpture begins where material touches space, and maintained "that sculpture may begin where space is encircled by the material." *Woman Walking* (1912), in which the torso is a void enclosed by material form, was, as he recalled, his first successful creation of "space with symbolic meaning."[80] The female belly that was emphasized in the nineteenth century by tight lacing is here rendered by shapely emptiness; space has become the guts of his art. In *Woman Combing Her Hair* of 1915 (Figure 8) the arching arm frames the empty space that is her head, and its shape is repeated in the convex severed arm and the concave neck. There were precedents for the use of concavity in bas relief, intaglio, and African masks, as Archipenko himself observed, but never before in sculpture were essential elements such as a figure's face represented by completely empty space. In this work the traditional division of pos-
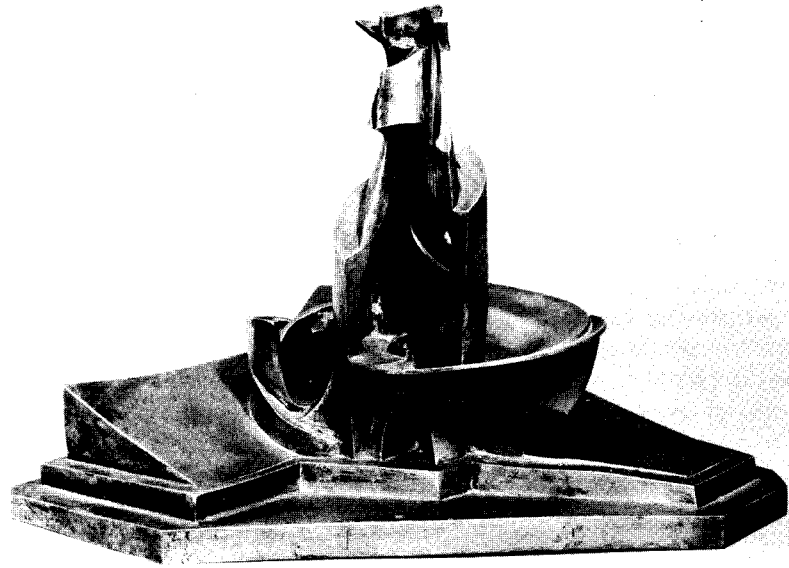
Fig. 7. Umberto Boccioni, *Development of a Bottle in Space*, 1912.

itive and negative space is dissolved as material and spatial forms flow together and constitute the woman with equal force.

The emergence of positive negative space in painting contrasts sharply with earlier conventions of rendering the subject with far greater emphasis than the background. For centuries the background had framed the subject as the pillow frames a head. Portrait painting of the eighteenth century, for example, was often executed by a team of the portraitist and his assistant. The best known artist to exploit this hierarchical arrangement was Sir Joshua Reynolds. The critical parts of the portrait—the overall design and the face—were executed by Reynolds, while the subject's clothing and the background were done by an assistant, the drapery painter.[81] In the modern period the background took on a positive, active function of equal importance with the subject and demanded the full attention of the artist.

The Impressionists took a first step to give space its due with their depiction of atmosphere.[82] They used coastal fog, steamy summer haze, diffused forest light, overcast winter twilight, the orange wash of a low sun, to fuse subject and background into a single composi-

tion of color and form. Monet unified the pictorial surface in his series on the Rouen Cathedral at different times of the day and seasons of the year. Space and light preempted the nominal subject, which he painted twenty times over as though it mattered less than the play of light around it. Cézanne deplored the loss of clear forms in the Impressionist atmosphere but affirmed the constituent function of space by ignoring the former distinction between the subject and the less important background and according equal significance to every portion of the canvas.[83] In portraits he gave as much attention to the shape of a space between the head and the picture frame as to the shape of the head itself. In his still life paintings the part between the edge of the table and the edge of the canvas was as crucial to the overall composition as his apples and vases. And in his late landscapes the skies are filled with interlocking faceted sections of empty space itself. There is no negative space in Cézanne's painting. All forms are of equal value, all constitute the subject of the work. A similar statement of the positive function of the background appears in the work of the Austrian Secessionist artist Gustav Klimt. As Carl E. Schorske observed, "In a series of three portraits painted between 1904 and 1908, Klimt progressively extended the dominion of the environment over the person of the subject."[84] Although in each of these the background does function as a frame for the portrait subject, it has a solid geometric structure that rivals the subject for the viewer's attention, and in the 1907 portrait of Adele Bloch-Bauer it engulfs the figure in a gold metallic brilliance.

With Cubism the emergence of space as a constituent element is complete. Braque and Picasso gave space the same colors, texture, and substantiality as material objects and made them all interpenetrate so as to be almost indistinguishable. Spatial forms became especially prominent in Braque's *Harbor in Normandy* (1909), where the lighthouses, docks, boats, and sails are rendered with the same faceted elements as the sea and sky and the spaces between the objects. In an interview Braque explained that the main attraction of Cubism was "the materialization of that new space which I sensed." He discovered a "tactile space" in nature, and he wanted to paint the sensation of moving around objects, the feeling of the terrain, the distances between things: "This is the space that attracted me, because that was what early Cubist painting was all about—research into space." The leveling of space and material object and the interpenetration of the two reached a high point in his *Violin and Pitcher* (see Figure 6 above). The neck of the violin retains its discreteness but the body is fractured into sections that open into

a space rendered as substantially as the splinters of wood. It is impossible to distinguish clearly between subject and background as plaster, glass, wood, paper, and space are rendered in a fluid pattern of similar forms. Braque explained: "The fragmentation enabled me to establish the space and the movement within space, and I was unable to introduce the object until I had created the space."[85] The pitcher and violin are just different kinds of space, occupied by solid objects that can be simplified, geometrized, fragmented, and then reformed in space. In Braque's painting all spaces are qualitatively equal.[86]

The American poet William Carlos Williams was especially struck by these Cubist techniques and tried to approximate them in "Spring Strains" (1916) by giving substance to the space of the sky as well as to the objects in it.

> . . . Vibrant bowing limbs
> pull downward, sucking in the sky
> that bulges from behind, plastering itself
> against them in packed rifts, rock blue
> and dirty orange!
>
> But—
> (Hold hard, rigid jointed trees!)
> the blinding and red-edged sun-blur—
> creeping energy, concentrated
> counterforce—welds sky, buds, trees,
> rivets them in one puckering hold! . . .

The limbs suck in the sky, but the sky, rendered substantial in "packed rifts," plasters itself against them. Even the colors are the rather subdued hues of the early Cubist landscapes that contributed to the unification of the entire picture surface. And, as if welding were not strong enough, the buds and trees and sky are also riveted together in "one puckering hold."[87]

Just as in physics space was recognized as both constituent and active with atomic theory and field theory, so in art space was realized in two positive modes. Its constituent function was most explicit in the Cubist representation of the space between objects, and its active function can be seen in Van Gogh, Munch, Cézanne, and the Futurists, who depicted space energized by objects in it.

In the extraordinarily creative last two years of his life Vincent

Van Gogh created on canvas an unforgettable dynamic world. His landscapes are visual metaphors for the turbulence in his mind. Roofs undulate with the contours of the terrain, skies flow with surging mountains, and trees grow before our eyes, whipping lines of force into an atmosphere that spirals into stars, eddies around a prominent sun. In the self-portraits speckles of color explode as if the energy in his eyes had burst into the space around his head. His universe was a continuous field of energy circuiting through mind, world, and art; in his last months, when he was insane, a pervasive scream seemed to fill all space.

The Norwegian painter Edvard Munch gave visible form to such intensities in *The Cry* (1893). It shows a terrified screaming figure on a bridge, clasping its head in its hands, cut off from two people in the distance who are walking away. The emptiness of the surrounding space and the isolation of the figure contrast with the ubiquity of the scream and the feeling of intense pressure it evokes. The landscape behind the skull-like head and the space above it pulsate with the sound waves. Cézanne also energized the space around objects. In his late landscapes Mont Sainte-Victoire comes to life like a volcano, disrupting contours of the countryside and erupting into space. In a painting of it in 1904 the foreground is dematerialized and broken into vertical and horizontal brush strokes of greens, yellows, and blues.[88] The earth lunges toward a peak accented by sparks of color that hover in the space above it. The sky echoes the forms of the land as if the mountain had just pushed out of it and was still sending shock waves through the atmosphere. There is a similarity to Van Gogh's landscapes, as terrain, verdure, and sky form continuous patterns of line, color, and brush work.

While Cézanne's canvases bulked with muscular spatial forms, the Futurists depicted lines of force in space created by movement, light, and sounds. In a manifesto of 1910 Boccioni articulated their belief in an active, dynamic space: "To paint a human figure you must not paint it; you must render the whole of its surrounding atmosphere."[89] He gave visible form to his idea in *The Forces of a Street* (1911), where the clanging sounds, beaming headlight, and lurching of a streetcar take on substance and modify the colors and forms of the surrounding persons, buildings, and atmosphere. In 1909 Balla filled a canvas with the radiance of a street lamp, and in 1912 he painted another with scalloped and puff-ball formations of "atmospheric densities." In 1912 the Futurists explained that an object would be expanded by the use of "force-lines" determined by its

form at rest, its continuity with surrounding space, its past and future trajectories, and the way it would be "decomposed according to the tendencies of its forces."[90] With such multiple determinants its actual depiction took many forms, but in all variations space is rendered as an active and constituent element of equal importance with the "subject." In Boccioni's study for *Dynamism of a Cyclist* (1913) force-lines spin off the speeding bicycle as if it were racing through a puddle and make continuous lines with the bicycle itself. In the finished work bicycle and rider merge with the surrounding space and give a single image of movement.

Western historians began to ponder the concept of "empty space," as their nations discovered that none was left. In America the census of 1890 declared that the frontier was closed, and by the end of the century the dominant world powers had finished taking the vast "open" spaces of Africa and Asia. Government officials considered the political impact of the closing of the world frontier, and scholars developed a new discipline to codify its significance. The great pioneer of the new "geopolitics" was the German researcher Friedrich Ratzel.[91] In an essay of 1893, "The Significance of the Frontier in American History," Frederick Jackson Turner applied geopolitical theory to explain the development of American character and institutions. The presence of an open frontier, he speculated, created a spirit of individualism. Settlers, compelled to adapt to the challenges of crossing a wilderness and rebuilding their lives again and again, sacrificed traditions and leveled religious, social, and political hierarchies. The constant expansion fragmented religious authority and led to the proliferation of rival churches scattered in the frontier towns. Continuous social dislocation made it impossible to maintain the fixed social order of the older Eastern cities, where families remained in the same place and intensified class distinctions with each passing generation. But the most important effect of the frontier was "the promotion of democracy here and in Europe." Life in the wilderness broke down complex society into a primitive organization based on the family. The need for improvising brought out new social organizations in which everybody played a role and was vital to the survival of the community. These circumstances produced "antipathy to control, and particularly to direct control."[92] No single person could monopolize power in frontier settlements where cooperation and democracy flourished. In an article of 1903, he elaborated: "Whenever social conditions tended to crystallize in the East,

Fig. 8. Alexander Archipenko, *Woman Combing Her Hair*, 1915.

whenever capital tended to press upon labor, there was this gate of escape to the free conditions of the frontier. These lands promoted individualism, economic equality, freedom to rise, democracy."[93] But when the gate closed, capital concentrated in the fundamental industries and there was commercial and political expansion overseas. These developments reconstituted hierarchies of wealth and imperial power and reversed the leveling tendencies of an open frontier. Turner's thesis and the historical circumstances that suggested it form part of a general appraisal of the constituent function of empty space. The closing of the frontier highlighted the significance of open territorial space—especially the erosion of traditional hierarchies—for the entire population, and Turner's interpretation focused attention on its social and political consequences.

A contemporary historian, Roderick Nash, pointed out that "the establishment of Yellowstone National Park on March 1, 1872, was the world's first instance of large scale wilderness preservation in the public interest." The intention was to protect the geysers, but in the 1880s and 1890s a few people began to realize that the wilderness in general had been protected, and by then a movement was under way to protect open territory for public use around the world. Such parks were open to the public, in contrast with the private preserves of kings and noblemen and the wealthy.[94] Their significance in promoting the democratic spirit, like that of the frontier, was clarified precisely as the empty spaces of the world threatened to disappear. The exploration of entirely uncharted territory also came to an end in this period. Robert Peary reached the North Pole in 1909, and two years later Roald Amundsen made it to the South Pole. Bootprints tracked over the untrodden snow and the last great frontiers of the world closed.

From the 1880s the literary bounty of stories about empire matched the psychological, political, and financial yield of the land grab of the major imperialist powers. In a survey of hundreds of novels in this genre, the literary critic Susanne Howe concluded that their characters suffered from claustrophobia at home. They became greedy for land, annoyed with boundaries, enraged by fences, and "intoxicated by space." While some were thrilled others were horrified, like the woman in Olive Schreiner's Story of an African Farm (1883), who, fresh from England, exclaimed at her first glimpse at the endless miles of bush: "Oh it's so terrible! There's so much of it! So much!"[95] Whether they found it an inspiration or a horror, a setting for riches or for ruin, the vast emptiness weighed upon them and

shaped their lives. In one of the greatest stories about empire, Conrad's Heart of Darkness (1899), the empty space was overpowering: it drew Marlow and destroyed Kurtz, the man he went to find. Marlow's journey is an allegory of the history of mankind in reverse, a devolution of the species into the past, into darkness, into nothing.

As a boy Marlow used to stare at the great blank spaces on the map and dream of the glories of empire. The Congo especially continued to fascinate him. By the time he had grown up it had become filled with rivers and lakes and names. "It had ceased to be a blank space of delightful mystery—a white patch for a boy to dream gloriously over. It had become a place of darkness." He remained intrigued and got a commission to patrol the Congo River for a company that traded in ivory. At the coastal station he first heard about Kurtz, the company's man in the interior, who had sent out great quantities of ivory and who, it was feared, was in some terrible trouble. Marlow's journey thus became a quest to find and rescue him. On a trek to the central station to get his steamer his surroundings were images of negation—empty land, abandoned villages, dead carriers, and "a great silence around and above." His trip up the river, he observed, was like traveling back to the beginning of the world when vegetation rioted on the earth, but in spite of the lush flora this world seemed to be "an empty stream, a great silence, an impenetrable forest." He felt cut off from everything he had ever known as he penetrated "deeper and deeper into the heart of darkness." Strange sounds came from natives along the shore. There were outbursts of shrieking which suddenly stopped and left "appalling and excessive silence." But the stillness was not peaceful—"it was the stillness of an implacable force brooding over an inscrutable intention." The natives in the bush were cannibals, and their hunger symbolized more of the emptiness. Marlow found darkness everywhere—in the wilderness, in its people, in Kurtz, and, finally, in the condition of man.

At the inner station he saw severed heads stuck on poles surrounding Kurtz's house. They were "black, dried, sunken, with closed eyelids"—a final symbol of negation. Deep in this theater of hunger and emptiness only the prospect of speaking with Kurtz offered the hope of some illumination, some affirmation. But he discovered in Kurtz a man who had been stripped of the values of modern civilization. The wilderness had taken revenge for his invasion and whispered terrible things that echoed loudly within him, "because he was hollow at the core." Kurtz was dying and Marlow took

him away. They spoke on the steamer, but, Marlow observed, "his was an impenetrable darkness." And, as though at the very end he had a sudden vision of his life, Kurtz expired with a cry: "The horror! The horror!"

Marlow concludes on a positive note as he ponders Kurtz's dying words. Kurtz's life was an adventure into the darkness where terrifying urges surfaced, but he gave his life a form, and at the end, "He had something to say." Marlow is impressed that he was able to sum it up—"The horror!" This was a judgment. "It was an affirmation, a moral victory paid for by innumerable defeats, by abominable terrors, by abominable satisfactions. But it was a victory!" At the conclusion the ivory remains. In spite of the slaughter of the elephants and the evil it inspires, it is the stuff of art, a dazzling whiteness in the heart of darkness. The emptiness itself is the subject of the novel, a force of darkness that rules the wilderness and triggers the actions of men who seek to survive in it.

This novella is a comment on the age, and Conrad took pains to make Kurtz a man of his times: "His mother was half-English, his father was half-French. All Europe contributed to the making of Kurtz." It is a catalog of literary images of the void applied in the context of imperialism. Conrad interprets the darkness as a leveling force that negates the status distinctions of class and privilege that regulated European life. In the wilderness the older class lines were obsolete. Cannibalism and head-hunting obliterated status distinctions. Marlow noticed the sharp contrast between the hierarchical society at home and the more egalitarian Congo when he returned to London and was at last able to understand the creative potential of the wilderness. In the face of danger, in the darkness, all men are pretty much alike.

A few years later another story was written about a jungle, a journey, and the void—Henry James's "The Beast in the Jungle" (1903). It is about John Marcher, who is convinced that a rare and strange fate awaits him, crouching like a beast in the jungle to leap out and slay him. He gains the affection of May Bartram, who undertakes to watch and wait with him, and over the years she comes to understand, but does not tell him, what the beast is. Marcher too is a man of his age—well-mannered, disciplined, reserved, and, except for his dependency on May, self-reliant. Everything in his life is in order— his library, his garden in the country, his feelings. When May becomes seriously ill he anticipates that the loss he will feel over her death must be the beast, but she tells him that it has already leaped

and that he failed to notice it. Her explanation is confusingly negative—"your not being aware of it is the strangeness in the strangeness." She confounds him further by saying that she is glad "to have been able to see what it is *not*." In the end Marcher will learn the meaning of this second negation: that the beast was not his love for her or his sense of loss. After her death he must wait alone for something that has already happened but that he does not yet understand. A year later, while making one of his dutiful visits to her grave, he notices another man deeply stricken with grief. Marcher realizes that the stranger's face shows an intensity that he had never felt. He looks back at May's grave and suddenly sees the beast. The name on the tombstone becomes "the sounded void of his life." She was what he had missed, and that was his special destiny—"he was the man of his time, *the* man, to whom nothing on earth was to have happened." He had been anesthetized by the refinements of modern civilization and could not feel deeply for her either before or after her death. The beast in the jungle was—a lack of feeling. This was not an active spirit of negation, like Mephistopheles in Goethe's *Faust*, but an inner emptiness, like the void that sounded from the silence of May's grave.

His terrifying insight, like Kurtz's dying words, are two modes of negativity. In Strindberg's *A Dream Play* (1901) there is another climactic discovery of nothing. For many years an officer attempts to get past a guard and open a door that is prominently visible in the center of the stage. Like John Marcher's obsession with the beast, the officer is obsessed with looking behind the door. "That door," he exclaims, "I can't get it out of my mind . . . What's behind it? There's got to be something behind it." In the course of the play a number of other characters come to want it opened, and when they finally succeed several university officials are clustered about and discover that there is nothing behind it. The Dean of Theology immediately interprets its significance: "Nothing. That is the key to the riddle of the world. In the beginning God created heaven and earth out of nothing." The Dean of Philosophy observes: "Out of nothing comes nothing." The Dean of Medicine makes a diagnosis as if he had just lanced a harmless boil: "Bosh! Nothing. Period." The Dean of Law suggests that the whole thing is a case of fraud. Faust had found nothing to help him affirm life from his mastery of these four fields, and Strindberg has the custodians of them struggle to explain away this reminder that the end of life is nothingness itself.

The beasts of nineteenth-century novels were generally tangi-

ble—forces of nature, vices, machines, institutions. There was prostitution, alcoholism, and gambling; there were railroads, factories, and coal mines; and there was materialism, capitalism, and the big city. As terrifying and overwhelming as these things seemed, they could at least be named. But the beasts of the twentieth century would be far less identifiable, living in the mysterious realm of negativity we find in Conrad, James, and Strindberg. For them the void supplies the focus. Their characters seek meaning outside themselves—in a jungle, in a cemetery, behind a door—and find only the horror of nothingness within.

Positive negative time is silence. The recognition of its constituent role resembles the recognition of the constituent function of empty space in its various literary forms as darkness, emptiness, nothingness, the void. While creative silences were most explicit in poetry and music, they figured prominently in some prose works.

In the opening of *Silence* (1910) by the Russian writer Leonidas Andreiyeff, Father Ignatius and his wife are discussing their daughter who has just returned pregnant from a trip to St. Petersburg that she took against their will. They are chastising her mercilessly. She refuses to speak, and, after several days of brooding silence, commits suicide. The mother has a stroke that leaves her silent too. From the day of the daughter's funeral the house was silent. "It was not stillness," Andreiyeff explains, "for stillness is merely the absence of sounds: it was silence, because it seemed that they who were silent could say something but would not." Just as empty space became the focus of Archipenko's sculpture, so silence assumed the central role in this story. The house was filled with symbols of it. The wife did not utter a sound, the daughter's portrait seemed especially mute, and, after her pet canary flew away, the cage "kept silent" as a reminder of the emptiness. Every morning Father Ignatius sat and agonized in the silence of the house, and upon his return from work he always felt as if he had been silent the entire day. It enveloped him as darkness enveloped Marlow. Father Ignatius visited his daughter's grave and pleaded for some response to fill the void. She seemed to be speaking but with the same unbroken silence. "He fancied that the entire atmosphere trembled and palpitated from a resounding silence." The absence of sound became a presence that took a substantial form: "With icy waves it rolled through his head and agitated the hair." He returned home and begged his wife to break the terrifying quiet, but she remained silent as the story ends

with them staring at each other "dumb and silent" in a "dark, deserted house."[96]

The Belgian mystic writer Maurice Maeterlinck wrote like the wailing of oboes. He explored the mysterious experiences of intuitions and supernatural occurrences, the inexpressible feelings and unconscious thoughts that course beneath the surface. In an essay on "Silence" he argued that we fear the absence of sound because it betokens death and therefore spend a good deal of time making senseless sounds. Many ordinary friendships or even loves are based on a common "hatred of silence." These negative feelings illuminate the importance of silence and point on the positive side to its binding and creative powers. Far from being the mere absence of sound, silences express what no words or sounds possibly could. The most memorable moments between lovers are made up of silences, and the quality of them reveals the quality of the love. "As gold and silver are weighed in pure water, so does the soul test its weight in silence, and the words that we let fall have no meaning apart from the silence that wraps them round." This revaluation of the relative importance of silence and sound suggests a broader kind of leveling in the social sphere that Maeterlinck elaborated explicitly. "The silences of a king or a slave in the presence of death or grief or love reveal the same features."[97] On the other hand, monarchs are announced by trumpet fanfares.

The silence of a generation that came home after four years of killing and discovered that nobody spoke the same language or felt the old feelings any more was one subject of Proust's novel. Forgetting, silence, and time lost are variations on the theme of negation. The novels of the nineteenth century were as vivid as Jean Valjean's flight through the sewers of Paris, as palpable as the Count of Monte Cristo's treasure. They revolved around great noisy events—war and revolution, crime and punishment. Even Flaubert—who claimed that he wanted "to write a book about nothing, a book without any exterior support, which would sustain itself by the inner force of its style . . . a book which would be almost devoid of subject, or at least in which the subject would be almost invisible"—even he structured *Madame Bovary* around the passionate outbursts of seduction and adultery, the agonized cries of the victim of a botched surgical operation, and the sounds of a grotesque suicide. But Proust centered his novel on the forgetting and remembering of tea and cakes and the lost time that that recollection enabled him to understand. He was a great architect of silence. The ting of a spoon striking a cup was one

of the most significant sounds of his novel. Silences cast lovers into despair as forcefully as the whisperings of betrayal and the shouting of insults. It was Rachel's failure to write that tormented Saint-Loup: "Thus her silence did indeed drive him mad with jealousy and remorse. Besides, more cruel than the silence of prisons, that kind of silence is in itself a prison. An immaterial enclosure, I admit, but impenetrable, this interposed slice of empty atmosphere through which, despite its emptiness, the visual rays of the abandoned lover cannot pass."[98] The words "Mademoiselle Albertine has gone!" begin a volume of the novel that dwells exhaustively on someone who is no longer present. Proust explores the initial shock of Marcel's discovery that Albertine has left him and everything that follows—regrets over the way their affair had gone, fantasies about her feelings of loss, the transformation of his happy memories into bitter ones, the blow of learning of her subsequent death and the realization that it only intensified his jealousy, and eventually the indifference and forgetfulness—all triggered by her absence and the silence that settled into his life.

While empty space and silence were used as subjects of novels and short stories, in poetry there was a formal shift in the conception of the poem from an arrangement of words to a composition of words *and* the blank spaces between them. Already in the 1880s some French symbolists began to experiment with "free verse" stretched across consciously shaped white spaces on the page.[99] This technique was most fully developed by Stéphane Mallarmé, who used the blanks between words for a kind of visual pause to establish a rhythmic movement of words and images like notes in a musical composition.[100] He also believed that poetry should be evocative, urging, in an often-quoted instruction, "Paint not the thing, but the effect it produces." Once again the subject—the thing—lost its former prominence. As Braque toppled its pictorial authority by rendering the space around it with equal substance, Mallarmé diminished its literary authority by leaving it out of poems and creating verbal compositions out of its shadows and effects. In a lecture of 1895 he explained that the new poetry dispenses with precise descriptions and employs rather evocation, allusion, and suggestion. It makes "sudden jumps and noble hesitations" that hint at things and allow the reader to respond freely with his own imagery and associations. He challenged the older aesthetic that rested on the metaphysical assumption that "only what exists exists." (This was a literary analog of Geoffrey Scott's attack on the older architectural aesthetic

that concerned itself only with "what occupies our tools and arrests our eyes" and failed to appreciate the central task of creating spaces.) Mallarmé held that the most important part of the poem may be what the poet has left out.[101]

Later in his life he developed a way to make the evocative nature of his poetry visible by representing the absences with empty spaces between words and between lines. These breaks symbolized the lacunae of sequential thinking, the gaps in human communication, the silence surrounding every utterance. As he explained: "The intellectual framework of the poem conceals itself but is present—is located—in the space that separates the stanzas and in the white of the paper: a significant silence, no less beautiful to compose than the lines themselves."[102] In one essay he insisted on the historical uniqueness of this kind of composition: "We must bend our independent minds, page by page, to the blank space which begins each one; we must forget the title, for it is too resounding. Then, in the tiniest and most scattered stopping points upon the page, when the lines of chance have been vanquished word by word, the blanks unfailingly return; before, they were gratuitous; now they are essential; and now at last it is clear that nothing lies beyond; now silence is genuine and just."[103] Blanks were indeed essential in his last poem, *Un Coup de dés* (1897), a final testament to the creative force of negativity.[104] The poem is extremely difficult to understand, and his statement of purpose in a preface written in prose suggests how important it was that his method be clearly grasped. There he explained that the white spaces "even out and scatter" the words across the page, make possible a simultaneous vision of the entire page, and indicate the rhythm of the lines so that the poem may be read like a musical score.

The poem itself was first published in a journal, but Mallarmé wanted it to be a separate book. It never appeared in that form during his lifetime, but before he died he did get so far as to correct galleys for the book, and they show the importance of the white spaces. His marginal notes directed the printer, who had taken some liberties with the original spacing, to move words and lines back to create the exact "measures" he intended. The publisher printed the cover on grey paper, but Mallarmé was emphatic about keeping it on the same white paper as the rest of the poem.[105] He insisted that it be printed across two pages, with the crack in the middle as an essential part of the spacing of the poem as a book. He carefully studied the printing types available and chose eight different ones to present the

various voices within the poem. The unique typography drew attention to the printed surface and contributed to the visual unity of the entire page, with all elements playing an essential constituent role.

Although Mallarmé was particularly concerned about the visual presentation of the poem, he also cared about the way it sounded and read it first aloud to Paul Valéry, who recalled the extraordinary impact of that reading. Mallarmé read in a low, even voice, to let the words and pauses give the poem its full force without the theatrical ornamentation in vogue among professional speakers. Valéry heard "embodied silences," "whispers and insinuations made visible," and saw a new language that seemed to shine out of the paper like stars. In a literary fragment Mallarmé had compared the black-on-white of printing with the "luminescent alphabet of stars" on the "dim field" of the heavens. Valéry used that same image of the interdependence of black and white, remarking that in *Un Coup de dés* Mallarmé tried "to elevate a page to the power of the starry heavens."[106] Poetry had always been evocative and concise, but with Mallarmé the blanks assumed a more active role than the incidental, background function they formerly had.

In music silence is as essential to the recognition of sound and rhythm as the white of paper is to the identification of print. Throughout the history of music there had been significant silences, but they generally occurred at the end of movements and had a separating function. In the new music of this period the pauses occurred in the middle of sections and took on a more constituent function. Several critics noted conspicuous silences in Debussy, Stravinsky, and Webern, and indeed their music does contain some novel auditory negativities.

Just as Mallarmé was inspired by music, so Claude Debussy was inspired by Mallarmé's poetry, especially his *L'Après-midi d'un faune.* In 1893 he finished *Prélude à l'après-midi d'un faune*—a musical impression of the same theme. The notes of the flute solos sound like steps of the faun pacing, stopping, and starting again. There is one mysterious pause in the sixth measure, and other, subtler suggestions of the faun moving in and out of sight amidst the foliage, as in the poem, "an animal whiteness ripples to rest." In reaction against the massive and ornate orchestration of Wagner, Debussy keeps his score simple. Notes flash and fade like the light on the skin of a moving animal in the forest. The exchange of the melody line by different instruments creates the impression of disappearance as each becomes conspicuously silent. The explicit debt to Mallarmé indi-

cates that Debussy intended the pauses or the suggestion of them to be as essential to the overall musical effect as the blank spaces were in the poem.

Archipenko identified a similarity between silences in music and the concavities and empty spaces of his own sculpture. He explained that rhythm in music is possible only if there is some kind of alternation between sound and silence. "Silence thus speaks. In the Ninth Symphony of Beethoven, a long pause occurs twice and evokes mystery and tension. The use of silence and sound in a symphony is analogous to the use of the form of significant space and material in sculpture."[107] His example from Beethoven implies that there was nothing new in the modern music, but there was. Composers began to use silences more consciously and more conspicuously than ever before. Roger Shattuck suggested that the conclusion to Stravinsky's *The Firebird* (1910) contains silences that are unique in musical composition. "The accumulated grace notes and syncopations and sforzandos lead up to silence—twenty-two measures of rests alternating with single percussive chords. And these stretches of silence are the most moving of all, as if all the earlier pages had to be composed in order to allow a few bars of peace to emerge at the end. Many have tried, but few composers have succeeded so well in inverting our conventions of hearing so that silence has more weight than sound."[108]

The most daring composer of negativities was Anton von Webern. The extreme brevity of his compositions (whole movements less than a minute long) echoes with all that is left out, and what can be heard is laced with frequent breathtaking silences. In the first nine measures of the *Passacaglia* (Op.1) there are as many pauses as notes. As Otto Deri explained: "The function of the pause is not that of a rest as used in common musical practice; the pause in Webern's music has a functional significance in the rhythmic scheme. There is in Webern's music a new relation between *sound* and *no sound.*"[109] And even when notes are sounding there are suggestions of silence, as one instrument tosses the melody to another and begins a long rest. Musicians playing such works become intensely aware of those rests as they wait to take up the melody again. Webern rejected polytonality and composed symphonies with single notes that sound as if they were ringing in outer space, surrounded by the silence of the rest of the full orchestra for which they were written. The performance of the symphonies gives a sense of the orchestra as missing and of musicians listening, counting rests, and waiting to resume playing.

There is some exaggeration in the claim that the negativities are of equal importance with the subjects of art. Braque's painting was titled *Violin and Pitcher* and not *Space between Violin and Pitcher*, and the words of *Coup de dés* intrigued the critics far more than the spaces that Mallarmé put between them. A more tempered evaluation of the relation between the subject of perception and the background that frames it was made by a group of psychologists that emerged just before World War I. The pioneers of Gestalt psychology—Max Wertheimer, Wolfgang Köhler, and Kurt Kaffka—elaborated laws explaining how the "ground" and the "figure" create each other in perception, but they also maintained that the figure was more prominent. Their theory rejected the associationist view that complex perceptions are built up out of simple, discrete elements. They argued rather that perception is an experienced whole, and the task of understanding must be of that whole and not of separate parts. In a book on the visual appearance of figures of 1915, Edgar Rubin reproduced a drawing of the so-called "Peter-Paul Goblet," which may appear either as two faces in black staring at each other or as a goblet in white framed by two black shapes. It illustrates the interdependence of figure and ground and the way they may flip back and forth with shifts in the viewer's attention. Rubin maintained that the figure is more "striking and predominant" than the ground, but the ground does play an essential role.[110] In considering the whole perceptual field, the smallest detail of a Gestalt may be as important as the more conspicuous figures in it, for all elements interact and give each other meaning.

Insistence on the unity of the perceptual field accorded with the radical empiricism of William James. In *The Principles of Psychology* he illustrated the power of negatives in a discussion of the stream of thought or, in his specific example, of sound: "what we hear when the thunder crashes is not thunder pure, but thunder-breaking-upon-silence-and-contrasting-with-it."[111] The hyphens bridge the gap between words to illustrate the continuity of experience and reverse the analytical tradition in experimental psychology. The interdependence of sound and its absence is but one example of the mutual interaction of positives and negatives that make up our mental life. James also pointed out the constituent function of negatives in his brother Henry's essay *The American Scene*. In a letter of 1907 to Henry he wrote that his style was to avoid naming something straight out "but by dint of breathing and sighing all round and round it to arouse in the reader who may have had a similar percep-

tion already . . . the illusion of a solid object, made . . . wholly out of impalpable materials, air, and the prismatic interferences of light, ingeniously focused by mirrors upon empty space . . . your account of America is largely one of its omissions, silences, vacancies. You work them up like solids."[112]

A contemporary of William James perceived the leveling effect of positive negative space in James's thought. In 1914 Horace Kallen, a philosopher at the University of Wisconsin, wrote: "Pure experience has no favorites. It admits into reality . . . evil as well as good, discontinuities as well as continuities . . . James . . . is the first democrat of metaphysics." James refused to detest the material world as did the idealists—nothing was more or less real to him than anything else. He recognized "the democratic consubstantiality of every entity in experience with every other."[113]

Few of the developments we have surveyed had a direct relation to major political, social, or religious change. But the affirmation of positive negative space, the notion that what was formerly regarded as a void now has a constituent function, had one feature in common with the progress of political democracy, the breakdown of aristocratic privilege, and the secularization of life at this time: they all leveled hierarchies. Although the link between these two clusters of developments was rarely explicit, the thematic similarity is striking and makes the connection compelling. The challenge of this generation to the notion that the subject was more important than the background spread in ever widening circles to the notions that some people were more important than others in selecting political leaders, that aristocrats were entitled to social privileges and hereditary rights, and that the sacred space of religion was more important than all other "profane" ones. Most people continued to accept the old hierarchies and defer to rank, but there was nevertheless a significant change that affected many aspects of life and thought. It came even from those who, like Nietzsche, insisted that a nobility become worthy of its status by creating new forms out of the uniform dust of the universe. There were to be no special materials anointed by priests, no special classes ennobled by kings, no special individuals enfranchised by laws. There were to be only the special creations of artists out of simple materials for anyone who could appreciate them.

Some drew an explicit connection between the new sense of space and democracy. Turner saw the open space of the frontier as a force for democracy. William James's thought was characterized by

Horace Kallen as a democratic metaphysics, while James himself implied that his brother's interpretation of the American scene with its "omissions, silences, vacancies" captured something of its uniquely democratic spirit. George Mosse suggested that the "nationalization of the masses" involved the creation of an extended "living space" around monuments used by the masses, thereby denying the hierarchy so forcefully implied by the imposing granite or bronze of the monuments themselves. The architect Louis Sullivan envisioned a new "democratic" architecture that would challenge conventional design and create new structures appropriate to the antimonarchical modern ethos.

The most profound and troubling disturbance of traditional hierarchy occurred as a consequence of the secularization of life and thought. According to the concept of divine right, legitimacy to rule comes from God. In the course of the eighteenth century the rationale for monarchy began to change from divine right to the principle of popular sovereignty. As a result the court and aura surrounding Christian monarchs lost much of its mystique and "sacred" aspect and was replaced in popular imagination by the corridors of power of parliaments and congresses. Just as the decline of a Christian metaphysical framework transformed the sense of time, so did it affect the sense of space; and the setting for significant events in history shifted from the sacred spaces of heaven, the church, and the palace to the profane spaces of the battlefield, workshop, marketplace, and home.

Throughout the nineteenth century intellectuals and artists struggled to come to terms with an ever more secularized and "profane" world. Some, including Feuerbach and Marx, rejoiced that the loosening grasp of religion had at last made it possible to begin to create a city of man in an entirely human space. The critic J. Hillis Miller has analyzed reactions to the "disappearance of God" among five English writers who spanned the century—Thomas de Quincey, Robert Browning, Emily Brontë, Matthew Arnold, and Gerard Manley Hopkins. They found the prospect of such a disappearance intolerable and struggled to create a new relation between man and God. But it was a losing battle, and the last of them, Hopkins, sank into the despair of his final days, alone and impotent—"time's eunuch," straining to build "and not breed one work that wakes."[114] In 1882 Nietzsche's "madman" announced that "God is dead." But the madman was not mad. His elaboration of the consequences included a vivid picture of the new sense of emptiness in a world without holy

sanctuary. "What were we doing when we unchained this earth from its sun? Whither is it moving now? Whither are we moving? Away from all suns? Are we not plunging continually? Backward, sideward, forward, in all directions? Is there still any up or down? Are we not straying as through an infinite nothing? Do we not feel the breath of empty space?"[115] Thus did Nietzsche metaphorically link positive negative space and the profanation of religious space by suggesting that the death of God had forced man to feel "the breath of empty space."

Not only directions in space but the values of the Western world lost their former inviolability with the collapse of traditional faith. The most material consequence of the loss was a blurring of the distinction between the sacred space of the temple and the profane space outside. "Profane" means "outside the temple," and many artists and intellectuals found themselves outside, not only wondering which way was up but also faced with the realization that there was no longer a temple to return to. In a world without God all men confront nothingness, and, as Nietzsche noted, most "would rather will nothingness than not will."[116] But some people avoided nihilistic despair and learned to create their own sanctuaries. This was to be the great creative effort of the overmen, the artists and intellectuals who affirmed life and learned to love their fate in the face of the void. If there are no holy temples, any place can become sacred; if there are no consecrated materials, then ordinary sticks and stones must do, and the artist alone can make them sacred. It is no accident that the leading architects of this period displayed the simple materials of wood, stone, brick, and glass and stripped away the façades and ornaments that had adorned sacred and royal structures of the hierarchical past.

New constituent negativities appeared in a broad range of phenomena: physical fields, architectural spaces, and town squares; Archipenko's voids, Cubist interspaces, and Futurist force-lines; theories about the stage, the frontier, and national parks; Conrad's darkness, James's nothing, and Maeterlinck's silence; Proust's lost past, Mallarmé's blanks, and Webern's pauses. Although these conceptualizations were as diverse as the many areas of life and thought from which they emerged and upon which they had influence, they shared the common feature of resurrecting the neglected "empty" spaces that formerly had only a supporting role and bringing them to the center of attention on a par with the traditional subjects. If figure and ground, print and blanks, bronze and empty space are of equal

value, or at least equally essential to the creation of meaning, then the traditional hierarchies are also open to revaluation. Value was henceforth to be determined by aesthetic sensibility, public utility, or scientific evidence and not by hereditary privilege, divine right, or revealed truth. The old sanctuaries of privilege, power, and holiness were assailed, if not entirely destroyed, by the affirmation of positive negative space.

6.   The Nature of Space

1. Albert Einstein, "Autobiographical Notes," in *Albert Einstein: Philosopher-Scientist*, ed. Paul Arthur Schilpp (Evanston, 1949), 9–11.

2. Max Jammer, *Concepts of Space: The History of Theories of Space in Physics* (Cambridge, Massachusetts, 1969), 144–146; A. d'Abro, *The Evolution of Scientific Thought from Newton to Einstein* (New York, 1927), 35–48.

3. Lawrence Beesley, *The Loss of the SS. Titanic* (New York, 1912), 105.

4. Henri Poincaré, *Science and Hypothesis* (1901; rpt. New York, 1952), 50–58. See also his article, "On the Foundations of Geometry," *The Monist*, 9 (1898): 42.

5. Ernst Mach, *Space and Geometry in Light of Physiological, Psychological, and Physical Inquiry* (1901; rpt. Chicago, 1906), 9, 94.

6. V. I. Lenin, *Materialism and Empirio-Criticism: Critical Comments on a Reactionary Philosophy* (1908; rpt. New York, 1927), 176–189.

7. On the political context of this issue see "Lenin and the Partyness of Philosophy," in David Joravsky, *Soviet Marxism and Natural Science 1917–1932* (London, 1961), 24–44.

8. Cited by Lenin, *Materialism*, 189.

9. Albert Einstein, *Relativity* (New York, 1961), 9.

10. Ibid., 139.

11. E. de Cyon, "Les Bases naturelles de la géométrie d'Euclide," *Revue philosophique*, 52 (July–December 1901): 1–30.

12. Louis Couturat, "Sur les bases naturelles de la géométrie d'Euclide," in ibid., 540–542.

13. E. von Cyon, *Das Ohrlabyrinth als Organ der mathematischen Sinne für Raum und Zeit* (Berlin, 1908), chap. 7.

14. Jacob von Uexküll, *Umwelt und Innenwelt der Tiere* (Berlin, 1909), 195. He extended these findings in *Bausteine zu einer biologischen Weltanschauung* (Munich, 1913).

15. The other categories discussed included cause, class, substance, number, and force. There is an analysis of these arguments in Steven Lukes, *Émile Durkheim: His Life and Work* (New York, 1973), 436–445.

16. Émile Durkheim and Marcel Mauss, *Primitive Classification* (New York, 1970), 43–44, 82, 86.

17. Émile Durkheim, *The Elementary Forms of the Religious Life* (New York, 1965), 22, 32, 489–492.

18. In *Consciousness and Society: The Reconstruction of European Social Thought 1890–1930* (New York, 1958), H. Stuart Hughes interpreted this generation as having discovered "the subjective character of social thought," the necessary mediation of consciousness in the study of man and society. According to Hughes, Durkheim was one of many who "found themselves inserting between the external data and the final intellectual product an intermediate stage of reflection on their own awareness of these data"; see pp. 16, 17. For a discussion of the polarization of space between the right and left hand in the religious practices of different societies see Robert Hertz, "La Prééminence de la main droite: étude sur la polarité religieuse," *Revue philosophique* (December 1909): 553–580. The Marxist historian Henri Lefebvre has analyzed the social "production of space" (especially unique capitalistic and socialistic forms), and he has identified a breakdown of the older uniform

space around 1910, when "Euclidean and perspectival space disappeared as referents along with the other common places (the city, history, paternity, the tonal system in music, the moral tradition, etc.)." See *La Production de l'espace* (Paris, 1974), 34 *ff*.

19. Oswald Spengler, *The Decline of the West* (New York, 1926), I, 174–178; 188–190; H. Stuart Hughes, *Oswald Spengler* (New York, 1952), 78–79.

20. Spengler, *Decline*, 337.

21. A pioneer study of the cultural impact of the introduction of perspective is Erwin Panofsky's "Die Perspektive als 'symbolische Form'," *Vorträge der Bibliothek Warburg* (1924–25).

22. Samuel Y. Edgerton Jr., *The Renaissance Rediscovery of Linear Perspective* (New York, 1975), 30–40.

23. L. Keith Cohen, "The Novel and the Movies: Dynamics of Artistic Exchange in the Early Twentieth Century" (Ph.D diss., Princeton University, 1974), 49–50.

24. For a general discussion of Cézanne's role in the breakdown of scientific perspective see Fritz Novotny, *Cézanne und das Ende der wissenschaftlichen Perspektive* (1938; rpt. Vienna, 1970), 184 and *passim*.

25. John Rewald, ed., *Paul Cézanne Letters* (Oxford, 1946), 262.

26. Maurice Merleau-Ponty, *Sense and Non-Sense* (1948; rpt. Evanston, 1964), 14.

27. Georges Matoré, *L'Espace humain: l'expression de l'espace dans la vie, la pensée et l'art contemporains* (Paris, 1962), 236–242; Standish Lawder, *The Cubist Cinema* (New York, 1975), 12.

28. Charles B. Brewer, "The Widening Field of the Moving-Picture," *The Century Magazine*, 86 (1913): 73–74.

29. Roger Allard, "At the Paris Salon d'Automne" (1910), in *Cubism*, ed. Edward Fry (New York, 1966), 62.

30. Jean Metzinger, "Cubism and Tradition" (1911), in ibid., 66.

31. Guillaume Apollinaire, *Cubist Painters* (1913; rpt. New York, 1944), 13.

32. E. Jouffret, *Traité élémentaire de géometrie à quatre dimensions* (Paris, 1903), 153. This connection was made by Linda Dalrymple Henderson in an article on possible influences of physics and geometry on the Cubists: "A New Facet of Cubism: 'The Fourth Dimension' and 'Non-Euclidean Geometry' Reinterpreted," *The Art Quarterly* (Winter 1971): 411–433. She refutes the facile connections between Cubism and science made by Paul M. Laporte and others and shows that although the Cubists could not have known about Einstein's relativity or Minkowski's space-time theory, they might have learned about the fourth dimension and non-Euclidean geometry from their friend, the insurance actuary Maurice Princet. Although Picasso denied having discussed the fourth dimension with Princet, she speculates that it is possible that he or the other Cubists picked up a suggestion of it from him indirectly.

33. See Judith Wechsler, ed., *Cézanne in Perspective* (Englewood Cliffs, New Jersey, 1975), 7.

34. Albert Gleizes and Jean Metzinger, "Cubism," in *Modern Artists on Art*, ed. Robert L. Herbert (New York, 1964), 7–8.

35. Pablo Picasso, "Statements to Marius de Zayas" (1923), in Fry, *Cubism*, 168.

36. Novotony, *Cézanne*, 141–143, 188.

37. Siegfried Giedion, *Space, Time, and Architecture* 5th ed. (1941; rpt. Cambridge, Mass., 1967), 435.

38. Pierre Francastel, *Peinture et société: naissance et destruction d'un espace plastique de la Renaissance au cubisme* (Lyon, 1951), 247.

39. Max Kozloff, *Cubism/Futurism* (New York, 1973), 70.

40. Wylie Sypher, *Rococo to Cubism in Art and Literature* (New York, 1960), 263–277.

41. Marcel Proust, *Swann's Way* (1914; rpt. New York, 1928), 258–261. On the Cubist nature of the steeples of Martinville see Matoré, *L'Espace humain*, 206. On multiple perspective in Proust and Einstein see Camille Vettard, "Proust et Einstein," *La Nouvelle revue française* (August 1922): 246–252.

42. Cited in Georges Poulet, *Studies in Human Time* (Baltimore, 1956), 319.

43. Proust, *Swann's Way*, 611.

44. Joyce, *Ulysses*, 698–699, 736.

45. Edmund Wilson, *Axel's Castle* (New York, 1931), 221. R. M. Kain wrote of *Ulysses*: "In its cubistic arrangement of contrasting planes and perspectives it is a perfect art form for the modern era"; see *Fabulous Voyager* (New York, 1959), 240. For another aspect of multiple viewpoint in Joyce and its possible connection with cinema see Paul Deane, "Motion Picture Technique in James Joyce's 'The Dead,'" *James Joyce Quarterly* (Spring 1969): 231–236.

46. Friedrich Nietzsche, *Thus Spoke Zarathustra* (New York, 1954), 237.

47. Friedrich Nietzsche, *On the Genealogy of Morals* (New York, 1967), 119.

48. José Ortega y Gasset, "Adám en el Paraíso," in his *Obras Completas* (1910; rpt. Madrid, 1946), I, 471. See Julian Marías, *José Ortega y Gasset*, n.p. (1970), 325–378.

49. José Ortega y Gasset, *Meditations on Quixote* (1914; rpt. New York, 1963), 44.

50. José Ortega y Gasset, "Verdad y perspectiva," *El Espectador*, 1 (1916), 10 *ff*.

51. José Ortega y Gasset, *The Modern Theme* (New York, 1961), 143.

52. Gasset, "Verdad y perspectiva," 116.

53. José Ortega y Gasset, "Doctrine of Point of View," *The Modern Theme*, 94.

54. J. J. Thomson, "Cathode Rays" (1897), in *The World of the Atom*, ed. Henry A. Boorse and Lloyd Motz (New York, 1966), 426.

55. Jean Perrin, *Les Atomes* (Paris, 1914), 226.

56. William Clifford, "On the Space-Theory of Matter" (1876), cited by Max Jammer, *Concepts of Space: The History of Theories of Space in Physics* (Cambridge, Mass., 1954), 161.

57. Hiram M. Stanley, "Space and Science," *The Philosophical Review* (November 1898): 616-617.

58. Richard Herr, *Wireless Telegraphy Popularly Explained* (London, 1898), 17.

59. Harriet Prescott Spofford, "The Ray of Displacement," *The Metropolitan Magazine* (October 1903).

60. Albert Einstein, *Relativity*, 150; "The Problem of Space, Ether, and the Field in Physics" in *Ideas and Opinions* (1934; rpt. New York, 1976), 274.

61. Bruno Zevi, *Architecture as Space* (New York, 1957).

62. Study cited by Reyner Banham, *The Architecture of the Well-Tempered Environment* (Chicago, 1969), 55 and *passim*, on the history of lighting and ventilation.

63. Peter Collins, *Concrete: The Vision of a New Architecture* (London, 1959); Giedion, *Space, Time, and Architecture*, 326-330.

64. Banham, *Well-Tempered Environment*, 81-2, 171-78.

65. Siegfried Giedion, *Mechanization Takes Command* (1948; rpt. New York, 1969), 301, 390.

66. Charles Voysey, "The Aims and Conditions of the Modern Decorator" (1895), cited by David Gebhard, *Charles F. A. Voysey Architect* (Los Angeles, 1975), 52.

67. Friedrich Naumann, "Die Kunst im Zeitalter der Maschine" (1904), cited by Nicolas Pevsner, *Pioneers of Modern Design* (London, 1964), 35.

68. Adolf Loos, "Ornament und Verbrechen" (1908), cited by Reyner Banham, *Theory and Design in the First Machine Age* (New York, 1960), 93-94. Loos's friend Karl Kraus fought to simplify language, politics, and society along the same lines. In the first issue of his journal *Die Fackel* (April 1899) Kraus announced that his program will be a "drainage system for the vast marches of phraseology." In Musil's *The Man Without Qualities* Ulrich finds himself suffocating under the elaborate conventions and traditions of Viennese society. He systematically withdraws from human relationships and tries to divest himself of all the "qualities" that that ornate society had imposed upon him.

69. Hendrick P. Berlage, *Gedanken über Stil in der Baukunst* (Leipzig, 1905); *Grundlagen und Entwicklung der Architektur* (Berlin, 1908), 46, 68, 115.

70. Frank Lloyd Wright, "A Testament" and "An Autobiography" in Edgar Kaufmann and Ben Raeburn, *Frank Lloyd Wright: Writings and Buildings* (New York, 1960), 314, 76, 313.

71. Theodor Lipps, *Grundlegung der Aesthetik* (Hamburg, 1903), chap. 3, "Raumaesthetik."

72. Geoffrey Scott, *The Architecture of Humanism* (1914, rpt. London, 1924), 226-228.

73. For a discussion of their works see George R. Collins and Christiane Crasemann Collins, *Camillo Sitte and the Birth of Modern City Planning* (New York, 1965), 17-18.

74. Camillo Sitte, *Der Städtebau nach seinen künstlerischen Grundsätzen* (1889; rpt. Vienna, 1909), chap. 2.

75. Adolphe Appia, *Die Musik und die Inscenierung* (n.p., 1899); Lee Simonson, "The Ideas of Adolphe Appia," in Eric Bentley, *The Theory of the Modern Stage* (New York, 1968).

76. Gordon Craig, *The Art of the Theatre* (1911); Joachim Hintze, *Das Raumproblem im modernen deutschen Drama und Theater* (Marburg, 1969), 94 ff.

77. George L. Mosse, *The Nationalization of the Masses: Political Symbolism and Mass Movements in Germany from the Napoleonic Wars Through the Third Reich* (New York, 1975), 62-66.

78. In a textbook of sociology published in 1908, Georg Simmel identified the specific social functions of empty space (*leerer Raum*). It can function as a neutral zone between rivals or as a meeting place or common ground. It can be a place for trading or a place where individuals or groups at war meet under peaceful conditions to negotiate a truce. Although Simmel's examples were drawn from the historical record, his elaboration of a theory of the social function of empty space was unique to this period. See his *Soziologie* (Leipzig, 1908), 703-708.

79. Boccioni, "Technical Manifesto of Futurist Sculpture" (1912), in *Futurist Manifestos*, ed. Apollonio, 61-65.

80. Alexander Archipenko, *Archipenko: Fifty Creative Years 1908-1958* (New York, 1960), 51-56.

81. I am indebted to Sean Shesgreen for this example.

82. Fernand Léger observed, "From the day the impressionists liberated painting, the modern picture set out at once to structure itself on contrasts; instead of submitting to a subject, the painter makes an insertion and uses a subject in the service of purely plastic means." "Contemporary Achievements in Painting" in *Functions of Painting*, ed. Edward Fry (New York, 1973), 14.

83. Pierre Francastel has assessed this contribution: "Cézanne introduced the notion of the reality of the 'motif,' that is to say the positive character of voids constituted by the intervals between objects. With him appeared the unity of every part of the figurative image." See his *Art et technique* (Paris, 1956), 222.

84. Carl E. Schorske, *Fin-de-siècle Vienna* (New York, 1980), 269.

85. Dora Vallier, "Braque, la peinture et nous: Propos de l'artiste recueillis," *Cahiers d'art*, 29 (October 1954): 15-16.

86. John Golding concluded, "For the first time in the history of art, space had been represented as being as real and as tangible, one might say as 'pictorial,' as the objects which it surrounded (here one must distinguish between an Impressionist depiction of atmosphere and the painting of empty, clear space, such as it is found before Cubism only in the work of

Cézanne)," in his *Cubism: A History and an Analysis, 1907–1914* (London, 1959), 185.

87. For a discussion of this poem and the rest of Williams's early poetry in the context of developments in art and photography see Bram Dijkstra, *Cubism, Stieglitz, and the Early Poetry of William Carlos Williams: The Hieroglyphics of a New Speech* (Princeton, 1969), 66 *ff.*

88. Meyer Shapiro, *Cézanne* (New York, n.d.), 125.

89. Boccioni et al., "Futurist Painting," in *Futurist Manifestos*, ed. Apollonio, 27.

90. Preface to the Bernheim-Jeune catalog of the first Futurist exhibition in Paris in 1912, cited by Marianne W. Martin, *Futurist Art Theory 1909–1915* (Oxford, 1968), 111.

91. I will discuss the development of geopolitics in Chapter 8.

92. Frederick Jackson Turner, "The Significance of the Frontier in American History," paper read at a meeting of the American Historical Association in Chicago, July 12, 1893; published in Frederick Jackson Turner, *The Frontier in American History* (New York, 1920), 30.

93. Frederick Jackson Turner, "Contributions of the West to American Democracy," in ibid., 259.

94. Roderick Nash, "The American Invention of National Parks," *American Quarterly* (Fall 1970): 726–735.

95. Susanne Howe, *Novels of Empire* (New York, 1949), 85.

96. Leonidas Andreiyeff, *Silence* (Philadelphia, 1910), 16, 29, 32.

97. Maurice Maeterlinck, "Silence," in his *The Inner Beauty* (London, 1911), 36, 47.

98. Marcel Proust, *The Guermantes Way* (1920; rpt. New York, 1970), 85.

99. Suzanne Bérnard, "Le 'Coup de dés' de Mallarmé replacé dans la perspective historique," *Revue d'histoire littéraire de la France* (April–June 1951): 183.

100. Aimé Patri, "Mallarmé et la musique du silence," *La Revue musicale* (January 1952): 101–111; for a historical interpretation of his contribution to composing with blanks and the connection with silences see Camille Mauclair, *L'Art en silence* (Paris, 1901) and Jean Voellmy, *Aspects du silence dans la poésie moderne* (Zurich, 1952), 24–32 and *passim*.

101. Stéphane Mallarmé, "La Musique et les lettres," *Oeuvres complètes* (Paris, 1945), 635–657.

102. Stéphane Mallarmé, "Sur Poe," *Oeuvres complètes* (Paris, 1954), 872.

103. Stéphane Mallarmé, "Mystery in Literature" (1895), in *Mallarmé: Selected Prose Poems, Essays, and Letters*, ed. Bradford Cook (Baltimore, 1956), 33.

104. Stéphane Mallarmé, "Un Coup de dés," *Cosmopolis* (May 1897): 419–427.

105. Original proofs of the projected Lahure edition of "Un Coup de dés," with marginalia by Mallarmé, in the Houghton Library Collection of Harvard University.

106. Paul Valéry, "Le Coup de dés," *Variété II* (Paris, 1929), 173.

107. Archipenko, *Fifty Creative Years*, 58.

108. Roger Shattuck, "Making Time: A Study of Stravinsky, Proust, and Sartre," *The Kenyon Review* (Spring 1963): 258.

109. Otto Deri, *Exploring Twentieth-Century Music* (New York, 1968), 358–359. In an obituary, "Le Silence de Anton von Webern," René Liebowitz wrote that "if a silence surrounds Webern's music, it also forms a part of it"; *Labyrinthe* (November 1945): 14.

110. Edgar Rubin, *Synsoplevede Figur* (Copenhagen, 1915). The first German translation appeared under the title *Visuell wahrgenommene Figur* (Berlin, 1920).

111. William James, *The Principles of Psychology* (New York, 1950), I, 240.

112. William James, *The Letters of William James* (Boston, 1926), II, 277–278.

113. Horace Meyer Kallen, *William James and Henri Bergson: A Study in Contrasting Theories of Life* (Chicago, 1914), 11, 30, 105.

114. J. Hillis Miller, *The Disappearance of God: Five Nineteenth-Century Writers* (Cambridge, Mass., 1963); " 'Thou art indeed just, Lord'," in W. H. Gardner, ed., *Poems and Prose of Gerard Manley Hopkins* (New York, 1979), 67.

115. Friedrich Nietzsche, *The Gay Science* (1882; rpt. New York, 1974), 181.

116. Nietzsche, *Genealogy of Morals*, 163.