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**TECHNICAL: APAL – 36 YEARS SERVING
THE ALUMINUM INDUSTRY AND
SURFACE TREATMENT**



Nuno Lopes
Diretor

The twelfth CMM conference is scheduled for 21 and 22 of November of 2019 and will have as special theme: "Steel structures as a response to the climatic changes". The preparations are now in progress for one more edition of the forum of reference in the promotion of steel and composite construction in Portugal.

With regard to the contents of this issue of "Metalica" firstly a presentation is made of the Portuguese Aluminum Association and its activities in the promotion of the aluminum industry and surface treatment. It is an association with common interests with CMM whose existing cooperation benefits both parties.

The second part of the article on the architecture of the Louvre museum, by Prof. Vitor Murtinho, completes his vision of the intervention carried out in 1984, highlighting the impact of the famous pyramid and its relation with the surrounding museum. Prof. Altino Loureiro brings us one more lesson on the application of welding in steel construction emphasizing, this time, the safety in welding and cutting operations of metals. We are presented with another great work in steel structure in Brazil, by Prof. José Guilherme Silva and his team, highlighting the eco-efficiency and sustainability achieved with the use of steel solutions. And in this edition we have a new opinion article in "Metalica", dedicated to the structural application of high strength steels, by Dr. Trayana Tankova.

Finally, as part of the activity of CMM Industry, a further information note is now issued on the documentation involved in various phases of the execution of steel structures in relation to the establishment, maintenance and control thereof. This initiative is added to the varied activities of CMM, such as the technical training courses, the events of Portugal Steel and the different publications.



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Prof. Vitor Murtinho
University of Coimbra

The Great Louvre: securing the future, inventing a present to perpetuate the past [Part 2]

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“Some people may be able to do more, but they stop before reaching their limit. I like to think that I go to the limit.”

I. M. Pei*

Although very disputed the intervention that I. Pei developed for the purpose of reorganization and enlargement of the Louvre Museum, this made possible the irreproachable confirmation of this space as one of the most sought cultural destinations in the world. And if in the context of this work the most iconographic part corresponds to the famous pyramid placed at the center of the court designated Cour Napoléon, the truth is that the authentic revolution took place in the basement and inside the Louvre Palace. The collection of this museum which has some of the most charismatic and well-known works of Western art such as Leonardo da Vinci's Mona Lisa, sculptures like the Venus of Milo or Victory of Samothrace alone would not be enough to keep alive the interest of a visit to a site that, until the Pei project, was considered a place with labyrinth characteristics, disorganized and spatially very little suited to its function. Although the museum is philosophically considered a place of death, it must also be a place of transfiguration, where the past presents itself in a reborn way and in new forms.¹ Now it was precisely these latter aspects that the Louvre was failing to fulfill the dignity that was expected.

It is said that as a student at Harvard, Pei told Walter Gropius that history and architecture

were two inseparably linked areas, to which the founder of the Bauhaus has replied to demonstrate it². Knowing that, in some way, the most defensive tendencies of modern art legitimized very much the innovation and a policy of tabula rasa, this courageous position of Pei, is also demonstrative of a thought more contemporaneous with the patrimony and less radicalized in its relation with the traditional city. Somehow Pei, in attempting to create a visible spatial separation between the existing and the new in the Louvre project, is clearly defining a path that fits into the logic he would have previously defended before Gropius.



Figure 1. Aerial view of the Louvre with pyramid in the center.

Looking generally at the monumental French spaces, one can say that the Louvre is clearly unique. In general, each monument corresponds to an expressive synthesis of a historical period or a style of architecture. If it is so with the Eiffel Tower, with the Cistercian abbey of Thoronet – space that impressed Le Corbusier

* Quote from I. M. Pei – Words for the Future, Architecture and Urbanism magazine, Special Issue, Tokyo, 2008, p. 60.

¹ Salles, Georges, Au Louvre, scènes de la vie du musée, Domat, Paris, 1950, p. 9.

² Jodidio, Philip, “1983-2008: Ieoh Ming Pei et le défi de l’histoire”, I. M. Pei Architecte, Éditions du Chêne, Paris, 2008, p. 217.

during his visit in 1953 – or even with the Cathedral of Chartres, in the case of the Louvre it gathers within its space eight centuries of history, confusing itself with its own memory and development of the country. A very long period, which made the place almost a permanent shipyard, where many styles of architecture are represented and where many of the best architects worked each of them in their time.

For the transformation of the Louvre, what was to be expected, as occurred in other processes implemented by President François Mitterrand, was the international public tender procedure. However, the president, exceptionally chose for the direct invitation.

One of the biggest problems that architects usually have is concerning the acceptance of their projects. In normal terms, public opinion is convinced of the ease in understanding architecture. This apparent simplicity induces some lightness in the foresight of any proposal. Now reality has proved the contrary, with the realization that very often the capacity for analysis and foresight is



Figure 2. Cour Napoléon before the works, still as car park.

very limited on the part of individuals outside the broad disciplinary field, making social acceptance only occur after construction and starting the use of the buildings. That is, as Pei admits, it is not difficult for people to accept things after they are built, but the difficulty is getting to this important stage.³

³ Von Boehm, Gero, *Conversations with I. M. Pei, Light is the Key*, Prestel, Munique, 2000, p. 80.



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Figure 3. Louis-Ernest Lheureux (1827-1898), *Monument à la gloire de la Révolution Française*, 1886.

Relying on the communication signed by the seven Conservatives of the Louvre Museum, and widely publicized on February 3, 1984, we retain a cohesive position in defense of the project, making public that the pyramid was not meant to be a modernist scenic or architectural device, but rather a strong proposition that for its coherence and quality gave substance to an entire project.⁴ In truth, this evaluation is somewhat visionary because even after almost thirty years of the inauguration, this work maintains its vitality and continues to play a leading role that inscribes it in the best of our timeless heritage.⁵ And the assertive and very consistent position of the conservatives, as we know, was decisive both for the defense of the project and for the structured development of a solution that integrated the extensive and varied collection into a single exhibition space.

In the situation prior to the intervention of IM Pei, the Louvre was separated from the hustle and bustle of the city given the physical barrier caused by the premises of the Ministry of Finance, preventing access to the rue de Rivoli – to the north –, limited by the presence of the river Seine – to the south – and assisted by the decrepitude of the Orsay station⁶, located on the right bank of the river. The central courtyard of the Louvre Palace (*Cour Napoléon*) was previously occupied as a car park, being one of the project's aims its use as a monumental square.⁷ What happens is that criticism at the time put its spotlight almost exclusively on the question of the pyramid and arrangements of the *Cour Napoleon*, somehow ignoring the profound revolution that would take place inside the buildings and underground. Being the project of Pei very transformative, the question of the pyramid, would

not have a role as as important as intended. Even in terms of urban space, one of the crucial aspects of Pei's approach was the transformation of that piece of territory, facilitating pedestrian traffic, organizing traffic, frankly and expeditiously linking the *Place du Palais Royal*, in front of the premises of the then Ministry of Finance, on the left bank of the river Seine. In the reorganization of the movement, a decisive and integrative aspect was the creation of the Richelieu passage, which, crossing the interior wing of the former Ministry, made the entrance to the Louvre much more accessible, while its day and night operation made the area safer and more secure.⁸ To the Richelieu passage, in a logic of circulation permeability, was also associated the desire of the Chinese-American architect to create several entrances to the museum, thus increasing the possibilities of offers and, of course, increasing accessibility. This last aspect, which was not feasible, determined the almost endless queues of access, while agglomerations in a single atrium made circulation difficult and required a revision of the entire local spatial organization (elimination of the bookstore on one side and of the restaurant on the other).⁹ What emerges in this burning process of re-creation of the Louvre was an open-minded stance, far from prejudices or stereotypes, to perceive and correctly evaluate what exists, to start from this presupposition and to have a very clear idea of what can be effectively done.¹⁰

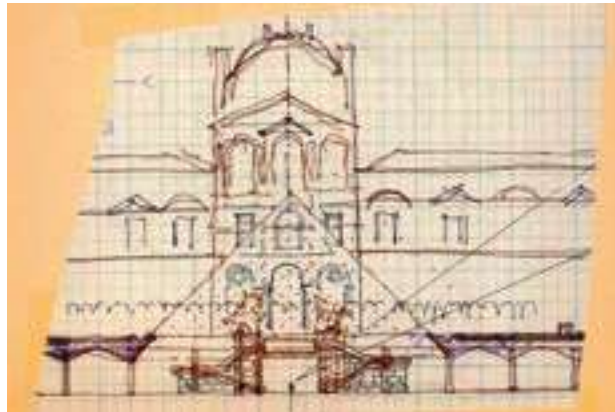


Figure 4. Study of design of the pyramid by I. M. Pei.

The solution of the pyramid was a proposal that had already been explored in that area, previously, although most likely at the time of the development of the Pei project, this circumstance was not known to him. In the context of the first centenary of the French Revolution, some projects were designed to celebrate the date.

⁴ "Le communiqué de février 1984 des conservateurs en chef du musée du Louvre", in *Le Grand Louvre. Histoire d'un projet*, directed by Dominique Bezombes, Le Moniteur, Paris, 1994, p. 205.

⁵ The pyramid and the adjacent underground spaces were inaugurated, by François Mitterrand and Jack Lang, on 30 March, 1989.

⁶ The platform would be converted into a museum and opened to the public in December 1986 with the design of the Italian architect Gae Aulenti.

⁷ Subileau, Jean Louis, "Introduções", *Os Grandes projectos Arquitectónicos em Paris*, Fundação Calouste Gulbenkian, Lisboa, 1985, p. 17.

⁸ Coignard, Jérôme, et alii, *The Grand Louvre and the Pyramid*, J. N. Beyler, Itália, s/d, p. 14.

⁹ Jodidio, Philip, "1983-2008: Ieoh Ming Pei et le défi de l'histoire", *I. M. Pei Architecte*, p. 246.

¹⁰ Wiseman, Carter, *I. M. Pei, A Profile in American Architecture*, revision edition, New York, 2001, p. 11

One of the places chosen for this purpose, given its strategic location, was the site formerly occupied by the *Tuileries Palace*. The monument proposal developed by Louis-Ernest Lheureux¹¹ in 1886 resembled something between an Aztec pyramid and an Indian stupa. His approach, which made a stereotyped exploration of widely known forms, helped legitimize his proposal to create a symbolic and universal monument. The formal coincidence between Lhereux's proposal and Pei's solution, plus the circumstance of the proximity of the place of implantation, provided arguments for some detractors to try to see in it a possibility of plagiarism, thus minimizing the originality and importance of the pyramid of the Louvre.

In view of all the configurations that the architect may have investigated, the pyramidal form is one that presents a greater volume saving, since it allows some planimetric occupation, but quickly dilutes in height. Viewed from the outside it certainly presents less visual

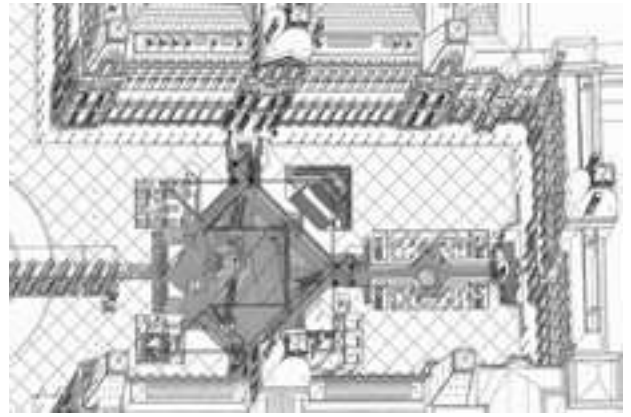


Figure 5. Axonometria of the proposal of I. M. Pei, with special emphasis on the underground organization of *Cour Napoléon*.

impact and produces less visual obstruction. From the inside, it is the form that defines more welcoming, as it becomes face to face with the passers-by. It is also worth mentioning that the theme of the pyramid, or the pyramidal form is something that in the case of the Louvre will bring other points and aspects

¹¹ As a curiosity, this architect was a student of Henri Labrouste and was very close to Viollet-le-Duc.

Fig.

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Figure 6. *Cour Napoléon* during the works.

of the project. For example, the inverted pyramid¹² under *Carousel Square*, or the design of the coffins on the slab that is adjacent to the main entrance of the museum, also explore the dynamics and aesthetic potential of the aforementioned form¹³ The solution also has three smaller pyramids about a quarter of the height of the main pyramid and an inverted pyramid with one-third the height of the main pyramid, located in the *Carousel Square*, whose volumetry is projected below the ground.¹⁴

Considering the value of the property and the low acceptability in terms of public opinion for the direct increase of the volume of the building, it seemed plausible a methodology based on the exploration of the potential of the subsoil. A subsoil which, was known to be fertile in archaeological remains and which, in the vicinity of the Seine, presented increasing groundwater difficulties (the excavations could not go beyond 8m depth). In that context, the existence of vestiges was inevitably a barrier that could either help to valorize a hypothetical intervention, or could constitute something insurmountable, bearing in mind the historical importance of all that involvement. Thus, the fronts of knowledge of the territory were marked mainly in the *Patio Square* and the *Cour Napoléon*. In the first case, confirming what was known about the site given the inevitable existence of vestiges of the old fortress and the second leaving open a huge margin for intervention given the scarcity of archaeological remains.¹⁵ But, given the depth-of-penetration conditioning, the amplitude of the buried spaces was a somewhat limited solution, so the creation of zones of zenithal illumination became an

almost imperative project. The extent of the buried area, which greatly facilitated all internal circulation (Denon pavilion, on the Seine side, Richelieu pavilion, in the opposite zone to the north and Sully pavilion on the side of the square courtyard), to escape the closure effect, it needed aeration, the effect of direct sunlight and the vision of the sky to be an attractive space, where it would be pleasant to be and to wander.¹⁶

The choice of a pyramid aligned simultaneously by the axis of the square yard and the other axis defined by the aligned wings that separate and draw four of the small courtyards of the buildings, two by each lateral wing, allowed the optimization of the implantation that somehow almost corresponds to a gravitational center. This awareness of the importance of alignments, the role that the axes have in terms of orientation and organization, confirms the very structured character of Pei's spatial ideas and above all is a testimony of his perfectionist character. The way in which Pei organizes

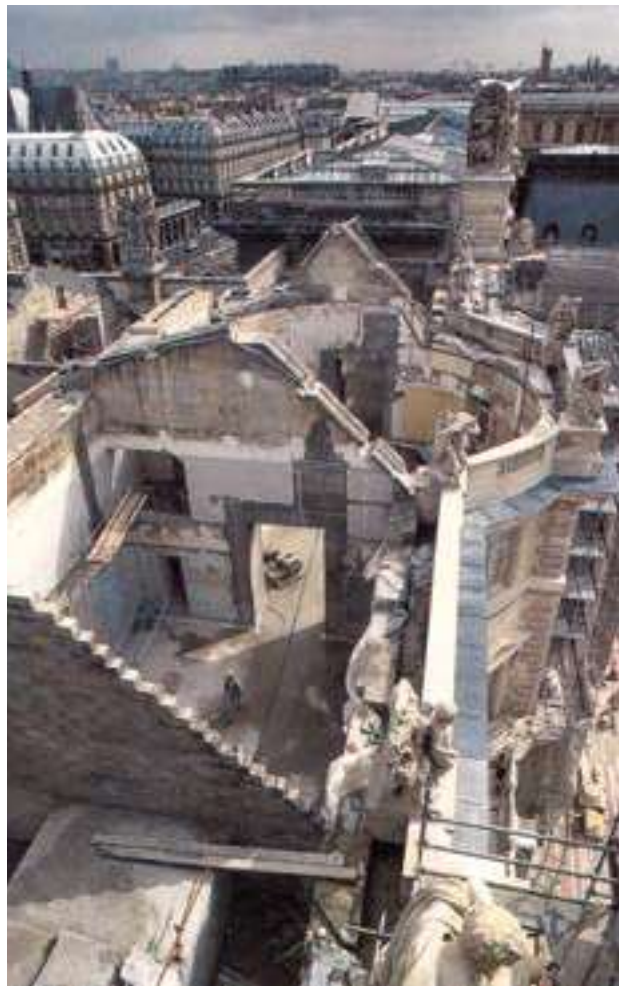


Figure 7. Demolition and consolidation of the ward occupied by the former Ministry of Finance.

¹² This pyramid that is located in the commercial area has been the subject of some speculation due to the fact that American Dan Brown in his bestseller, *The Da Vinci Code*, had written that the tomb of Mary Magdalene would be under it. Excellent free publicity for the Louvre – we will say.

¹³ Charleson, Andrew, *La Estructura como Arquitectura*, Editorial Reverté, Barcelona, 2007, pp. 158-159.

¹⁴ Delrue, Alexandra, *Balade Parisienne: 1er arrondissement*, BoD – Books on Demand, Paris, 2017, p. 93. Also see Jodidio, Phillip, *Discovering Architecture. How the World's Great Buildings Were Designed the Built*, Rizzoli International Publications, New York, p. 237.

¹⁵ Von Boehm, Gero, *Conversations with I. M. Pei, Light is the Key*, p. 82.

¹⁶ Macary, Michel, "O projecto do Grande Louvre", *Os Grandes projectos Arquitectónicos em Paris*, p. 40

the paths, introduces form and dynamism that induces the users of the space to move and, the circumstance of the perception of the space, to be precisely the result of the idea of course, of active contemplation, made the production of this Chinese -American be a very distinctive brand that identifies a way of doing and approaching architecture.

This was a solution that masterfully solved the problem of the entrance of the public in the museum and the distribution to the different spaces of the building of the palace of the Louvre. The boldness of a proposal whose monumentality is affirmed above all by the purity of a simple volumetry that solemnly recovers the memory of the great Egyptian pyramids. In this line, the pyramid of Khufu in Giza in Egypt, one of the Seven Wonders of the Ancient World, is always a vision that remains in the soulful imagery of those who visit the Louvre and certainly constitutes an always redeemable referential.

If, in a context of diminishing design, the Louvre pyramid was extensively being associated with a

residence of the dead¹⁷, what emerges is only a plastic identity, an inspiration that uses an architectural model that is part of the universal imagery of art. A form which, sadly and in a derogatory way, is too often compared to the Egyptian pyramids as a funeral space, thereby suggesting that such grand heritage as the Louvre can not be associated with the inertia or devaluation of life. But if one really thinks of the symbolic issues of the pyramids in Egypt, they are inevitably associated with inevitable upward movements since the burial chambers were in a position above the height of the outer pavement. And if we look at Pei's solution, his pyramid transfuses a downward movement, where people are induced to immerse themselves in the subsoil and from that point on, to be able to observe and contemplate some of the greatest wonders of human creation and ingenuity¹⁸. In

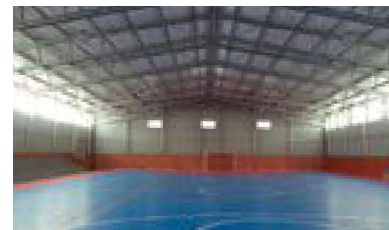
¹⁷ Chaine, Catherine e Verdet, Jean-Pierre, *The Grand Louvre. From the Fortress to the Pyramid*, Hatier, Paris, 1989, p. 10.

¹⁸ Jodidio, Philip, "1983-2008: Ieoh ming Pei et le défi de l'histoire", *I. M. Pei Architecte*, p. 241.

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reality, transposed the entrance zone, the access to the interior platform, distributive of the space, is made by a helicoidal staircase, that surrounds a central cylinder where an elevating platform is embedded. This curved shape, contrasts with the flat faces of the pyramid, allows for the existence of a graceful movement that interconnects the point of arrival to the museum and the place where the various visitors can structure the contemplation of an unrepeatable collection of exceptional value. What really stands out is a kind of glass and steel "iceberg" that floats in the *Cour Napoléon* and favors diving into a complex, innovative, service network and service spaces of the museum¹⁹. That is, although it is a very strong element in the project, the most important is how a minimal impact solved the biggest problem of the Louvre: the lack of area to satisfy a whole universe of needs.



Figure 8. Interior of the pyramid with museum access zone.

The pyramidal form proposed by Pei agglutinates the space of the *Cour Napoleon* giving it a centripetal energy, indelibly marking the radiating point for the later visit of the museum. The position of the pyramid indicates exactly the center of gravity of the three pavilions of the museum, which gives it a status of predominance and relevance in the context of the proposal. The volumetric purity of this regular, transparent quadrangular prism raises some duality, in the sense that form appears spatially defined, but materially almost devoid of corporeity. A corporeity that theoretically dilutes during the day due to the enormous transparency of the pyramid, but brutally marked at night, functioning as a huge glass lantern. A source of light that marks a contemporary superstructure, with a very distinct symbolic value and which unequivocally marks the entrance to the Great Louvre²⁰. The shape of the solid that marks and distinguishes the access to the museum is a solid that structurally anchors itself cohesively in the soil and, by its nature, fades as it rises on the horizon. Thus, the pyramid, therefore, is the solid that has the least impact in its spatial relationship with

the surroundings. The fact that the planes are inclined makes it impossible for the direct reflection of the observers, reduces the reflection of the surrounding architecture and above all reflects on the surface the dynamic nature of the landscape, when the weather and the winds allow it. Given the state of faceted plans of the palace roofs, the structural stability of form and its capacity for transparency, coupled with its break with tradition, made that solution a *work of our time*.²¹

The work of the architect is of great delicacy and denotes a concern with numerous aspects, ranging from understanding the history of the site and the building, to a particular attention to detail issues that for others could be misrepresented or even forgotten. In the context of the Grande Louvre project, Pei rescued the equestrian statue of Louis XIV from the original author Lorenzo Bernini, executed in 1684, later altered by François Girardon, placing a copy exactly following the axis defined by the center of the Arc de Triomphe and from the center of the Arc de Triomphe of the Carousel²², having its exact location been implanted, at the time, using the most advanced technology.

²³ This statue had the peculiarity of belonging to a foreign artist whose project had been discussed with the king and then executed after the artist's return to Rome. This detail is a good example of Pei's interest in history in general, and the preoccupations and study that this architect has made in the context of his work at the Louvre are very evident. But this attitude may also contain in itself a provocative character, as many opposed to the fact of not having a francophone architect to develop such an important project and Bernini somehow, in the context of his time having been disregarded also in his remarkable baroque design for the Louvre. On the other hand, Pei's willingness to establish bridges between past and present, a past that is inherited and a present he promotes and eternalizes, is well known.

Choosing the hypothesis of the use of glass as global coating of the pyramid, the problem of reflections and eventual coloring of the surface was immediately present. This aspect, like many others, reflects the architect's great concern with the constructive and execution question. He knows that in addition to drawing research, part of the project's success lies in an adequate follow-up of the work, by the way in which the quality of the technical detail is enhanced.

²¹ Von Boehm, Gero, *Conversations with I. M. Pei, Light is the Key*, p. 84.

²² This monument was built under the order of Napoleon Bonaparte in 1809, by Charles Percier and Pierre Fontaine, to celebrate the victory at the Battle of Austerlitz, located on the esplanade opposite the old Tuilleries.

²³ Boissière, Olivier, *Il Grande Louvre di Ieoh Ming Pei*, L'Arca, rivista internazionale di architettura, n° 2, december 1986, p. 65.

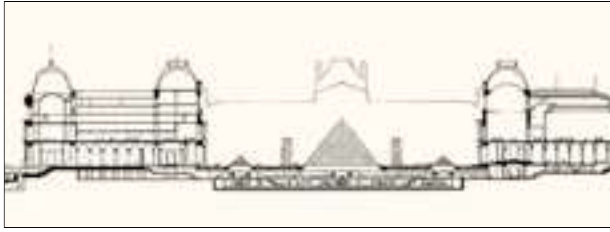


Figure 9. Architectural section crossing the Seine River with an area formerly occupied by the Ministry of Finance on the left side.

Pei's determination was to have a glass with maximum transparency, understanding that it would be the best way to neutralize, as much as possible, his proposal. However, the available commercial glass varieties had the incorporation of iron oxide in their manufacturing process and usually had a green coloration which, as the thickness increased, became more intense and darker. Although the well-known and prestigious French brand Saint-Gobain has the capacity to manufacture a glass similar to the one intended by the architect, this company expressed its disinterest given the amount involved and the cost of production that such a solution implied. Faced with this adversity, Pei requested the intervention of Mitterrand, thus allowing the resolution

of this first obstacle. This was made possible by the use of white Fontainebleau sand with excellent properties for the manufacture of glass with a high level of transparency. A second problem had to do with reflections and that resulted from the need for the glass to be as smooth as possible, avoiding distorting effects on vision. There, in order to have an absolutely flat glass, the solution was to call upon an English company. Another aspect was still the stability of the whole. As it was not structural glass, it was necessary to guarantee the stability of the 675 diamonds and 118 triangles. In this case, the choice was made through collaboration with a company specialized in boat cables, Navtec, in Massachusetts. It was this company that developed the solution of nodes, bars and cables of the system that guaranteed all the structural sustainability of that set.²⁴ In what had to do with Pei's quest for almost absolute transparency, we must say that fortunately this effect was not accomplished. Thus, this is not as translucent as desired, but the reflections that propitiate, translate the nature and the climate of the city, seeming to be in

²⁴ Jodidio, Philip, "1983-2008: Ieoh Ming Pei et le défi de l'histoire", *J. M. Pei Architecte*, p. 238.



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Figure 10. Overview of Cour Napoléon from the Sully Pavilion.

line. Thus, as Pei said, "it is like a living organism, and for that reason I think it is a success."²⁵

In terms of drawing, if we consider the square of the pyramid and from the vertices of the side draw a new square in a rotated position and then again represent another square that passes through the vertices of the second square and in a position such that its sides are parallel to the sides of the initial pyramid, we obtain a configuration that defines the design of the water mirrors adjacent to the entrance area of the Louvre. Thus, in terms of representation, what results from the scheme of the drawing of I. M. Pei is an *ad quadratum* construction in which successive squares are obtained by tangency and by rotation. As a curiosity and in geometric terms, if one starts from the larger square, the second will always have half the area of the first. The successive intersection of the three squares referred to is that it generically defines the seven water mirrors, and the square of the intermediate clarifies a path between the various water planes, at the same time as it leads the pedestrians to the point of entry of the public into the pyramid. In turn, the three smaller pyramids, which provide illumination and mark the visit paths, underground, respectively for the Sully, Richelieu and Denon pavilions, are implanted (in a rotational position relative to the main pyramid) in the alignment of the axis defined by the midpoint of the opposite faces of the main pyramid and with implantation outside the largest square mentioned above. This strategy means that only in the axis and in the part of the entrance there is no pyramid and the rest are placed in strategic points and with their implantation respecting the logic already described. This game of use of square in diverse and regulated dimensions is a stratagem recurrently used by the architects, whose origin is projected for very remote times. In close observation, one can easily find similarities between the approach Pei had in the spaces adjacent to the pyramid and the landscape logics used by le Nôtre.

In the beginning, in the nineteenth century, museums were simply places where an estate was presented without much concern for the characteristics of the hostel space. Over time, the process has been transformed, making the space occupy an almost identical protagonism and in some cases even exceed the value of the collections. Now what Pei's intervention comes to solve is precisely the valorization of the exhibition space, proceeding with the rescue of a building with value, but which in the context of the spectacle had a position incomprehensibly of subalternity.²⁶

According to Henri Loyette, director of the Louvre between 2001 and 2013, most visitors point out that what motivates them for their visit to the Louvre is the Mona Lisa, the Venus of Milo and, of course, the pyramid.²⁷ The real dimension of the work transcends its physical measure and is projected in the timeless panorama of the great works of architecture, leading to affirm that "in the hands of Pei, the pyramid and the project that it represents can be understood as the healing of old wounds, the reconciliation of past and present times."²⁸ The remaking of the Louvre was the way in which Mitterrand expressed himself in relation to the need for in-depth intervention in the face of the near-inoperability of that equipment. But, as Lacouture emphasized, considering the framework of intervention, there may be other terms with a more diverse character, and which mainly go through refoundation, rejuvenation, reinvention, but it will be difficult to ignore that the nature of the latitude of that intervention brought a revolution to that place, approaching it vertiginously to the act of creation.²⁹ Imbued with this transformative, metamorphic spirit, that intervention fosters a daring alliance between a memorable past and a very promising future.* ■

²⁶ Lacouture, Jean, "Le palais des métamorphoses", in *L'Invention du Louvre*, Éditions Odile Jacob, Paris, 2001, p. 71.

²⁷ Quote from Hojnicky, Carrie, I. M. Pei's Famous Louvre Pyramid Named Timeless Architecture by AIA, posted in 19 December 2016 and available in www.architecturaldigest.com/story/im-peis-louvre-pyramid-named-timeless-architecture-aia, accessed on 5 May 2018.

²⁸ Jodidio, Philip, "1983-2008: Ieoh Ming Pei et le défi de l'histoire", *I. M. Pei Architecte*, p. 250.

²⁹ Lacouture, Jean, "Le palais des métamorphoses", in *L'Invention du Louvre*, pp. 87-88.

* Corresponds to the second part of the same author's article published in the previous issue of the magazine *Metálca*.