Although it may seem trite, it must be said that it is impossible to cover all aspects of Gaudí’s approach to building in the brief time allowed by a conference. Given this limitation, certain matters of great interest will necessarily be left untouched. Moreover, the matters that are indeed discussed may not be dealt with in the depth that they deserve. Proof of the great extension that would be required for this subject is the book that my partner (González and Casals 2002c) and I have recently published. In that publication, over two hundred pages were required to discuss four of Gaudí’s works, but not even that was enough to allow us to present all we know about them.

Now, on beginning this talk, I must make a few remarks to justify this fact for the people who think that Gaudí is simply an extravagant architect, an opinion that arises from a superficial observation of his buildings. It should be emphasized that Gaudí was not only original in his formal aspects—as may be easily seen by looking at his works—but he was also very original in the way in which he used building resources to arrive at his forms. Consequently, if a mere formal analysis of his work is complex, the combination of such an analysis with the study of his building configurations is even more complicated.

Before starting it should also be mentioned that I do not seek to sing once again the praises of Gaudí. Rather, I wish to discuss him with an admiration and acceptance of what were, unquestionably, his very important innovations, innovations that allow us to credit him with consummate originality. However, I will do this with a critical attitude that will permit a distinction to be drawn between his extraordinary accomplishments and his enormous mistakes. My primary activity, university teaching, demands that I proceed in this way.

Likewise, on beginning this conference a statement must be made that summarizes in a few brief words the essential facet of Gaudí, the characteristic that underlies his various works and that underlies, within these works, each of the scales of analysis that can be used to study them, from their materials and structures or wrought-iron details to each building as a whole. Does anything of this nature really exist? I can state flatly that it does indeed.

To designate this characteristic, I will be using a word that has already turned up several times in this talk: «originality». Albeit with certain nuances. What’s more, there is a phrase that concurs with this, a phrase that is attributed to Gaudí himself: «Originality means returning to the origin». This is a famous phrase that has appeared on posters announcing exhibitions connected with Gaudí in Barcelona in the year 2002, and some architects who admire him even write it on their visiting cards. In my opinion, however, this is a rather redundant and ambiguous affirmation that requires interpretation. To interpret it, we must relate the way that Gaudí acted and the circumstance common to all the phrases that are attributed to him, namely, that we are acquainted with them, in reality, through the memories of his disciples.
My interpretation is that, for Gaudí, originality meant going to root of problems and finding solutions devoid of any stylistic or technical prejudice. If this is called «going to the origin», I am in agreement with the phrase. In short, it would be reasonable to replace this phrase with another one: «Originality arises on finding solutions by the radical analysis of problems». It may be affirmed that this was Gaudí’s underlying course of action throughout his whole life and the characteristic of the solutions that he applied to both the smallest elements of his constructions and to his largest buildings.

Of course, this obviously does not mean that this very particular way of proceeding, so characteristic of Gaudí, leads automatically to successful solutions. Solutions may be wrong. Neither does it mean that all solutions are totally innovative. Traditional solutions are correct on many occasions and Gaudí had no difficulty incorporating them into his repertoire. However, it is precisely this attitude of radical analysis that allowed him, on propitious occasions, to act in an original way.

The aspect of propitiousness should never be forgotten, especially in the case of Gaudí. In some jobs he was able to unfold his creativity without restrictions, while in others he encountered impediments. It is only natural to speak more about the former than the latter.

Another prominent characteristic of Gaudí, which was a logical result of the critical attitude that marked him, was the fact that he underwent great changes over the course of his creative life. Generally speaking, people do not have the same inventive capacity on completing their studies as they do after exercising their profession for thirty years. In Gaudí’s case, his selfsame critical attitude caused his evolution to be much more intense than that of other persons who accepted the existing criteria in a disciplined way. For this reason, not only will I be referring to the buildings in which he felt free to apply himself, but I will be discussing particularly the ones that are rather more characteristic of his mature age, the buildings in which he was unquestionably able to express himself as he wished. However, this does not mean that clear signs of constructive originality do not appear in his earlier works, such as the Vicens House, El Capricho, the Güell Palace, etc.

His works after 1900 fall into two distinct groups with respect to the concept of creative freedom: an apartment house on a plot of Ildefons Cerdà’s Eixample district in Barcelona is not the same as a housing development or two of his churches. Güell Park, the church of the Güell Colony and, by extension, the Sagrada Familia, are the works where he unquestionably expressed himself with an almost complete formal and constructive freedom.

**METHOD**

Having made these clarifications, which are indispensable in the case of Gaudí, it is now necessary to give a brief description of the method that may be followed to approach his complexity. It is based on the method that I apply in general to both the teaching of construction and to analysis (González, Casals, and Falcones 1997, 2001), involving the interrelationship between two groups of variables arranged by means of a matrix. On the x-axis lie the various scales by which the analysis of a building may be undertaken: the processes used to make the structures and the materials, elements and parts, be they roofs, facades, etc., that give shape to the building which we usually consider really to be defined by the space that it creates. On the y-axis lie the various objectives that have always been pursued by architects: stability against gravitational and horizontal forces, a suitable ambience for its use, and durability with respect to the passing of time, all this through forms and surfaces that create a pleasurable feeling or, in Gaudí’s case, a strong sudden emotion in the spectator.

**PROCESSES AND MASONRY**

With respect to the masonry, materials and, generally, the processes of building, Gaudí used only those that were provided by tradition, that is to say, stone and brick masonry, lime mortars, wood, etc (González and Casals 2002a). He used the major novelty of the 19th century, rolled steel, almost only for a rather modest span in the Güell Palace. Figure 1. (González 1998; González and Casals 2002c, 44–53, 143–155). In the rest of his buildings it always plays a subsidiary role that does not allow the full utilisation of all the possibilities that this extraordinary material provides in relation to spans across spaces. He began to use
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one of the big novelties of the turn of the century, Portland cement, but always as an unclearly understood substitute for lime in mortars. Lastly, the other great novelty of the turn of the century, reinforced concrete, was absent from Gaudí’s work until shortly before the end of his creative life, when he used it in the San Bernabé Tower of the Sagrada Família.

If we search for innovations in his bonds, we find only a very early case: the containment wall opposite the courtyard of El Capricho, where the mason’s lines are slanted 45 degrees. In other structures, such as those of rough-stone or dressed-stone masonry, the strictly formal solutions in their bonding are not treated innovatively by Gaudí.

Gaudí also followed a way of doing things of his times and of previous centuries that involved mixed structures: rough-stone masonry with brick, or rough stone with dressed-stone masonry, but he did so in a way that was free of stylistic conditioning factors, seeking maximum effectiveness from a practical standpoint. A notable example of this is to be seen in the Teresian School. Just as Professor Alfonso de Sierra pointed out, the brick masonry of the top floor, with greater tensile strength than rough stone masonry, forms a crown with both expressive-formal functions and structural functions (González and Casals 2002c, 65).

Despite it all, in Gaudí’s building processes, this utilisation of traditional structures does not stand in the way of a radical attitude that allowed the architect to introduce major innovations. The most notable case was that of the ruled surfaces he achieved by means of the simple inclination of one of the two rules that direct that generatrix of the surface, that is, the mason’s line or string. In this very simple way he went from the plane to what would be one of his great formal and, at the same time, constructive contributions: ruled surfaces. Although one finds examples in early works, such as the hoods of the chimneys of the Güell Palace (González and Casals 2002a, 61), this feature reaches its greatest development in small elements such as the church of the Güell Colony and, with its full power and creative capacity, in the vaults of the nave of the Sagrada Familia. This is an innovation that affects the form of the element but not the structure itself. He was able to apply this formal innovation with the greatest force to thin masonry vaults or timbrel vaults (bóvedas tabicadas): good examples are the roofs of the pavilions at Güell Park. Figure 2.

Nevertheless, it should be kept in mind that if it is wished to apply a finish that is different from that of the structure itself, these warped forms require claddings that adapt to this surface, which is so different from that of a plane. The achievement of another of Gaudí’s key characteristics—colour, with all its possible variations,—led him to the solution of ceramic tiles broken into fragments, which could be used to cover any type of surface. Gaudí used this magnificent surface-cladding and formal solution, which is usually called trencadís in Catalan, in a very large number of cases. Figure 2. Although it cannot be said that Gaudí invented it, it may be affirmed that he carried it to really notable extremes, and one case of this is, unquestionably, the finish he applied to history’s first hyperbolic paraboloid vaults, in the porch of the Güell Colony.
The roofs of the pavilions at the entrance of Güell Park are built with slender ceramic vaults or timber vaults clad with tile fragments or *trencadís*.

**Elements**

The vaults of this extraordinary porch are a notable achievement presenting at least three really substantial innovations: a) Their form. Figure 3. b) The way in which this form is clad, accentuating its geometrical features while creating a finish of extraordinary visual quality. Figure 4. c) The building process coherent with the form and its cladding. Figure 5. Just as I have pointed out (González and Casals 2002b; González and Casals 2002c, 175-180), this is a case in which it may be said that Gaudí applies the processes of Roman construction, precisely in quest of the formal innovation entailed by the hyperbolic paraboloid.

These vaults are extremely remarkable, as are the arches that support them, arches that were treated by Gaudí with what could be called a subtle irony. He follows his anti-funicular method while transgressing it since, mechanically, these are straight arches resting on two great brackets; by adding two curved elements, however, they recover the arched form derived from the wire model. Figure 6.

Although the arches in this porch are coherent in their way of working and in their anti-funicular origin, it is more than questionable whether they are coherent with their form and whether the arches of more less parabolic profile that frame the openings in one wall entail a certain mechanical advantage. In a
façade wall, the arch may adopt any form since, even if it departs from a perfect anti-funicular profile, the descent of its loads will find a line of pressures that, issuing from the arch and embedding itself in the masonry structure of the wall, stabilises successfully the imbalance produced by the void of the opening.

This leads to my theory: the anti-funicular method or the application of graphic statics, in the case of Gaudí, is not so much a matter of mechanical or constructive rationality as a will to create form.

Remaining on the level of elements, two extreme and quite distinct cases should be emphasized that seem significant with respect to the architect’s characteristics. One of these, from the standpoint of stability, is the big mistake of the foundation elements of the Casa de los Botines building, which reveals a Gaudí who was most likely acting with an unjustified wilfulness (González and Casals 2002c, 155–161). Figure 7. As opposed to this, almost simultaneously in time, there is another element that shows Gaudí’s concern for users, for the comfort of the people who

Figure 5
A model illustrating the hypothesis of the vaults’ construction using process similar to that of the Roman vaults

Figure 6
The mechanical arch is formed by three straight sides; its final shape recalls its anti-funicular origin

Figure 7
There was resistant soil one metre beneath the point where Gaudí situated the foundation plane of the Casa de los Botines
lived in his buildings: the wooden floor assemblies with an unusual cross-section that separate the servants’ floors from that of the owners in the Güell Palace (González and Casals 2002c, 114–118). Figure 8.

Figure 8
Detail of the cross-section of the Güell Palace’s floor assemblies, situated on line ff of Figure 1

PARTS OF THE BUILDINGS

Continuing the increase of scale, two significant cases may be pointed out. On the one hand, I can mention the hypothesis of a Gaudí who was excessively acquiescent with his customers by designing a roof that provided them one more floor than was permitted by the ordinances, as it is reasonable to surmise with respect to the Casa de los Botines (González and Casals 2002c, 129–132). As opposed to this, there is a façade that, presenting no disadvantages for users and perhaps even certain advantages—at least during its first one hundred years—, responds to an idea of absolute freedom: this is the façade of the Milà House. Figure 9. It is difficult to find this extraordinary formal and expressive wealth, based fundamentally on its undulating forms alone, but its consequence is a serious limitation in time. If it is wished to lend greater durability to this façade, its restoration may involve extremely high costs since the iron rods that Gaudí installed, which have already rusted in many cases, must be replaced with stainless steel elements (González and Casals 2002a, 63).

THE BUILDINGS AND THEIR SPACE

In the buildings in their totality, we continue to find proposals of extraordinary originality that are not free, however, of contradictions and paradoxes.

Continuing with the case I have just mentioned, that of the Milà House, this unlimited freedom that Gaudí looked for in the façade was also sought, naturally enough, in the ensemble of the building and in its distribution, for which reason the architect avoided load-bearing walls from the start. To achieve this, Gaudí adopted the porticoed system of columns and girders, precedents of which appear, in reality, only in industrial buildings, of which there were hundreds in Catalonia, derived from the English factories and designed on the basis of cast-iron columns and wooden or metal girders (González and Casals 2002c, 44–45). Figure 10. This system had never been transposed, however, at least in our country, to an apartment building. Gaudí did not so much seek flexibility of use throughout time, as would later be the paradigm of Le Corbusier’s flexible plan, as absolute freedom in making vertical
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Figure 10
Plan of the Milà House’s load-bearing structure

divisions and, consequently, domestic micro-spaces. This did not prevent him from emphasizing that this flexibility of use would have allowed, as he himself stated, the transformation of La Pedrera into a hotel, or as has now happened, the transformation of some of its floors into exhibition halls.

If we continue to consider apartment buildings but go on to the y-axis of our analysis model, with its ambience factors, it is indispensable to mention the extraordinary case of the Batlló House, which is also exceptional for other reasons. But here I will quote what was written by the expert on the building and its restorer, Josep Maria Botey: «It is exciting to discover the passive ventilation systems that Gaudí applied on connecting the courtyard to the main façade by means of tubes that promote vertical ventilation, boosted by the creation of a laminar current on the roof’s skylight, which produces a Venturi effect and, consequently, an absorption and a continuous supply of fresh air, enhancing the typical ventilation system of the little courtyards that characterise the Eixample». Figure 11. (Conference of the architect J. M. Botey in ETSAB, Architectural School of Barcelona in November 2002. Not published). Botey went on to point out how Gaudí used mechanisms and devices that affect the windows and doors to distribute successfully this ventilation throughout the ensemble of interior rooms. This building has, unquestionably, been studied little or not at all from this standpoint, as has previously been the case with so many other aspects of Gaudí, whose ambient applications have been almost always overlooked.

Now, proceeding still further with this ascending scale of freedom, of size, and of Gaudí’s age, it is necessary to discuss his two churches. In his masterpiece we find yet another paradox. The commission was made to him when he was, in my opinion, too young —31 years of age—, and it was moreover an «envenomed» commission since it involved nothing more than the continuation of what another architect, who was very much more conventional than he himself, had already begun. In fact, Gaudí took a long time to contribute something that was really coherent with his creative capacity. All experts have emphasized that the major formal

Figure 11
The arrows mark the path of the air flow that Gaudí devised to force the ventilation of the Batlló House’s courtyards.
contributions of the Sagrada Família appeared from the year 1915 and were the result of Gaudí’s work on his other church, which was not subject to practically any functional or, in principle, financial limitation: the church that was commissioned to the architect by Eusebi Güell for the Colony Güell. This was where Gaudí, probably for the first time in his life, was able to do what he wanted in an unhampered way: to make a physical reality of his system of devising forms by means of the anti-funicular process. In the passage from wires to reality, he brought to bear all his constructive-formal creativity. See figures 3 and 6.

Nevertheless, if we make an analysis from the standpoint of adaptation to the always scarce available resources, we can demonstrate that the space resulting from this system is not free of serious problems with respect to spans, internal views and, especially, building processes. Figure 12.

All this reaches its high point precisely in Gaudí’s great work, the Sagrada Família. Although the determination of form here does not follow the anti-funicular method, it does make use of graphic statics, which is nothing other than a similar and more economical way of achieving the same end: to find linear elements of structure, both straight and arched, that receive only axial compression stresses and that consequently do not require auxiliary elements such as buttresses or, in the case of the Gothic style, flying buttresses (González and Casals 2002c, 82–95, 167–170).

This objective dominates the design process of the towers and the aisles of the Sagrada Família church, as is reflected in many of the maxims recorded by Gaudí’s disciples.

In the case of the towers, the surpassing of the Gothic lay in making them continuous by means of their spindle-shaped form, far from the caricature drawn by Gaudí himself when he stated that Gothic towers were like spyglasses, reducing their cross-section by setting back each successive floor. Gaudí’s form is obviously different, but it would be difficult to prove that it entails any mechanical improvement. Having reached the point where we now stand today, there is something ridiculous about criticising the Gothic towers and it suffices to recall in this respect the towers of Bologna, without mentioning those of the French, English or German cathedrals.

Another aspect in which paradoxes continue to pursue the works of Gaudí is the design process he used for the central nave. The quest to surpass the Gothic led him to make statements that were, in the end, rather grotesque, such as when he said that the Gothic flying buttresses are something like crutches. That was the old trick of seeking to outdo someone by mocking him (Schopenhauer [1864] 1990). However, just as may be easily seen from the accompanying drawings, in order to balance his aisles, since the structure was made of stone masonry (resistant to compression alone), Gaudí had no choice but to resort to another Gothic technique, which was none other than the use of pinnacles that verticalise loads, carrying them to extremes in hyper-pinnacles that, in the central nave, become another building that reaches the height of a second superimposed church, comparable to the cathedral of the city of Barcelona itself. Figure 13.

If it is wished to avoid the use of buttresses, then the anti-funicular system or graphic statics applied to single-resistance structures do not offer any other solution than this one, which calls for the reduction of spans at the same time. This is one of the key characteristics of the Sagrada Família: compared with those of many Gothic buildings, its spans may be considered even ridiculous. This may be observed by comparing it, for example, to Bologna’s San Petronio.
an unquestionable genius who created new forms in history, forms that are valid in themselves and coherent with the aesthetic revolution in which he lived in the last part of his life. He displayed an extreme creativity based on the consummately intelligent use of the geometrical properties of ruled surfaces. This is the great legacy that has been left to us in the aisles of the Sagrada Familia, Figure 14.

Figure 14
Despite all its contradictions, the ensemble of vaults of the Sagrada Familia’s nave is one of Gaudí’s most beautiful works.

**FORM AND SUBSTANCE**

If we seek an identifying characteristic of all the contributions of Gaudí’s last stage, it has already been stated on a multitude of occasions that it is none other than formal continuity, justified by Gaudí many times for constructive reasons, in most cases with insubstantial arguments. These are solutions that only make sense, in reality, from an aesthetic-formal standpoint, which is neither good nor bad but forms a distinct architectural reason that must be valued as such.

For me, however, continuity is a characteristic that actually goes beyond the merely formal since it extends to the continuity of scale, the continuity of arguments and the continuity of objectives (González and Casals 2002c, 194–197). Gaudí —and in this respect he succeeded Viollet-le-Duc—is the architect who stands farthest from the fragmentary theory of academic architecture, the origin of which lies in the
erroneous interpretation of Vitruvius’s triad, which continues unfortunately to be upheld in all the world’s architecture schools (González 1993, Casals 2002). For Gaudí, architecture requires and takes advantage of the assemblage of all scales, and of the assemblage of all objectives and of all the intricate relationships that may be established between them.

This is indeed the great architectural-constructive legacy that makes Gaudí —divested of the useless character of a legend and with all his contradictions fearlessly laid bare— deserving of consideration as a great architect who offers lessons on methods for carrying out the quest for roots — for the origin, as he said. These are methods that allow us, on the one hand, to approach problems from their beginning and, on the other, to develop, without ever marginalising users, solutions free of all stylistic and constructive prejudice, even if they are not devoid of the risk of error, just as Gaudí showed us throughout his career.

REFERENCES


References relating directly to Gaudí’s approach to building

Rovira, J., 1990, Aspectos constructivos puestos de manifiesto en la restauración del Parc Güell de Barcelona. Informes de la Construcción, 408.