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Abstract

This article derives from the undergraduate diploma paper "Cosmocria: interactivity and experience in Architecture", developed in 2016 in the Architecture and Urbanism Course of the Federal University of Mato Grosso do Sul and it had the principle of Cybernetics as theoretical foundation for the later development of the architectural project. Based on the investigation of the media and technological devices influence in the contemporary society, the interactive architecture and the human experience in the spaces are connected through the systemic cybernetic gaze. In order to reflect the diversity and dynamicity of contemporary society, the proposal of the work is an architectural project based on the cybernetic interactivity allied to the urbanity of the democratic public space within the hybrid networks that weave the city. While the interactive space seeks more responsive, sensorial, adaptive and stimulating environments, the democratic space seeks the diversity of situations, interactions, experiences and uses from the human dimension in spaces. It is a sensitive public space that reflects the people's needs through interaction. The hybrid character of the project organizes the concepts in both the physical and virtual realms in a connected way with the people of the city creating a collaborative space that does not encourage the role of one protagonist and the audience, but that, in a context of equality, everyone can be protagonist of their own sensory experience in space. It is also worth noting that this collaborative space proposed by Cosmocria aims to foster research, the "do it yourself" culture and technological development in Campo Grande, MS, Brazil.

Keywords: Interactive architecture; Cybernetics; Urbanity; Collaborative space.

Introduction

From the second half of the twentieth century, when the population explosion, the transition to the urban environment, the germination of technologies and the awakening to emerging problems resulted in a globalized world, society and ways of life underwent important transformations. The cities, base of contemporary social, cultural and economic activities, had developed uncontrollably along these years simultaneously with the reflections on the urban problems and the search for strategies that can surpass them. In this scenario, architecture worries about and brings with it a great potential for changes that emerge from its context, where a social compromised strategy is directed at maintaining the spaces alive, collaborative and interactive. A few decades ago, digital technological devices were relatively disconnected from architectural space. Today there are several experiences where they are used in many practical applications of architecture, interfering in the design and the experience of the space (NOJIMOTO, 2009; CARNEIRO, 2014). These devices - static, dynamic or purely digital - bring to the architecture the ability to capture, store, process and transmit information, endowing the architectural object with action, reaction and interaction.

The daily experience with the digital world, although recent, is already considered irreversibly for culture of the new generations. The point is how the technological world affects our lives, because through the media we are in a global scenario in which the whole world is an event. Our cultural and leisure space once seen as a mere shelter of people is being transformed into a living organism. Technology, by changing our perception of the world around us, has also changed the way we view architectural forms, structure, performance and spaces, which are increasingly moving towards more interactive and experiential.

Through Cybernetics it is possible to understand how the different levels of interactivity act in society and in the systemic layers of physical and virtual networks of the world. Since people are learning systems that interact with the world at different levels of feedback, everything connects in some way (BERTALANFFY, 2009; PASK, 2011). Just as the human body is constantly in interaction between its parts, also a building should be. In this sense, interactivity enables the connection of the parts and the creation of an idea of a hybrid organism, where space can also be a fluid extension of people (DUBBERLY; HAQUE; PANGARO, 2009).

The term hybrid here is aligned with two views. The first, based on *Territórios Híbridos* concepts produced by Nomads USP (2013), discusses hybridism as a territory that is made up of the set of physical spaces and their uses, plus the actions, relationships, and interactions made possible by the use of the media where the integrated experience is provided by networking, which allows the local dimension to be enlarged. The second, from the book **This is Hybrid** (2011), by Aurora Per, Javier Mozas and Javier Arpa, presents hybridism as the diversified overlap of coexisting uses in the same building.

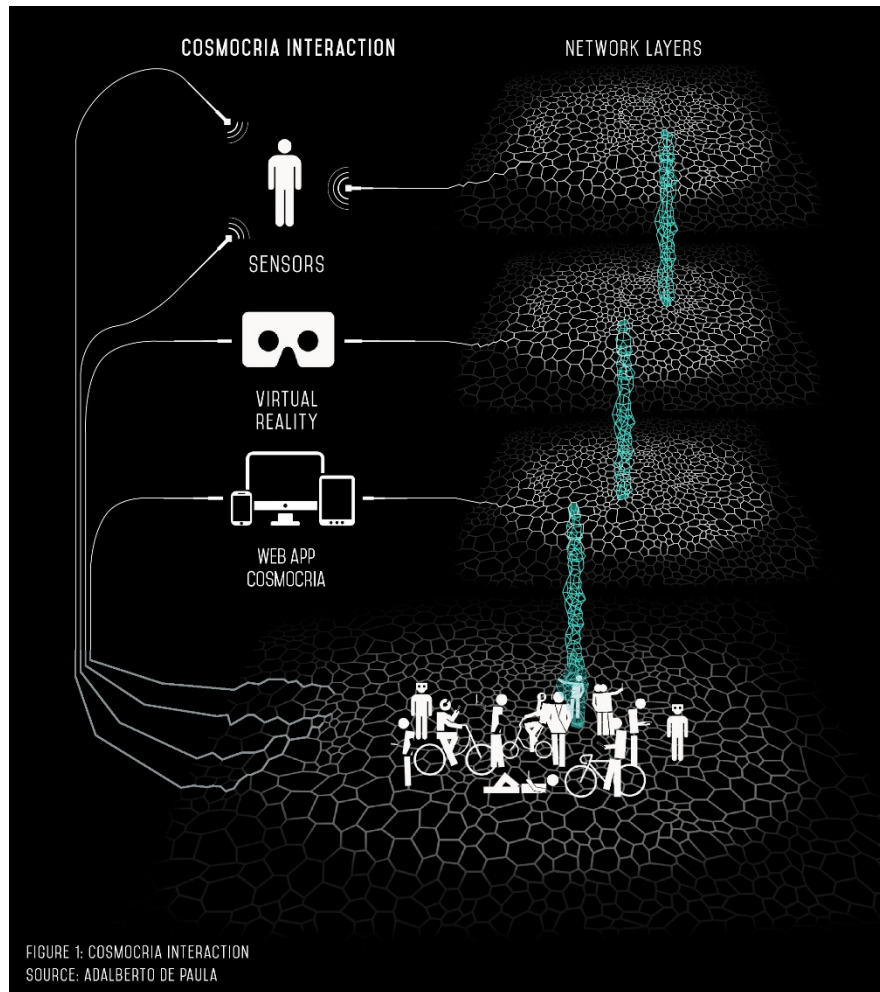
Richard Rogers (2001) defends the idea that in the future, buildings will tend to dematerialize through indeterminate, adaptable, and floating structures that respond to daily changes in the environment and usage patterns in order to contribute to spatial continuity by blending the street, the square and the buildings themselves. These buildings of the future "will be less like unchanging classical temples of the past and more like organic, thinking, and mobile robots" (Rogers, 2001, p 165, Our translation). In this sense, the proposal of the Cosmocria

aims at access and social integration with the city where everyone, without distinction, is welcomed.

Taking the **Fun Palace** project of the English architect Cedric Price as a reference, the idea was to design spaces that were of relevance to the population in order to encourage new uses that contributed to the flexibility of spaces. The essence of Fun Palace did not consist of concepts related to style and function, but rather to the enhancement of personal relationships through interaction. Its objective is, therefore, to create spaces in which its organization instigates the participant to actively intervene, or passively enjoy, depending on the settings and uses that space may suggest. When architecture embraces the uncertainty and unpredictability leveraged by technology, spaces take on other desirable characteristics, such as adapting to people's needs. Just as the Fun Palace offered an interactive universe different from other spaces in the city, it was the intention of the project to create a space considered as a cosmos of interactions that joins the urban public space in order to form a feedback cycle between population and the hybrid concept of the building.

The Cosmocriaconcept

Within the infinite possibilities of design, the spaces of the Cosmocria building must interact with the people who use them in order to reflect their needs. This interaction between person and space happens through three fronts of technology: sensors, virtual reality and web applications for mobile phones, tablets and computers. As they are part of the building concept, the interaction with these devices adds to the physical spaces layers of overlapping networks allowing the individual to be the protagonist of their spatial experience. Through a networked system of sensors, of the virtual reality system and the Cosmocria app, people are free to configure the space, creating, from this, a dialogue between the building and its users that opens the doors for a more democratic use space. Each of the three technology fronts provides different ways of interaction, but when added together they are part of a larger complex system.



The building relies on virtual reality (VR) as a portal to access the reality of non-physical spaces. The VR would function in coexistence with the physical reality of the spaces, but giving access to other layers of information and possibilities of interaction. Thus, the project uses this technology in three activities: **games, creation and communication**. The VR games have the purpose of leisure and information for both the people who use the building daily and those who visit it sporadically. It is intended to create access for the population that normally does not have the conditions to enjoy this technology.

As for the field of creation, VR is present in the project offering immersion as a tool in the elaboration of the projects developed by the creative space. In addition to these devices that aid in choices, paths, and information exchanges, the building also uses VR in the creation of digital realities to stimulate individual and collective human experiences in non-physical spaces. Thus, the idea is to unite VR technology with the use of neurosensors so that the VR glasses could help develop inputs through associations coming directly from the neurotransmitters of each user's brain. In this way, a non-physical reality personalized instantly based on brain stimuli would be created. The output provided from the glasses (the created digital environment), would be shaped by the person to the person. Because it is a conceptual idea, just as an environment is created based on the individual reading of the brain synapses of a single person, the sums of several brain readings could create a collaborative and collective experience by mixing a systemic reality, thus making it possible to emerge unimaginable realities. This VR space can be understood as another dimension within the Cosmocria building. A parallel reality, a kind of creative cosmos, available for the

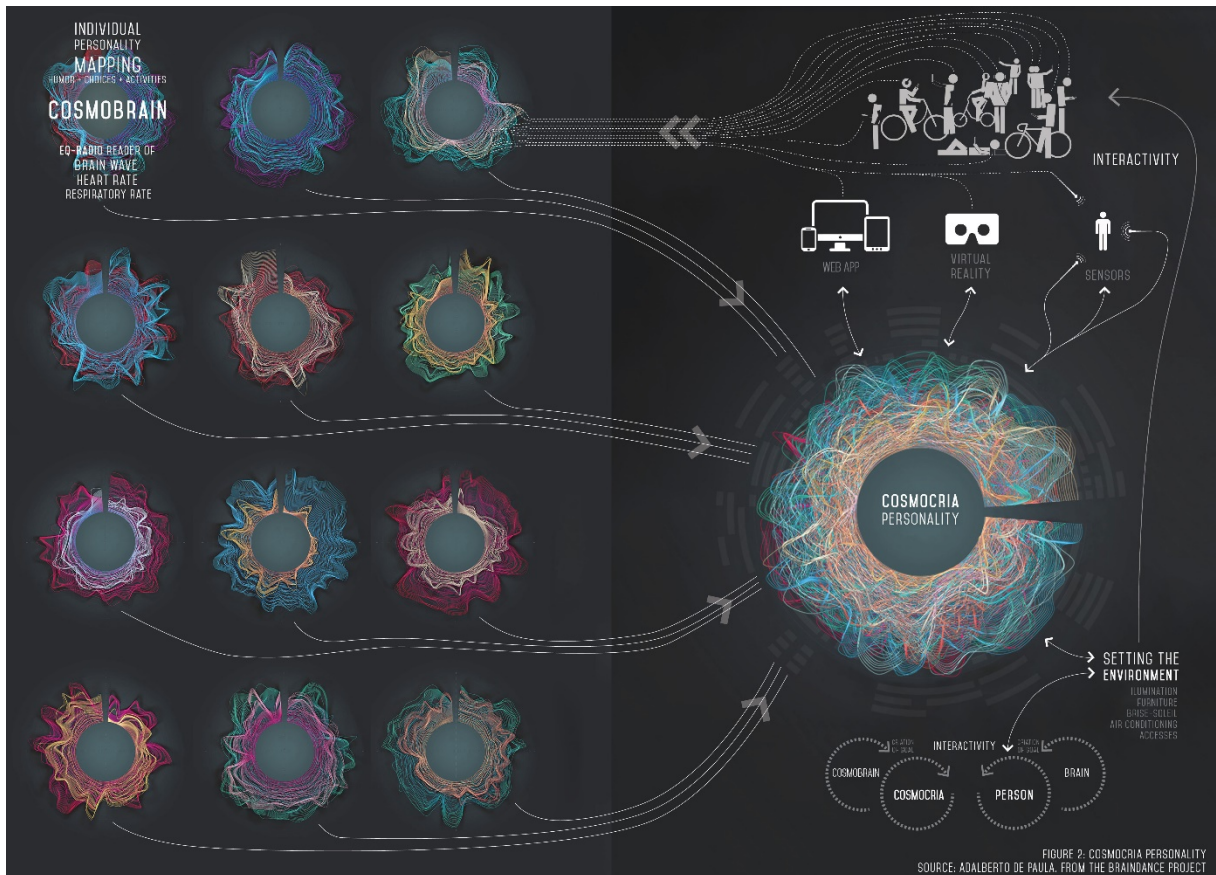
city to access.

Once understood that cell phones, tablets and computers are both a node of access to the information network, as a node of connection between people and systems, it is part of the design strategies of the building, the cooperation between existing physical and non-physical spaces. Thus, it is proposed to create a web application as a tool for interaction between spaces and person. This application would mediate between the building and its users in order to highlight the objects and systems with which they can interact in the moment according to the location of each individual within the spaces. With the use of the GPS of each device, the proximity or not of an object is determinant for the interaction through the application. Thus, the project understands that guaranteeing access to the Internet is a basic necessity not only to enable interactions within the building, but also to the democracy of unrestricted access to information of contemporary society. In this way, the building has in its upper portion a Wi-Fi antenna for the city. The access to the Internet made possible by the antenna of Wi-Fi realizes in a large scale the feedback loop with the own city, relating to everything that happens in the building and potentializing the mediator of this communication that would be the web application **Cosmocria**.

The application functions aim at the sensory experience of the individual within the building. With it, people can connect to VR immersion rooms, interact with the exterior lighting of the facade as well as the inside spaces, control ambient sounds, project films and images on the surface of the multimedia hall, suggest videos to be projected in the Interactive Hall and check the schedule of activities developed in the building. Also, the application would graphically display a personality map according to the interactions and choices made over time: the **Cosmobrain**.

As human beings, during our life we leave memories and marks in the spaces and in the history. When using a building, our choices and developed activities leave traces over time. Thus, the project also seeks to create a database of individual and spatial readings of each person. The recording of these readings would happen through an individual mapping based on the choices made by the application, in the activities developed within the building as pointed out by the GPS and sensors, and the mood of the people indicated by EQ-Radio and the neurosensors connected to the VR.

Inside the application, people would have access to the infographic of how the building reads them. This infographic, called **Cosmobrain**, was based on the Slovenian project **PlesMožganov (Braindance)** carried out by the group **platFORME Collective** and **BlackBox Company**, which establishes a bridge between science and art. The **Braindance** project deals with the difference in the visualization of the cerebral activity in relation to the basic adjustment of the music and the possibility of visual interpretation of the musical listening. The project graphically maps people's reactions to listening to certain layers of music. Likewise, **Cosmobrain** would map how people are creating a changeable chart daily. Thus, the union of these individual readings would form an average of behavior and mood: the **Cosmocria personality**.



The program

In a scenario beyond the territory of Campo Grande, MS, Brazil, the Cosmocria aims to attract the population by stimulating technological innovation, inducing the collaborative culture and innovation in the state. It also hopes to enhance the interactions, networks and transfer of knowledge and skills between the Cosmocria and the people of the city. Cosmocria would also connect to other spaces in Brazil or the world, in order to welcome anyone interested, universities, schools and other spaces of the same nature, such as Google Space. This open connection can happen through the digital platform, partnerships, visits, lectures, scholarship programs and even by virtual reality. In this way, Cosmocria can be characterized as a center of innovation that houses startups, incubators, accelerators, temporary housing, coworking and Fab Lab, as well as it treats spaces as responsive to experience.

In a simplified way, the program was divided into [1.] collaborative space, of a character to create cooperative relations in the development of ideas, and [2.] interactive space so that it can better meet the needs of people while maintaining interest in the site through a building that interacts with its agents. The spatialization of the program in the intervention area was given in order to create a feedback loop between city and building. All the basement and access sectors are characterized by spaces belonging to the interactive cosmos, which embraces the character of urbanity with the responsibility of keeping the public space diversified, democratic and, mainly, alive. The program that touches the ground invites people to interact and seeks to reflect on their actions in order to adapt to their needs. With the exception of the Fab Lab, which has a greater need for visibility in order to attend the community more easily, all the collaborative space happens in a stratified way by the

overlapping of common uses. The intention is that the building to reflect the visiting population in order to contribute to the development of ideas, where through circularity there is an exchange of information and knowledge. Therefore, the worked program is expressed in the manner presented in the Figure 3.

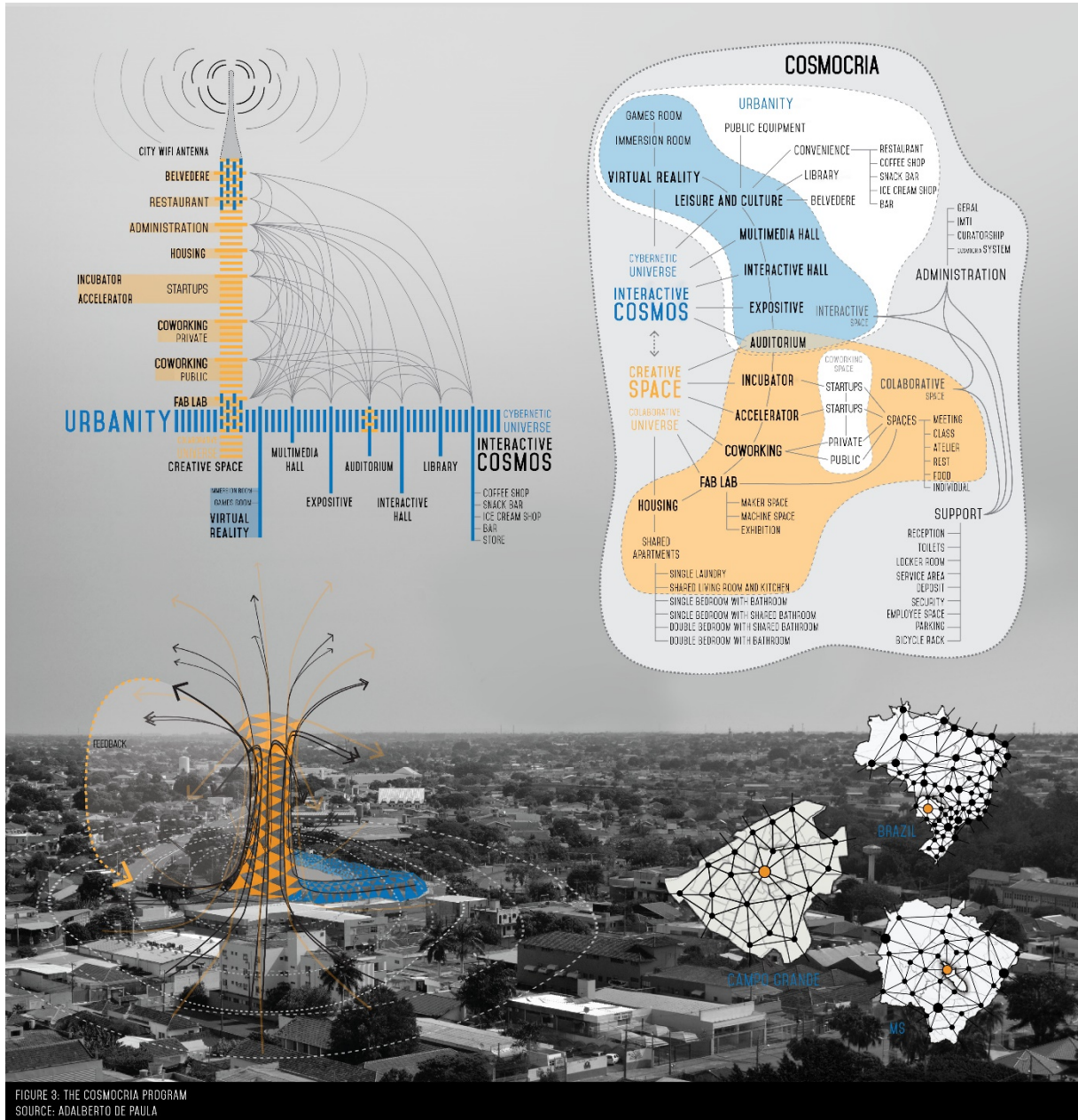


FIGURE 3: THE COSMOCRIA PROGRAM
SOURCE: ADALBERTO DE PAULA

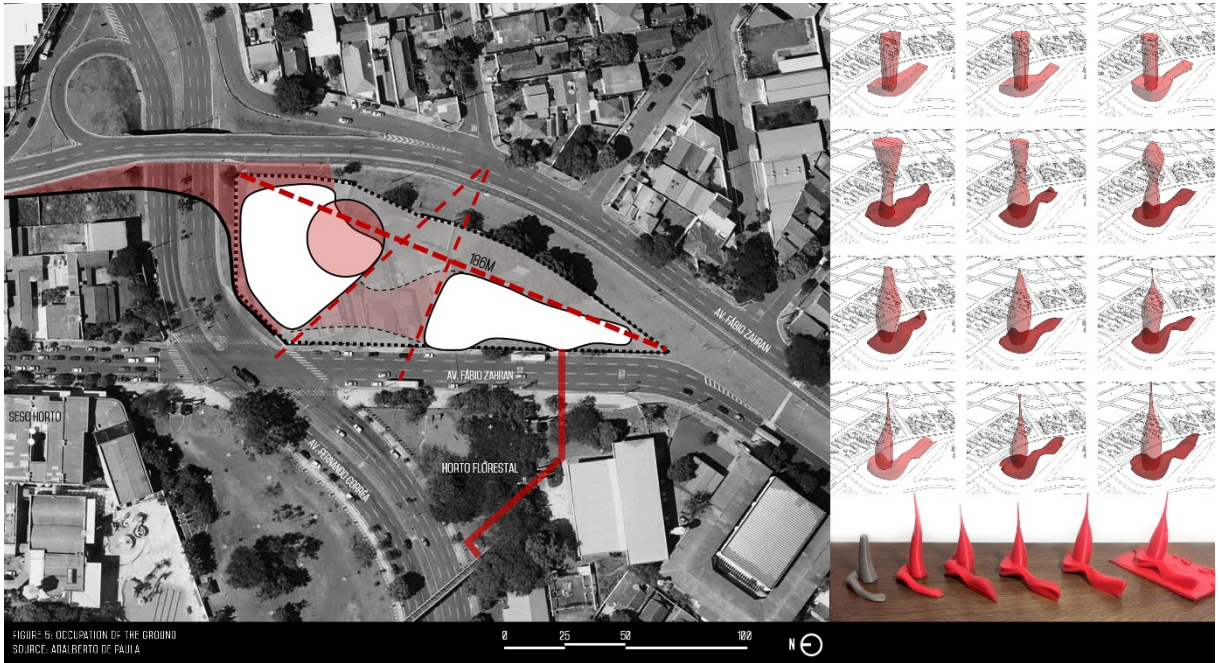
The project

The growth of Campo Grande towards the periphery results in a series of urban problems, especially in older places, such as the city center, which, with the real estate speculation, is gradually being abandoned. The area of intervention was chosen because it presents the greatest number of favorable conditions for the proposal, such as a good territorial dimension, location with a knot in the urban fabric, proximity to *HortoFlorestal* Park, possibility of establishing public attractor space, connection with the cycling network of the city, direct connection with the south region of the city (more populous and needy), varied accesses and many perspectives provoked by the unevenness of the terrain. Therefore, the

project would be a kind of connecting hub between people and ideas that flow through the city.



As for the spatial occupation of the building on the ground, the project has as its starting point the local urban layout and the conditions in which it is found. As the largest diagonal of the terrain is about 186m, the first guideline was to create a pedestrian walkway within the terrain from the midpoint of this diagonal so that occupation of the building does not obstruct visibility for *HortoFlorestal* Park. When dividing the land with this passage two areas are created for the occupation, one in the north end and another in the south of the terrain. In order to better interact with the surrounding accesses, the viaduct expansion also guarantees a connection by ramp to the corner of *HortoFlorestal* Park and, in a complementary way, a footbridge that integrates with the existing *HortoFlorestal's* footbridge was proposed. Thus, a direct connection is created between the building and the park, in order to encourage its use and create more possibilities of routes.



By positioning the tower to the north of the terrain, due to the latitude at which Campo Grande is located, a more shaded public space is created to the south during the year since the shadow of the tower would advance over the square. Regarding the choice of circular shape as a section of the tower, it is because it has a continuous perimeter and the facade surface is treated as a unit, therefore presenting a natural structural locking without fragile points, unlike what happens with the rectangular ones. The circular section also assists in the performance of the passage of the winds by having less surface in contact with the air.



Once the directives of communication with the context were defined, the volumetric evolution of the building took place in order to consider legislative, geographic, technical and

psychological aspects, wondering how a person could react to the geometry according to each perspective that offered by it. Therefore, in the search for the pleasure in being observed, the horizontal volume suffers more deformations because it is closer to the eyes at a human scale of the public space. The topological surface has more speculative influence on the human imaginary than a simple flat surface perpendicular to the ground. In contrast, the vertical volume keeps the circular section throughout the length of the shape. The variations present in the geometry of the tower happen in the radius of the circular section, that diminish according to the proximity to the Wi-Fi antenna at the top of the building and in the slight displacement of the axes of the circles towards the south in order to ameliorate the exposition of the south facade caused by the decrease of the section of the tower, as can be seen in Figure 7. During the project design and development process, digital modeling went through a variety of forms and languages, with 3D printing of various prototypes until their final definition.



FIGURE 7. WEST FACADE AND THE CONNECTION WITH THE FOOTBRIDGE OF MORTO FLORESTAL PARK
SOURCE: ADALBERTO DE PAULA



The free span created for the pedestrian crossing goes beyond this unique activity, because the intention is to create an emerging meeting point and a space of open conviviality to the diversity of the democratic public space. As all the building's horizontal volume has the character of a public equipment of the city, the interactive spaces will be in constant change since they are conditioned to cultural and leisure activities to invite the population. This invitation also extends for food trucks and free fairs that contribute so much to the urbanity.

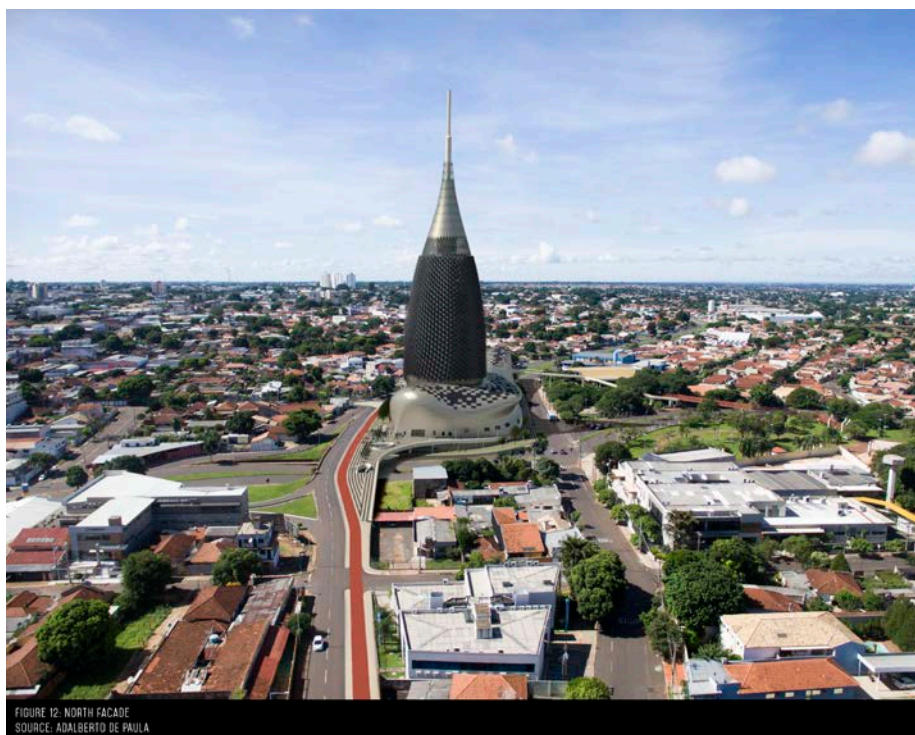


With the intention of creating flexibility in the public spaces, a furniture design is implanted that moves on rails along the square. The route followed follows the design of the floor in four axes, two in the north-south direction and two in the east-west direction of the terrain. The arrangement of the furniture suits the needs of the people, varying the positioning to meet

from the isolation, the meeting of friends, or the search for shadowing while sitting. These furniture consist of tables with attached benches, benches without backrest, seat with backrest and chaise-longue. Made of two types of wood, its materialization is through the intercalated union of the two shades of pieces from the cut of the raw sheets by the CNC machine.



The entire horizontal volume of the interactive cosmos is composed of a self-supporting space truss that bends to touch its ends in the ground. This constructive method was chosen because it presents great structural efficiency through the network distribution of the efforts, requiring smaller thicknesses of the parts by the loads not being discharged punctually, and also by enabling the confection of these parts and parametric plates through the digital manufacture. The height dimension of this truss varies from 1m to 1.5m and between its weave would pass electrical wiring and logic networks. In addition to the parametric space truss, this surface has several coating finishes. Both internally and externally, there is the predominance of the titanium plate with a layer of waterproofing on the external face. However, there are modules that are composed of photovoltaic cells with the intention of generating energy, by glass in order to form windows and by stainless steel in order to create a reflective surface. The creation of a few openings and the control of light also helps the digital interfaces spread across the Interactive Hall and the Multimedia Hall that require a smaller light for better visualization.



The self-supporting skin structure of the tower works by distributing the network of forces only as a way of locking the geometry, and it can be seen as a large circular pillar. Even with the network locking, efforts are discharged to the ground in a punctual manner. The hexagonal pattern was chosen because there are both diagonal and vertical lines in its geometry and no horizontal lines to prevent visibility. The material used for weft structure is steel and for the fence, glass and titanium. At the base of the tower, the structure does not have any closure allowing people to pass through, but as the tower rises, the fence is made up of glass to bring transparency and natural lighting to the collaborative spaces. When the weft arrives at the level of the technical pavements, the transparency gives place to the opacity of the titanium avoiding the exposure in the facade.



FIGURE 13. BRISE-SOLEIL PANELS WITH PHOTOVOLTAIC AND LED CELLS
SOURCE: ADALBERTO DE PAULA

The *Brise-soleil's* skin is parasitic on the tower's weft. Its fixation takes place by a shelving bracket system that holds the cylinder responsible for the movement of the panels. The base module of these panels has the triangle as the base geometry because it allows a greater resolution in the curvature that accompanies the slope of the tower frame. The movement of this module has one of the edges of the triangle, allowing the other end an opening up to 90 ° in relation to the facade of the building. This *brise-soleil* activity is in response to the movement of the sun in order to generate as much shade as possible within the building. The movement at first is conditioned to the sun, but can be reprogrammed to respond to other standards, as well as to respond to the individual will of an opening. This dynamic facade comes alive not only during the day with its movement, but also at night with its own lighting. The surfaces of the panels are composed of solar sensors, photovoltaic cells and LED cells.



FIGURE 14. BRISE-SOLEIL PANELS ILLUMINATED INTERACTING WITH THE CITY
SOURCE: ADALBERTO DE PAULA

The structure of the floors of the building follows independent of the facade structure. Within the three skins that form the aesthetics of the building, the structure of the floors is traditional. For this, the horizontal volume floors are prestressed slabs supported on circular concrete pillars and the tower floors are also prestressed slabs, but supported by the structural core of concrete that has 8.4 x 8.4m. The structural core in addition to supporting the weight of the floors is the base for the Wi-Fi antenna that is aligned on its axis. As for the slabs, depending on the span that the prestressed slab has to overcome, changes its thickness, so the project presents several massive sections of slabs, varying from 20 to 60 cm.



The interactive hall is the largest space in the building and it is offered as a city public space. In this space are distributed totems of 2.5 x 2.5 x 0.6 m that have a face that people can interact with an digital interface and other face that allows the action of sitting, lying down and contemplation of it as a piece in itself. Made of black acrylic, the totem can one day be standing or another, lying down, thus dictating which use it will have on that day. In addition to changing the faces on exhibition, the totems are reconfigurable at all times by a Kuka robot on rails, guided by the Cosmocria personality.

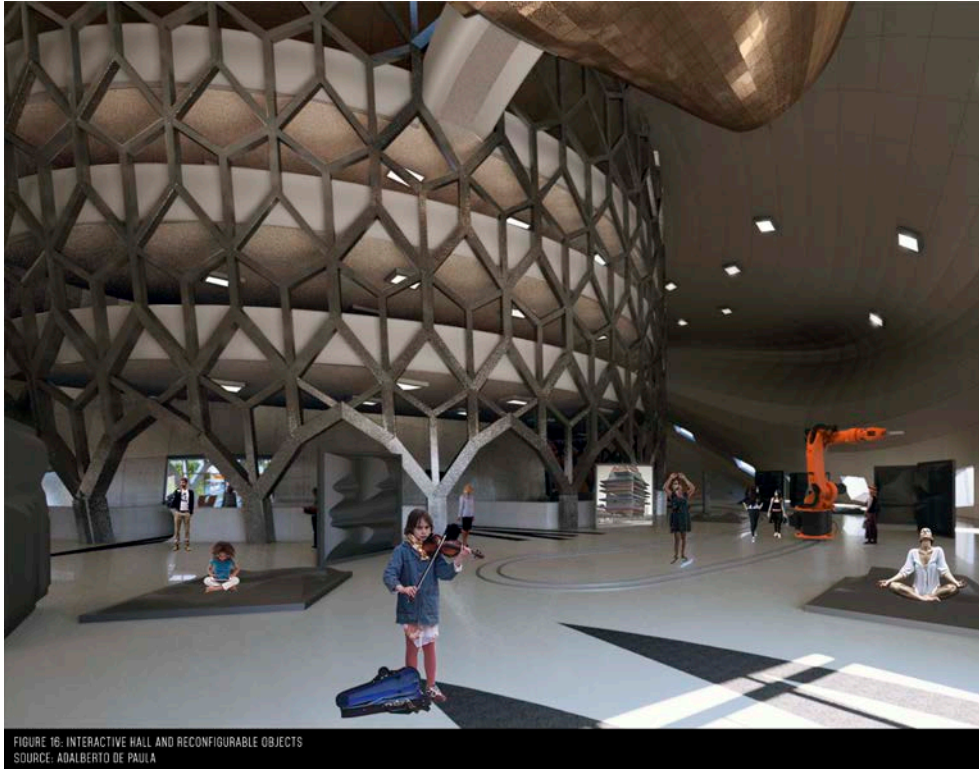


FIGURE 16: INTERACTIVE HALL AND RECONFIGURABLE OBJECTS
SOURCE: ADALBERTO DE PAULA



FIGURE 17: INTERACTIVE HALL, RECONFIGURABLE OBJECTS AND THE IMMERSION CAPSULE
SOURCE: ADALBERTO DE PAULA

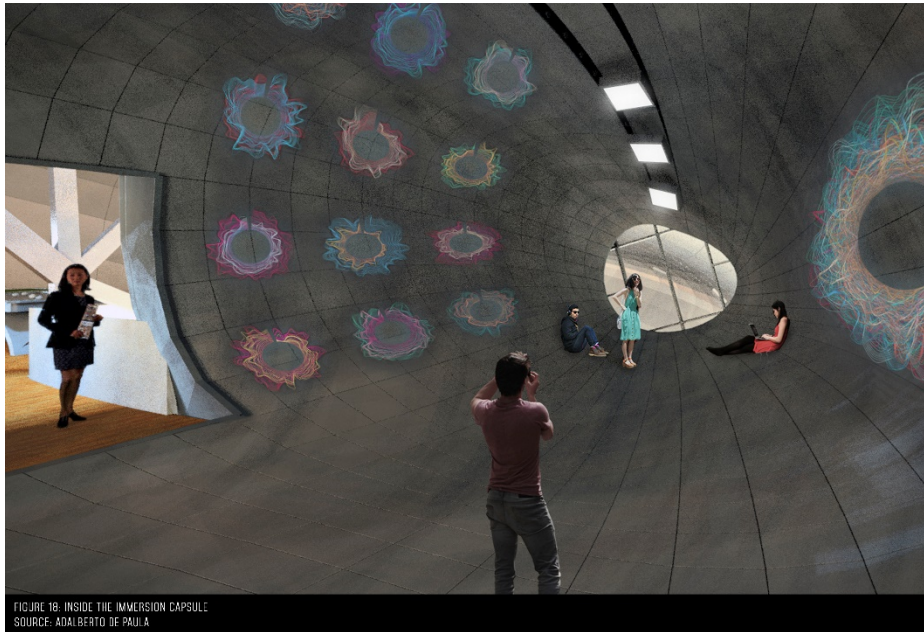


FIGURE 18: INSIDE THE IMMERSION CAPSULE
SOURCE: ADALBERTO DE PAULA

The immersion capsule has the constructive method similar to that of the horizontal space truss volume, but on a smaller scale. In this case, the spatial truss is cabled by steel cables on the roof of the Interactive Hall and has an ovoid shape with a glass closure at both ends. The same geometry of the outside of the capsule is reflected in its interior, because the idea is that upon entering the person feels the sensation of losing the leveling of the floor, thus creating a new spatial perception.

In addition, at the top of the staircase to access the Exhibition Hall, a hyper surface was implanted that interacts with the presence of people. As an invitation for people to come up, this interactive surface materializes through cylindrical pistons with LED bulbs at their end. So the interaction happens in movement, sound and light when a person goes through it or directly by using the application Cosmocria by playing a song, or drawing with the light.

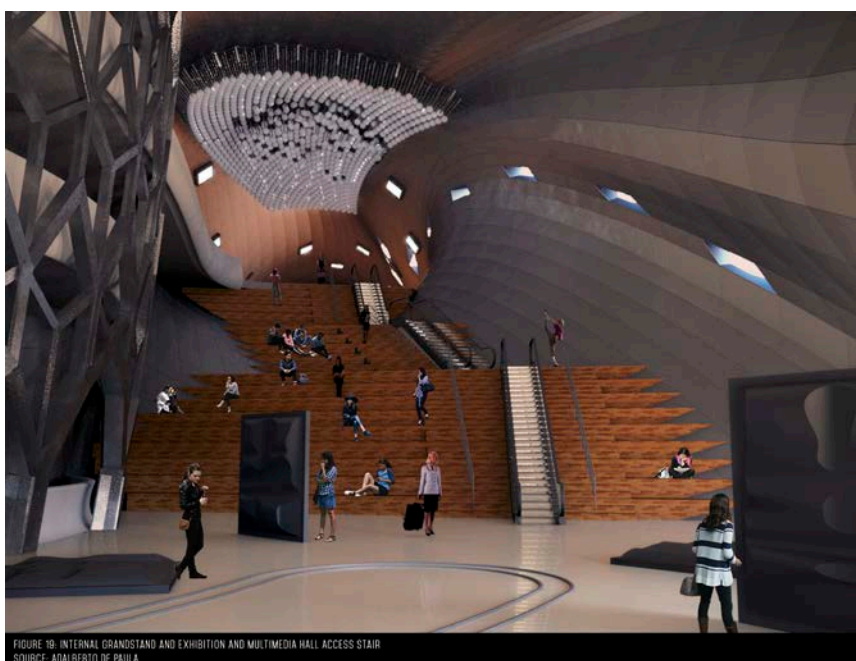


FIGURE 19: INTERNAL GRANDSTAND AND EXHIBITION AND MULTIMEDIA HALL ACCESS STAIR
SOURCE: ADALBERTO DE PAULA



FIGURE 20. HYPER INTERACTIVE SURFACE IN SOUND, LIGHT AND MOVEMENT
SOURCE: ADALBERTO DE PAULA

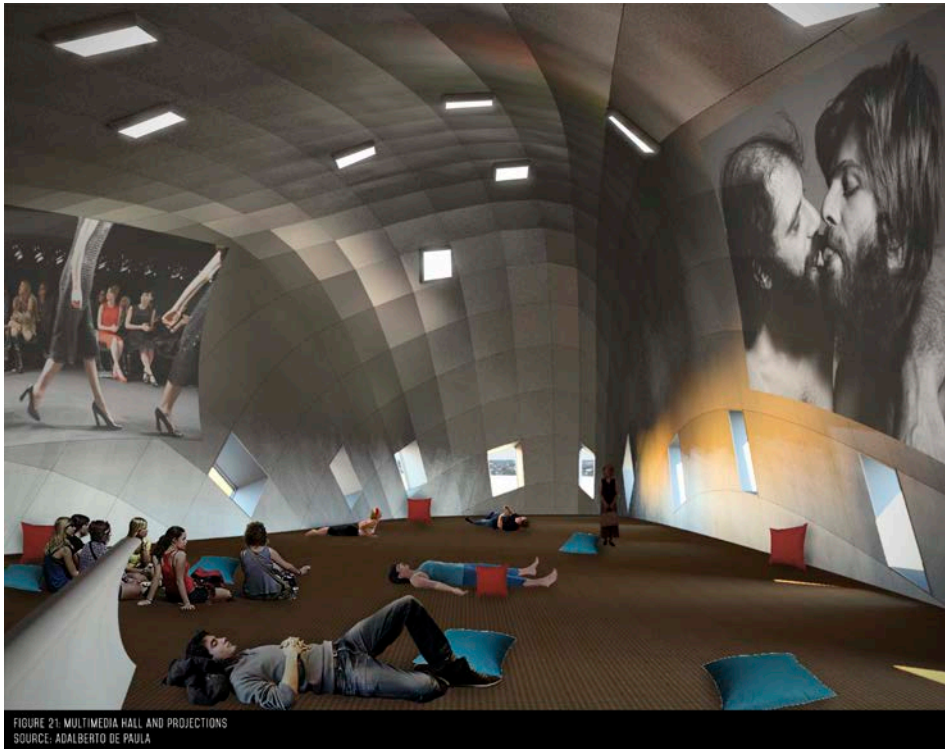
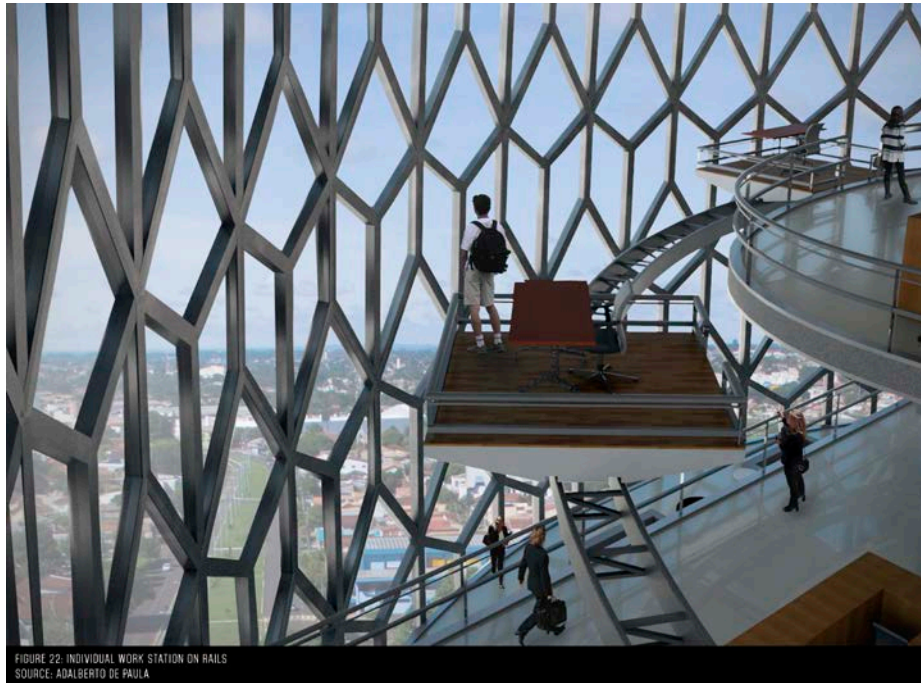


FIGURE 21. MULTIMEDIA HALL AND PROJECTIONS
SOURCE: ADALBERTO DE PAULA



Based on Benghazi's Google conceptual project in China, the concept of individual workstations that run on rails is implemented in the project in order to streamline the work environment. In this case, the isolation of the workspace for concentration is not restricted to a small room, since the insulation is done by raising the rail. Thus, the workstation appears to be floating in space, maintaining the visual permeability of space.

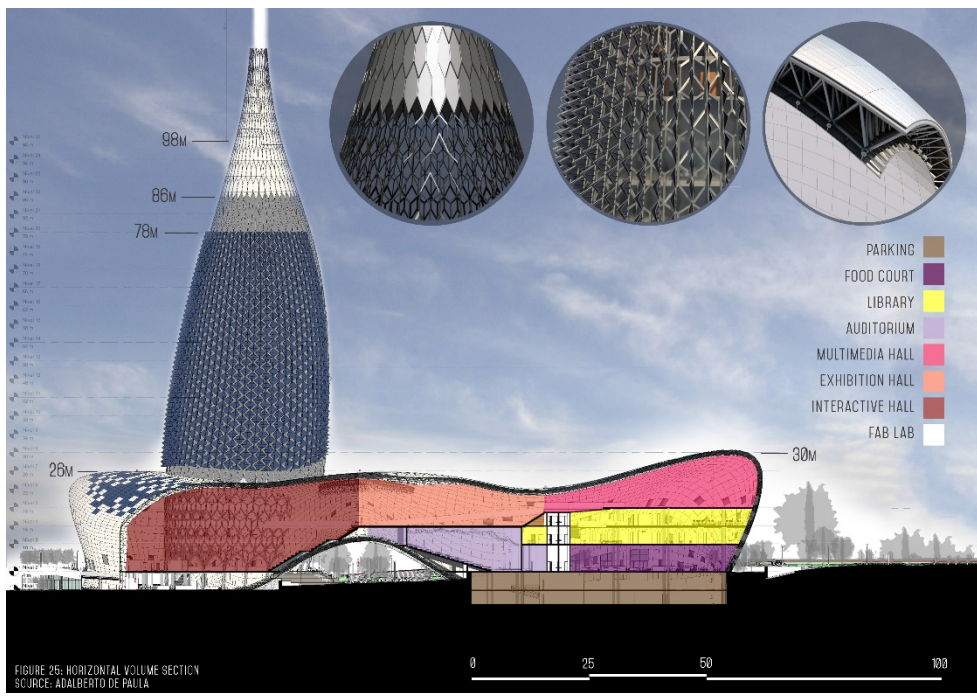
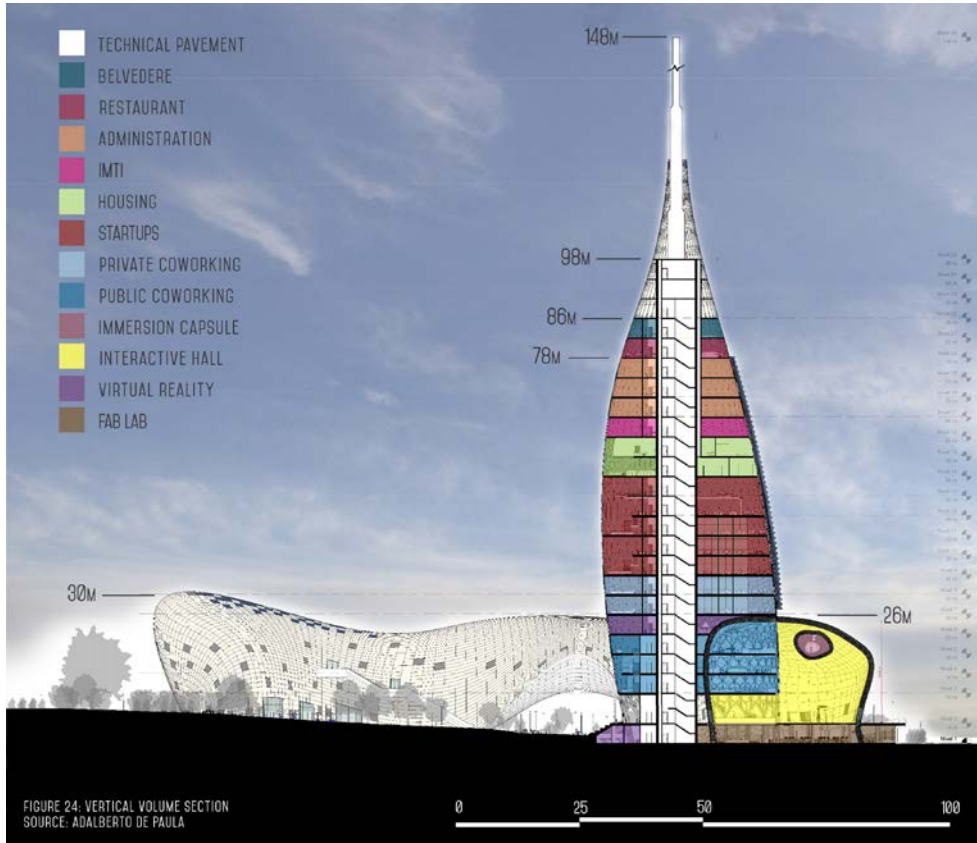




FIGURE 26: PANORAMIC VIEWPOINT
SOURCE: ADALBERTO DE PAULA



FIGURE 27: EXTERNAL GRANDSTAND AND THE FREE SPAN
SOURCE: ADALBERTO DE PAULA



Final considerations

Throughout the development of the project, several reflections were made aiming at establishing what the interactive architecture is, and in addition, to propose strategies for the elaboration of the project through some concepts coming from Cybernetics. Therefore, studying and applying cybernetic concepts in the architecture field is, primarily, to be open to understanding the world in which we live from other orders and perspectives. The reflections that we had gone through allow us to affirm that interactivity, in its various manifestations, is a fundamental characteristic of spaces inhabited by contemporary society.

Communication technologies are transforming our economy, our ways of learning, our working methods, our ability to change environments and even our daily tasks and pleasures. Nowadays, it is part of daily life that people are connected to their cell phones and electronic devices in order to expand the space in which they are. The physical presence of a person is increasingly dissipated in the potential of the media and manifestations of ubiquity. We are connected to each other in a layer of space beyond the physical plane in which the transformations that had occurred in society over time are irreversible. Like the other revolutions of humanity that have transformed people's ways of life, the current technological and informational revolution is increasingly influential. We must therefore adapt the spaces of human interaction so that they become increasingly interesting in order to create more dynamic interactions that allow people to conceive in a collaborative way the environment in which they are living and experiencing. Architects must be able to orchestrate the multidisciplinary that a contemporary architectural project demands.



We believe that from the potential of digital mediation, architecture should encompass the thought of action, reaction and chain interaction, where everything is in constant relation of influence with another action, reaction and interaction. Starting from a systemic and cybernetic view, one cannot conceive an isolated object in space. Everything connects in multiple networks, in a way that an accumulation of a simple action in space can generate other experiences and future bigger and richer developments for the society, updating the concept of Architecture and extending its limits.

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