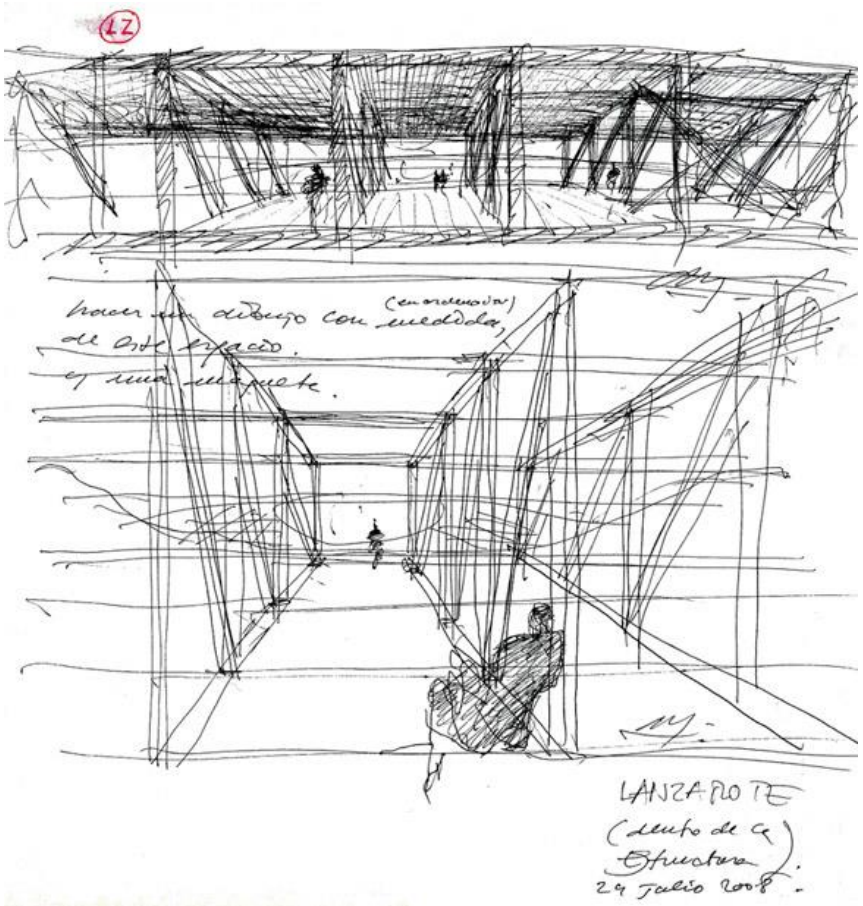
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hacer un dibujo con (en ordenador) medida,
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LANZAROTE
(centro de C
Estructura).
24 Julio 2008.

OF ELEPHANTS AND BIRDS

On Structure

Historically speaking, the structures of buildings have been made, are being made, and will continue to be made ever lighter. At the same time, they have tended to look less like the cave and more like the hut. Clearly, the giant advances of economies, materials, and technology play a role. However, the phenomenon also results from architects' changing mentalities regarding the conception of space.

If in the past one preferred to eliminate pillars in favor of greater luminosity, transparency, or continuous space, today one could say that pillars are dispersed, or more pedagogically, that large bones are replaced with small ones; the *humerus*[1] for the *phalanx.*[2] Small bones substitute for large bones, both decreasing their weight and increasing their quantity, especially when it is a matter of supporting the same load. Now there tend to be more pillars, but thinner ones. The hypostyle, or roof supported by columns, has recently regained currency, though abandoning the clear order of classical geometry; the forest versus the hypostyle.

Just as birds, over the course of evolutionary history, developed ever more intricate bones and complex skeletal structures in order to take flight, so too architecture wishes to fly once more, hoping to avoid the fate of Icarus.

FOSTER, PIANO AND ROGERS

Each day, when I walk down the street from my studio on 72nd Street in Manhattan to catch the subway to Columbia University, I greet Norman Foster's Hearst Tower which proudly rises 182 meters from its privileged spot near Columbus Circle. Its façade of rhombuses, which is pure structure, stands out in comparison to the other buildings.

What interests me most about his building, however, is that besides departing from a clear idea, of which the structure is the first consideration, it is also a patent demonstration of many of the things I would like to expound upon here. Its structure represents a radical departure from convention and appears to be rationally dispersed and broken down into its parts. It could be said that it is a manifesto of what I will be arguing in this text.

Of course, the opposite could also be valid. After breaking the structure and walls into smaller parts, one could bring the structure further in, giving more freedom to the façade. A lot of contemporary architecture has moved in this direction. But if that exterior structure is resolved by recourse to dispersion, with beams and geometric forms serve a better structural logic, let the same technique be welcomed in the façade as well. Foster's building is a good example: the *humerus* is replaced by the *phalanx*, while the orthogonal line becomes rhomboidal. The result is that that the structure reveals itself proudly on the surface, not merely within.

On that note, when people talk about the so-called "disappearance of the façade," they are speaking about something impossible; that is unless cities were to vanish within invisible and transparent clouds. Thanks to steel, however, it is actually possible to disperse the load bearing elements–the structure–and façade into smaller parts. In this way, extraordinarily light façades can be achieved. The Pompidou by Piano and Rogers, built in 1977, is a clear example. The entire façade is structure.

What is the Pompidou, I ask, if not an operation of lightening structure, going for some three dimensional trusses in bars that are carried with overwhelming logic to the façade? Could it not be considered a first manifestation of this “dispersion” of the bones of structures?

The device, which gains with the passage of time, is not just logical, but beautiful. It is no mistake that Jean Prouve and Philip Johnson, the committee members at the time, selected the Piano and Rogers’ building. Besides fulfilling its intended functions, it was able to endow Paris with new image, recovering the capital’s much-desired architectural leadership for some time.

STRUCTURE

I’m more and more convinced of the importance of structure in architecture. It obviously important since it bears gravitational loads, but above all, it is important since it establishes the order of space.

When I defend the “unity of the architectural fact,” a unity inherent to any artistic creation, I defend neither uniformity nor simplicity. Architecture can be simultaneously complex and unitary. When in my conversations at the Madrid School of Architecture, I demand a say in what the Departments of Structures and Construction are going to teach to the best young architects, I do nothing more than emphasize how the “lay out” of the parts in the conception and design of architecture is just as important as structures and construction. In short, all of these issues must play a role in the developing idea of the Project, from its unitary conception. It can’t be otherwise.

Therefore, when I speak of Elephants and Birds–of many small bones as opposed to a few large bones–I do not intend to make a merely structural reflection, but also one that is basically an issue of design.

MIES

When Mies van der Rohe constructs his cruciform and brilliant, mirror-like pillars, first in Tugendhat House, and later in the Barcelona Pavilion of 1928, he does nothing more than attempt to prove that he actually can make the pillars vanish, so that the superior plane–the ceiling–floats. Of course, Mies always makes his structures with bones–complete pillars, precise and perfectly laminated profiles, and welded seams that wish to disappear. He, who spent his life making “Architecture” with a capital A, with capital bones and athletic profiles, did not cease to pursue, to the end of his life, something of what we are talking about here.

In contemporary Architecture, the idea of changing large bones for smaller ones appears with greater and greater force. Architecture had always transmitted the loads directly, with continuous structures that, like stone and brick, worked basically by force of compression. Only wood, despite its problems of durability and conservation, could work in a different way.

HISTORY

The end of the Gothic period produces a certain phenomenon of such dispersion. Antonio Mas Guindal, professor of Structures at the Madrid School of Architecture, recently published a book with the suggestive title *When Structures were Not Calculated*. The cover is illustrated, as if a précis of its more than interesting contents, with the drawings of several well-known Gothic battlements, roofline stone adornments, which in so far as they resemble lace seem impossible.

My interpretation, albeit biased, is that the Goths lightened structure from above not only for motives of weight, but in order to procure more light. But in any case, if it were a matter of bones, the humerals become phalanges.

When at the start of the previous century structures composed of steel began to appear, they were generally used in industrial constructions or bridges, so as to balance considerations of structural aesthetics with greater usage load. Later on, structures composed of latticework came around for reasons of financial, logistical, and technical viability. All of the beautiful industrial architecture and bridges of that time are a testimony to this decomposition of structure.

TECHNOLOGY

Of course technology has a lot to do with all of this. To make the first composite structures, the joints were entrusted to rivets and bolts, screws and nuts. Later on, welding could be trusted.

In the building I am now constructing in front of the Cathedral of Zamora, we have placed a radical glass box inside bold stonewalls, fixing all of its joints with structural silicone. Our decision to shun the conventional recourse to metal pieces, though causing some weariness in others, demonstrates my absolute trust in new technologies.

Mies, naturally, fully trusted welding. Today, welding without added metal material eliminates defects, and not only increases the perfection of execution, but also facilitates it.

What used to be done solely for economic reasons in those first steel bridges and industrial buildings is now done for other reasons. One can now speak of the search for a greater lightness, or even a better penetration of light.

CENTRAL FORMAL THEME

However, in architecture, generally speaking, this substitution of the large bones for smaller ones has never been conceived of in the same way as it is now: replacing the powerful, one-piece rolled steel beams with composite exposed profiles, making a show of it, and perhaps even turning it into the central formal theme.

In the 1960s, when Alejandro de la Sota builds the Maravillas Gymnasium in Madrid[3], he not only utilizes the composite structure in service of the large hall's light, following the form of the catenary, but he also makes it "occupy that structure." He dares to situate the classes among the beams, which he leaves exposed on top of it all. Something of a premonition of this dispersion of the structure already permeates the whole idea of that building.

But it would be figures from the international scene, like Fuller, who would directly propose, for financial reasons, the generalized use of these structures of bars and small bones.

It is a movement from elephants to birds.

OF ELEPHANTS AND BIRDS

If you have ever eaten a well-cooked bird, you have certainly noted how difficult it is to eat an animal with so many tiny bones, no matter how delicious it may be. And even if none of us have eaten an elephant, you may assume that the meat would come to the table without the bone.

As I can only assume that we will be collectively ignorant about animal bones, it might be helpful to browse through Google to look at elephant[4], bird[5], and human skeletons. They are like marvelous sculptures crafted by a very wise sculptor. We see the skeletons of men in which the bones change size as they reach the extremities. Reaching the hands and feet, for example, the bones drastically change in quantity, size, and intricacy. The skeletons of elephants too, made up of huge bones, stand in great contrast to the smaller, thinner, and lighter skeletons of birds, which are comprised of smaller, thin light bones.

Of course, there are evolutionary reasons for all of this: birds have to fly and elephants do not. Only when they alight on a branch do birds have to bear gravitational force directly. When they fly, on the other hand, the forces at work are more complex; when they walk, they do so hopping, as if dancing. Only a small number of fowl mostly domesticated–chickens or ducks for example–seldom fly and clumsily walk.

Bridges are resolved with composite structures for similar reasons, in order to save considerable spam, when they are made out of either wood or steel. Latticed beams, the trusses or Pratt beams, and other variants appear, in this way, with full propriety. Moreover, for still similar reasons, they appear in industrial buildings and warehouses that require large open spaces.

STRUCTURE IS THE KEY

When I teach my students about the importance of structure, of the skeleton, I give them an example they will never forget. I tell them that if Halle Berry, the American actress, is gorgeous, which she is, it is above all because she has a perfect skeleton, which she has: a perfect structure. From the first moment of her life, her structure–her skeleton–has established a perfect arrangement of space and order which allowed her stunning completeness. They all smile, but not one of them will forget the importance of structure in architecture.

An elephant cannot have small, delicate bones. It cannot have the skeleton of a bird. Nor can a bird have the powerful bones of an elephant. One must consider, throughout the construction of a building, about how many elements, like a door or a window, a material or a color, a texture or a detail, can be exchanged. But what one cannot do, and must not do, is change the structure inappropriately. One can't put the little bones of a bird on something that was born an elephant and vice-versa.

If we had to mention some contemporary architects who use more small bones than large bones in many of their works, we might bring up Foster. Foster continues to follow Fuller's already quoted advice to the tee when he asked him, "How much does your building weigh, Mr. Foster?" We might imagine Renzo Piano, moreover, without a Fuller to scold him, following the recommendation by W.Strunk and E.B.White in their book *The Elements of Style:* "omit needless words." All writers in English are familiar with that injunction, and architects should know and practice it as well.

But it is perhaps Kazuyo Sejima, SANAA, who in a most provocative, almost demagogical manner poses this question in some of his latest buildings like Park Café, the Yokohama and Naoshima terminals, and the Rolex Center of the EPFL of Lausanne.[6] J.Jaraiz, in his illuminating doctoral thesis, compares and contrasts this Forest Space by Sejima with the Hypostyle Space with great clarity.

ADDENDA

In some of my latest projects, when there were clear reasons for it, I have tried to apply this system of lightening the structure, replacing the big bones with little ones, a few humerals with many phalanges.

In my first design solution for the Center for Nature Interpretation in the Salt Flats of Janubio in Lanzarote[7], since the building "flew" over the powerful existing slope, I resolved the protruding part of the structure with a few large triangular trusses. These trusses had sufficient height to house the requested functions inside, diagonals included. The resulting space, in which the diagonal bars gave a special quality to the space as one moved among them, was large and well tensed by the structure and the light. Naturally, the structure was the protagonist of the space.

In the end, zoning regulations obliged us to change the site to another, completely flat lot, and the design had to change. In the new project, all resting upon a now completely flat plane, it made no sense to repeat the structural solution that the large protrusion had called for in the other situation.

In the Porta Milano[8] space I designed with the Portuguese architect Paulo Durao for the Malpensa Airport, we conceived of a stereo structure: a straight parallelepiped rectangle, that is a six-faced polyhedron, all of it comprised of white-painted small bones. An internal and external double skin, in laminated translucent glass, provided both thermal insulation and protection against the elements. A few deliberate perforations in the translucent butryal that binds the glass would allow a play of lights that could be defined as a solid light perforating the space of translucent light: rays of sunlight crossing the large interior space as if it were a cloud. All of this was clearly dependent on three dimensional structure white-painted small bars situated between the two translucent skins, such that the light could be adequately diffused within.

A similar solution of double translucent skin encasing a light structure of small white pillars is what I am currently planning for the entrance piece to the MIA, the Museum of Italian Art that I'm designing for the Olnick Spanu family in New York. In order to give this space a special lighting and quality, I make use of a 10x10x10 meter, semi-underground cubic room of which emerging upper half is a translucent half-cube. The structural support for this upper translucent half cube is a dispersed, light structure of small bones, comprised of delicate white pillars. Like a delicate gown, a double skin of laminated glass covers it. The exterior skin, with carpentry, will solve the matters of water and thermal control. The inner skin will be more delicate in its construction. Both skins will have many small transparent perforations in butryal, so that as the sun passes through them in its daily habitual movement, solid rays of light, thanks to the scale of the construction and perforations, will become visible. We thus achieve a space of diffuse light pierced by solid light–a cloud pierced by the sun. Should structure be able to be made lighter, this effect would make it even lighter than it already is.

CONCLUSION

Make structures lighter? Are we in pursuit of a lost ethereality?

Architecture is about making things with meaningful intent. If this search for structural lightness has a deeper meaning, it is most welcome! In our museum in New York, there are clear reasons for making the translucent glass box that covers the entrance with a very light structure, the lightest we could construct. We not only seek greater lightness, but simultaneously greater light.

Moreover, as the structure arises out of the graceful hands of geometry and translucent glass, we want it to dissolve into the mist.

The structures of the future will be light: clear in their conception; simple in their construction; perfect, durable, and easy to maintain in their final execution. Once again, structure will be, as it has always been throughout history, the architecture's central consideration. Structure establishes the order of space, and constructs space as light constructs time. Space and time: these are the themes of architecture.