GLOBAL CITIZEN
THE ARCHITECTURE OF
MOSHE SAFDIE
Since its inauguration in 1967, Habitat has witnessed the lives of three generations, suffered forty-three Montreal winters, and endured the passing of several currents of architectural thought—Utopian optimism, into which it was born, followed by postmodernism, deconstructivism, critical regionalism, and the list goes on. Habitat was conceived in hand-drawings and models, engineered by hand computations and the slide rule, before computers and computer-aided design. It was created to fit into an industry proud of its assembly-line, mass-production techniques, self-sufficient in producing each and every one of its components.

Today, industry has been transformed into globalized, decentralized productions, where a product is made with a great number of specialized components manufactured across the globe. Habitat came to a planet populated with 3.5 billion human beings; now the total exceeds 6.7 billion. Having reached a respectable age, it has weathered well, developed a patina, wrinkles and all. But, above all, Habitat was and is a happy and satisfying home for the 158 families who reside in it.

To revisit the concept of Habitat almost half a century later demands that we reconsider and rearticulate the objectives of this enterprise. What did Habitat aim to provide? How has it lived up to its promise? How might it be improved as a living environment or made more affordable? Or made more sustainable? Or made more adaptable to current urban conditions? These questions draw on issues of lifestyle, social interaction, construction technologies, and real estate economies, to mention but a few of the relevant issues.

Habitat was, above all, about the theme “for everyone a garden,” a metaphor for making an apartment in a high-rise structure into what connotes “house”—a dwelling with its own identity, openness in a variety of orientations, and adjacent personal garden space set within a community. One of the charms of Habitat was that it maintained the feeling of an agglomeration of houses, not of high-rise apartment living. The individual identity of the house is maintained—its autonomy within the whole, its abutting garden open to the sky, its multiple orientations transcending the decades-old malaise associated with apartment living.

These qualities were achieved by “fractalizing” the mass of the building. Of course, in 1967 the term “fractal” did not yet exist. (Benoit Mandelbrot was to introduce his new branch of mathematics in 1975.) Yet, essentially, this natural phenomenon—the breaking down into clusters and sub-clusters into what appears to be random, yet is a mathematically ordered pattern—that is the foundation of Habitat’s concept. The payoff is that, by increasing the surfaces of the building, not only multiply opportunities to maximize light and views, but also to transform the mass of large buildings, perforating the surface so that, basketlike, you can see the sky beyond and allow the air to flow through the building mass.

In Habitat this is facilitated by the modular construction. The prefinished concrete module becomes the basic building block, combined to form larger clusters, and even larger assemblies, within the whole. The building block also combines to form a diversity of apartment types and sizes. While fractalizing the mass of the building opens up many environmental opportunities, in it lies the economic
challenge. The multiplicity of surfaces is susceptible to energy loss: the building acts as a radiator, demanding extensive insulation, water proofing, and surface treatment. Forty-three years of habitation have demonstrated, almost overwhelmingly, the satisfaction of the residents of Habitat in this life provided by its houses. They come to live there and stay there decade after decade because it is unlike either the suburban house they might have lived in or the downtown apartment they might have left. They come and they stay because it seems to have fulfilled the notion of a house that can be created within a high-rise, urban structure. They feel that way even though in the winter they must traverse the open-sky street to their apartment and otherwise sustain a life in the harsh, cold climate of Montreal. Habitat has also met the challenges of the seasonal cycle, as residents added solariums extending outdoor life to all seasons. But, with Habitat’s success, there have also come the doubters: if Habitat is so wonderful, how come it has not proliferated everywhere? If it provides a superior environment, why do traditional and typical apartment building developments prevent its success? As analysts in 1974, the cost of habitation is to sustain the greater amenities it provides, recognizing that it will always be more costly both to build and operate than the closely stacked massing of the traditional apartment buildings. In the vertically stacked apartment building, structural forces will flow directly to the ground, plumbing lines will not be interrupted, and the exterior envelope will be reduced. Habitat’s “fractalization,” which includes the inclined and stepping massing, plays havoc with the building systems, profoundly affecting the economics of building. These economic constraints do not apply or affect the one percent of super-luxury dwellings currently being constructed around the globe, in New York or Dubai, Singapore or Shanghai, Hong Kong or São Paulo. Eminent architects have joined with developers to provide the super-luxury buildings, some stacked traditionally, some dramatically suspended in space, costing many millions of dollars per unit. Indeed, for that market, Habitat today presents an ideal model, as demonstrated by recent projects by Santiago Calatrava and other architects who have joined the developers’ quest for this segment of the market. Clearly, however, Habitat cannot respond to the wider demand of middle- and upper-middle-income urban dwellers, it will not proliferate.

HABITAT RECONSIDERED

In deciding to embark on Habitat of the Future, we face the question how might we do this today at the beginning of the twenty-first century? We must carefully define our objectives if we are to avoid an ambiguous drift, seesawing between questions of economics and density on one hand, and amenity and livability on the other. Should the study concentrate on maintaining the level of amenity and quality of life provided by Habitat, but in arrangements and construction methods that might crack the economic barrier? Or should one seek to improve on what had been achieved in 1967 as a living environment? In seeking affordability, should one accept, not with an air of defeat, but of experience and wisdom, the necessity of somewhat reducing these amenities, making buildings more compact, reducing the building envelope, and improving the efficiency of the structure? And how does all this sit with the ever-increasing pressures for greater densities and mixed uses as it attempts to address the needs of contemporary urbanism and the vast network of closely packed, very high-residential complexes and office buildings covering many miles of our megapolis?
HABITAT STUDIES FOR THE 21ST CENTURY:

Our studies for a Habitat for today focus on a number of fundamental issues affecting feasibility, livability, and economic parameters that impact any proposal.

Buildability: Recognizing that the cost of housing is affected by structural complexities, as well as complexities of the mechanical and electrical systems, speed of construction, and the cost of enclosing a structure, some of the studies focused on greatly simplifying these elements as compared with Habitat '67. Some studies were premised on maintaining a simple, vertically stacked structure, traditional plumbing shafts, and greater compactness with reduction of skin area for the buildings. As these simplifications occurred, we pushed the envelope to maintain, as much as possible, exposure to light and optimal orientation, garden spaces for all or most apartments, and greater flexibility in interior planning for the residents.

Density and Mixed Use: A criticism leveled at Habitat in 1967 was that it was, in the final analysis, limited to medium-density housing. Even Habitat's unbuilt original scheme, twenty-five- and Thirty-stories high, was not as dense as some of the apartment complexes rising today in Hong Kong and Manhattan, Shanghai and São Paulo. Over the past years, we have increasingly become aware of the development of many urban sites in which both housing and offices — work space, living space, and shopping — comprise the development program. This can be seen in development areas abutting or within the central business districts. In New York, for example, it is the program proposed for such major redevelopment sites as the Con Edison site on the East River and the railroad lands on the west side, as well as developments proposed for the Queens and Brooklyn shoreline on the East River. High density and mixed use go well together. Mixed-use development offers us the opportunity to reshuffle the traditional mode of juxtaposing, side by side, office buildings and residential buildings. In the traditional development mode, residential and office towers collocate alongside another; often, with the result that views and daylight are compromised where for residential development, which metaphorically and in reality are built in the shadow of office buildings.

The advantage of mixed-use structures is that functions can be reshuffled three dimensionally. Retail always thrives along the streets at ground level. Offices naturally form the base of the development, where daylight can often be brought into the larger-footprint buildings through atria. Residential spaces for all or most apartments, and greater flexibility in interior planning for the residents.

Buildability: Recognizing that the cost of housing is affected by structural complexities, as well as complexities of the mechanical and electrical systems, speed of construction, and the cost of enclosing a structure, some of the studies focused on greatly simplifying these elements as compared with Habitat '67. Some studies were premised on maintaining a simple, vertically stacked structure, traditional plumbing shafts, and greater compactness with reduction of skin area for the buildings. As these simplifications occurred, we pushed the envelope to maintain, as much as possible, exposure to light and optimal orientation, garden spaces for all or most apartments, and greater flexibility in interior planning for the residents.

Density and Mixed Use: A criticism leveled at Habitat in 1967 was that it was, in the final analysis, limited to medium-density housing. Even Habitat’s unbuilt original scheme, twenty-five- and Thirty-stories high, was not as dense as some of the apartment complexes rising today in Hong Kong and Manhattan, Shanghai and São Paulo. Over the past years, we have increasingly become aware of the development of many urban sites in which both housing and offices — work space, living space, and shopping — comprise the development program. This can be seen in development areas abutting or within the central business districts. In New York, for example, it is the program proposed for such major redevelopment sites as the Con Edison site on the East River and the railroad lands on the west side, as well as developments proposed for the Queens and Brooklyn shoreline on the East River. High density and mixed use go well together. Mixed-use development offers us the opportunity to reshuffle the traditional mode of juxtaposing, side by side, office buildings and residential buildings. In the traditional development mode, residential and office towers collocate alongside another; often, with the result that views and daylight are compromised where for residential development, which metaphorically and in reality are built in the shadow of office buildings.

The advantage of mixed-use structures is that functions can be reshuffled three dimensionally. Retail always thrives along the streets at ground level. Offices naturally form the base of the development, where daylight can often be brought into the larger-footprint buildings through atria. Residential spaces for all or most apartments, and greater flexibility in interior planning for the residents.

Structural Simplification:

We have embarked on schemes that have emerged from the supposition that the greatest way to improve the affordability of Habitat is to stack the units vertically. Thus, both structure and plumbing are not compromised in their simplicity. In these schemes, the building’s envelope can vary, be compact or more open, and massing can be modulated depending on the climatic setting.

As we pursue this strategy, we recognize that one of the qualities of the original unbuilt Habitat design was its attempt to provide a constant sun-exposed face to each and every dwelling. In the original Habitat ‘67 proposal, the rhomboid membranes sloped, stepping down gently, either to the southeast or southwest. In Habitat ‘97, as realized for Expo ‘97, this ambition was not sustained. Units facing the city or river were oriented south, sometimes east, west, or north, providing a greater variety and less consistency of orientation. The sensitivity to the direction of exposure varies climatically. In a tropical setting one might prefer north or south exposures. A dominant consideration would be to assure ventilation by prevailing winds. But, as one moves north (or south) from the equator with great seasonal variations, the need for sun in winter and shade in summer becomes more acute. Hence, orientation becomes less an issue for compromise and more a pre-condition for energy efficiency.

Study Number 1

Vertically Stacked Habitat

The vertically stacked Habitat proposes to construct the entire complex from prefabricated panel systems consisting of floor slabs and bearing walls, forming continuous, uninterrupted, vertical-support walls for the building. While the walls stack vertically to form columns supports for the cross-spansing slabs, they also have the capacity to cantilever inwards and outwards in two directions by twenty-six feet. To maintain efficiency of the structure, the full depth of one floor forms the cantilevering beam, minimizing the structural impact. The result is a structure that is modulated in and out. It extends outward towards the east, then recedes to extend towards the west, and so it goes, to the full height of the building. Each dwelling is approximately the same depth, stacking in and out to form gardens for each dwelling on the roof of the unit below. Every five floors at the center of the building, a pedestrian walkway threads through, running from one elevator core to the other. Each alternating vertical wall is doubled to accommodate, within it, access stairs to the unit. Whereas some units are entered directly off the pedestrian street, others are accessed through the stairs, never more than two floors above or below the street. Units can also be two-story-high duplexes. They can occupy the full width of 30 feet, from one structural wall to the other, accessing in size from 600 square feet to 2,400 square feet or more, with almost limitless variety. As an option, a structural subfloor can be installed above the structural slab, thus giving full flexibility to placement of kitchens, bathrooms, air-conditioning, and data distribution. Also, the subfloor detail allows for the effective waterproofing of the roof garden, as the floating deck facilitates roofing drainage while maintaining level continuity for indoor and outdoor spaces.

In this concept there is greater variation in quality of the environment offered within the dwellings than at Habitat ‘67. Some houses project dramatically out of the building envelope, maximizing exposure to light and air; others recede deeper into the building, producing a shadier environment. But, as one moves north (or south) from the equator with great seasonal variations, the sensitivity to the direction of exposure varies climatically. In a tropical setting one might prefer north or south exposures. A dominant consideration would be to assure ventilation by prevailing winds. But, as one moves north (or south) from the equator with great seasonal variations, the need for sun in winter and shade in summer becomes more acute. Hence, orientation becomes less an issue for compromise and more a pre-condition for energy efficiency.
**Study Number 2: Urban Window Habitat**

Like Study #1, Study #2 consists of vertically stacked buildings and structural systems in vertical modules of twenty stories. The individual slab buildings, sometimes rectangular, sometimes stepped to form roof terraces, are stacked corner to corner and can accommodate offices, hotels, or residences. As these slabs are stacked vertically, trusses allow for the slabs to span from core to core, forming large-scale, 150-foot-wide by 240-foot-high “urban windows.” The resulting mass is exceedingly porous, framing views of city and sky and providing open views from within.

Assuming a linear site along an urban edge, a riverfront, a waterfront, or a great park, the complex would be organized along a pedestrian street accommodating shops and community facilities. We have developed such a model for the Marina Bay Sands complex in Singapore. The first layer of slabs would primarily be office space: two slabs form an L-shaped structure joined by a glazed atrium and connecting to the pedestrian urban spine. At the twentieth floor, a secondary community pedestrian street traverses the entire complex in trusses that span the lower office blocks. Community-related facilities are clustered along this route. A second and third stack of slabs, primarily residential, complete the project to its height of a total of sixty floors. The density achieved is formidable, yet the urban windows, as well as the terraced massing of the residential slab, provide for openness, views, and generous daylight, with multiple orientations. Approximately half the units in the complex are provided with gardens open to the sky; others are compensated with solariums, bay windows, and balconies.

The extraordinary achievement here is the reliance on completely traditional, vertically stacked slab towers, with the exception of the trusses that enable them to span from core to core. This means conventional construction and structures, plumbing, building services, and vertically stacked elevators are placed with great efficiency, and fire-exiting and safety schemes are both effective and efficient. The building economics of such a proposal are familiar and predictable, yet the level of amenity offered greatly exceeds that of traditional mixed-use complexes of similar densities.

Compared to the amenities of Habitat ’67, undoubtedly, this scheme does not provide as consistent, as generous, or as private accommodations. On the other hand, it promises to be exceedingly more affordable and capable of application to a great variety of urban development sites today.

**Study Number 3: Undulating Membrane Habitat**

One of the features of the unbuilt Habitat proposal was its formation on hill-like “membranes.” These were structures with housing terracing downwards but hollow from behind. Thus, the seemingly floating membranes provided for terracing open to the sky with apartments that opened in two and sometimes three directions. As in a hill town, alleys or walkways occurred every three, four, or five levels, traversing horizontally along the contours served at the ends by vertical or inclined elevators. In the original Habitat proposal, the membranes were supported by structural A-frames at each end, which also accommodated an inclined elevator system (such elevators are today an off-the-shelf product, but more costly and slower). While membranes provided the rich amenities of hillside living, the structural liabilities of an inclined structure with economic consequences were considerable.

In response, we have developed two variations of membrane hillside housing. The first membrane warps from a gently inclined plane to a vertical one, undulating into a second cycle inclining in the opposite direction. Thus the warped surface, sixteen-stories high, goes through the transition of inclined to vertical and again inclined. The vertical juncture point in the membrane is where a core of vertical elevators and fire stairs is located. Though there is a variable degree of inclination forming terraces and roof gardens, the structure itself is self-stiffening, self-supporting, and served by traditional vertical cores.

To minimize the impact of the membrane inclination, the floor slabs at each level, working in tandem with columns of variable inclination, are braced on the underside of the membrane by a diagrid — or diagonal grid — structure that spans between the vertical cores. This helps support the horizontal thrust forces, minimizing the structural liability of the inclined membrane. An undulating, wavelike public promenade caps the roof and serves as a community public garden. A system of horizontal pedestrian streets traverses the structure every five floors and, in a manner similar to Studies #1 and #2, leads to apartments either one or two floors up or down from the main street level. The street level, having been placed on the outer face, benefits from daylight and dramatic views.

The extraordinary achievement here is the reliance on completely traditional, vertically stacked slab towers, with the exception of the trusses that enable them to span from core to core. This means conventional construction and structures, plumbing, building services, and vertically stacked elevators are placed with great efficiency, and fire-exiting and safety schemes are both effective and efficient. The building economics of such a proposal are familiar and predictable, yet the level of amenity offered greatly exceeds that of traditional mixed-use complexes of similar densities.

Compared to the amenities of Habitat ’67, undoubtedly, this scheme does not provide as consistent, as generous, or as private accommodations. On the other hand, it promises to be exceedingly more affordable and capable of application to a great variety of urban development sites today.
Study Number 4
A-FRAME MEMBRANE HABITAT

One of the weaknesses of Study #3 is that the undulating membrane structure forms a wall-like element in the urban landscape. This wall of building mass does not allow for open-view corridors. These are needed to mitigate the wall-like syndrome, particularly when development occurs along scenic routes, such as beaches and major parks. While recognizing the inferior overall economics of an A-frame membrane structure, we pursued a study in which the original unbuilt Habitat design is modified to be structurally more efficient by varying both the geometry and the structural system from the original. The “rhomboid” of the unbuilt Habitat was changed into curved membranes supported on each side by A-frames. These frames accommodate inclined elevators and fire stairs. Floor slabs, inclined columns, and diagrids make up the structure as in Study #3.

Large urban windows — dramatic gaps or openings — are made possible within the porous building. The structural efficiencies, direct plumbing lines, and reduced building envelope all make this scheme considerably more economical than the original Habitat design. It also creates flexible loft spaces that can be constructed at will by residents into any combination of dwelling sizes.
The original Habitat design from 1964 proposed housing “membranes” shaped as rhomboids supported by A-frames as the basic housing structure. The prefabricated modules were stacked in spiral formations, inclined and supported by a network of pedestrian streets acting as lateral beams, in turn supported by A-frames. As they leaned back against each other, large land areas were sheltered under these membranes, partially open to the sky and partially covered by the housing. Parking structures, community shopping, schools, and some offices were integrated into this lower-level base.

For the central urban areas of great metropolitan cities, however, the demand for greater densities prevails. As a strategy for increasing density, the concept of stacking office towers topped by residential development emerged. Layering offices with housing above helps achieve triple densities without serious compromise to the quality of life provided at the upper-level housing, particularly in terms of views and sunlight.

In Study #2, this layering is achieved by office and housing “slabs” stacked vertically, made possible by bridge trusses spanning from core to core. Could a similar density be accomplished by deploying inclined membranes for the upper housing component spanning atop office towers? Study #5 endeavors to achieve this. From the base of a linear pedestrian spine accommodating retail and community facilities, as well as parking, rises a series of office slabs to a height of twenty-five floors. The office slabs are connected at their roof by a continuous “community street,” which spans from tower to tower. Rising above are inclined residential structures contained by A-frames, which are supported by the office slabs and their elevator cores. The pedestrian bridges, which span from tower to tower, tie the structure together into a stable whole and resist the lateral forces created by the inclined buildings. Thus, hillside membranes of terraced housing rise above the office towers, leaning against each other, achieving high densities while leaving the ground level open for parks and recreation.
CONCLUSION: HABITAT AND BEYOND

The studies carried out through 2007–2008 reveal a great diversity of issues — density, geography, and building technologies — that profoundly affect the investigation of future projects. Certain common themes are worth noting as tentative conclusions.

Mixed Use: As we explore greater densities of urban development, the advantages of mixed uses — office-employment space, residences, commercial development, and community services — become apparent. Specifically, the vertical layering of office space and residential development makes increasing density possible, while achieving optimal massing and daylight for the residences.

Stacking of uses also suggests that bridging high-rise structures at intermittent levels enables horizontal communication, enhances security and mobility, and can lead to the creation of community amenities of great quality, open to dramatic views of the city.

There is a threshold of increasing complexity between structures that fundamentally remain vertically stacked, deploying traditional vertical elevators and structures, and those that are inclined, twisted, or terraced. This becomes particularly acute as the height of buildings increases beyond twenty-five floors.

Fractalization: The more we break up the building mass, the greater potential for roof terraces and multiple orientations for every dwelling. In fact, the porosity of the mass helps to psychologically mitigate density. On the other hand, fractalization increases surface area, with a resulting impact on energy consumption and construction economics. The studies indicate the need to find a balance between adequate exposures for the dwelling without overstretching the building envelope. This balance fluctuates from climate to climate, with the severe colder climates presenting a greater constraint to fractalization than tropical ones.

Orientation: The Habitat studies of 1967, developed for a Montreal setting with its particularly severe winter climate, recognized the ideal of southern orientation to maximize exposure to sun in winter and transitional seasons. The original unbuilt Habitat concept comprised housing membranes sloping towards the southeast and southwest, achieving a uniform optimization of this idealized orientation for all dwellings. In contrast to the original scheme, Habitat '67, as constructed with three twelve-story clusters, compromised this ideal. Units were oriented towards the city and river, varying orientation from southeast-southwest to include northern exposure.

The current studies demonstrate the difficulty of achieving standardized orientation. Certain sites and building arrangements, which may have many geometric structural advantages, end up compromising on orientation.

It is an open question whether a consistent orientation is relevant in all climates. Certainly, in the tropics and other typically hot climates, cross-ventilation might take a priority, though western orientation can be problematic. Similarly, housing membranes that shade public spaces at the ground level can have great advantages in tropical climates, while being potentially oppressive through the winters of colder climate zones.

Building Technology: The verdict is not yet in on the optimization of construction technology for high-rise residential development. The concept of three-dimensional modules prefabricated in the factory, embraced by the original Habitat, has proven its limitations. The conflict between the size of shippable modules and the size of dwellings has meant that only part of the dwelling unit can be prefabricated. Even the joining of two or three trailer houses to form one unit demonstrates the technical difficulties entailed.

The shift has been to deploy different structural frames, either steel or concrete, creating floor plates which are then finished and enclosed more traditionally. Pre-made modules, such as bathrooms, kitchens, and other residential components, can still be used and are subject to further development. There have been technological advances in prefabricating the building skin as well. However, what we have not yet seen in the construction industry are lightweight, fireproof materials, capable of bearing loads, that can replace the concrete boxes of Habitat.

The rationalization of the building process for residential development is therefore yet unclear. It remains field- and labor-intensive, subject to endless corrective actions during construction, all to be once more modified as residents shape their dwellings in their own image.

Finally, in response to the question of why Habitat has not proliferated, it is important to note the continued tension between desire and resources. As we have seen in recent years, the super-luxury housing that occurs in many cities often seeks to create the amenities similar to those provided in Habitat. The line of desire, therefore, remains constant. One must conclude that the concept of Habitat is an idea whose time is yet to come.