Builder Faced Bigger Crisis Than Falling Windows
By Robert Campbell
March 3, 1995, *The Boston Globe*

Note: This essay won the 1996 Pulitzer Prize for Criticism. The text below comes from the Pulitzer Prize web site, www.pulitzer.org*, and is copyright 1995* The Boston Globe.

photo source: Wikipedia (photo by Bobak Ha'Eri; Creative Commons rights apply)

What everyone remembers is the windows.

It was Chicken Little's panic come true: The glass was falling out of the sky.

The glass in question was from the 10,344 windows of the John Hancock Tower. They began to fail almost from the start. The crisis came in a winter gale on the night of Jan. 20, 1973, while the tower was still under construction. Gusts reached 75 miles per hour at the upper floors. Huge panels of glass, each weighing 500 pounds, shattered and dropped like sequins off a dress, smashing into other windows on their way down. In all, at least 65 fell.

Streets and sidewalks were hastily roped off. In the ensuing months, more windows broke. By April more than an acre of the Hancock's surface was covered not with glass but with sheets of plywood, painted black. The Plywood Palace, people called it. Nobody had the slightest idea what was happening.

Today that's all in the past. The 60-story, 790-foot mirror-glass tower, designed by Henry Cobb of the famed firm of I.M. Pei and Partners, is Boston's most visible, most spectacular building. A recent Globe poll of architects and historians rated it the third-best work of architecture in Boston history.

But the story of the Hancock disaster is important because even today very few people know the real facts. It's timely, too, because a crucial anniversary is about to arrive. On March 6, to be precise.

Myths about the Hancock continue to flourish. They're all persuasive but they're all wrong. One myth -- still believed even by former Hancock executives -- is that the windows fell out because the tower was swaying too much in the wind. It's not true -- although, as a matter of fact, the tower was doing exactly that. Another myth is that the glass was sucked out by bizarre wind forces at "hot spots" caused by the sharp angles of the tower's rhomboid shape. Again, not true -- although there were such hot spots, and although the tower's shape did prove to be a critical factor in its problems. Still another myth is that the windows broke because they were stressed when the tower's foundations settled. Again, not true -- yet there really was a terrible problem of settlement.

There's a reason for all these myths, all this ignorance. Everybody involved in the Hancock drama -- owners, architects, engineers, suppliers, builders -- signed a legal pact to keep secret what really happened. Nobody talked then and nobody talks now. But over the years, through interviews with people who are knowledgeable but not legally constrained, it's been possible to piece together what really happened.

What hardly anyone understands -- and this is the real story of the Hancock -- is that problems with the windows weren't even the biggest disaster to strike this haunted high-rise mirror, which always seems to be reflecting clouds as if it were brooding on its own grim beginnings.

That's why March 6 is a key. It was on that Thursday in 1975 [...] that a Swiss engineer named Bruno Thurlimann flew from Zurich across the Atlantic to inform the owners of the Hancock that their building was in danger of falling down.

That's right. Falling down. Like a dead tree in the forest.

What follows is the real story of the most interesting architectural crisis in Boston history. We've divided it into four mini-chapters. Each is the story of a separate disaster. Bruno Thurlimann's announcement, it turns out, doesn't arrive until Chapter Four.

Builders began their work by digging a huge excavation for the Hancock's basement. The sides of this hole in the ground were braced with steel. The steel proved inadequate and the sides caved in, sometimes as much as 3 feet. Because of the cave-in, earth all around the site shifted and settled. Cracks appeared in nearby buildings. Underground utility lines ruptured. In the worst case, an entire transept wing of Trinity Church came within a hair of collapse before the problem was discovered.

It was a major disaster, but it had nothing whatever to do with the windows. The tower didn't even exist yet. Its foundations rest on steel piles driven down to bedrock. They never moved.

Because of the glass problem (which is going to be the subject of Chapter Three), the Hancock became, by far, the most closely studied building in history. Instruments were placed all over and around it, to measure how much it was moving in the wind and to find out if that movement was making the glass break.

It turned out that, yes, the Hancock certainly was moving too much. But the movement wasn't doing any harm to the glass, nor to the structural integrity of the building. What it was doing was making life very uneasy for people on the upper floors. The tower, in ordinary wind conditions, was accelerating too fast for comfort. It was doing a sort of cobra's dance, swaying a few inches forward and back and, at the same time, twisting. It happened that the natural period of vibration of the forward-and-back motion was very close to that of the torsional motion. The two motions were reinforcing each other.

All problems have solutions. Perhaps the Hancock could have been braced with guy wires, like a ship's mast. But instead a knight arrived on the scene in the person of William LeMessurier, a famous Cambridge engineer. LeMessurier slowed the Hancock's dance by installing something called a Tuned Mass Damper, which he'd just invented for the Citicorp Tower in New York.

Here's how the damper works. Two 300-ton weights sit at opposite ends of the 58th floor of the Hancock. Each weight is a box of steel, filled with lead, 17 feet square by 3 feet high. Each weight rests on a steel plate. The plate is covered with lubricant so the weight is free to slide. But the weight is attached to the steel frame of the building by means of springs and shock absorbers. When the Hancock sways, the weight tends to remain still -- that's inertia, right, class? -- allowing the floor to slide underneath it. Then, as the springs and shocks take hold, they begin to tug the building back. The effect is like that of a gyroscope, stabilizing the tower. The reason there are two weights, instead of one, is so they can tug in opposite directions when the building twists. The cost of the damper was $3 million.

The Hancock's cobra dance was, obviously, a second major disaster. But it, too, had absolutely nothing to do with the windows falling out. Which brings us to:

After all this technological excitement, the solution to the mystery of the falling glass comes almost as an anticlimax. Samples of the Hancock window panels were being exhaustively tested in a wind tunnel in Ontario. They were subjected to vibration and oscillation until they failed. Eventually it was found that the whole problem was right there in the window unit itself.

Each panel was a sandwich: two layers of glass with an air space between, all held in a metal frame. To cut the glare and heat of the sun, a coat of reflective chromium was placed on the inside surface of the outside pane of glass. (This layer of chrome was what gave the building its mirror effect.) The window frame was bonded to the chrome with a lead solder. During the testing, it was noticed that when a window failed, the failure began when a tiny J-shaped crack appeared at the edge of an outside pane of glass. What was happening was this: The lead solder was bonding too well with the chrome -- so well, so rigidly, that the joint couldn't absorb any movement. But window glass always moves. It expands and contracts with changes in temperature, and it vibrates with the wind. So the solder would fatigue and crack. The crack would telegraph through to the glass, and the cycle of failure would begin.

Investigators found that similar failures had occurred with this same window type, by this same window manufacturer, in other, less conspicuous buildings. All 10,344 of the Hancock's double-pane windows were replaced with single sheets of tempered glass. The window maker paid the cost, which was $7 million. Part of the deal was that everyone agreed to keep the secret.

Ever wonder what happened to the original windows? The 5,000 undamaged ones went on sale, at $100 each, in bargain outlets in Hingham and Lynn and in Maine. Many are now tabletops, picture windows or greenhouses. As for the plywood, much of it went to the Boston Redevelopment Authority, where it was used to board up abandoned buildings. Life goes on.

We're near the end now. Faced with such a multiplicity of problems, the architect, Harry Cobb, decided he needed some ultimate reassurance that his building was safe. He hired Thurlimann to review its structural integrity because Thurlimann was the world's leading authority on high-rise steel-frame buildings.

Thurlimann's discovery is the most astonishing of all these events. He announced that, according to his calculations, under certain rare but entirely possible wind conditions, the Hancock might fall over. Most amazing of all, it would fall on its narrow edge.

Nobody ever thinks of a long thin building like the Hancock falling over in the long direction. You'd imagine that if it ever blew over, it would fall on a flat side, since obviously the flat side -- like a sail -- receives much more wind. But no, said Thurlimann: The building was stiff enough in the flat direction. The danger was that it might collapse on a narrow edge. It would be as if a book standing upright on a table were to fall on its spine.

The problem is in the Hancock's shape -- not its funny angles, but its length, almost 300 feet. If it shifted out of plumb by even a tiny bit in the long direction, the force of gravity, acting over such a great length, would begin to pull it farther.

This gravity action would give the tower a longer natural period of vibration -- something like 16 seconds instead of 12. With each period it would move a little farther, until it fell.

Thurlimann convinced his audience. Over the next few months, at a cost, this time, of $5 million, the tower was stiffened from its base to its top with 1,500 tons of diagonal steel braces. These were placed along the walls of the service core, the central blob of elevators and toilets. In that location -- purely by chance -- there was just enough room for them. It was the Hancock's only stroke of luck.

Nobody was to blame. The Hancock met every structural building code. So it was necessary to stiffen not only the tower but also the codes, and that was done.

Would the Hancock ever, really, have fallen down? Nobody knows, but nobody was willing to take the risk. Is it safe today? A very few panes of the new glass have failed, but that's normal. After all the testing it went through, the Hancock today has got to be one of the safest high-rises in the world. It possesses the strength of a survivor.

So does its architect. Harry Cobb went on to become chairman of the department of architecture at Harvard and [designed the] new federal courthouse on Boston's Fan Pier.

It's only fair to remember that we're talking about a building that, in its aloof way, is among the world's most beautiful. So we'll conclude with a passage from a John Updike story that appeared a year after these events. Updike's narrator, walking past Copley Square, is musing to himself:

"Now I am aware of loving only the Hancock Tower, which has had its missing pane restored and is again perfect, unoccupied, changeably blue, taking upon itself the insubstantial shapes of clouds, their porcelain gauze, their adamant dreaming. I reflect that all art, all beauty, is reflection."