Beyond Habitat

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11 Making it work

Once Habitat started breaking the housing industry's rules and conventions, every aspect of the process of building seemed to require rethinking. Some of the products and details we developed were needed to make Habitat work and some were done to demonstrate what we meant by a pre-manufactured factory component.

One of the problems of piling up boxes in a complex three-dimensional pattern is the plumbing. In conventional building each fixture has a vent to the atmosphere to eliminate the vacuum that is created when the water is sucked out of the toilet, tub, or sink. These vents are traditionally carried to the roof, where the odor is dissipated. If we had used this conventional method little pipes would have stuck up in people's gardens and vented the stink of the neighbor below. We asked our mechanical engineers, Huza-Thibault and Nicholas Fodor, to tackle the problem; they suggested Sovent, a system that had been developed in Switzerland. It had never been used but its inventors claimed it could eliminate the need for a vent. It is a funnel-shaped piece of pipe that stirs up the water as it goes down the drain and mixes it with air so that it does not create a vacuum in the trap. We ordered one from Switzerland and, after considerable testing, convinced the City of Montreal that it was worth a try, and they amended the code to permit its use, on condition that we provide reserve systems should Sovent fail. The potential application of Sovent goes beyond Habitat, of course. It would be very attractive even for a vertically stacked apartment building since it would save one complete pipe run. Ironically, the Copper Pipe Manufacturing Institute in the United States recently bought the Sovent patent and now permits its use only in projects where the entire plumbing system is copper.

Another question was the heating-cooling system. My initial thought was that each house should have its own self-contained heating and cooling plant. This would emphasize the feeling of independence. We found a system that appropriately met that principle. It's called Frigistor, a patented system of thermocouples or thermo-electric semi-conductors. It had been used before for heating and cooling nuclear submarines. A Frigistor is a group of sandwiched coated metal plates; if you run a DC current in one direction it heats, if you reverse the current it cools. With a single fan and no other moving part, it air-conditions or heats the whole house. It also acts as a heat pump, absorbing heat from the cold atmosphere and exhausting it into the house, making it efficient in power consumption compared with other electric heating systems. Borg-Warner Corporation of the United States owned the rights, and its Canadian subsidiary built a full-size demonstration mock-up. We were all set to use it when the project was reduced from a thousand units to a hundred and sixty and tooling-cost amortization made it uneconomical.

The alternative we developed was a relatively conventional system. A fan coil unit in each module receives either chilled water or hot water from the central plant. To eliminate the typical radiator or large grille in the ceiling or floor for supplying the hot or chilled air, we devised a very thin half-inch slot as a continuous element around the edge of the room. One section was the air supply and the other was the return. It is flush with the floor and quite inconspicuous in the room.

The other innovation was in the central cooling plant. Normally one circulates water that heats up during the air-conditioning process. This heat has to be dissipated, usually in a cooling tower on the top of the building where water sprays are cooled by a fan. It occurred to me that cooling was potentially a much more attractive thing than just a big slatted box full of water on the roof. It could come to life in the landscape. Children could play in it. We suggested to the mechanical engineers that a series of pools with fountain sprays designed to lose heat through evaporation could replace the cooling tower. They worked pretty hard at it and developed a system that has functioned successfully. We placed the pools under the inclined slope of the building in an area that is shaded all afternoon. It was a pleasure during Expo to see hundreds of visitors cooling their feet in them.

The upper-level pedestrian streets introduced a series of problems, some conceptual and some technical. The first decision we had to make was whether it should be a heated indoor space or open to the weather. The attractions of a heated space in the Canadian climate were obvious but so were the problems. An enclosed street would have to be ventilated thoroughly if we were to avoid accumulating odors from all the different houses. Also, if it were mostly glazed it would become a hot house in summer and would require a tremendous amount of heat in winter. All these factors tended to make it more and more like a corridor and less a street. My own feelings were that we should accept the fact that it was a street and ought to be outdoors, with the proviso that it should not at any time be less comfortable than walking at ground level on a street with, say, two-storey houses on either side.

It was difficult however, to predict air movement around such a complex three-dimensional structure by the river, and I did not feel that we could leave such a critical thing to chance. There are a number of places in Montreal where the mass of a building creates critical wind tunnels: one is next to the Sun Life Building, another is on the plaza of Place Ville-Marie where at one point wind velocity is so high that in winter it is practically impossible to cross. The invisible behavior of air around a building is as critical to the success of the environment as adequate light, but aerodynamic environmental engineers do not seem to exist. In our search, we approached the aerodynamics laboratory at McGill University where one member of the faculty, George Fekete, became interested and was willing to take on a thorough aerodynamic study of the building. I convinced Expo to award him a contract as consultant.

Professor Fekete's study was in three parts. The first was to establish how air would behave around the building generally, in terms of comfort on the plaza, in the individual gardens, in the houses when one opened a window. The second was to find exactly what conditions would occur on the pedestrian streets, to measure the wind velocity on them in relation to some given standard of acceptable comfort, and to develop with us a street shelter design that would deflect and direct the winds so that the street met that comfort standard. The third was to predict through model studies how snow would settle on the building so that we could work backward and provide for built-in snow-melting in public circulation areas.

The first part of the study showed that the inclined structure and the openings within the mass of the building decreased the build up of pressure and made conditions in the gardens and on the plaza relatively comfortable. Through Fekete's studies we discovered that a slot at the bottom of the railings in the gardens greatly decreased turbulence and incidentally reduced the accumulation of snow. (At the end of winter there was hardly one terrace in Habitat that had more than a few inches of snow, as compared with two feet on the roof terrace of my apartment on Pine Avenue.) We made a wood model of the building, three feet square, which was put into the largest wind tunnel at McGill, and a smaller model that could be put in the smoke tunnel, where you could see – not just measure, but see – what was happening to the air.

No standards of acceptable comfort existed, so we had to set our own. We picked a typical residential street with two- and three-storey townhouses in Westmount. Fekete measured the wind velocity and compared it with the wind velocity a hundred feet in the air at Montreal's Dorval Airport, a standard aerodynamic measure. He found that the wind velocity on the street was about twenty per cent of what it was a hundred feet in the air. We then set that as the criterion for comfort. If winds high in the air were blowing at forty miles an hour there would be an eight-mile-an-hour wind along the street; at one hundred it would be twenty. Habitat streets should give equal protection. We kept modifying the shape and location of the plastic street shelters until we achieved the same twenty per cent of wind velocity a hundred feet in the air, along the entire street. Fekete's studies influenced the shape of the shelter, which was designed to deflect the winds in the least turbulent pattern.

Finally, he did a snow-settlement study, sprinkling the model with particles under different wind conditions to find where they would settle. From that information we located our snow-melting system. All public circulation areas within the building were to be automatically cleared of snow by electric heating. After the building was up, the studies proved to have been surprisingly accurate.

Almost always technical problems were the result of a conceptual attitude.

I had always felt that plant life was an integral part of the environment of the streets and the gardens. But to actually achieve that, posed technical problems. Plants within a structure in two feet of earth would dry up very quickly. Three or four days without rain would kill them. Our landscape consultants told us that it wasn't the freezing but the evaporation of moisture from earth that kills plants in the fall and early spring. It appeared that if plant life was to be an integral part of the three-dimensional environment it had to be self-sustaining. You could not rely on people to water the plants, certainly not in the public areas and not even in the private gardens. So the idea of an irrigation system was born, where plant life in the entire building would be automatically irrigated and fertilized.

The resistance to this idea was overwhelming. For some reason it became the symbol of extreme luxury. The whole system cost thirty thousand dollars, about two hundred dollars for each house, and yet every time Expo had a meeting to try and cut things out of Habitat and save money, the irrigation system was inevitably a target. I argued that in the broadest sense plant life is essential to survival; it is the symbol of ecological balance. Hence it has a much deeper significance to us, a deep psychic significance, which must be respected.

The early twentieth century industrial city, which virtually eliminated plant life, is only a temporary nightmare. Even though the nature of plant life in the city is quite different from that in the open country, it has its rightful place. In a typical Mexican town like Taxco, plant life is integrated with the buildings. It gives color and shade and texture to the town. In the industrial city we have eliminated soil by massive paving and construction. Now as the city becomes three-dimensional, as we build it up on many levels, we create a new kind of environment where the plant can exist only if man-made structures make a place for it. A window facing the sun can be shaded with a venetian blind but it can also be shaded with a tree or a vine. The vine very obligingly will shed its leaves in winter to let the sun come in when it's needed and clothe itself with leaves to shade the window in summer. I think that is a superior way of shading a window.

The detailing of a building is an inseparable aspect of design. For the traditional forms of construction, accepted ways of doing things have been developed over the years: a method for terminating a pitched roof on a brick wall, a method for inserting a window in a brick opening, a way of making a sill or mullion in wood. But in Habitat, all these had to be considered from first principles. Each detail – a window, waterproofing and flashing, terrace paving – had to be thought of in terms of its performance, in terms of its logistics in the construction procedure, and in terms of its ability to perpetuate the total concept.

Should the window frames be cast in the concrete? What material should they be made of? How should they operate? I thought the window frame should be invisible. The important thing is that you have an opening in the wall which you want to look out of. The wall surface should stop and the glass should take over. We wanted to embed the frame in the concrete, yet we were designing for great temperature differentials: twenty below zero in winter and ninety above in summer. A regular metal window would sweat, wood required heavy sections. We decided to explore the possibility of using a plastic in combination with metal. With the co-operation of a window manufacturer we developed a whole series of double-hung windows and sliding doors of Geon plastic and aluminum.

The windows appear to be cut into the boxes at random but in fact their location is systematic. We had three or four window sizes, all of which were multiples of the three-foot-six modular unit. As long as they occurred on the grid, they could be anywhere without sacrificing standardization in production. We consciously tried to make the windows face as many directions as possible in every room and in every house. This proved to be extremely significant. The fact that you have windows facing three or four ways makes you feel that you are on your own, in space, that you are not slotted in.

We started the development of the prefabricated partitions and found that we couldn't run electrical wire in them the way you do in a regular wood-stud wall. We couldn't run it in the outside walls which were concrete, either. In anticipation of real modular partitions, I wanted a system that would be totally independent of the walls and accessible for rewiring or any other change in services. We made a baseboard ductway at the point where the partition meets the floor, the door frames themselves being the vertical channel to the light switches. The baseboard was clipped on in modular sections. You could dismount each piece and introduce new plugs anywhere at any time – a new phone or TV outlet, rewiring for a new computer service or a TV dial system that might come in a few years. But then the door frames were too narrow to accommodate a conventional light switch, and a low-voltage system had to be used with a small push button for a switch.

Not always did the results live up to expectations. We had to compromise on conventional partitions, and the baseboard, although installed as a modular component, relied on conventional cable. If we had had enough time to refine the detailing and get code approvals, it could have been a raceway with simple insulated wiring. That would have cut the cost of house wiring by fifty per cent.

I was also concerned with providing a safe environment for children in the gardens and the public places. I felt that if they could not look out, they would inevitably climb the wall railings. The one way to avoid this danger was to provide at least one face of the garden with a kind of window railing, a place where they could sit and look out and still be safe. The top of the railing is two feet wide. When you stand behind it you can't look down into the neighbor's garden. We set a curved, clear acrylic insert below it, from which a child or a seated adult can look out to the view. It curves outward in such a way that the bottom slab becomes a seat for a child.

In the pedestrian streets and public places where I had concrete railings, I introduced three-inch slots every twenty feet that children could look through as they walked along. It was fascinating to watch children once the building was being used. They would go into the garden, immediately sit under the railing, and look out. Walking along the street they automatically looked through the slots. I don't recall ever seeing children climbing on the railings. David Jacobs, the architectural critic who writes for the New York *Times*, came to live in Habitat to write an article about it, and the first observation in his article was how his child reacted to the railings and slots.