

Joaquim Cardozo & Oscar Niemeyer

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Joaquim Cardozo (1897 – 1978) was a Brazilian poet, engineer, playwright, art critic, professor, and translator among other things who is well known in his home city of Recife, in the state of Pernambuco, Northeast Brazil. Among general Brazilians, he is more well-known as a poet and among Brazilian architects and engineers, he is known as the gifted structural engineer of Oscar Niemeyer (1907 – 2012). From the 1941 to 1971, Cardozo worked collaborated with Niemeyer on the most daring projects that produced a distinctive Brazilian modernism, all in reinforced concrete. Together they completed Niemeyer's first wave of internationally recognized work, beginning with the Igreja São Fransisco de Assis (Church of Saint Francis of Assisi) in the Pampulha Lake complex in the city of Belo Horizonte and continued to the even more refined and recognized buildings in newly built capital of Brasília.

Cardozo's story is typically told through two lenses: through his poetry and connections to famous Modernist Pernambuco poets like João Cabral de Melo Neto, and through his engineering work connected to Oscar Niemeyer, which this essay will focus on. While Cardozo's talents in poetry and structures were recognized among his peers, their more famous work shadowed his own work, theories, and participation.

Cardozo's poetry and structural capabilities are intractably linked. He is often called a "structural poet," (Dornas 2016) combining his two main activities into one. While it is well known that his poetry effected his engineering, and vice-versa, how did this shape his collaboration with Niemeyer, whom Cardozo called an "architect-poet" (Serro 2012).

Brazilian modernism is usually understood through the sensual and free form curves of Niemeyer. The engineering work and theories of Cardozo not only explain Niemeyer's forms, but also a different version of Brazilian modernism, one based on mathematical logic and aesthetic expression that was made possible with reinforced concrete.

While Niemeyer is well known all over the world, the engineer that made so many of his most ground-breaking work possible is not. This is essay is an attempt to gather the information on Cardozo's story for an English audience and understand Cardozo's collaboration with Niemeyer and his influence on Brazilian modern architecture, focusing on their first collaboration, the Igreja São Fransisco de Assis.



Figure 1. Joaquim Cardozo. Photo most likely dating to the 1940's. Unknown source.

INTRODUCTION

Joaquim Cardozo (1897 -1978) was a man of many disciplines. He was a poet, an engineer, art critic, surveyor, editor, cartoonist, playwright, and professor of engineering and art. Though Cardozo was an erudite man of many talents, his work is not well known outside of Brazil.

This essay follows the life of Joaquim Cardozo, tracing his interactions with the founding groups of Brazilian modernism in both literature and architecture. Understanding Cardozo's history is crucial to understanding his relationship to his longtime collaborator and friend, the famous architect Oscar Niemeyer. From 1941 to 1971, the two constructed a distinct vision for Brazilian modern architecture in reinforced concrete.



Figure 2. Map of Brazil shown Joaquim Cardozo's native city of Recife in the Northeastern state of Pernambuco.

Typically, the canonical story of Brazilian modern architecture is told through Niemeyer's architecture, barely mentioning Cardozo. If Cardozo is mentioned, it is only as the calculator of Niemeyer's forms rather than a collaborator or even influencer of said forms. The general understanding of Brazilian modernism starts with Lúcio Costa, who is often regarded as the "godfather" of Brazilian modernism inviting Le Corbusier to Rio de Janeiro in 1936 to consult on the design of the Ministry of Health and Education. On the team was a young Oscar Niemeyer who impressed the Swiss master with his drafting skill. Thus, the mantle of modern architecture is passed directly from Le Corbusier to the young Brazilian architect.

This version of how modern architecture came to be in Brazil misses Cardozo's influence on modern architecture in Brazil and its beginnings not in the cultural capital of Rio de Janeiro but in Recife, Cardozo's hometown, where he worked on some of the first ever modernist projects and exhibitions with architect Luiz Nunes.

In describing the life of Cardozo an understanding of his relationship with Niemeyer through their architecture and theories of reinforced concrete begins to emerge. And through Cardozo, a richer understanding of the beginnings of modern architecture in Brazil begins to form.

Though Cardozo left no autobiography, he did leave his writing on architectural and engineering theory, history, art and poetry. Since the 2007 50th anniversary of the construction of Brasília, Cardozo's work as an engineer is getting a much-needed updating. Though Cardozo and Niemeyer's constructions in Brasília are the most well-known and regarded, this essay focuses on their first work together, at the early career of Niemeyer, the Igreja São Francisco de Assis, the small church in the Pampulha lake complex in the city of Belo Horizonte, constructed in 1943. The church was Niemeyer's first major project that distinguished his early career and this essay argues that it the



Figure 3. Igreja São Francisco de Assis. Built 1943. The first collaboration between Cardozo and Niemeyer.

churches iconic forms, a series of parabolic vaults, could not have been designed without Cardozo's help, not necessarily because of his engineering skills, but his influence on Niemeyer with his theory of liberating plastic forms of reinforced concrete.

JOAQUIM CARDOZO EARLY LIFE, POETRY, AND THE BEGINNINGS OF BRAZILIAN MODERNISM

Joaquim Moreira Cardozo was born on August 26, 1897 to a poor family in the Northeastern state of Pernambuco, in the city of Recife (Dantas 2007). His father, José Antônio Cardoso, was a smalltime bookkeeper and it is probably through his childhood proximity to many books, in different languages, that Cardozo acquired his love of poetry and literature.

It should be noted that Cardozo was first a poet, then an engineer and after that all the other disciplines in which he dabbled, like writing plays, art critic, historian and professor. When Cardozo was a teenager, he published a magazine with his friends called *O Arrabalde*, where he made his literary debut with the short story "Alegre Astronomia" ("Merry Astronomy") in 1913. In 1914 he published cartoons for Sunday editions of the local Recife newspapers *Diário da Tarde* (Evening Diary) and *Diário de Pernambuco* (Pernambuco Diary) (Dantas 2007). His early experience in literary circles and magazines would continue throughout his life, culminating in the *Módulo Magazine* edited by Cardozo and Niemeyer.

In 1915 he entered the Free School of Engineering of Pernambuco where he studied civil engineering. When he finished his third year of engineering school, in 1918, Cardozo qualified as "engineer-geographer" (surveyor) and was admitted to the Geodesic Commission of Recife (D'Andrea 1993). Around this time Cardozo's father died and to support himself and his 12 other siblings Cardozo chose to work with the Commission rather than continue his engineering studies (Dantas 2007, Santana 1998). After his mandatory military service in 1919, he worked for the Commission from 1920 to 1924 (D'Andrea 1993).

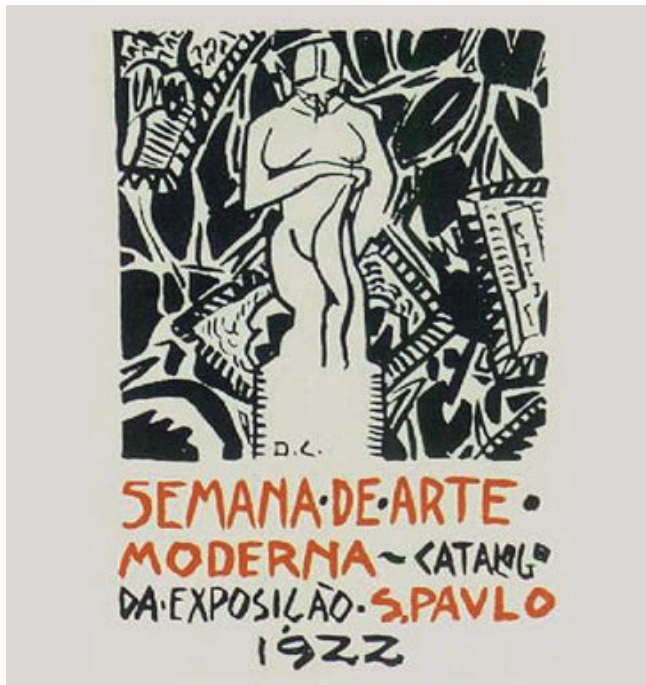


Figure 4. From 1924 to 1927 Cardozo worked as an editor, writer graphic designer and cartoonist for the Revista do Norte. (D'Andrea 1993)

While working as a surveyor for the Commission, he measured the coast of Pernambuco which exposed him to many regions native flora and topography that influenced poetry, which is described as “regionalist” without being picturesque.

Cardozo began his surveying career in the ongoing wave of Modernism that was propelling Brazilian art, literature and architecture away from colonial aesthetics toward its own creation. The history of this movement begins with the ephemeral Semana de Arte Moderne (Modern Art Week) in São Paulo in 1922, which only occurred once from February 10 – 17 (Jones 2017) . The movement spread across Brazil, eventually Northeast to Pernambuco. The poet and writer Oswald de Andrade was an influential member, whose thesis on “anthropophagism” stated that Brazilians should “cannibalize” other cultures; meaning European, African, and Native American to produce their own distinct Brazilian culture.

After the Semana de Arte Moderne made its way North to Recife, Cardozo reached out to the editors of Revista Do Norte (Northern Magazine), a regionalist magazine. From 1924 to 1927 Cardozo worked as an editor for the magazine, critic, and wrote poetry and drew cartoons for the magazine, continuing the literary career that Cardozo and his friends started as teenagers.

In 1924, the magazine published their most famous piece, a poem by Cardozo called Recife Morto, “Dead Recife:”

Recife,

Ao clamor desta hora noturna e mágica,

Vejo-te morto, mutilado, grande,

Pregado à cruz das novas avenidas.

E as mãos longas e verdes

Da madrugada

Te acariciam. (Santana 1998)

Recife,

To the clamor of this magical night time,

I see you dead, maimed, big,

Nailed to the cross of new avenues.

And the long green hands

At dawn

They caress you.



Figure 5. Architect Luiz Nunes (1909 -1937) who worked with Cardozo and Burle Marx at the Diretoria de Arquitetura e Urbanismo.



Figure 6. The Ministry of Health and Education (1936-1943) in Rio de Janeiro designed by Lúcio Costa and Oscar Niemeyer with the consultation of Le Corbusier. The typical story of the modern architecture movement in Brazil begins with this building.

Geraldo Santana, a professor of engineering in Pernambuco and one of the few main historians of Cardozo's engineering work, says that Cardozo's poem sets up a tension old and new, of the traditional Recife dead and maimed but renewed and caressed in the coming morning (Santana 1998). The modernist wave that started in São Paulo with *Semana de Arte Moderne* in February 1922 crashes on the shores of Recife, and Cardozo sees the carnage of the modernist movement but also its vitality.

In 1930, Cardozo finally finished his last year of engineering studies and begins proper work as an engineer as a public servant for the *Secretaria de Viação e Obras Públicas* (Secretary of Roads and Public Works) (D'Andrea 1993). In 1934 Cardozo joined the *Diretoria de Arquitetura e Urbanismo do Recife* (DAU) (Board of Architecture and Urbanism in Recife), the second board in South America and the first in all of Brazil specifically dedicated to architecture and urbanism (D'Andrea 1993, Andrade 2018). The team included architect Luiz Nunes and landscape architect Roberto Burle Marx, who would go on to be Niemeyer's long-time landscape architect for many of his projects.

Cardozo says of his time with the DAU team from 1934-1937:

Tive a oportunidade de colaborar com arquitetos que chegaram a aliar instintivamente a consciência perfeita do meio físico ao espírito tradicional, conseguindo, ao mesmo tempo, os melhores efeitos plásticos do concreto armado. ...Foram utilizados todos os elementos arquitetônicos novos, a cobertura-terrace, o pilotis, as janelas de grandes vãos, a cor como elemento modificador do espaço e da iluminação, a estrutura independente etc., assim como o emprego de estruturas especiais para a realização de formas puras, que somente com o concreto se pode realizar e que são soluções mais livres e perfeitas... E se procurou integrar os edifícios na paisagem... (Santana 1998)

I had the opportunity to collaborate with architects who came to instinctively ally the perfect awareness of the physical environment to the traditional spirit, while at the same time achieve the best plastic effects of reinforced concrete All new architectural elements were used, the roof-terrace, pilotis, large bay windows, color as a modifying element of space and lighting, independent structure etc., as well as the use of special structures for the realization of pure forms, which can only be made with concrete and which are freer and more perfect solutions ...

Here Cardozo makes clear that the architects he is working with at the DAU are using reinforced concrete in the correct modernist manner directed by Le Corbusier. For Cardozo concrete is the material expression of plastic forms that are "freer" and "more perfect solutions." Concrete represents its own aesthetic that "free" of older (colonial) forms, while at the same time, those forms have structural capacity with engineered solutions.

In 1935, the DAU built the Pavilhão de Pernambuco for the *Exposição do Centenário da Revolução Farroupilha* (Farroupilha Revolutionary Centennial Exhibition) in Porto Alegre. The Pavilhão was a design by Luiz Nunes, who says that this pavilion, engineered by Cardozo, was the first exhibition of modern architecture in Brazil, predating the 1936 design of the Ministry of Health and Education building in Rio de Janeiro, designed by Lúcio Costa with a young Niemeyer and Le Corbusier himself as consultant.

Angelo Bucci, a currently practicing architect in São Paulo, mentions that when Le Corbusier first visited Rio de Janeiro in 1929, Lúcio Costa, who was then only 27 years old, did not meet Le Corbusier but felt inspired to invite him as a participant for the modernist building in Rio de Janeiro (Bucci interview 2018).

Though Brazilian modernism traces its roots to Le Corbusier, it was his writing that made its way to Brazil first, rather than the man himself and his consultation on the design for the Ministry of Health and Education building. And though Rio de Janeiro was the historic capital and cultural capital of Brazil, the modern movement did not start there. The modern movement started first in São Paulo with the *Semana de Arte Moderne* in 1922, which then traveled throughout Brazil and was facilitated by young poets like Cardozo in regional magazines.

If the Pavilhão de Pernambuco, first exhibited in 1935 truly is the first modernist project in Brazil, as Nunes says, then Cardozo represents a link between the literature and poetry of the *Semana de Arte Moderne* and the modernist structures built and exhibited by the *Diretoria de Arquitetura e Urbanismo* (DAU). This version complicates the trajectory of modern architecture in Brazil but it shows how instrumental Cardozo was making it possible.

CARDOZO'S MOVE TO RIO DE JANEIRO AND THE BEGINNING OF THE NIEMEYER COLLABORATION

Starting in 1936 Cardozo taught classes in Infinitesimal Calculus and Analytical Geometry at the School of Engineering and Theory and Philosophy of Architecture at the Fine Arts School in Recife (Macedo & Sobreira 2010). While it is surprising nowadays for an engineer to teach architectural theory, it proves Cardozo's erudition.

In 1937, the government of Pernambuco suffered a military coup d'état which saw the end of the *Diretoria de Arquitetura e Urbanismo*. Though with Luiz Nunes the team had constructed a few modernist projects around the state, including the Olinda Water Box (1936-38), which now houses an elevator with a panoramic view of Recife and the Alberto Torres Rural School (1935-36), which has experimental parabolic arches that suspend a ramp on one façade.

While professor, Cardozo travels for a few months to Spain, France and Portugal in 1938. It is unclear which works he saw

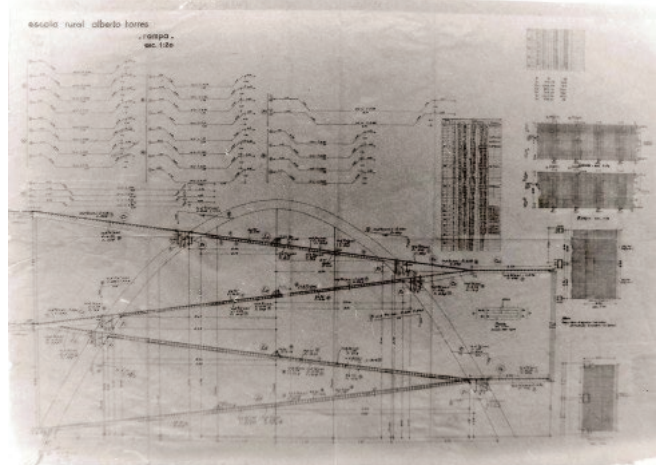


Figure 7. The Alberto Torres Rural School (1935-36), designed by Luiz Nunes and calculated by Cardozo. The parabolic arches support a suspended ramp and looks like a miniature bridge. (Source: Eduardo Aguiar [Arquivo Público Estadual Jordão Emerenciano Anexo I]).

during his travels but Cardozo was influenced by what he saw in Europe (Santana 1998). At the end of 1939, during a lecture to a graduating class of engineers Cardozo criticizes the current state government for not doing enough public works, stifling the disciplines of engineering and architecture (Dantas 2007).

His comments immediately land him in trouble with the conservative government. According to Maria de Paz Ribério Dantas, who was one of the first to study Cardozo's poetry for her literature dissertation, says that as punishment, the government gave him the task of studying dirt roads. After Cardozo refused, he was fired from his public position at the *Secretaria de Viação e Obras Públicas* (Secretary of Roads and Public Works) for "technical incapacity" and fired from his teaching positions.

This loss moved Cardozo to Rio de Janeiro in 1940 where he worked for SPHAN (*Serviço do Patrimônio Histórico e Artístico Nacional* – National Service of Historic and Artistic Heritage) which was created in 1937. Lúcio Costa and Roberto Burle Marx, Cardozo's old friend from the *Diretoria de Arquitetura e Urbanismo do Recife* were part of that team. It was most likely through Costa that Cardozo met Niemeyer sometime in 1940.

In 1940, Oscar Niemeyer was 33 and was just beginning his architectural career. After helping Lúcio Costa and Le Corbusier design

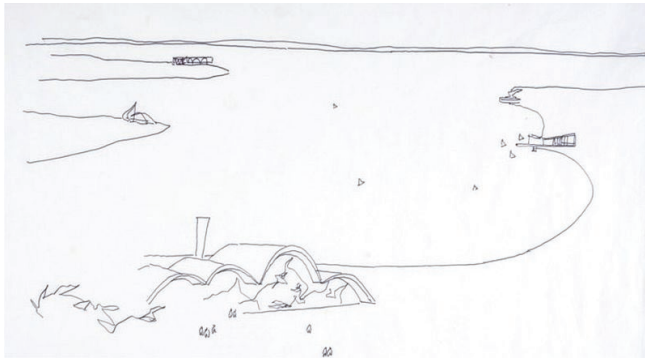


Figure 8. Oscar Niemeyer sketch of the Pampulha Lake complex in Belo Horizonte. The building in the forefront is the church, Cardozo and Niemeyer's first collaboration. (Source: Niemeyer 200).



Figure 9. Igreja São Francisco de Assis. from the UNESCO archive.



A HANGAR (FREYSSINET & LIMOUSIN)
 Width 250 feet, height 150 feet, length over 900 feet. The Nave of Notre Dame is 40 feet wide and about 107 feet in height.

Figure 10. The Orly Hangers as shown in Le Corbusiers 1927 translation of Towards a New Architecture.

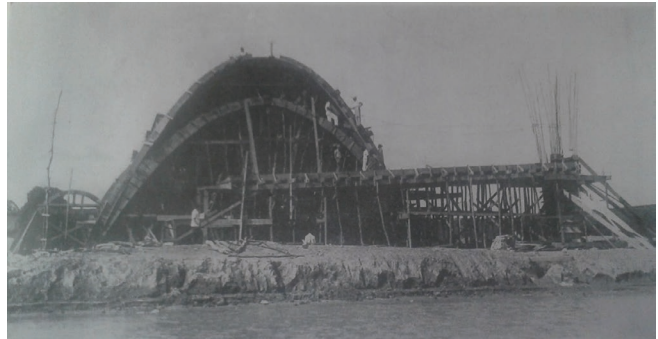
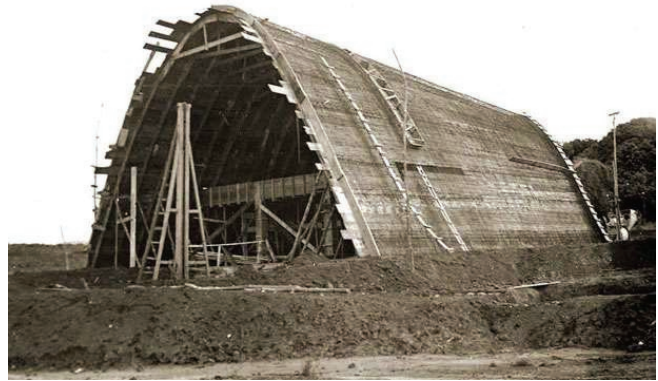


Figure 11. The church under construction. In the bottom image, the form work for the adjoining shell is being built. In the background left of the main shell, is are the smaller shells. (19040s Unknown Source)

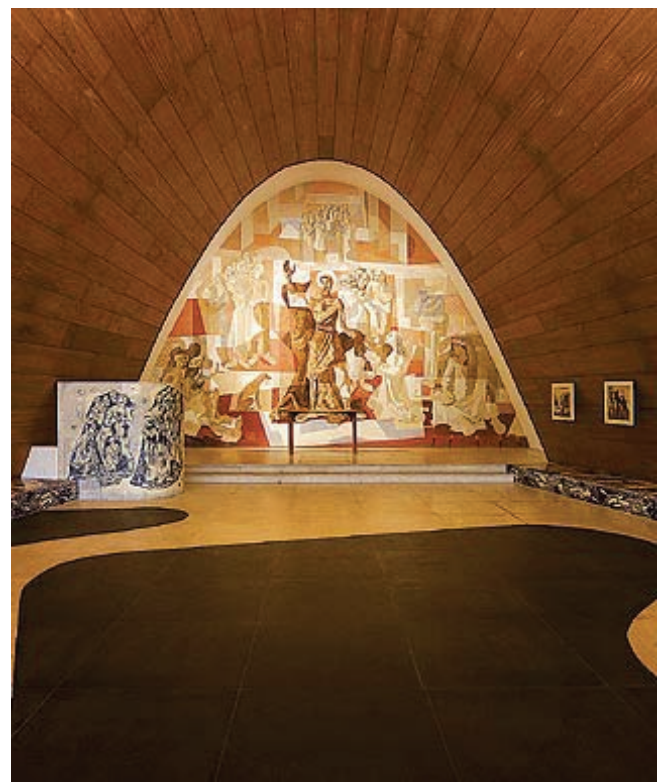


Figure 12. Interior of the nave with view to the altar. The white parabolic band joins the two shells of the church into one while also supplying light with window cut-outs to the altar.

the Ministry of Education and Health, the first state-sponsored modernist skyscraper, in 1936, three years later he designed the Brazilian Pavilion for the 1939 New York World Fair. Sometime in 1940 he met Cardozo and Juselino Kubitschek, then mayor of Belo Horizonte, the capital of the state of Minas Gerais.

Kubitschek would have an enormous influence on the lives of both Niemeyer and Cardozo. He was a politician with big building projects in mind. He enlisted Niemeyer to design a suburban complex on the artificially built Pampulha Lake. Programs included a casino, dancehall, restaurant, yacht club, golf club and church. In 1956, Kubitschek would assume the Brazilian presidency and help usher the construction of the new capital of Brazil, Brasília, planned by Lúcio Costa with most buildings designed by Niemeyer and calculated by Cardozo.

PAMPULHA CHURCH

Niemeyer already had experience designing with the Ministry of Education and Health (1936-1943) and the Brazilian Pavilion at the New York World Fair (1939). However, his architecture and career really began in the Pampulha complex. Niemeyer says "Pampulha was the starting point of this freer architecture full of curves which I still love even today. It was in fact, the beginning of Brasília" (Salvaing 2002).

The first project Niemeyer designed and built for Kubitschek in Pampulha was the casino. The 1940 design logically follows from Niemeyer's 1939 design of the Brazilian Pavilion for the New York World's Fair. Both projects feature rectangular and curvilinear forms, ala Le Corbusier, in plan extruded vertically as walls. The prominent structural feature of both buildings make use of pilotis on a flat slab. This building was not engineered by Cardozo, who had either not yet met Niemeyer in 1940 yet or was settling in Rio de Janeiro.

The second project for the Pampulha complex was the Igreja de São Francisco de Assis (Church of Saint Francis of Assisi) commonly referred to as the Igrejinha da Pampulha (Little Church of Pampulha) which was built with the help of Cardozo and his old friend, the landscape architect Roberto Burle Marx in 1943. The church would mark the first project Niemeyer would design with the engineer and the landscape architect.

The church features parabolic vaults that form the roof as well as the walls of the structure. The outside of the walls and interior fresco are painted in bold blue, azulelo, painted by the famous Candido Portinari. In his memoirs, Niemeyer recalls that he basically did the project for free and charged a fraction of what the Portinari murals cost, for the construction of the whole church (Niemeyer 2000). (One wonders what Cardozo was paid for his efforts?)

Immediately, the church's free form uses of reinforced concrete and radical design propelled Niemeyer to international fame. But the unique structural form of the building and the mural of

a starving and ragged Saint Francis by Portinari did not appeal to conservative church board who refused to consecrate the church until 1959. In 1959, Time Magazine, wrote that the Archbishop of Belo Horizonte called the church "the devil's bomb shelter" (Time 1959).

Niemeyer and Portinari were both communists and atheists, which did not sit well with the church board. Rumors spread that the church is inspired by the communist symbol of the hammer and sickle (Lugares Romanticos 2016). Cardozo's own political views were probably aligned with Niemeyer and Portinari, as just a few years earlier he had been fired from his state job for criticizing them for not taking on more social projects (Dantas 2007).

The Church of Pampulha used a large parabolic arch for the nave and a series of 4 smaller parabolic arches for the sacristy and auxiliary spaces. The form of the church takes inspiration from the French engineer Eugène Freyssinet Orly Airport hangers, which is found in Le Corbusier's *Toward a New Architecture* (1923), and the bridges of Swiss engineer Robert Maillart, who was one of the pioneers of thin concrete arches (Philipou 2011).

In the first edition of *Módulo* magazine in 1955, which was founded by Niemeyer, Cardozo wrote about the about the Church of Pampulha inaugurating "a new style of Brazilian architecture" (Philipou 2008). Along with the references to Freyssinet and Maillart that Cardozo listed in the article, there could be added two more; the Church of Notre Dame in le Raincy (1922-23), and Cardozo's own project with Luiz Nunes for the Alberto Torres Rural School (1934-35).

The Church of Notre Dame in Le Raincy was a design by Auguste Perret (1874 – 1954) and his brothers, who were among the first in France to use reinforced concrete as an exterior material in their building. Perret's church in Le Raincy uses reinforced concrete on the outside but also uses a series of reinforced concrete vaults in the nave of the church. In Niemeyer's memoirs, he writes about Perret's famous phrase "one has to make the supports sing" (Niemeyer 2000). With Cardozo's help, the church in Pamulhia sings in harmony.

It should be noted that a Le Corbusier's first internship was at Perret's office from 1908 to 1910. While Niemeyer can trace his modernist roots to Le Corbusier, Cardozo uses Le Corbusier's mentor as an influence for his structural form, further ingraining Cardozo in the long lineage of modernist architecture.

The parabolic arches for Pampulha were first tested by Cardozo in the Alberto Torres Rural School in Pernambuco in 1934-35 with the architect Luiz Nunes when both were part of the *Diretoria de Arquitetura e Urbanismo*. The Rural School is an awkward building with two distinct elements; a rectangular extrusion that is the houses the classrooms and a series of 3 parabolic arches that suspend a floating ramp attached to one side of the rectangular extrusion. The arches and the ramp are colored yellow while

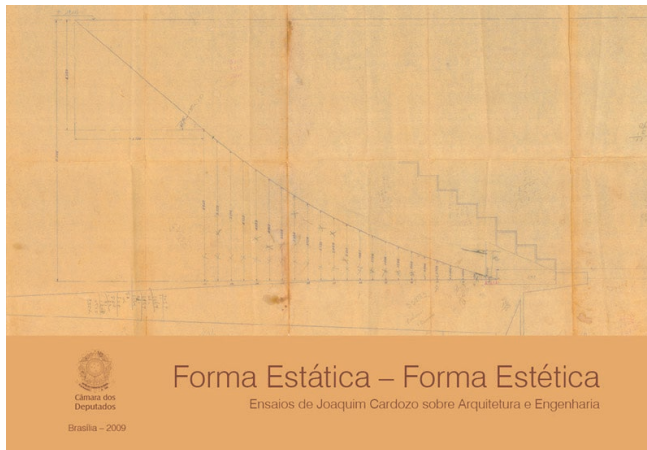


Figure 13. Oscar Niemeyer sketch of the Pampulha Lake complex in Belo Horizonte. The building in the forefront is the church, Cardozo and Niemeyer's first collaboration. (Source: Niemeyer 200)



Figure 15. Destruction of the Pavilhão da Gameleira in 1971 once support beams were removed. Cardozo was blamed and jailed for 2 years.

the building is white washed, further highlighting the distinction between the two independent structures. The arches and ramp look like a miniature suspension bridge, seem to be the work of Cardozo's influence.

Cardozo was a well-read person who translated texts from English, Hebrew, Arabic, Sanskrit, Russian, Greek, Latin, Spanish, French, German, Italian and Chinese, according to an interview with Cardozo in 1977, his last before his death in 1978 (D'Andrea). Along his studies, Cardozo became infatuated with the flat-slabs patented by Robert Maillart in 1909 and the thin vaults introduced by the engineers Dyckerhoff and Widmann for the Zeiss company in 1923 Germany which came to be known as the Zeiss-Dywidag System (Macedo & Sobreira 2010).

Cardozo's and Niemeyer's vaults for the church in Pampulha trace their forms to the long history of vaulted baroque cathedrals, the material of reinforced concrete to the French with Auguste Perret, and then directly from Le Corbusier, and the shell calculations to the German mathematical principles. All these ingredients were fused harmoniously into one structure for the church in Pampulha. Since July 2016, the church has been declared a UNESCO World Heritage Site (UNESCO 2016).



Figure 14. Palácio da Alvorada (1957-58). Cardozo constructed the iconic columns with more reinforcing steel than was typical to achieve to the desired aesthetic form of the supports.

Danilo Matoso Macedo, one of the current researchers of Cardozo's engineering, emphasizes that the works in Pampulha, are the result of the collaboration between Niemeyer and Cardozo.

Macedo says:

Mais que um técnico, Cardozo exercia papel ativo e pensante na busca e sugestão de novas soluções estruturais coerentes com as tecnologias e técnicas que se desenvolviam no Brasil à época. (Macedo 2008)

More than a technician, Cardozo played an active and thinking role in the search for and suggestion of new structural solutions consistent with the technologies and techniques that developed in Brazil at the time.

Cardozo and Niemeyer both understood that their first collaboration at the church in Pampulha was a special moment in Brazilian architecture. Niemeyer himself references the Pampulha projects as the "starting point of my career as an architect" (Niemeyer 2000). Niemeyer continues:

I was totally enthusiastic about my first project, which also inaugurated a series of lengthy car trips on bumpy dirt roads, often so muddy that we were forced to stop for help. One day we even had a yoke of oxen towing our car! The project was an opportunity to challenge the monotony of contemporary architecture, the wave of misinterpreted functionalism that hindered it, and the dogmas of form and function that had emerged, counteracting the plastic freedom that reinforced concrete introduced. I was attracted to the curve—the liberated, sensual curve suggested by the possibility of a new technology yet so often recalled in venerable old baroque churches. (Niemeyer 2000)

Though Niemeyer is unclear of whom is talking about when he uses the word “we” it is easy to imagine Cardozo in the bumpy car ride to Pampulha lake as they talk about the “misinterpreted functionalism” that had set in architecture. Perhaps this is why Cardozo mentions the baroque churches, which the church in Pampulha is often regarded as. And perhaps this is why in Oscar’s memoirs, the second sketch is that of the Pampulha complex designed with Cardozo which prominently shows the church (Niemeyer 2000) . (The first sketch in the book is that of a man, most likely Niemeyer himself, standing on top of the curvature of the Earth).

Cardozo himself proudly remembers the church and his architect friend as well, considering the church one of “the great impulses of modern Brazilian architecture” (Macedo 2008). Though the church was immediately controversial, both architect and engineer knew they were at the forefront of not just Brazilian architecture, but international modern architecture.

In 1956, Cardozo explains how the structure itself formed the aesthetic of the church:

Nesse conjunto da Pampulha o arquiteto Oscar Niemeyer começa a manifestar a sua ilimitada força de invenção, toda ela dirigida para o problema da estrutura: estrutura no seu aspecto formal e nos seus princípios de equilíbrio. Procura purificar a forma retirando das estranhas posições de equilíbrio um conteúdo emocional que é, segundo o critério de muitos, o principal atributo da ‘beleza nova’.

[...]Cumpro assinalar entretanto que nesses projetos da Pampulha a idéia de forma purificada não repousa mais naquele espírito geométrico tradicional e sim nesse outro mais moderno de desafio e oposição às teorias estabelecidas, onde se investigam as possibilidades de novas funções matemáticas que não se subordinam a essas teorias, introduzindo no pensamento dedutivo um sentido de aventura e talvez mesmo sugerindo uma ordem para a fantasia. (Macedo 2008)

In this set of Pampulha the architect Oscar Niemeyer begins to manifest his unlimited force of invention, all directed to the problem of structure: structure in its formal aspect and its principles of balance. It seeks to purify form by withdrawing from the strange positions of equilibrium an emotional content which is, according to the judgment of many, the principal attribute of ‘new beauty’.

It should be pointed out, however, that in these Pampulha projects the idea of a purified form rests no longer in that traditional geometrical spirit, but in this more modern one of challenge and opposition to established



1. Set of straight pillars, curved framing and hidden locking in the masonry are enough to support the three smaller vaults.

2. The parabolic vault of the altar actually functions as one shell, but with swings on the sides to make way for the vertical pillars and to compose the eaves of the facade with the smaller vaults.

3. Although they require a concrete frame, the lateral inclined walls do not receive loading from the vaults.

Figure 16. Construction sequence of the Pampulha church according to researcher Danilo Matoso Macedo. (Source: Macedo 2008).

theories, where the possibilities of new mathematical functions that are not subordinated to these theories are investigated, introducing in deductive thinking a sense of adventure and perhaps even suggesting an order for fantasy.

Here, Cardozo aligns his structural forms with mathematical theories rather than geometric symbolism. This is also concurrent with the general trend in Modern architecture to move away from symbolism toward expression. With Cardozo, Niemeyer’s expression finds their mathematically proven shape.

Since the church in Pampulha was their first project together and is such a radical form for both the engineer and architect, there are dubious moments in the structure. For example, Macedo points out that there are bending moments introduced where the largest shell of the nave meets the smaller shell of the altar (Macedo 2008) . In this area Cardozo provided a band of structural reinforcement with a masonry arch that joins the two shell, which can be seen in the photos of construction.

The auxiliary spaces roofed by smaller shells also are put into question since their finishing walls on the East and West sides do not extend the arch of the parabola but a tangent line to the ground. It is not known if there are diagonal or orthogonal pillars that support these sloping walls and the rest of the smaller auxiliary vaults. The smaller vaults appear to be touching the ground only on the walls on the East and West, that which give the church an elegant free-from look that also hide the underlying structure. While the larger arch of the nave supports loads to the ground, the smaller shells use awkward pillars. As much as Cardozo tried to make the

geometry perform structurally, its free-forms do not allow to do so fully. Macedo thinks that perhaps this is why Niemeyer never published a full plan of the church, showing it instead only in perspective and isometric views, where he could erase the supports in favor of concept clarity.

Cardozo knew that his structures would face harsh criticism from his fellow “structural purist” engineers of the day, like Pier Luigi Nervi, Eduardo Torroja and Felix Candela. In 1958 responds to the purists in an essay called *Forma “Estática – Forma Estética”* (Static Form – Aesthetic Form):

“Mas essa contribuição do engenheiro no conservar o espírito real e intrínseco da arquitetura tem sido, muitas vezes, exagerada; tem-se mesmo, freqüentemente, considerado como formas as mais puras da arquitetura moderna as que resultam exatamente da estabilidade da construção, ou, melhor dizendo, as dos perfis de igual resistência, reduzindo assim a “forma estética” a uma consequência da “forma estática.” E como esta última, na sua expressão modernamente aceita, é a que manteria o equilíbrio com a menor quantidade de matéria, o problema estético se reduziria ainda a um problema de economia, o que é absurdo. Pelo menos do ponto de vista estético-especulativo.” (Cardozo 1958, Macedo & Sobreira 2009)

“This contribution of the engineer in preserving the real and intrinsic spirit of architecture has often been exaggerated, and it has often been regarded as the purest forms of modern architecture that are the exact result of the stability of construction or, that is to say those of the profiles of equal resistance, thus reducing the “aesthetic form” to a consequence of the “static form.” And as the latter, in its modernly accepted expression, is the one that would keep the balance with the least amount of matter, the aesthetic problem would still be reduced to an economic problem, which is absurd. At least from the aesthetic-speculative point of view.”

Cardozo disagrees with the seeming structural purity of Nervi, Torroja and Candela, that justify their aesthetic form with only economy and efficiency of their static form. The structures that have the simplest load paths or efficient use of materials do not always make the best looking structural forms. Cardozo also sees how the “structural purist” easily reduces architecture to “an economic problem” and advocates for the expression of the architect to make aesthetic forms.

For Cardozo, the static form does not always equal the aesthetic form. Macedo and Sobreira use the same title of the essay in the 2009 book dedicated to Cardozo’s structural work and writings on architecture and engineering, which is the only books dedicated to Cardozo’s work. Though the title represents what Cardozo does not want to equate together, it is a fitting description of Cardozo’s engineering philosophy. As an art critic and historian, he privileged the plasticity of reinforced concrete over any functionalist argument for it.

While the church in Pampulha does chide the masters of structural “purity,” it still stands today as a wonderful and reinvigorating expression of reinforced concrete drawn through the hands of Cardozo and Niemeyer.

THE FRIENDSHIP OF OSCAR NIEMEYER AND JOAQUIM CARDOZO

After their success with the church in Pampulha and the ensemble of structures around the lake, Cardozo and Niemeyer, along with their powerful political benefactor Juscelino Kubitschek, continued their work together, supplemented by their long-time friend and collaborator on landscapes, Roberto Burle Marx. This was a powerful design team in Brazil that collaborated from 1940 until the 1970’s.

Cardozo was the scholarly and worldly elder who facilitated Niemeyer intuitive hand and eye for design, with Burle Marx capable of accenting their structure with another layer of native Brazilian flora, and of course Kubitschek to supply the cash and connections necessary for the team to build.

In the late 1956 Kubitschek won the Brazilian presidency. His penchant for building grew even stronger and plans were made for the relocation of the capital of Brazil to the center of the country. Brasília would be planned by Lúcio Costa, with most buildings designed by Niemeyer and Cardozo, with the landscaping by Burle Marx.

From 1956 to 1964, Niemeyer was enjoying the fame that came along with the construction of Brasília. It during this period in the mid-50’s that Niemeyer and Cardozo expand on their theories of how to use reinforced concrete in expressive ways in the Magazine *Módulo*. The magazine was funded by Niemeyer and was also a media tool to showcase modernist projects and art in Brazil, with a heavy dose of his own projects. The advertisements of the magazine typically show one of his buildings. For example, the graphite company Toison D’Or showcases a pencil with the *Palácio Palácio da Alvorada* (Palace of Dawn), the residence of the president.

Along with more bumpy road rides to the construction site of Brasília, Niemeyer recalls the shared conversations he had with Cardozo on all manners of topics ranging from reinforced concrete to Cardozo’s poetry and plays. Their friendship and collaboration having cemented itself in the church of Pampulha expressed itself fully in Brasília.

The *Palácio da Alvorada* was a special project for both Cardozo and Niemeyer. The columns of the building are an iconic three-dimensional cross upside down supporting the roof and itself on slender points. Since Cardozo did not adhere to any “rationalist” or “purist” approach to reinforced concrete but instead to an expressive one, he was fine with including 20% more steel reinforcing bars in the columns than usual to achieve the striking forms (Guedes 2012).

Their friendship is reinforced in a legend about Cardozo waking up Niemeyer at 2 o'clock in the morning saying enthusiastically "I found the tangent!" (Guedes 2012). Niemeyer himself writes about an episode when he threatened to quit because some official wanted another engineer to double check Cardozo's calculations (Niemeyer 2000).

Cardozo's and Niemeyer's careers came under tension when a military dictatorship took over Brazil's government. Because of Niemeyer's leftist politics, he was exiled and left for Paris in 1966. Cardozo stayed behind overseeing the construction of the Brasília projects.

In 1971, Niemeyer's design for the Pavilhão Gameleira collapsed. The building was to span 240 meters by 30 meters, killing 85 workers under 100,000 tons of concrete (D'Andrea 1993). Since Cardozo was the engineer on the project and Niemeyer was in exile, Cardozo was blamed by the government for the damage and loss of life. At 74 years old he was arrested by the military government for two years (D'Andrea 1993). Cardozo's friend Lúcio Costa started a petition with more than two hundred signatures of architects and engineers in support of his calculations.

After two years, Cardozo was acquitted of the charges, which were actually due to the rapid pace government officials wanted the structure built. However, Cardozo's life was forever changed (D'Andrea 1993). At that late in his age Cardozo did not fare well with the tragedy and became sick.

In late 1977, a year before his death, Cardozo called Niemeyer to help him. Niemeyer had Cardozo come to Rio de Janeiro where he stayed in a hotel close to Niemeyer's office. Niemeyer had Cardozo stay at the hospital his brother Paulo headed for some time, before returning Cardozo to Recife where he died November 4, 1978 (Niemeyer 2000, Dantas 2007).

CONCLUSION

Cardozo was an all-around Renaissance man who was modernized the disciplines of poetry and architecture through his calculating genius and theories on reinforced concrete. Cardozo presents an alternative understanding of Brazilian modernist architecture that links him with the movement's early phases in literature art and poetry to architecture. His partnership with Niemeyer showcased the possibilities of reinforced concrete to express form rather than simply respond to load cases in the most efficient way. This collaboration was expressed most clearly with their first project together, the church in Pampulha which propelled their careers forward and marked a new style of Brazilian-specific modernism.

Regrettably, his tragic end of life meant that Cardozo's work was never fully appreciated. And while scholars are doing the hard work of analyzing his structures and poetry to piece his life together, his story is little known the wider world.

LIST OF WORKS BY CARDOZO & NIEMEYER

- 1940-42: Cassino da Pampulha Belo Horizonte
- 1940-43: Clube da Pampulha Belo Horizonte
- 1941-43: Igreja São Francisco de Assis Belo Horizonte
- 1946-47: Edifício sede do Banco Boavista Rio de Janeiro
- 1950-51: Fábrica Duchen, São Paulo
- 1951: Edifício Juscelino Kubitschek Belo Horizonte
- 1951: Hotel Diamantina Diamantina
- 1957-58: Palácio da Alvorada Brasília
- 1958-60: Palácio do Planalto Brasília
- 1958-60: Palácio do Congresso Nacional Brasília
- 1959-60: Catedral Metropolitana de Brasília
- 1959-70: Palácio Itamaraty Brasília



Figure 17. Joaquim Cardozo Statue Recife, Brazil.



JOAQUIM MOREIRA CARDOZO (1897 - 1978)

- Born in Recife, Pernambuco State, 1897
- Portuguese decent. Poor family
- Started engineering training in 1915, finished 15 years later, 1930, due to financial struggles. Worked as a surveyor between the years
- Worked in Rio de Janeiro in preservation with Lucio Costa and was taken on as engineer for Pampulha
- Spoke many languages and translated works of art, poetry, and plays
- Well known poet in home-state of Pernambuco. Was also a playwright, writer and self-taught philosopher.

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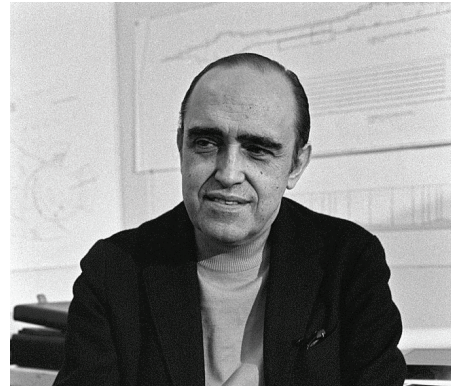
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OSCAR NIEMEYER (1907 - 2012)

- Born in Rio de Janeiro, 1907
- German great-great-great-grandfather. Upper-middle-class family.
- Trained at National School of Fine Arts in Rio de Janeiro and graduated in 1934
- Worked with Lucio Costa (no pay) after school.
- Spoke Portuguese, French, possibly Spanish, Italian Hated speaking English. Did not speak German
- Fervent leftist thoughts. Left Brazil in 1964 for Paris due to military coup and subsequent dictatorship.

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