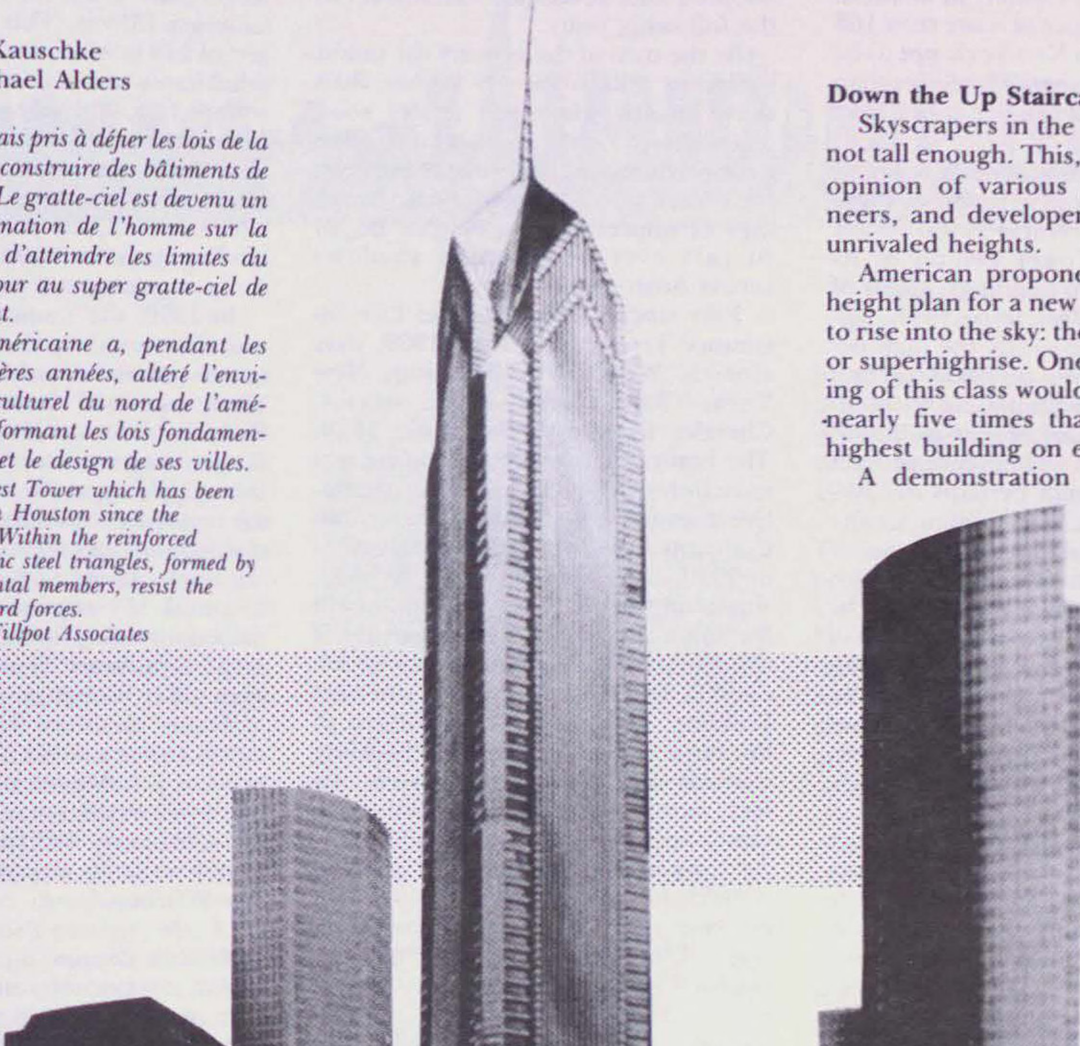
Down the Up Staircase

Hans-Gerhard Kauschke
Translator: Michael Alders

L'homme est à jamais pris à défier les lois de la gravité en voulant construire des bâtiments de plus en plus haut. Le gratte-ciel est devenu un symbol de la domination de l'homme sur la nature. Le besoin d'atteindre les limites du paradis a donné jour au super gratte-ciel de 150 étages de haut.

Cette tradition américaine a, pendant les quatre-vingt dernières années, altéré l'environment social et culturel du nord de l'amérique tout en transformant les lois fondamentales de la nature et le design de ses villes.



Bank of the Southwest Tower which has been under construction in Houston since the beginning of 1985. Within the reinforced tubular frame gigantic steel triangles, formed by diagonal and horizontal members, resist the windward and leeward forces.
Photo: Lloyd Jones Fillpot Associates

Down the Up Staircase?

Skyscrapers in the United States are not tall enough. This, at any rate, is the opinion of various architects, engineers, and developers in this land of unrivaled heights.

American proponents of increased height plan for a new class of buildings to rise into the sky: the superskyscraper or superhighrise. One projected building of this class would achieve a height nearly five times that of the current highest building on earth.

A demonstration model designed

Layout by: Daniel McGean and David Morin

for construction-boomtown Houston calls for a structure to exceed one mile and some 500 stories. In Chicago there are plans for a 210 story, 2500 foot high World Trade Center, in addition to another skyscraper of more than 168 stories. Builders in New York, not to be outdone, have presented no fewer than four plans for buildings of more than 135 stories.

In light of these proposals it seems certain that a new generation of high-rises will leave the World Trade Center and the Sears Tower behind in its shadow. These two buildings, giants of 1,352 and 1,453 feet respectively, apparently no longer satisfy the high demands of America's architects. Their response, the traditional concept of height as quality, of bigger as better, will take American architecture another step upward, though perhaps not forward.

An American Tradition

The American love of the superlative has often spurred developments of technological pre-eminence in architecture as well as in other fields. It is in architecture though, that development and innovation in methods of construction are discernable to all in the skyline (see fig. 1).

A century ago, the tallest buildings were constructed of massive, six foot thick masonry walls. Then, in 1885, engineer William Le Baron Jenny had the ingenious idea of diverting the gravitational forces of the Home Insurance Building into the ground by means of a steel, or at that time iron, framework. He hung the exterior walls upon the resulting metal frame skeleton. This principle of skeleton frame construction with a suspended facade was adopted and developed extensively in the following years.

By the turn of the century the tallest buildings still stood no higher than thirty stories. Municipal rivalry soon engendered fierce architectural competition however, particularly between New York and Chicago. Thus, buildings of unprecedented heights began to cast ever lengthening shadows across American cities.

Fifty stories, Metropolitain Life Insurance Tower, New York, 1909; sixty stories, Woolworth Building, New York, 1913; seventy-seven stories, Chrysler Building, New York, 1929. The battle for the tallest building was sometimes conducted in a wily deceptive manner. The Bank of Manhattan Company Building, under construction in 1929, was planned to rise 928 feet, surpassing the 791 foot-tall Woolworth Building. However, a former partner of the Bank of Manhattan project developed a secret plan for the Chrysler Building, also under construction at the same time. The Chrysler Building was officially to be approximately two feet lower than the Bank of Manhattan, that is until the famous spire was unexpectedly added, enabling the building to hold the height record of 1,047 feet for two years following its construction. The Empire State Building deposed it with 1250 feet and 102 stories in 1931 and remained unchallenged for the following forty years.

World War II brought peace to this war of altitude, and it was not until eleven years after the war's end that Frank Lloyd Wright was daring enough to propose a one mile high tower for Chicago, Illinois. This unrealized project of 528 stories was to house 130,000 inhabitants within its seventeen million square feet. Fifty-six atomic powered elevators with top speeds of sixty mph were to have satisfied internal accessibility, while four-lane garage entrances and exits, 15,000 parking spots, and landing pads for 100 helicopters were to have guaranteed external access.

In 1970, the Empire State Building was dethroned by the two 1,352 foot towers of the World Trade Center. That was a hard blow for Empire State Building fans, and it moved Robert Wagenseil Jones to call for the Empire State Building to be levelled down to the eighty-first floor, with an additional thirty-one floors then to be added, giving the building a new height of 1,493 feet and 114 stories. This much discussed idea died in the 1970's after the 1,453 foot Sears Tower was built and even taller buildings were expected.

Today, the Sears Tower is still unrivaled, and if the proposal of engineer William J. LeMessurier were accepted, Chicago's tower would remain the tallest building on the planet as a memorial to its designer, the late Fazlur R. Khan.

American Dream

But everywhere in America, and even in Asia, there is sprouting ambitious plans to surpass the Sears Tower.

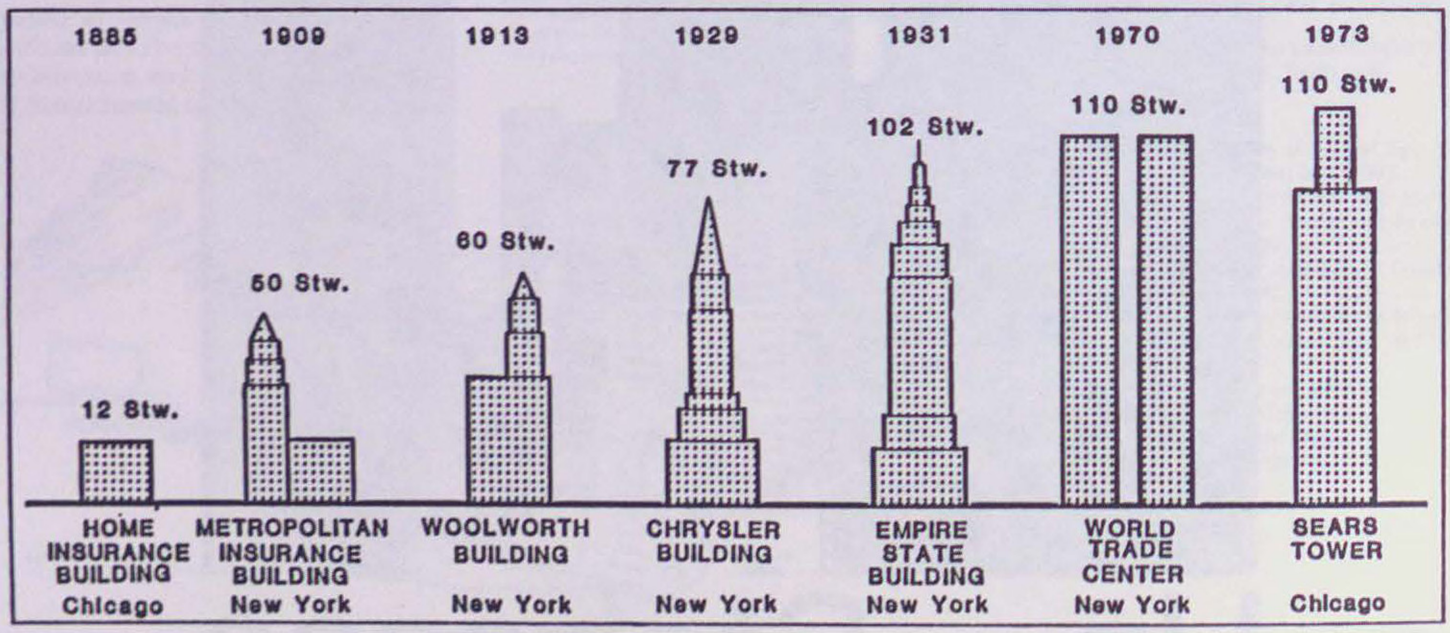


Fig. 1

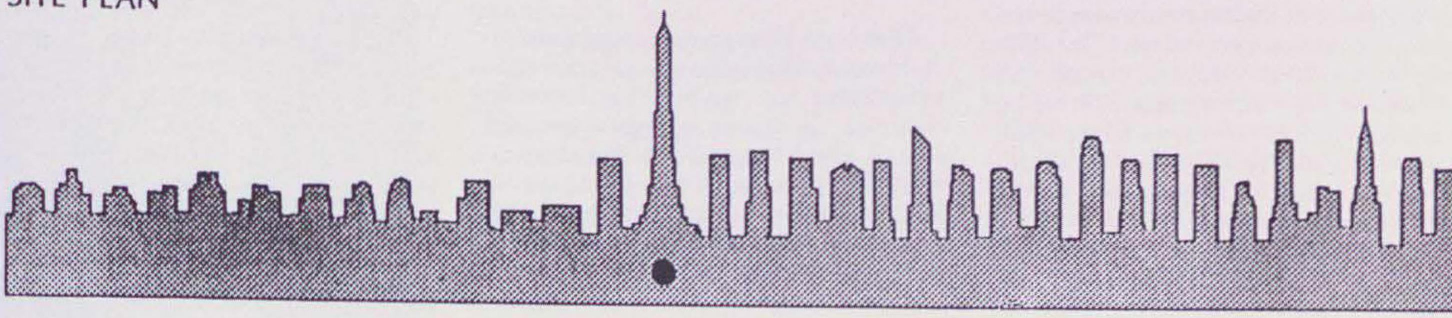


Fig. 3

There are rumors in New York that Mayor Edward Koch is disappointed that the World Trade Center is no longer the world's tallest building. In February of 1985, Kenneth Lipper, the city's deputy mayor for finance and development, called for a new highrise project to be built in Manhattan.

Lipper has even gone as far as to suggest the 150,000 square foot Coliseum as an ideal site for the new project. With the completion of the new convention center in 1986, the Coliseum, located on Manhattan's Columbus Circle, is now available.

New York architect Eli Attia has already designed a 1,600 foot, 137 story tower for this project. Together with the well known developer Donald Trump and a third partner, Mr. Kalikow, Attia proposes a 2.7 million square foot mixed-use complex, as well as improvements in local infrastructure that such a project will require (fig. 2).

The building's five story base of stone plates establishes a continuity with the sidewalk, while the slender tower rises 1,600 feet to take its place in the skyline as a new symbol of the city (see fig. 3). Proportioned in a series of seven setbacks according to the Golden Section, the facade will break the characteristic down-winds which develop at the front of a building. The 135 foot filigreed crown of open weave metal emphasizes the New York City's Gothic tradition.

Eli Attia developed an entirely new principle of construction for this project. Some maintain, however, that the parcel is too small for such a building, although the most vocal opponents protest out of a desire to see their own plans for such a project realized elsewhere.

In April of 1984, without naming an architect, the First Boston Corporation announced plans to construct a 140 story building in Midtown Manhattan. The building is to occupy an entire city block at Madison Avenue and 46th Street. To make it more believable, the groundbreaking has already been scheduled for 1988, the completion for 1990.

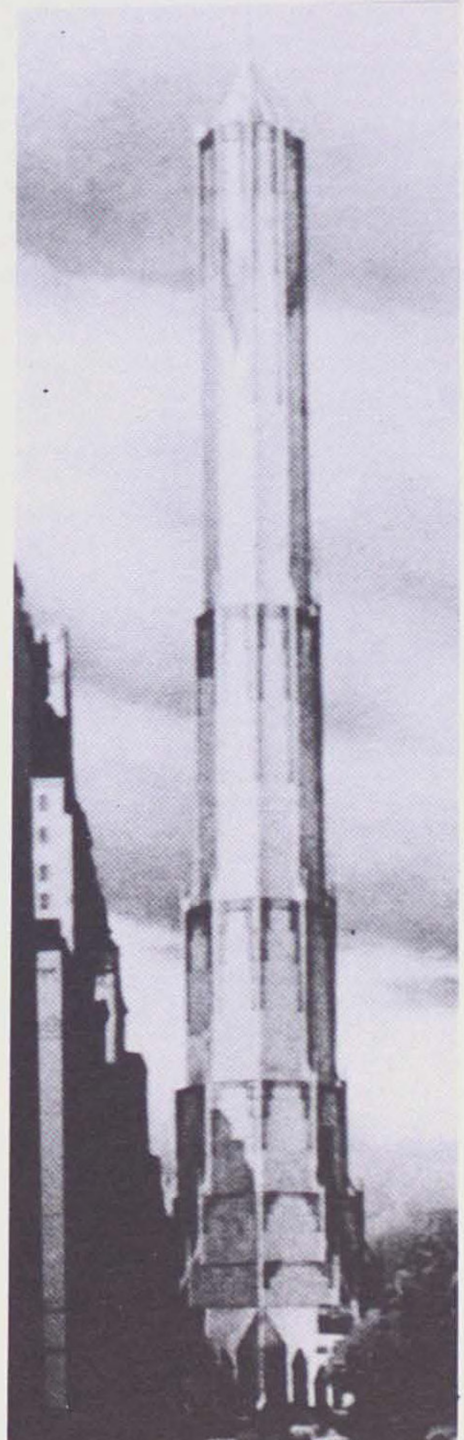


Fig. 2
A proposal for a 488 m high, structurally "mixed" complex flanking Columbus Circle in New York City. *Photo: Lee Dunnette*

Since millions are at stake, Donald Trump has announced yet a second project in addition to Ten Columbus Circle, the even more controversial East River Landing. Presumably for tactical reasons, he has declared a second site, a twenty six acre underwater parcel in the Hudson River (a one minute walk from Wall Street) to be particularly well suited for a superskyscraper (fig. 4). Here he wants to construct, in his own words, "The largest building ever". The bottom sixty floors of the 140-150 story building are to contain office space, and the next forty are to be luxury hotel rooms, with fifty storys of super luxury apartments featuring the spectacular view of the upper reaches of the building.

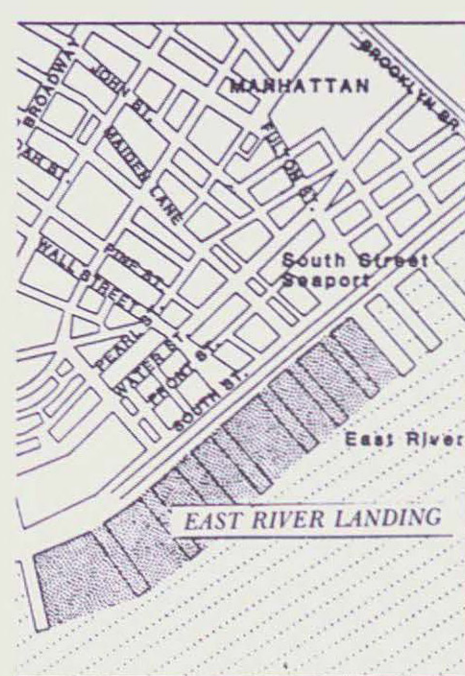


Fig. 4

Trump maintains that the 2,624 foot long parcel also has enough room for an attractive pedestrian concourse. He counters reservations about the 137 foot water depth with the statement: "It will be built at the highest level of the bedrock." He further declares that his project will finally establish an architectural equilibrium to the World Trade Center, and will also allow New Yorkers to enjoy having outdone the rival Sears Tower by an additional 485 feet.

Lack of Space Gives Rise to Innovation

The New York engineering firm of De Simone Chaplin and Associates offers another concept for 150-200 story buildings. With increasing height the base of a building must increase exponentially. This condition became the decisive factor in the design of the firm's braced towers, for most urban parcels which are of inadequate area to deal with this requirement. Vincent De Simone's idea is to connect different towers together by means of bracing walkways at various heights (fig. 5).

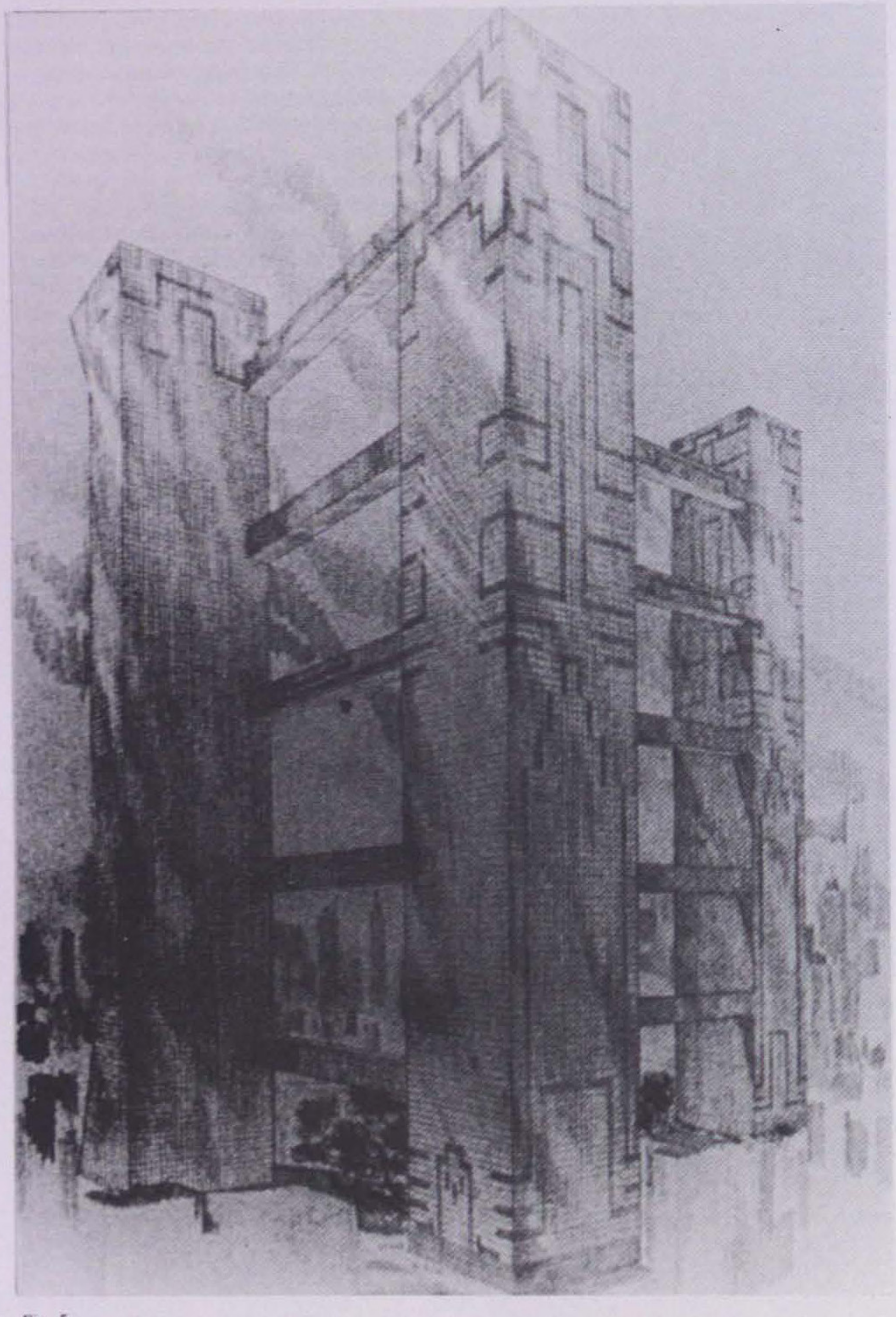


Fig. 5

Braced Towers by Secundino Fernandez (architect) and De Simone & Chaplin (engineers). As the sites are small in area, the buildings will be tied to each other, providing the bracing required to satisfy the physics of the structure.
Photo: De Simone & Chaplin & Associates

While structurally these walkways help the building to redirect horizontal wind forces into the ground, they also serve to divide sections of the building into staggered safety zones which will allow quick evacuation in case of emergency. The projected height for this project is given at 2,000 to 2,600 feet.

In Chicago, the architectural and engineering firm of Skidmore, Owings and Merrill (SOM) is working on a hypothetical study dealing with equally tall structures. For many years Fazlur R. Khan, as head of the engineering department, worked on the research and development of tubular and frame construction systems. Today, under the direction of his successor Hal Iyengar, a group of specialists is working on refining these techniques. Three years ago SOM unveiled a demonstration model of a 168 story super frame construction (see fig. 6). The great advantage of this scheme is that all the gravitational forces are directed into the frame, so that core walls and bracing are not needed in the building's interior.

Although engineer William J. LeMessurier has proposed the Sears Tower as a memorial for Fazlur R. Khan, he declares in the same breath that he is prepared to go higher himself as designer of the 207 story Erewohn Center. In this model he seeks to carry the gravitational forces of the building upon four massive supports, one at each corner of the quadratic base, with additional diagonal bracing to resist the horizontal wind forces. Due to the difficulties involved with the exposure of the building's interior to sunlight, as well as the limitations in area of typical urban parcels, he has limited the width to 220 feet. Thus the theoretical Erewohn Center acheives an as yet unreached aspect ratio of 12.6. The Sears Tower, with its base width of 226 feet, has an aspect ratio of only 6.5, and the World Trade Center, with a base of 207 feet, acheives a value of only 6.4.

The future World Trade Center in Chicago is to be 210 stories and 2,500 feet tall, declares architect Harry Weese. In collaboration with the engineering firm Lev Zetlin and Associates, his architecture firm has developed a building with an unusual form. The building winds forty-five degrees around its own axis in seven steps of thirty stories each. Each thirty story segment of the building is independently serviced with water, electricity, fresh air, and waste removal. Huge turbines located between segments are to transform the enormous windpower of

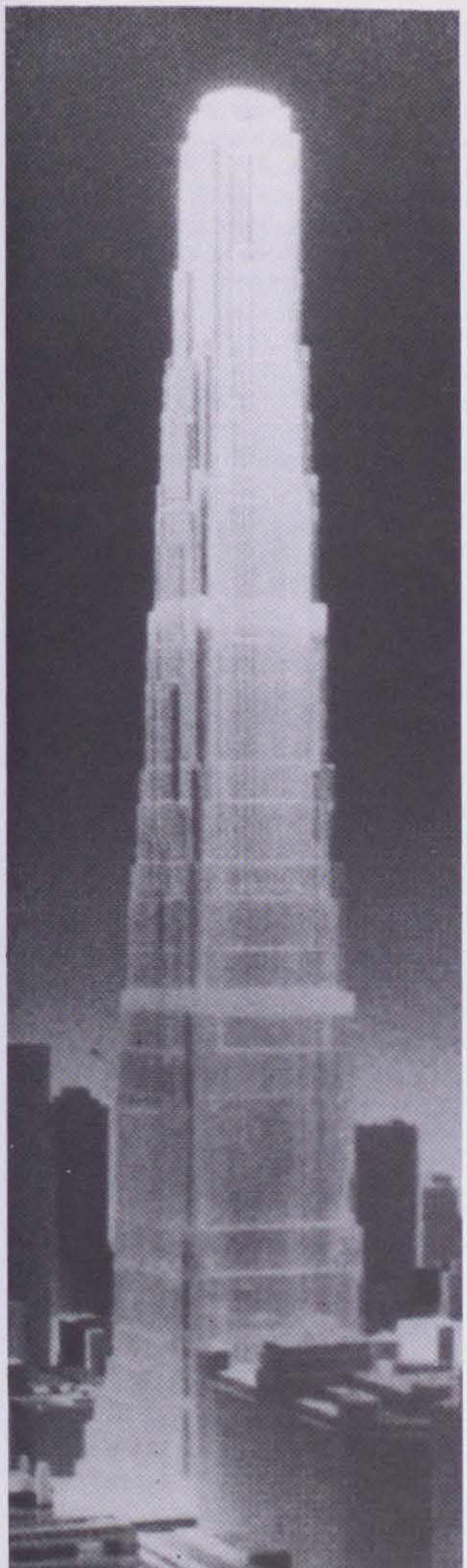


Fig. 6

Skidmore Owings & Merrill: Demonstration model for a particularly efficient structural system. All gravitational forces acting on the 168-story high building will be resisted by the frame; bearing walls and support in the interior are not necessary.
Photo: Skidmore Owings & Merrill

the Windy City into useful energy. The building has its own waste treatment facilities (fig. 8).

This project may have greater financibility than many others, as developer Stanley Raskow does see sufficient chance of amortization due to the planned 800 apartments, 2,400 hotel rooms, an international and trade fair center, retail stores, restaurants, three theatres, and a stellar observatory on the roof. Only 3,000 parking places are planned, since an electro-magnetic light railway is to service the complex.

Architect Robert Sobel of Emery Roth and Sons, New York, has clearly exceeded the present limits of financibility with his 500 story Houston Tower, which has primarily experimental-hypothetical value for him at this point. The gigantic 1.3 mile tower with its base-length of 800 feet would take up nine blocks in Houston's inner city (fig. 9). Emery Roth and Sons took part in the planning of the World Trade Center in New York and hope to employ and refine the experiences of that project in Houston.

Harsh Reality

What are the problems which arise from super-tall buildings? As long as there are skyscrapers and human beings there will always be both opponents and supporters of such construction.

The supporters of skyscrapers see in them magnificent sculptures that defy the forces of nature, symbolize man's pre-eminence, challenge his ingenuity, advance technology, and add excitement to the urban setting. They are enraptured by the view from the top of these buildings, and they enjoy rare excursions in an elevator, for most of these proponents themselves do not live in skyscrapers.

Critics see the epitome of egotistic arrogance in skyscrapers. They view them as a phenomenon that has overwhelmed and transformed the cities of the world into look-alike pestholes, condemned their inhabitants to a cave dweller's existence, and taxed their infrastructure to the point of rush-hour collapse.

One thing however is certain, whatever the reasons for man's acrophilia in the past, whether religious, political, economic, scientific, or aesthetic, inspiring structures have often been the result. The fruits of man's desire to build are visible from the pyramids at Giza and the Tower of Etemenanki in Babylon, to the Acropolis in Athens, to St. Peter's Basilica in Rome, to the Eiffel Tower in Paris, and to the Sears Tower in Chicago.

The function of the highrise of the future can be seen as the result of the cultural and political-economic framework in which it is built. With the increasing population density of American cities in particular, the potential profitability of the real-estate rises. The profitability can then be driven up even further through an even greater density of population. Rents in American cities rise enormously in a viscious circle until the point of either absolute market saturation or collapse is reached.

We can already see that the rentability of office space has declined over the last five years as a result of the automation of office work. Conversely, from a standpoint of residential use, these desolate canyons of steel, concrete, and glass are equally unrentable. It is also important to realize that in super-highrises the price per square foot doubles above the hundreth floor. The interest payments alone during the sometimes six-year construction period can be one billion dollars. In light of these conditions it is not easy to find a financier for such a risky and costly experiment.

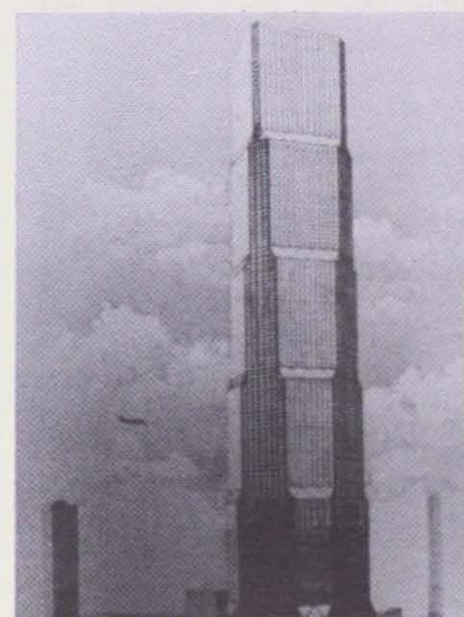


Fig. 8
Esquisse for the World Trade Center in Chicago, by Lev Zetlin & Associates.
Seven self-sufficient levels of 30 stories each twist about a 45° angle from the ground to a height of 762 m. Enormous turbines between these levels help resist the windloads.
Photo: Lev Zetlin & Associates

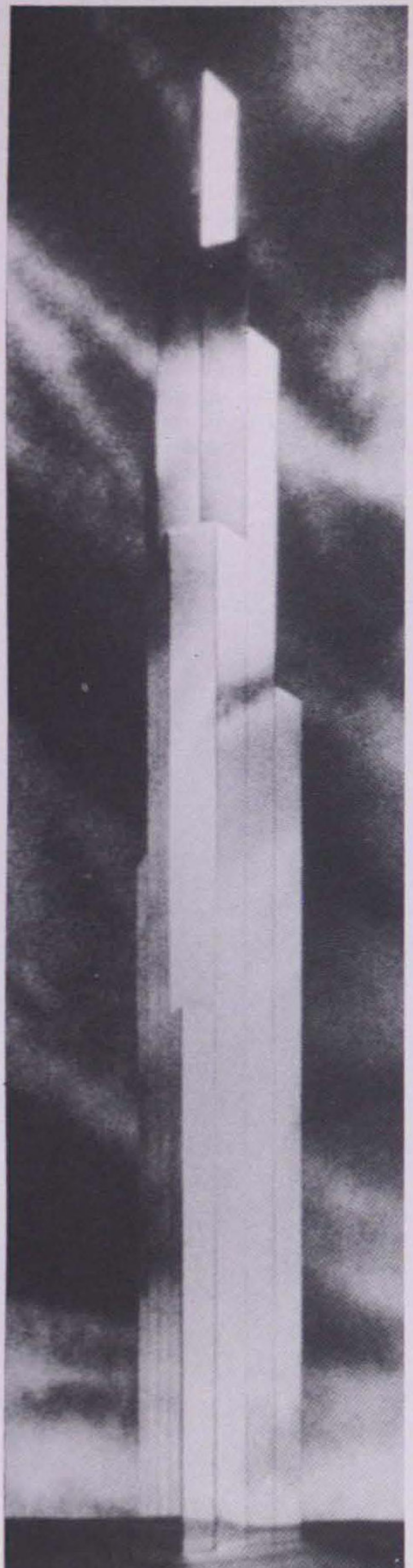


Fig. 9
Feasible but uneconomical: the 500-story high Houston Tower by Robert Sobel (Emery Roth & Sons).
Photo: Robert Payne

The architectural and engineering specialists have a much easier time of it, for they need only deal with the physical problems of construction. Because they know exactly the parameters within which they are working, they can more easily find solutions for the most extreme problems of construction.

The construction of a superhighrise, like that of every other building, must be able to absorb the forces of gravity, wind, and even a possible earthquake, and divert these safely into the ground. With increasing height these forces are magnified exponentially, and theoretically there is no limit to a building's height, if its base, as in the case of the Eiffel Tower, can also increase exponentially in cross section towards the ground. This is an important rule of thumb for the high-rise architect: the higher the building, the broader the base must be. This vertical/horizontal relationship, also called the aspect ratio, ranges in most highrises between six and eight. In superhighrises these values must be increased greatly due to the limited size of available parcels and municipal zoning ordinances. Most current plans call for aspect ratios of around ten.

Even though it is theoretically simple, by excluding all other design components (e.g. access, exposure, security), to constructively deal with the vertical forces of gravity, dealing with wind induced horizontal forces is far more difficult.

In a superhighrise, these horizontal forces can induce slipping, bending, oscillation, twisting, shearing, cracking, or even breaking (see fig. 10). We can leave aside horizontal forces which result from earthquakes, for ostensibly even in the earthquake country of Los Angeles these do not equal the forces of a hurricane in Houston.

Tension arises when these forces act upon the construction material. The material must therefore be able to absorb as many of the tensions of bending, pulling, torsion, shearing, etc. as possible. The construction itself must generate as little tension as possible within the material, and the actual form of the structure must be one that subjects the construction to as little horizontal force as possible. This point leads us to the dynamic behaviour of a structure when it is exposed to winds. Vortices arise when a square or a rectangular building is exposed to wind forces; these cause low pressure on the leeward side of the building, resulting in oscillation as the building yields to the higher pressure on the windward side (see fig. 11).

An aerodynamic structure is subject to less wind induced horizontal force than a quadratic structure; in aerodynamic automobiles for instance, this is indicated by lower gasoline consumption. Aerodynamic structures, however, according to the wind tunnel experiments of engineer William J. LeMessurier, also have a lesser capacity to divert vertically such horizontal forces as they strike the building. A structure that is stiffened by corners (with a quadratic or triangular ground plan) is in his experience twice as resistant as a cylindrical shape.

Although this surpises LeMessurier as well, he has not developed the idea of combining the aerodynamic advantages of a slippery structure with the stiffer and stronger quadratic design. A logical conclusion of this idea would be to place such a hybrid structure upon a rotating disk... But who would pay for such a construction?

The Human Factor

Which access, security, servicing, and disposal systems do we humans deem necessary?

The champions of the superhighrise claim not only to have satisfied all basic human needs in their buildings, but actually to have perfected the satisfaction of those needs. Total protection from the weather: heat, light, a continuous air supply, water, and electricity at the turn of a switch; and the effortless disposal of all waste are the rule in these buildings. That all of this requires proportionally more space is viewed as a minor problem. Electricity is conveyed under high tension and transformed to house current within special technical floors, water is kept in the building's own treatment plant, and trash is transformed into heat in the building's own incinerators.

The biggest problem of internal transport is the human ear. Even with the "slow" twenty mph elevators in the Sears Tower there are some people who experience pain upon descent. For the tremendously long and rapid rides in the superhighrise there will have to be transfer floors for rider equilibration.

In order to cut down on the sheer number of elevator shafts there will be two and three decker elevators which service various floors in one stop. What are really needed, say the designers of such systems, are self propelled elevators which can "leap" from one floor to another.

It was conceeded at the ENR-Symposium that security systems cannot offer absolute security. The risk factor rises along with the height of the building in the battle against the nature of fire, wind, and earthquakes. Even completely fireproof security zones can not alter instinctive human panic-behaviour.

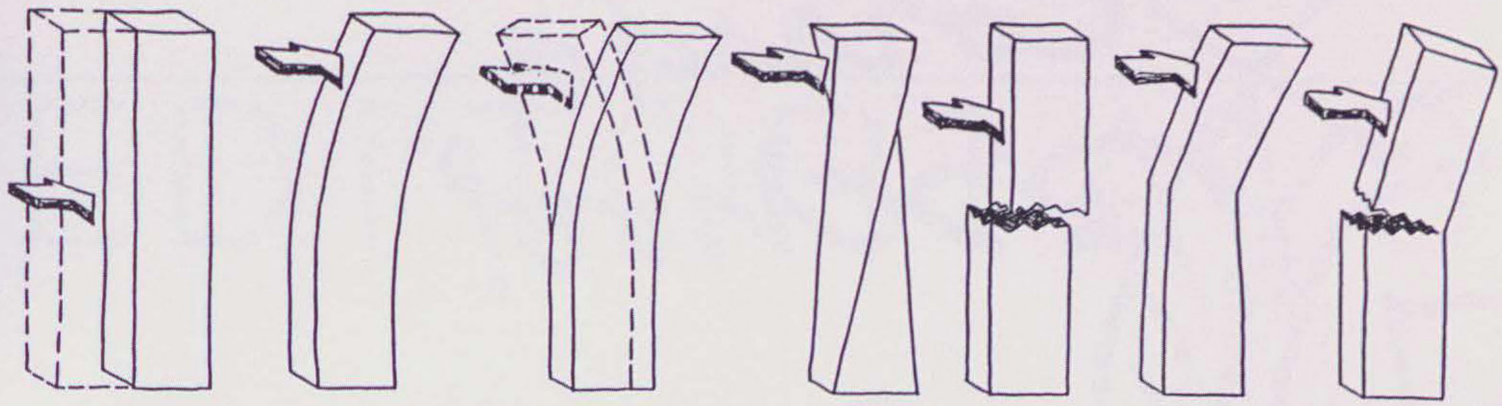


Fig. 10

Slipping *Bending* *Oscillation* *Twisting* *Shearing* *Cracking* *Breaking*

The Financial Question

The construction itself is primarily a financial problem, for theoretical cost calculations often prove to be wrong, as do proposed time schedules. The actual construction period, which can last years, generates no income even as the very high interest payments accrue. If new construction techniques are being tested, the risk of cost and time miscalculations rises.

The use of a superhighrise is determined by its price, as it is located in the most expensive part of a city and must generate corresponding income. The enormously high rents of superhighrises are only possible for corporate renters. In addition to this, the shadowy and windy inner-city landscape is generally not conducive to residential use, even though it must be allowed that city noise disturbances are no longer a problem above the hundreth floor.

Summary

For the most part we have the know-how for a new generation of highrises. As Robert Sobel considers buildings of up to 1000 stories technically feasible, we arrive, according to him, at new contemplations which transcend technological problems. The problematic of the building becomes the problematic of the environment. What are the social, environmental, and cultural effects, the costs of infrastructure, transport systems, etc., that the solution of the technical problem engenders? What effect does such a building have on the relationship between a city and its suburbs and outlying areas?

Does not the United States have a post-industrial responsibility to Europe and the developing countries to show how the mistakes of the past can be corrected, to show that architecture and city planning can be practiced along other lines than merely visions of quantity as quality?

Can America not finally resolve its historically grounded inferiority complex, reflect upon its accomplishments, and realize that indeed quality and not quantity will be the telling factor in the coming century?

Should we not as human beings orient ourselves more towards our direct requirements of integration into nature, rather than letting abstract data and rationalistic facts rule us?

Could we not strive to live in harmony with nature and plan our future without automatically reverting back to the stone-age in our thinking, without dreaming of a romantic past, but instead realistically working for a future where we can reconcile ourselves with the Earth?

We have not yet overcome the heritage of the middle ages to view nature as our enemy. We seek to understand the laws of nature, not so that we may live in harmony with it, but so that we may overcome nature's dominance and conquer it along with our own species.

Skyscrapers are symbols of dominance. Dominance over the laws of nature, our competitors, other cities, other countries, the Other in general. This type of black and white thinking keeps us in a struggle with ourselves without letting us understand that the Other is also part of us.

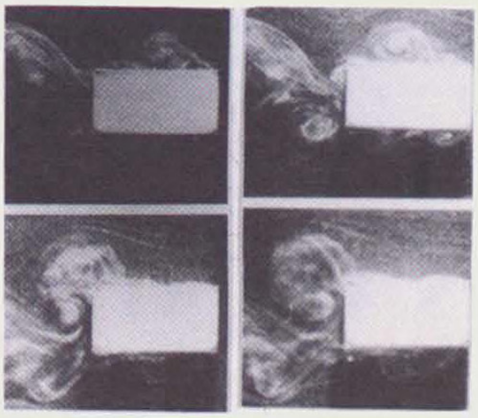


Fig. 11
Airflow/wave patterns about a building with a rectangular plan. Photo: Michael Mikitink

I see in the development of future highrises the danger that we will further alienate ourselves from our environment as we render it ever more artificial. Today's highrises can be compared to an airplane, tomorrow's to... a spaceship?

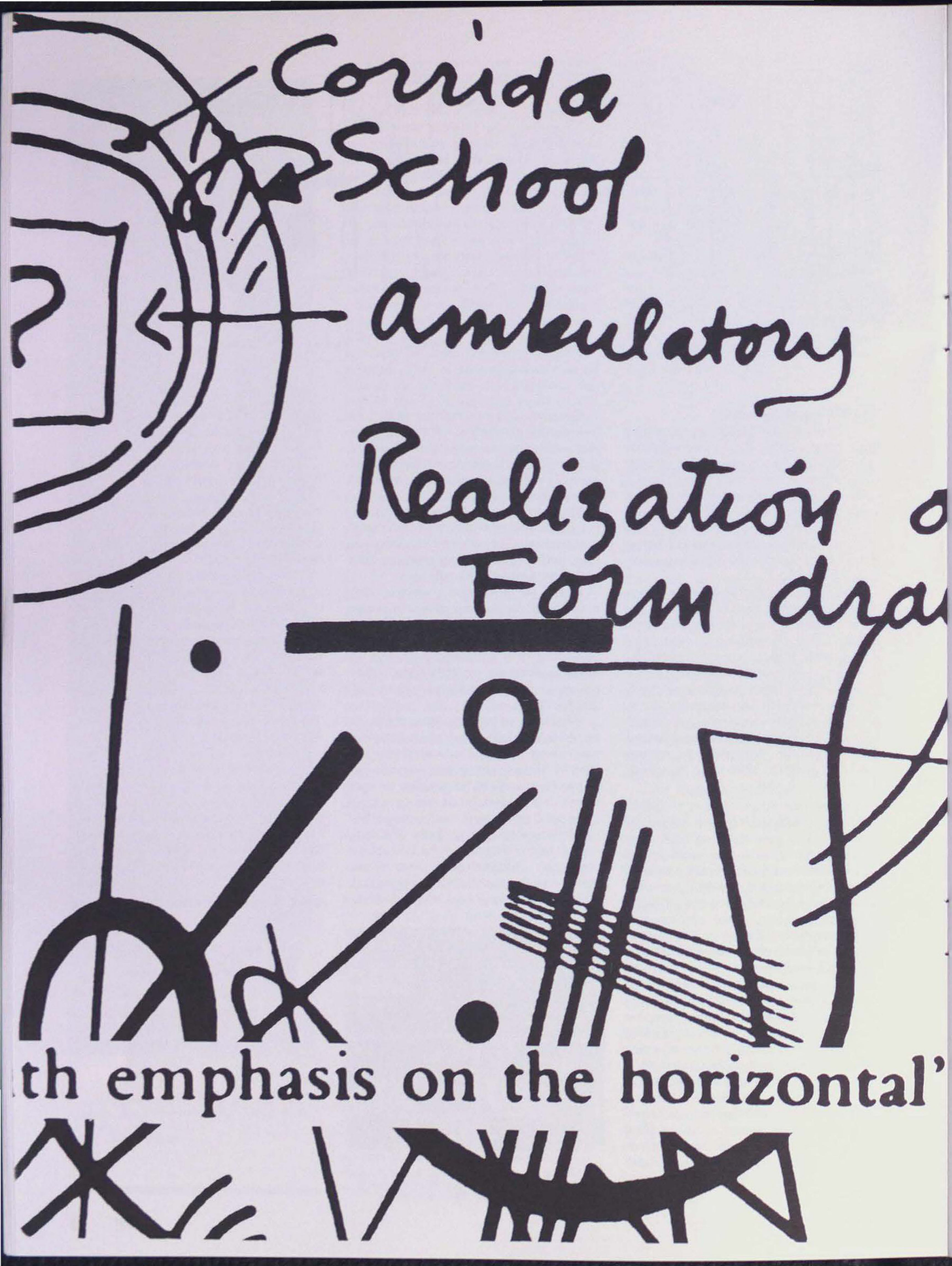
If we really have deep within our souls the desire to soar in the heights, couldn't we be satisfied with a short jaunt in a helicopter?

Granted, the development of the highrise has precipitated ingenious technological progress. But haven't we reached a point where height alone can not be viewed as intrinsically desirable, where we can psychologically afford to build on a smaller scale?

I would like to see in all cities a better quality of life on the streets and in the places where people live and work.

And it's strange; as soon as I stand on the observation deck of a skyscraper I can understand its proponents, but I can understand its opponents when I once again walk on the street in its cold shadows. ■

Hans-Gerhard Kauschke studied at the Bremen Architectural College and graduated from the Berlin Art Academy. He has worked in Berlin, New York and San Francisco.


Corrida
School
ambulatory
Realización o
Form dra
th emphasis on the horizontal'