

Felix Candela and the Making of New World Modernism

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The thesis of this paper is the proposal that New World Modernism has often achieved a critical and vibrant regionalism when addressing issues of building technology. The internationalism of modernism and its attendant formalist aesthetic preoccupation, has historically resided in a doctrinaire suffused with the romanticism of the late industrial revolution. The advent of CIAM and its longstanding attempts at presiding over the creation of a heroic international modernism are the most obvious manifestation of this globalist interest. *And yet, there are examples of architecture that refuse this romantic temptation and establish, through the innovation of materials and structure, particular to a place and time, an approach not derivative of the Old World but very much descended of the specific social and economic conditions of the New World.* In addition, this paper intends to argue that, in light of the normative aesthetic and formal positions that much of official civic Latin American architecture aspired to as a legitimizing strategy; there did exist, from the first days of the presence of Europeans in the New World, a parallel series of determining technological forces. These forces originated from the adoption of Old World industrial modernity; a system of complex modes of production, transport, and materials innovation entirely new to the developing economies of the New World. In this way, a new architecture predicated on the development of technology in the service of particular economic needs, has achieved an important degree of regionalism.

As a medium through which to examine these thoughts, this paper focuses on the work of one particular architect, the Mexican Felix Candela. While examining specific aspects of his work, the dynamics of the process that leads to a regional synthesis should become clear. In the pursuit of the notion of a regional architecture born of technological innovation specific to the work of Candela, there are three essential conditions that most clearly delineate the nature of this technological innovation.

They are the following:

- **Structural Innovation:** The *simultaneous* innovation of hyperbolic paraboloid thin-shell concrete structures both in the Old and New Worlds.
- **Materials Innovation:** The intense and directed reassessment of a building material; cast-on-site, two-way reinforced concrete, particularly suitable to the social and economic conditions that exist in the New World.
- **Renewal of the Multi-Disciplinary Builder:** The embodiment in one person of a wide range of interests and disciplines necessary for the design and construction of these structures.

As the result primarily of these three conditions, Candela produced an architecture that is composed of forms that seem to evoke a New World specificity. This specificity is what I would like to characterize as the aspect of his architecture that evokes a regionalism. This regional aspect is composed of interests of structure and

material that Candela actively pursued and in this particular context of time and place he created multivalent opportunities as well as unavoidable consequences.

Since labor was native, the materials were what was found at hand, ... a certain crossbreeding was necessary between European technology ... and native technology—knowing the materials, the climate and the geological characteristics of the country and transferring its skill in the carving and working of stone and wood to new orders and exotic styles. (Escobar Loret de Mola)

Candela's architecture simultaneously derives and develops forms and construction methods that attracted international interest, namely the use of thin shell structures as an enclosing membrane, while taking into account the local availability and appropriateness of the constructional techniques necessary to achieve built form. In the process though, his built forms achieve a sort of "strangeness," born of the use of these structurally unfamiliar new geometries. These geometries evoke relationships to a wide range of visual clues. From functionalist allusions, the bridges of Maillart and Christian Menn and other civil engineering structures, to the anthropomorphism of organic floral forms, these shells create a context for themselves that is at once comprehensible and unexpected. In building these folding and undulating, seemingly paper-thin, architecturally "unfamiliar" forms, Candela marries a set of universal technological principles, current at the time, with a generalized strategy of place-making. The aspect of this place-making most interesting here is the idea of an all-encompassing thin overhead cover in which the necessary programmatic elements are placed below. This idea of a continuous overhead structure relates quite directly to certain climatically appropriate architectures of the tropics, from the simple overhead sun shading device to buildings with extended eaves, as well as certain modernist ideas regarding the separation between the enclosing wall and interior programmatic delineations, such as LeCorbusier's Philips Pavilion of 1958.

[Critical regionalism] ... selects regional elements for their potential to act as support, physical or conceptual, of human contact or community, what we may call "place-defining" elements, and incorporates them "strangely" rather than "familiarily." In other words, it makes them appear distant, hard to grasp, difficult, even disturbing. It frames as if it were the sense of place in a strange sense of displacement. It disrupts the sentimental "embrace" between buildings and their consumers, "de-automatizing" perception and thus "pricking the conscious"... Hence, through appropriately chosen poetic devices of defamiliarization critical regionalism makes the building appear to enter into an imagined dialogue with the viewer.

It sets up a process of hard cognitive negotiation in place of the fantasized surrender that follows from familiarization and the seduction that follows from overfamiliarization. It leads the viewer to a metacognitive state, a democracy of experience as Jerome Bruner might have called it, it conjures up a "forum of possible worlds." (Tzonis and Lefaivre)

This paper also proposes that in addition to the place-making and the de-familiarization inherent in certain newly innovated structures, there is a specific dynamic at work in the creation of a regional form embodied in Candela's work. This dynamic is composed of the ability of his structures to acquire a regional legitimization by way of their forthright *functionalist aspirations*. If we are to accept a notion of regionalism that states essentially that "The fundamental strategy of Critical Regionalism is to mediate the impact of universal civilization with elements derived indirectly from the peculiarities of a particular place" [Frampton], then the deterministic approach that Candela adopted with much of his work does not diminish the assessment of his buildings in a regionalist way and in fact may add to their connection with the place and time of their construction. Candela was well known to have insisted that all structurally non-essential elements be eliminated from his designs. He was quick to label other architects as "formalists" when their work explicitly made the structure a secondary aspect of their designs. This positivist ideological fervor tended to greatly obscure the influence that other current modernist aesthetics possessed at the time. These prevailing modernist aesthetic preferences were primarily determined and strengthened by the series of conferences known as CIAM. In his assessment of CIAM IV held in 1933, Reyner Banham dismissed a good measure of that meeting's work when he wrote that, "**At a distance of thirty years we recognize this [the Athens Charter] as merely the expression of an aesthetic preference...**" (Frampton, *Modern Architecture*). Candela, for reasons that are not quite clear today, seems to have maintained a relative autonomy apart from these consensus building conferences. One reason may have been his consistently single-minded pursuit of this one particular type of structural form. Another reason may have been because he described himself as simply a "contractor" [Faber], even though he assumed a variety of roles in the realization of his projects.

Felix Candela was born in Madrid in 1910. The relevant facts of his education and early professional life are the following: he was educated as an architect in Spain and opened a small studio upon graduation in 1935. In 1936, soon after having planned an apprenticeship in Germany with leading thin-shell concrete specialists that was never to occur, he joined the Spanish Civil War on the Republican side. He eventually found himself in Mexico after a series of unfortunate events and in 1940 became a Mexican citizen. After having completed several buildings in Mexico City, as architect, engineer and contractor, Candela began to revisit his academic interest in thin shell construction. It is important to note that Candela's interest in thin shell concrete structures was not simply the application of the existing technology to architectural problems. Candela always maintained a very strong intellectual interest in the continued innovation of the technology by acquiring, annotating and correcting European and American technical articles that addressed the latest developments. His interest in the forms also included detailed mathematical analyses of proposed and theoretical structures. As a result, he began to publish extensively in Europe and the United States, offering, and eventually having accepted articles in the most influential structural engineering journals of the time. An article, published by the American Concrete Institute in 1950, led to what would become a lifelong series of speaking engagements at universities and professional societies around the world. At the same time, Candela was building his first thin-shell concrete structures. The Cosmic Rays Pavilion was the first significant structure to receive wide ranging attention. The way in which Candela approached building his first structure and continued to realize projects throughout his career clarifies the first essential point, described

above, that leads to a regional architecture. That idea being the *simultaneous development of structural technology* both in the Old and New Worlds. Candela's active involvement in the academic debate at the time immediately diffuses the notion that this technology, as used in the New World, is entirely derivative of developments in the Old. By 1954, when in the middle of construction of his La Virgen Milagrosa church, he was invited to lecture at MIT in Massachusetts. This event confirmed his position as the "leading practitioner of shell design in the world" (Faber). Therefore, in the work of Candela an essential aspect of establishing a regional architecture that severs, as a result of its innovation, the prescriptive and dominating architectural forms of the Old World, is the autonomous innovation of structural solutions that, through their "newness" and "strangeness," establish a notion of authorship. Candela established himself very clearly as the intellectual author of his shells. It is important to describe very specifically why it is that these forms establish so well an architecture of the New World by their inherent structural properties. The answers, I believe lie in the simplicity of their geometries. The forms that Candela primarily chose to use, the hyperbolic paraboloid three dimensional curve, takes on an infinite variety of saddle shaped surfaces that have the curious property of being able to be constructed entirely out of two straight lines. This simplicity allowed workmen to establish the coordinates for the construction of these surfaces from their bounding edges. As a result of the innate geometric simplicity of hyperbolic paraboloid surfaces, Candela was able to bring an incredible freedom to the variety of final building forms without the need for elaborate constructional techniques. Not incidentally, *fundamental to the use of these forms* is the structural property that most governs the economy of these buildings. These structures are able to achieve an incredible lightness precisely because the geometry allows for transferring all structural loads parallel to the surface. No loads normal to the surface need be resisted and therefore Candela is able to achieve an extreme thinness in the concrete shell of only 1 5/8" in particular projects; for example the Xochimilco Restaurant near Mexico City (1958). This particular building covers a circular area of 140 feet in diameter with only eight bearing points. The most important point here is that Candela is able to achieve extremely large coverage with a minimum of material. When he did not use this geometry, he often chose to configure his buildings as a series of folded plates, a geometry that still minimizes material usage but not to the extent that hyperbolic paraboloid shells achieve. This geometric simplicity in the service of economy of means served to employ low-skilled Mexican construction workers as well as provide inexpensive buildings for the rapidly expanding industrial sector of the economy. A good portion of these buildings were either factories, warehouses or other industrial buildings.

He used the twentieth-century form of hyperbolic paraboloid vaults rather than the pre-Industrial Revolution form of the circular cylinder. Candela's form became an integral shell rather than a complex of separate elements delineated by ribs.... The result shows how much more successful is a structure designed directly as structural art than one begun as architectural art and modified by structural ideas. Candela could design his vaults in Mexico, in part, thanks to a lack of building regulations, relatively low labor costs, and a rapid industrial growth following World War II. He was in the right place at the right time, ... and most importantly he had brought with him to Mexico his Spanish heritage, which included the tradition of their doubly curved surfaces begun by Gaudi. (Billington)

The two other essential points that define Candela's realization of a regional structure, material innovation and the design and construction approach, both can be illustrated by his previously mentioned statement, "I am a contractor...." His choice of cast-on-site concrete as the predominant material that forms both the exterior

enclosure and the super-structural system of his buildings can be traced back to his interest in the work of European theorists as well as his failed experiment, with his brother Antonio, of developing foamed concrete. In 1949, he abandoned plans to develop an aerated concrete that would have been even lighter than the concrete that he had been using. After they abandoned the project, the primary conclusion that Candela reached was that the technology used in the forming of concrete structures should conform first and foremost to a practical assessment of the general state of technological capabilities in Mexico City. In addition, the specific production needs should conform not only to available construction machinery and processes already tested and accepted, but also to the relatively inexpensive labor of post-war Mexico. In these ways, Candela addressed the fundamental aspects of the production of architecture by deciding to accept certain technological constraints while developing the ideal concrete mixes most appropriate for thin-shell construction. As a result, his structures of extraordinary simplicity and minimalism, were still achieved very much in the same way as any flat slab concrete building. Legions of minimally-skilled laborers toiled in the making of elaborate sapling-supported formworks that defined the mathematically complex compound curved surfaces of his buildings. In addition to the use of concrete as the predominant material, Candela utilized the most primitive constructional techniques primarily because this is what constituted construction labor at the time (and for the most part, still does in Mexico City). Through his *materials innovation*, he further grounded his projects in a regional reality based on an assessment of the possibilities inherent in available materials. Eventually, his innovations were communicated to a much larger audience of professionals outside of Mexico; but for a time his work was truly particular to a relatively small region of the New World. Writing in 1962, Ove Arup offers the following observations:

It has also been helpful to him that he has concentrated his effort in one particular sphere: the construction of light concrete roofs. Since he built his first shell a dozen years ago he has not looked back; he has built on his own ever-widening experience. He has become a specialist and a virtuoso in this field. The techniques he uses are also limited—concrete poured in situ in timber forms, reinforced with mild steel bars. This is the “clay” with which the bulk of his sculptures are created. This technique is both entirely suited to local conditions and offers complete flexibility for artistic creation, being unhampered by the restraints of mechanisation and mass-production. (Arup)

On the third point, of Candela’s assumption of a broad range of roles, Ove Arup goes on to remark that:

In another way his achievement is built on a broad basis: he is not just an engineer, or an architect, or a contractor and constructor, but all three rolled into one. And this is perhaps the most significant fact of all. (Arup)

The significance of this fact lies within the notion that a regional architecture must be somehow intimately responsive of local technological and economic realities. How does an architecture initiate the creation of regional forms if not tied to the economy and the larger social and technological forces? Candela achieves a regionalism by being very much involved in the time and place in which he built. As a contractor as well as a designer, Candela was extremely knowledgeable of the cost implications inherent in design decisions. In addition, the question of the dominance of Old World over New World society must be brought into discussion in relation to the modernism that Candela embraced.

Candela’s architecture addresses this issue directly. The aspect of the work that is most instrumental in establishing a New World architectural position is its overt modernism. Contrary to the definition of modernity most often accepted, “. . . those modes of social life

or organization which emerged in Europe from about the seventeenth century onwards, and which subsequently became more or less worldwide in their influence.” [Giddens], whose definition carries within it the assumption of one culture’s domination over another, Candela’s structures imply the generation of a newly conceived regional modernism springing from the conditions particular to the New World. The colonial forces that dominated the transformation of the Americas into nations consisted primarily of a dynamic of replacement and denial of preexisting cultural, social and economic structures. However, these structural replacements were not purely adopted by these formative nations. They were transposed and therefore transformed into a unique mixture of New World and European tendencies. The realization of building projects invariably consisted of the use of indigenous labor and local materials thereby ensuring that culturally stable European architectural forms would mutate into an architecture of curiously conflicted character. The entry of the global doctrinaire of modernism, initially through the passionate internationalism of CIAM, would further create cultural pressures that would result in a variety of urban experiments. If modernity is defined primarily in economic and technological terms, as CIAM originally attempted, then the architecture of Candela can be seen to be one example of the role that the New World has played in the redefinition of the origins of modernist forms. His architecture brings to the late 20c. the notion that modernism, as an evolving set of economic and social structures, is not bound first to its original places of origin nor to its original ideological tenets. And furthermore, neither is it bound to a particular Latin American country; it is not necessarily a nationalistic architecture. Even though there have been successful examples of regional architecture specific to several countries in the New World; for example in Mexico Luis Barragan, Juan O’Gorman and Diego Rivera, in Brazil Oscar Niemeyer, Lucio Costa, the Roberto brothers, in Uruguay Eladio Dieste, these architectures are not bound by geography in the same way that architecture has been in previous centuries. It has been noted that the cities of the New World are the best examples of the modernist city, unencumbered by historical cores or large scale premodern infrastructures; these urban places demonstrate most directly the consequences of modern production. It should also be noted that New World modernism should and will extend beyond the traditional boundaries of the New World to influence the Old World, as demonstrated by Candela’s international influence.

The concluding proposition that this paper wishes to present is the possibility, through theoretical speculation as well as current built examples, of a non-ideological modernism of critical regionalist import, established and developed primarily through the investigation of particular building technologies.

Issues of production based in the logistics of the manipulation of building material have demonstrated at what point modernism fails as an ideology and triumphs as an appropriate architectural language for technologically developing regions.

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