The Manufacturer and Innovation

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INTRODUCTION

Ninety percent of the output of our Group—Permasteelisa—concerns the external envelope of buildings, while the remaining 10 percent the internal cladding for office buildings. To explain how we are organized as a manufacturing company in the building sector, we need to imagine that we are almost like three companies joined together.

The first division is engineering, since we are dealing with architects and we try to interpret the architects' designs or, most of the time, their design sketches. This engineering division is the main focus and the main practical strength of our company. Of the 1,200 people in our group, 400 are dedicated to engineering development, each with his or her CAD station. In fact, we try to go beyond interpreting the architects' design by transforming the concept into performance, since what the client is asking from us is performance and durability, that is to say, a practical quality product installed on time.

The second division of the company is production, where the product is studied, designed and tested in the factory. When it is sent to the site as a finished product, the third division takes over and assembles the product on the site. Our company then becomes like a typical construction company.

The Group has four laboratories, one located in Sydney, one in Singapore, one near Venice and one in the Netherlands. In the four laboratories we can test mockups that can be as large as 15 m x 15 m for air and water penetration, resistance to wind pressure and earthquakes, thermal conductivity and thermal cycles; several other practical simulation tests can also be included. Research and development involves about 20 people in the Group, but most of our research is actually done with the buildings. We produce about 40 to 50 major buildings a year and every building has a different design with a different concept of the curtain wall. We use the knowledge and the experience we are constantly accumulating to help reinterpret the architects' designs (in fact, we need to practically carry out a redesign each time). The challenge is to transform the product so that it can be industrialized, whatever the type of product and whatever the architecture.

Since 1985, our production has been organized in quite an automated way and by 1988 we have been fully equipped with CAM machines and automated assembly line. This gives us the flexibility to accommodate the niceties of the different architectural designs.For our on-site activity, we very rarely use scaffolding; indeed, 99 percent of our activity is totally independent from the main contractors. We arrive on site with all the products packed in pallets as unitized panels, we hoist the products onto the appropriate floor and from the floor we install them from the inside and enclose the building.

We are cladding specialists but as such we are not passive. We do not refuse work because of the architect's requirements, but instead we contribute to the design process on the basis of our experience. Indeed, our experience, through one of our member companies, goes back as far as 1875. We were able to learn by observing the Crystal Palace in London which introduced fast track processes for the cladding (90 000 sq. m of glass cladding was installed in 17 weeks). We also observed another trend in the Chrysler building where 88 floors were erected and clad from bottom to top in 13 months in 1936. In other words, we have observed and respected the trend—over the last fifty years—to create buildings faster, requiring panelized systems that are produced and assembled in a sequential manner.

WORKING WITH FRANK GEHRY

Let me now share with you our experience of working with Frank Gehry. It started in the 1990s with a gigantic sculpture designed by Frank Gehry to be placed in front of the hotel designed by Bruce Graham of SOM for the Barcelona Olympics. The New York-based developers wanted to have some important sculpture in front of the building and they asked Frank Gehry to design it. As usual, Frank Gehry worked with physical and computer models which we then worked on, using KATIA to make our own computer model. I should point out in passing that this was the first time Frank Gehry was interacting with a company that used an extranet to transfer three-dimensional data from one computer to another. This enabled us to design and produce a steel structure with its cladding of great lengths of stainless steel strips.

A large portion was made and tested in the factory, resisting winds gusting up to 180 km/h; all the fixing elements were tested too.We installed the 60 meter long "fish" in Barcelona in about three and onehalf months, including all the steel structure without using any scaffolding. Indeed, it was a very exciting experience, working with Frank Gehry.

From that point on we installed a series of KATIA work stations for engineering, to complement our Autocad and other CAD systems. With KATIA we discovered we can work on projects that are more and more complicated.Frank Gehry then come to use with his project in Prague. It is an eight-story building which includes a series of punched windows accompanied by a double skinned wall forming virtually a second structure. From the computer model, we picked up all the points in order to create a prototype. We tested it with different types of glass and different types of custom-made beams (the beams may look simple but really they are three dimensionally curved elements—they were laser cut). Then we preassembled the wall completely in the factory (it looked like a big ship), disassembled it and reinstalled it on the site.

The double skin wall—it belongs to what we call "blue technology" (I will explain it later), and it reduces the heat gain and improves the comfort inside. Now let me describe our involvement with the Guggenheim Museum in Bilbao. Our task was cladding all the building with titanium. We worked in association with a local steel company and a local window manufacturer who did all the glazing for that building.The steel structure in the back was encased by galvanized steel sheets overlapping each other. On top of the galvanized sheets there was a double membrane and on top of that were the tiles of titanium which were only 0.34 mm thick. Internally, there is a gyproc layer that forms the cladding inside.

To create all the doubly curved surfaces we created a series of horizontal pipes and vertical studs attached to the main steel structure at the back. This was done by careful bending based on the computer model. Indeed it can be said that the steel frame behind enabled us to create all the curved surfaces of the building. Incidentally, one of the requirements of Frank Gehry was to maintain horizontal lines marking all the courses of tiles. This was an additional design constraint, as you can imagine, for which the use of KATIA was indispensable.The cladding was installed in eight months, virtually without scaffolding.

Since then we have been involved with the internal decoration for a restaurant in New York. It is quite an expensive restaurant; 800 sq. meters at over US$10 million (our part is about US$6 million). It has a perforated titanium finish on stainless steel and very elaborately bent glass. Tthe glass is not produced by us; it is produced by an American firm in California. Again, the combination of KATIA and Autocad, linked directly to the production equipment for cutting all the stainless steel was essential. Again, we assembled everything in the factory prior to shipping to the USA.

We are also currently involved with the Disney Concert Hall. Initially the building was designed with soft limestone walls, but earthquake and budget problems convinced Frank to come back to metal. One of the problems we face when working on designs like those of Frank Gehry is the need to have ruled surfaces, that is to say, surfaces that can be defined in terms of straight lines albeit in changing directions. This is very important, because otherwise you need to mold the surface which becomes almost impossible to justify in terms of cost.

The solution every time is to transform the Frank Gehry model by computer and try to find ways of introducing these rules. We have to discuss the problem with the architect and point out that in the absence of this geometric property, it is very expensive to produce.Sometimes we get a contract for Frank Gehry simply because the competition is far too expensive—probably because other firms have not acquired the know-how and do not possess the computer aided analysis and production equipment that we have found to be necessary.

BLUE TECHNOLOGY

We have put together a research and development group of people working on what we call the "blue technology." This is something related to green building and the future of environmentally sustainable building, and of course, concerns the external envelope of buildings.

If we look at the envelope that reacts to impinging solar energy, we all know that the glass is totally transparent to the incoming short wave radiation and totally opaque to the longer wave radiation that is trapped inside. This is inherent in the nature of glass and in the nature of the radiation. Radiation is the main source of problems in creating and maintaining a comfortable environment, since 54 percent of the direct solar radiation contains heat. It also accounts for 80 percent of the world consumption of energy just for maintaining the temperature inside a building. The usual technique using reflecting or coated glass has a physical limit of 60 percent light transmission, in which case we still have just under a 35percent solar heat factor, that is to say practically 35 percent of 1000 watts meaning that 350 watts go into the building per square meter. This is an enormous quantity of energy that during the warm season we need to take away.

In northern Europe, there are a number of buildings using double-leafed walls that are naturally ventilated (they cost about double the conventional curtain wall). It is a technique that is quite unusual for America, but it is starting to be used in Asia and in other parts of the world. The principle, which is quite simple, is to create a space in between the two glasses (one can have a double glass outside and single inside, or a single glass both outside and inside, depending on the local climate) and to provide a blind or a some similar element that interrupts the direct light transmission that contains the heat radiation. The long wave excess radiation is trapped in the cavity and is removed by ventilating the cavity in the double skin.

We have developed two variants on this principle: an active wall or an interactive wall. In the active system, the cavity between the external and the internal glazing is connected to the return air of the mechanical system. In this manner we maintain a velocity in the cavity of at least 0.1 m/s (using two air changes per hour). A wall of this type is recommended for cold areas of northern Europe or North America.

We can keep up to 70 percent light transmission using fully transparent glass and have a total energy transmission that is not over 20 percent. The thermal insulation is equivalent to 0.5 to 0.6—which is one third of the best type of thermal glass available today. The acoustic insulation, which depends on the thickness of the glass, is around 38 to 39db and is three times a double-glazed wall. Using such a type of curtain wall, you double the best performance of a high performing glass.

For tropical or warm areas we suggest to have what we call the interactive system. There is a little fan that consumes a few watts to move the air in the cavity when the temperature rises, and continuously maintains the flow rate of 0.1 m/sec. The performance of such double leafed curtain walls is as low as 8 or 12 percent of the total transmission heat gain, that is to say it is three times less than the best performing glass of today. The thermal insulation is around 1 and the acoustic insulation is the same as for the active system.

If we look back at what was considered to be normally acceptable in 1960 or 1970, we find that it took 30 years to improve the performance of curtain walls by 50 percent. Now we can double the performance using a double leafed wall. As might be expected, it costs a little more than the cost of a normal curtain wall—say 30 percent more—but if we recognize that the curtain wall is about 10 percent of the total cost of a building, the on-cost is about 3percent. This can easily be saved in the mechanical systems, because less ducts per square meter are required. Using double-leafed wall, one does not need to have very big fan coils using a lot of energy to keep the temperature down in the perimeter areas.

Also, the consumption and the maintenance costs are reduced. Our analysis shows that over a period of 25 years with a five percent annual interest rate, the life cycle cost is considerably less with a building using a double-leafed curtain wall. From the point of view of comfort, it is important to consider what happens near the perimeter of a building. With a normal curtain wall and with floor to ceiling glazing, there is an energy uptake of 240 watts per square meter near the perimeter. If, on the other hand, there is a 1.8 meter strip window, you still have 170 watts per square meter. With a double-leafed wall, these figures are reduced to 80 watts per square meter, which is close to the 50 watts per square meter you have in the center of the building.

By way of conclusion, I note that the architecture of the future is likely to move to more transparency and more interaction between the external and internal environments. It is, therefore, important to develop methods for achieving this goal without the burden of expensive HVAC systems while maintaining a comfortable indoor environment. Meanwhile, we have applied the double leafed curtain wall to 20 buildings in Singapore, in Kuala Lumpur, Hong Kong, Shanghai and elsewhere. Twenty more are in the pipeline including a design by Sir Norman Foster in Shanghai (200 meters high with an active wall).