Beyond Habitat

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19 New York: On the waterfront

A number of visitors to Expo were important to the continuation of my work. One was Carol W. Haussamen of New York. She heard of me from Wolf Von Eckardt, who met her when he wrote a story about Instant Rehab, which she had sponsored.

Carol owns considerable real estate in New York. For many years she has been active in sponsoring and initiating projects which she felt were of value to the community. The best known project is Instant Rehab. She also sponsored the beautification of 58th Street, including the design of street furniture, lighting, etc. A sense of rare elegance surrounds Carol and all that she does. Our job meetings, for example, always took place in the library of her vast penthouse apartment overlooking Central Park. Her interest in Habitat and her wish to sponsor a project which would extend these ideas to the circumstances of New York were a natural continuation of her work in the city.

Carol came to Expo 67 toward the end and I took her through Habitat. Her parting words were, "We must make one in New York, sweetie." A few weeks later she called to say she had met with Mayor John Lindsay of New York who had also seen Habitat, and that he was most enthusiastic about the prospect of a New York Habitat and suggested some city land could be made available for such an experiment. Soon I was in New York, and together with representatives of the city planning commission, the city housing authority, and Carol, looked at a number of sites, all waterfront or over-water.

Carol's idea was that the project should be privately financed as luxury housing. It would be easier to initiate experimental concepts in luxury housing and let the ideas filter down than start them off in low-income housing. And I think she was looking at it as a commercial venture, too.

The two most attractive sites were both on the East River: one around 95th Street just north of Gracie Mansion, the mayor's residence, the other between the Fulton Street fish market and Wall Street. I favored the downtown site, but Carol and her real estate advisers felt that uptown was less risky because it was accepted as a luxury residential area. My design for the uptown site was in considerable detail and well advanced into the estimating stage when the real estate advisors and Carol changed their minds and decided that downtown was the place to go. The progress of the Lower Manhattan urban renewal plans were partially responsible for this change. There was also a considerable reservoir of Wall Street people as potential tenants for a project within walking distance of their work and many of the financial houses and corporations were likely to rent apartments as well.

To justify paying the price of prime Manhattan land we had to achieve unusually high densities. In addition the project was to encompass a mixture of housing and commercial uses. The density of the uptown site was two hundred units per acre but the density recommended by the city for the downtown site was three hundred units per acre. It meant I had to build very high, close to fifty storeys. In these circumstances I became aware of the shortcomings of the box shape and rectangular geometry. I had been aware of these limitations in Habitat and even in my thesis, but the difficulty of finding a better answer and the fact that one could get away with rectangles in lower structures made me stick to the simplest solution. But with Habitat New York it became obvious that one had to find a modular unit that could be grouped to form a structure that carried its forces to the ground and resisted the horizontal forces of wind and earthquake in an extremely efficient way.

The obvious direction to explore was self-stiffening rigid geometrics; the ideal would be a module related to a tetrahedron or an octahedron, because of the strength inherent in their forms. The tetrahedron is the most stable form in nature, but I became aware in various experiments and studies that the spaces it produces are restricting, and furthermore you can't completely fill space with tetrahedrons; about a third is left over when you've packed in all the tetrahedrons possible. I wanted a plan generated by right angles for the sake of internal organization and because such spaces could most easily lend themselves to furnishing by the future tenant. The problem then was to find a triangulated space structure, a structure which is inherently stiff and efficient in transmitting forces, which nevertheless produced rectangular rooms. The solution I evolved was an octahedral modular unit measuring thirty-two feet across and high, sustaining within it a two-storey cube. When grouped in space, as they were for the uptown site, octahedrons form a triangulated space structure such that the housing modules touch only at the edges and at the end points. Each house, therefore, would be truly suspended in space – never the face of one against another.

But when it came to the downtown site, the octahedral geometry I developed for the first project seemed inefficient for a fifty-storey building. Furthermore, the cost estimates indicated some serious inefficiencies in the utilization of space and the distribution of mechanical services.

It was at this point that I decided to tackle once more the possibility of building a structure which is primarily in suspension. From a conceptual point of view it is obvious that in a multi-storey structure considerably less material would be required for structure in which the major stresses are carried in tension. A high-tensile steel cable with a cross sectional area of one square inch can carry in tension two hundred thousand pounds; the equivalent area in a column in compression, assuming an efficient shape that would prevent buckling, would carry only twenty thousand pounds. It is obvious that in any structure which acts in tension there must be some complementary elements that act in compression, but as Fuller has shown in his tensegrity truss structures, when these can be separated and the elements of compression concentrated and reduced in number, a very efficient structure results. I had attempted on several occasions in the past to evolve a total system in which the module itself is in suspension. My exploration of such systems in my thesis and later on in the Habitat plans all bogged down either in conceptual problems, or in unresolved technical problems inherent in a tensile structure, but the New York project seemed to have all the right parameters for such a system to be economically realistic and buildable.

The most obvious solution is to build vertical cores which contain the circulation and services, and then to suspend the floors or modules off cantilevered trusses on top. But this has two obvious shortcomings. First, the loads of all the units must go up to the top of the building then be brought down through the core. This is acceptable in itself if the total system results in material reduction, but the vertical compression tower itself is acting as a mast fixed only on the ground and subject to enormous horizontal wind and earthquake loads. It must, therefore, be made exceedingly stiff unless it is to be braced at various levels to other towers to stabilize it. Second, the loads of the houses carried by the cables to the top of the structure are transmitted to the tower via trusses which are elements in bending moment and quite inefficient. My main efforts were directed to eliminating these two weak elements, the truss and the tall unsupported mast, by introducing a major catenary system radiating from the compression tower in three directions – a most stable arrangement, somewhat like a suspension bridge going in three directions – off which were suspended, in turn, the housing modules. The catenaries, stabilized by being fixed to the ground, gave stability to the compression tower, and carried themselves in tension.

There were a number of additional advantages to this arrangement. The lower levels of the project were to contain an extensive commercial center, and the space requirements for such activities are different from those of the dwelling units. These areas would be free of the structural supports of the residences above. In this suspension scheme the lower levels of the building were totally free from the structure above. This also responded to the city planning commission's wishes that the lower levels of the structure be substantially open so that people behind the complex in the Lower Manhattan area would not have the river view blocked off. Thus evolved a structure which I could best describe in this way: three fifty-storey-high masts off which in three directions are suspended enormous sails of housing units connected to the ground at the extreme edges and to each other at the center, and sheltering under them several acres of public facilities and spaces.

This concept generated a whole new set of characteristics. The foundations became simpler and were reduced in number (they had to penetrate a hundred feet below the river to bedrock). The modules could be identical in structural design since all they supported was themselves. The thickness of the cable even at the fiftieth floor, including the fireproofing, was three inches, so that the efficiency in terms of the materials and useable interior space was almost incredible.

Considering the many years I had hoped to develop a tension system, this was a very exciting development. Habitat New York is not a plug-in, but the units are nevertheless standardized. We have avoided the redundancy of a frame superstructure with plugged-in modules where, in the case of a compression building, structurally both are doing the same thing. The modules are designed to be only strong enough to support themselves, and they are hung from the suspension structure, which is in tension.

To determine feasibility and cost estimates we all had to do considerable detail work in the area of structural analysis, particularly Conrad and T.Y. Lin, our engineers. T.Y. Lin himself participated in working out the tensile system with its multitude of problems, deflections, and construction and erection procedures. The George Fuller Construction Company, who joined forces with Carol W. Haussamen and participated in the development of the project, assigned some of their senior personnel to analyze each and every aspect of the building – the problem of building foundations and parking below water level, pouring the service towers in concrete with slip forms, and so on. We developed a method by which the modules could be lifted into position by a hoist located on top of the tower, with an extension running along the catenary cables, thus avoiding the need for a crane. This was particularly critical in view of the fact that no known crane was available that could lift the modules within the reaches and height required.

By mid-1969 we had completed the preliminary plans and the first run at construction feasibility and estimates, both of which had positive conclusions. Because of the great number of unprecedented procedures, however, it became apparent that considerably more detailed plans would have to be made. These could only be financially justified once the real estate and financing aspects of the project had been resolved.

We had numerous meetings with various city departments co-ordinating our efforts with their total master plan. As the plans progressed some external problems emerged. Other developers were very keen to put office buildings on the prime lands that had been designated to us. The board of directors of the

New York Stock Exchange and their architect, Gordon Bunshaft, of Skidmore, Owings & Merrill, who were planning a structure right next to us, were unhappy about their prospective neighbors. A residential community did not appear to them to be compatible with America's highest financial institution; they could envisage mothers with baby carriages strolling in the stock exchange plaza at lunch time.