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Hugh Ferriss and The City of Tomorrow: from a utopic dream to a scientific and philological reconstruction

Today it is possible to find virtual reconstructions of many types, and technological tools help a lot in these prefigurations. However, it is difficult to find research and studies done on an urban scale of entire utopian city projects that are connected to a particular historical period of the avant-gardes at the beginning of the 20th century. The research presented here fits into this context and concerns the critical analysis and virtual reconstruction of Hugh Ferriss's City of Tomorrow. Multiple factors come into play in virtual reconstructions. We often limit ourselves to some aspects, ignoring others. However, the right workflow requires that all aspects are analyzed and that the choices made are consistent and justifiable. In the case of the virtual reconstruction of Ferriss's City of Tomorrow, each developed decision has been weighted, combining graphic information with documentary information. It was a complex research because the initial choices did not always lead to a consistent outcome. So a continuous back-and-forth process was necessary so that the result was the optimal solution, although not the only one, but rational and analytical. The work presented is a unicum that currently has no other comparable examples. It links a reasonable and philological virtual reconstruction to render images of great graphic and emotional impact, in order not to lose the original intent of Ferriss himself.

Keywords:
Virtual reconstruction; Utopic city; City vision; Digital representation; Urban planning

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INTRODUCTION: VIRTUAL RECONSTRUCTION APPLIED TO DIFFERENT CASE STUDIES

The historical period we are experiencing is in continuous technological evolution, with solutions that were unimaginable only a few years ago. This revolution invests multiple fields, medical, genetic, scientific, infrastructural, physical and architectural. And from this last sector, with a pyramid scheme, many other revolutions arise (BIM, innovative materials, domotics ...).
In the field of representation, technological evolution has introduced new ways of drawing architecture, the city or the landscape. The analogue has gradually given way to digital through tools of knowledge of real space (survey with laser scanner, photomodeling, thermal cameras ...) or three-dimensional models that prefigure spaces, environments and architectural complexes not yet realized (Novello, G., & Marotta, A., 2015). However, there is another area of research that also involves the most historical-cultural aspect: the knowledge and dissemination of the modified or no longer present historical city, in its urban stratifications and characteristics. The digital tool made it possible to digitally reconstruct projects never made, portions of cities demolished or even destroyed by disastrous events. In this sector in particular recent studies have developed in particular in the areas that have suffered considerable damage in the last great earthquake that hit central Italy in 2016 and almost destroyed Amatrice, Accumoli, Arquata del Tronto.
The research is aimed at the virtual reconstruction of a three-dimensional model that can show "where it was, as it was" [1], through the study and analysis of historical documentation, a survey of intangible phenomena, cultural landscapes and built and destroyed heritage , thus recovering the historical memory of those places and supporting access, use and digital dissemination of knowledge of lost places.
There is a further field in which virtual reconstruction achieves excellent results through new technologies: the representation in a modern key of architecture never realized or, changing scale, of utopian cities. Examples of these researches show the reconstruction of the utopian visions of Sant'Elia (Sacchi, L., 2003), or that of a project by Borromini of which only a few sketches have been received (Bortot, A., 2016), the digital reconstruction of the unrealized projects of Sacripanti (Albisinni, P., & De Carlo, L., 2011), or, on a more urban scale, the three-dimensional visualization of Valadier's first project in Piazza del Popolo (Calisi, D., & Molinari, M., 2018) (Fig. 1).
However, it is difficult to find research and studies done on an urban scale of entire utopian city projects that are connected to a particular historical period of the avant-gardes at the beginning of the 20th century. The research presented here fits into this context and concerns the critical analysis and virtual reconstruction of Hugh Ferriss's City of Tomorrow.
The connection between utopian architecture and technological development is inevitable: in fact technological progress stimulates the impulse of building growth which, in turn, leads man to go further and think about a better future and

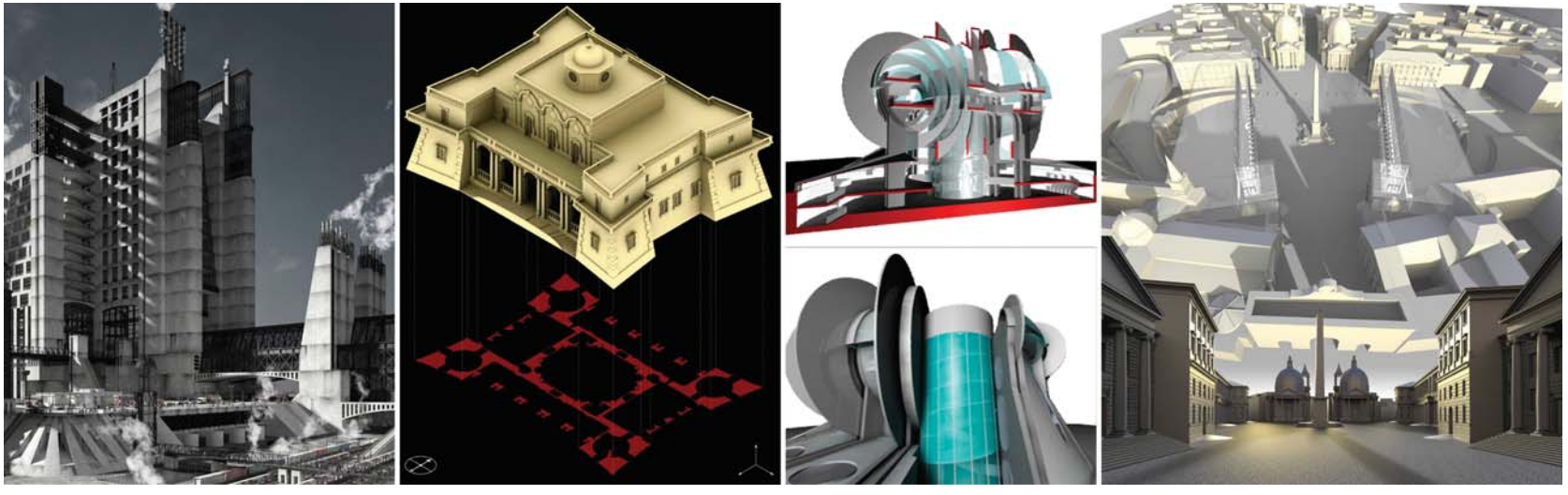

Fig. 1 - Some contemporary virtual reconstructions.

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functional city designed for human well-being so much so that many architects of the time developed their own idea of an ideal city.
The search for the ideal city by Hugh Ferriss is not limited only to the publication Metropolis of Tomorrow, but the collection of original drawings consists of 363 works that are today preserved in The Drawings & Archives Department of Avery Architectural and Fine Arts Library at Columbia University from New York.
His representations are constantly evolving as they are contemporary in an age in which change is concrete because it is realized and one can think of a metropolis where the real present merges with a science fiction future. According to Ferriss, man is unconsciously conditioned by the architecture that surrounds him: he walks the streets of the metropolis moving on its axes and along which he reacts unconsciously to the volumetric masses thought rationally by the architects who designed them. The view that Ferriss discovers every morning looking out from his terrace is one of the greatest sources of inspiration for his thought. Starting from an analysis of the existing buildings to then tell and abstractly represent the trends that have influenced his thinking, he then comes to outline a personal idea of a futuristic city.
This idea is also linked to a particular style of representation that uniquely characterizes Ferris' designs: gloomy atmospheres with a thick fog and often at night, a masterful chiaroscuro use to highlight the skyscrapers in comparison with the low building of the urban fabric.
However, Ferriss's drawings have the characteristic of following more of their own visionary logic than of geometric rules: the perspectives, almost all are birds-eye view, have a basic perspective construction with clear vanishing points, but are partly disconnected from the only plan of the utopian city left to us by Ferriss. The work of virtual reconstruction of the entire city had to bring together different sources and find the most adequate and philologically exact solutions. In the text, Ferriss sometimes provides dimensional information on the system of roads, on the heights of buildings, and describes his utopic city with useful details for reconstruction. This information was essential and, above all, remained unchanged in the reconstructive hypotheses. Another essential element is the plan, which has been redesigned and reconfigured ex novo, following the measurements of the text. And from it we proceeded in detail going to analyze the individual buildings that hierarchically compose the city of the Ferris.
The research falls within a much broader panorama, in which reconstruction has at times produced very interesting results, such as the visions of Sant'Elia, but at other times promoting results more similar to videogames than to philological reconstructions based on scientific choices.
The one on Ferriss was an extremely complex and innovative process, which led to a critical and scientifically correct virtual reconstruction that highlights the importance of history and its reinterpretation even in a modern key, reconfiguring the memory of the past into new spectacular visions.

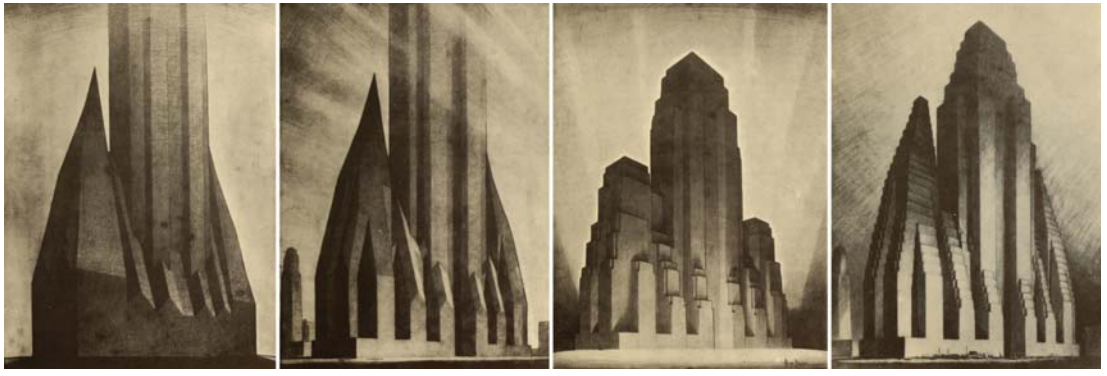

Fig. 2 - The design phases of Ferriss for the creation of utopically perfect skyscrapers.

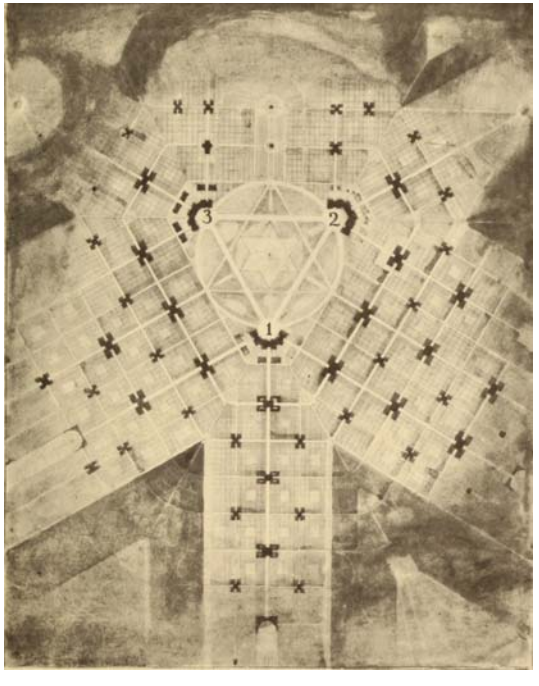

Fig. 3 - The original layout of the city of tomorrow.

HUGH FERRIS. A DREAMER IN VERTICAL

Born in 1889 in St. Louis, Missouri, Hugh Ferriss is an American architect and illustrator who, thanks to his visionary representations, characterized by a clever use of shadows and chiaroscuro, will influence entire generations of architects and urban planners after him.
He lives in an age in which the American cities, New York and Chicago in the first place, are

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Fig. 4 - The three main centers of the city: business, art and science.

subjected to an intense urban impulse (Linder, C., 2015), connected to the new structural researches that allowed the conception and realization of new volumes with vertiginous development in the high [2]. Starting in 1920, Hugh Ferriss outlines a true style of graphic representation of buildings, placing them in nocturnal contexts characterized by a dense surreal fog, where the manipulation of light and chiaroscuro highlight, in a grotesque way, the main features of the buildings. These evocative representations guarantee his place in periodicals and various magazines of the time, such as Century, Harper's Magazine, The Christian Science Monitor and Vanity Fair.
It is also thanks to his drawings that a study of the theories and architectural techniques of the early twentieth century in the United States can be delineated. Drawing thus becomes a means of research into knowing how to design architecture. Subsequently he outlined his own urban and architectural analysis of the major US metropolitan centers of those years - focusing mainly on New York, Chicago and Detroit - which led him to revisit the concept of utopia understood as an alternative to the existing reality (Ferris, H., 1953; Morshed, A., 2015).
In 1929 he created a collection of 59 representative boards [3], accompanied by an explanatory text entitled "Metropolis of Tomorrow".
In the early 1920s, Hugh Ferriss focused on the analysis of a new architecture created following the New York Zoning Resolution [4] of 1916 (Sica, P., 1977).
He analyzes a series of buildings built to the limits of the pre-established norms, enhancing their main features, taken up later in his ideal city: imposing volumes, glazed surfaces, vertical structures with a strong appeal to nature, functional but not only structural buttresses, study of the role of the light. In a first phase the volume of the structure is reduced so as to have a smaller number of occupants and, consequently, the amount of traffic and greater lighting on the roads is reduced. In a second phase the dimensions of the initial block are established. The third step consists in further dividing the structure with rectangular shapes that allow for regular and functional interior spaces. In the fourth phase it removes the excess parts, obtaining a pyramid-shaped building. With this process, Ferriss attributes a third dimension to architecture along the Z axis, so that each building assumes its own identity and individuality.
The design is enriched with a fifth phase which consists in emptying the building by creating openings in the façade to allow a greater flow of natural light and to give the architecture a greater aesthetic and functional quality (Fig. 2).

THE CITY OF TOMORROW: GENESIS OF THE IDEAL CONFIGURATION

The plan of the megalopolis (Fig. 3) represents an image of the infrastructural system and the layout of the buildings in the city of the future designed by Ferriss (Ferris, H., 2005) (Willis, C., Ferris, H., 1998): the main tower buildings are represented in black, while the lower ones and the distribution system are in white. The three main centers of the city, namely the Business Center (No. 1), the Art Center (No. 2) and the Science Center (No. 3), are connected by the Civic Circle. From this central ring, in correspondence of the three centers, the three residential radial areas branch out, with particular solutions in the intersections that had to be resolved in the virtual reconstruction. Near the peripheral residential area, the airports represented in the drawing with dark-colored triangular areas are located in the surrounding radial roads.
The metropolis is entirely crossed by a regular and homogeneous infrastructural grid, divided into blocks of rectangular buildings that have a height that never exceeds the width of adjacent streets, with internal streets of 20 meters. Four of these blocks form a site that is delimited, on the axes of symmetry, by towers about 300 meters high and almost one kilometer apart from each other.

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The infrastructural system is divided into three levels to maximize flows: local traffic is on the ground floor, fast traffic is buried at -5.00 mt and pedestrian traffic is guaranteed by a higher system and distinct from the previous ones at +3.50 mt.
The Business Zone constitutes the largest portion of the territory of the entire metropolis, with the highest and closest towers, which manages all the economic, legislative and governmental activities of the city; hosts the government headquarters and the legislative and executive offices. The main tower is located at the intersection of the two most important streets and reaches a height of about 365 meters. On the sides of the central body there are eight towers about half of it which, thanks to the connection elements, connect the four adjacent blocks. The center occupies another eight blocks, where the additional parts rise up to a height of 12 floors.
The Art Center is the artistic and cultural center of the city and, characterized by a structure that recalls the Ziggurat of Mesopotamia, guarantees free access to air and light.
The lower buildings consist of a roof that houses gardens and porches, with swimming pools and trees. In this area the tower buildings are more interposed than the Business Zone to ensure that there is more living space between one and the other. Finally, the infrastructural system allows numerous parking areas and orderly and non-chaotic traffic.
The Science Center is, instead, a structure that extends over the entire surrounding area and embraces the peripheral areas, is characterized by a very high central body surrounded by long wings. The latter is used to host scientific laboratories, research centers, faculties of science and engineering. The infrastructural system, flanked by a wide waterway, is structured on several levels and equipped to accommodate a considerable number of vehicles (Fig. 4).

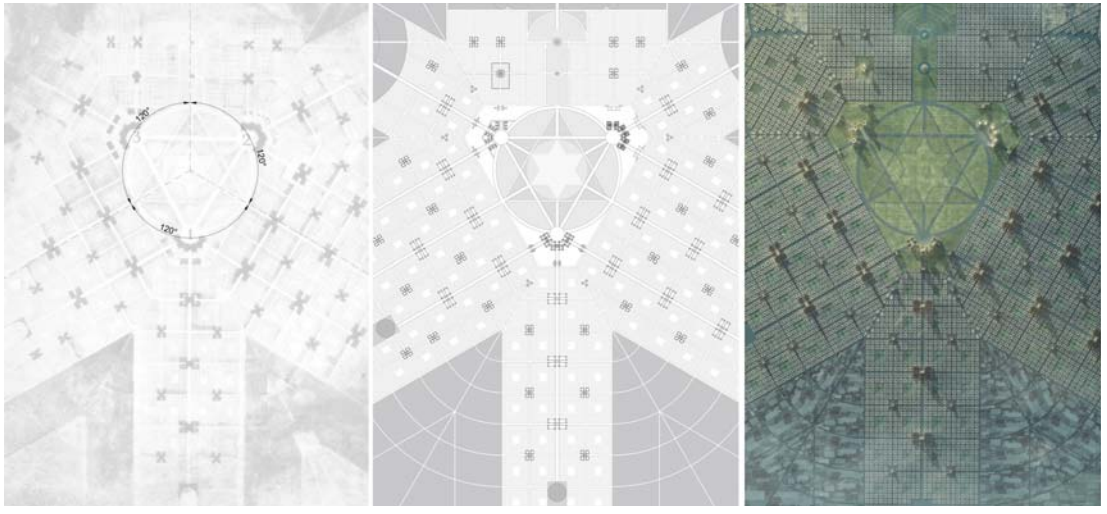

Fig. 5 - Geometric reconstruction and reconfiguration of the original plan. On the right a render of the reconstructed city.

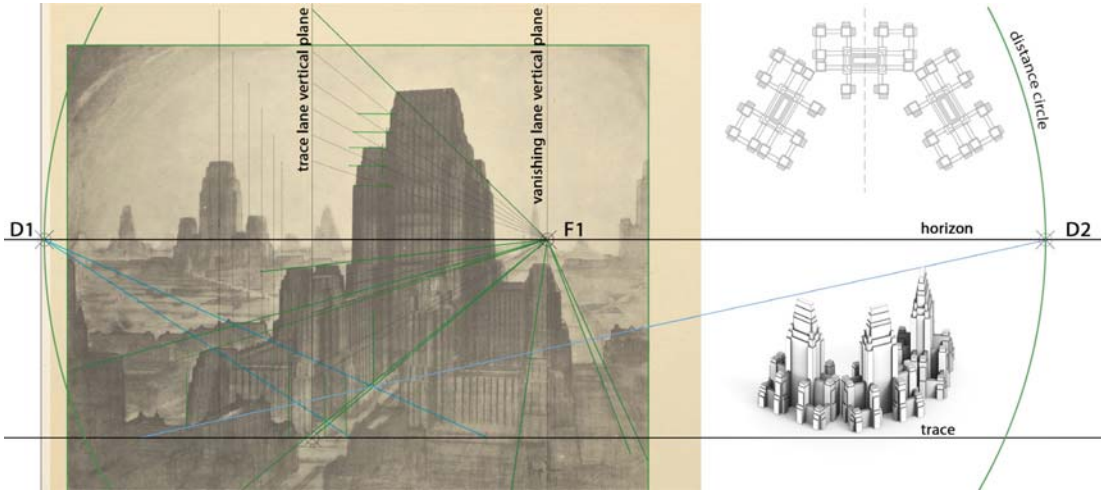

Fig. 6 - Perspective restitution of the Business Center, reconstructed plan and 3D model.

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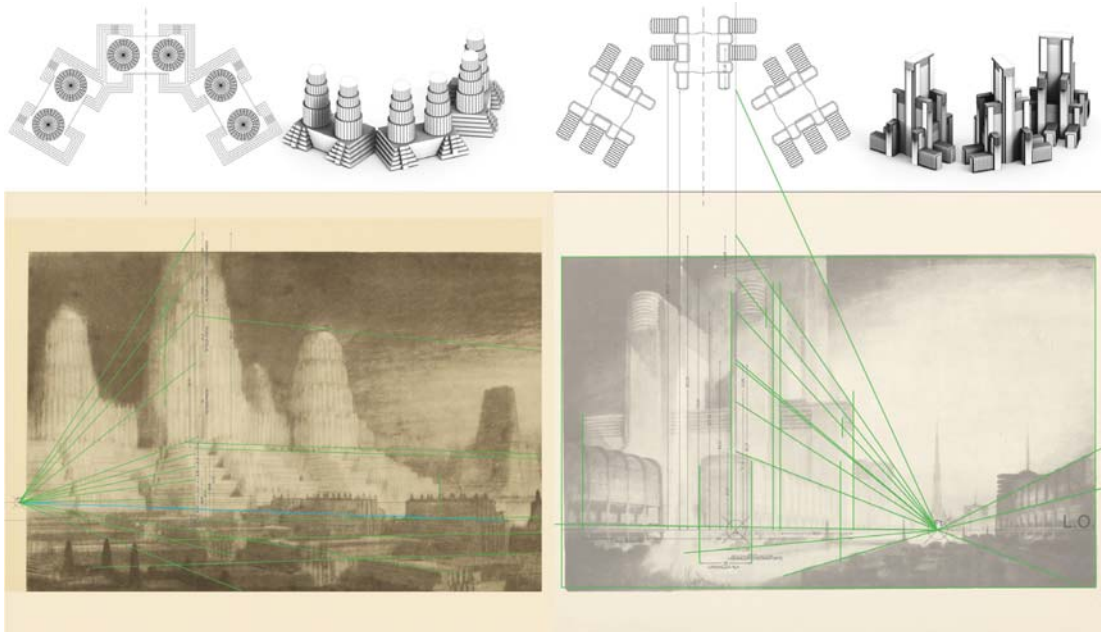

Fig. 7 - Perspective restitutions of the Art and Science Center, reconstructed plans and 3D models.

VIRTUAL RECONSTRUCTION

The virtual reconstruction was based on the only measurable configuration, the city plan. However, the first step of traceing the design led to a configuration that did not conform to the few descriptions and measurements cited by Ferriss in the text.
The first problem solved was to reconfigure the geometry of the plan, formally following the design but adapting it to descriptive information. From a careful analysis of the general plan prepared by the American architect, various axes of symmetry can be established, centered in the Civic Circle, rotated by 120 ° respectively. The vertices on the circle, by construction, are those of an equilateral triangle and on which the three directional centers are positioned. A second symmetrical triangle identifies the road axes, and configures the star of Solomon with six points, an emblematic symbol that sublimates the material and divine aspects, opposed but, at the same time, in relation (Fig. 5).
Later we moved on to modeling the different buildings of the city of which the shape and size on the ground floor was known, based on the plan reconfiguration. However, all the other Ferriss drawings are perspective and therefore not measurable except through a process of perspective restitution, which was made possible only thanks to two known measures indicated in the text by the architect himself (Fig.6).
Only the height of the central tower of 365.76 meters and width of 150 meters is known of the Business Center. In the perspective restitution, the first vanishing point is determined first, prolonging the more visible horizontal perspective lines that make up the drawing and tracing the horizon line that passes from the vanishing point of the horizontal straight lines.
At this point it is necessary to define the fundamental vertical line on which to report the sought-after measures: once the extreme edge of one of the secondary towers shown in the foreground has been chosen, it is possible to determine on it all the dimensions of the other elements making up the building from which vertices are drawn lines from the main vanishing point. Any sought height must be brought back to the plane that has the selected corner as a trace and as vanishing line the one passing through F1. Subsequently, having the depth measurements available from the plan, it is also possible to determine the projections of the protruding elements. Making the trace of the ground plane coincide with the chosen edge for the heights, you can detach to the right the measurement relative to the depth of the left block. This is the real measure that if combined with the edge in perspective, and extending the straight line, allows to determine the point of distance of the perspective, an essential element for measuring the projections in perspective, bringing them back to the trace of the ground plane.
This operation has been repeated from time to time for all the other buildings described and represented by Ferriss. For the Art Center, the known starting measure is the width of the central block in plan, which corresponds to 219.96 linear meters, while for the last of the three main centers of the metropolis, the Science Center, the reference measure is the length of the central module, which is equivalent to 150 meters in plan view (Fig. 7).
The secondary buildings are those buildings visible in the background in most of Ferriss's perspectives. The first of them is the tallest tower in the city whose perspectives represent it aberrated with respect to the plan reconstruction. There are two known starting measures: the height of the central tower of 365 meters. On the basis of the geometrized planimetric scheme, a control measure can also be used that allows greater fidelity to the plan drawing, that is the width of the left rectangle of 138 meters, that is 2 blocks of 60 mt plus the street of 18 mt.
A second building analyzed is the secondary tower

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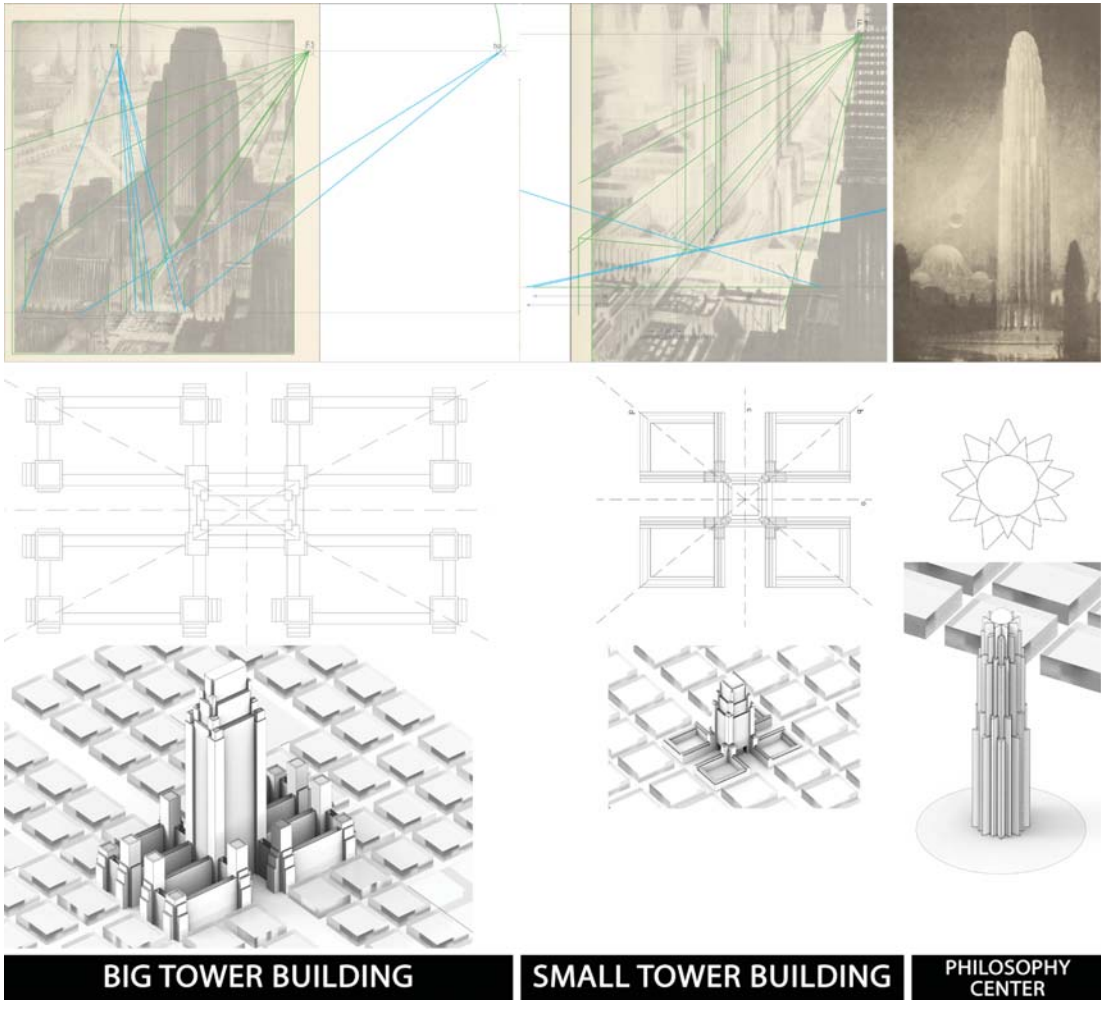

Fig. 8 - The process of virtual reconstruction of minor buildings.

present in each of the three areas of the city. Its known measures are the lower tower height of 19.80 meters and the lower block length on the left, which corresponds to 60 meters according to the general plan. The upper part of the tower in the foreground comes out of the drawing but it is possible to refer to the buildings in the background that follow the same compositional structure.

It can therefore be argued that the building grows by two more blocks and that the height of each block to follow is half that of the previous one.
The perspective restitution has again made it possible to reconstruct the formal aspect of the two types of towers.
The last building under consideration is the tower of the Philosophy Center. Ferriss writes that the architectural composition is given by the overlapping of three equilateral triangles such as to create a nine-pointed star that is repeated at different angles in the various levels in elevation. This description, however, is in contrast to the image showing an 18-point configuration. This second hypothesis was the one pursued because it was more consistent with the final image (Fig. 8).

FROM VIRTUAL RECONSTRUCTION TO EIDOMATIC REPRESENTATION

The refined images of the established *analog renderer* are designed to communicate the emotional power of architecture, which is analyzed from the experimental point of view thanks to its sophisticated technique of perspective and graphic representation (Hanson, M., 2005).
The views usually reproduce nocturnal scenes, where the light grazing from the bottom to the top, wrapped in an imperceptible mist, causes chiaroscuro effects that are able to communicate a strong emotionality and suggestion to those who observe them.
These sensations are those that can be recreated today in photography with the technique of *soft focus* [5] or with the use of photographic post-production software such as *Photoshop*, going to act on the blur settings.
The views produced by the scientific-graphic reconstruction of the *City of Tomorrow* are made with colour technique; this choice has established the direction of the study to one of the stylistic references that has been taken into consideration, Ridley Scott's *Blade Runner* of 1982, since it has in turn had strong connections with the representations made by Hugh Ferriss.
The metropolis designed by the American visionary

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Fig. 9 - The Science Center.

architect is the image, revised in a modern key, wanted by the director for its vertical retro-futurist megalopolis [6], constantly wrapped in smog, mist and neon lights, protagonist of many scenes of the film.
The study of the theory of color is the basis of each of the scenes created using the combination of complementary colors: once established the general color of a scene, the various lights present were set so that the color of the light itself and the intensity of the play between light and shadow would create a realistic atmosphere emphasized by Leonardo's aerial perspective.
The strong use of orange in the scene representing the *Science Center* (Fig. 9), for example, is contrasted with the use of blue cars and buildings on the opposite side. The cold colour of the neon of the cars on the right side is contrasted by the warm colour of the sky, which is particularly accentuated.
However in the post-production phase of the image the balance of the overall color is altered to increase the graphic quality of the same and therefore it is necessary to process the scenes in the rendering phase by dividing them into as many components as possible, so as to have the ability to change separately the various parameters (color, diffuse, specular, shadows) at a later time. This allowed an overall chromatic balance of the scene homogeneous and uniform.
In each of the scenes examined, the most advanced lighting techniques were used, emphasizing perspective, perception and vision of the overall image.

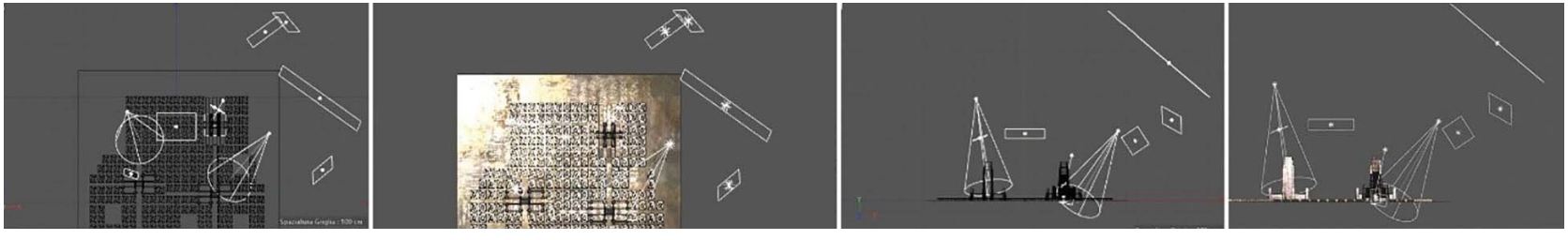

Fig. 10 - Lighting scheme of the city, with focus on the Financial Center.

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Fig. 11 - Financial Center lighting scheme

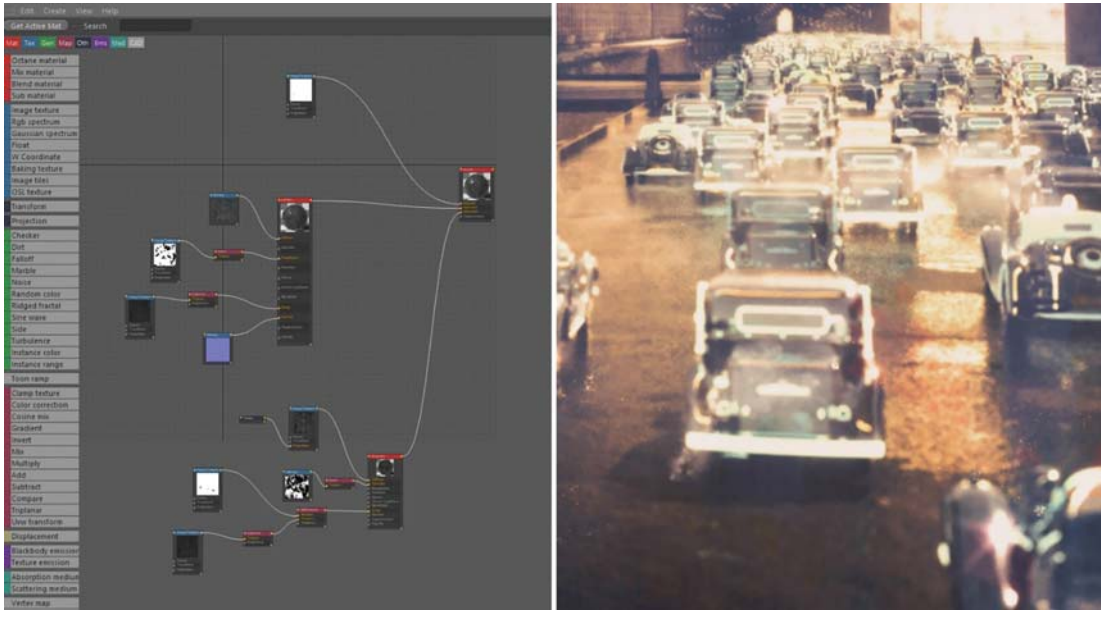

Fig. 12 - Node Editor of the composition of the material of the roads with wet effect and focus of the application of the material in the scene.

Even in rendering software the unit of light measurement is the Watt, and you must determine the real parameters in the setting of the power of light itself if you want to have a realistic effect. The lights present in each of the scenes of *Metropolis of Tomorrow* are treated in an artistic and, above all, futuristic way: there are tonal values that start from 2500 K so that contrasts of light create plays of shadows and restore volume to the scene, as opposed to that of a clear sky during the day, which reaches even 10000 K.
With the aim of obtaining atmospheres projected towards the future, the lights used have been altered by the Gaussian spectrum, through which it is possible to convert the RGB colour to be assigned to the light in well-defined wavelengths.
In the lighting design of the scenes of the city of tomorrow, we can see the presence of a well-defined light scheme that uses a general lighting given by a HDRI [7] combined with a DayLight light and several accent lights that create contrasts and atmosphere given mostly by some Area Light, or lights that enhance more details and points of interest (Fig. 10).
For example, the shapes of the lights, in the scheme for the Financial Center (Fig. 11), are of different shapes and have different heights from the ground to ensure that there is a play of shadows well contrasted to define the volume of buildings in a clear and evocative way.
The illumination generated by HDRI images can be adjusted by various factors such as light intensity, rotation of the image along the main axes, noise reduction in the environment, and the "sun tag" for Latitude and Longitude settings specific to a chosen location. It is a technology that extends the dynamic range of the image by showing details in light and shadow, allowing the creation of images that are very close to the actual amount of light present in a specific scene.
For each of the study scenes, the *Nishita DayLight Model* [8] was used, a physical model dependent on the rotation of the sun and the dispersion of the atmosphere, which implements atmospheric

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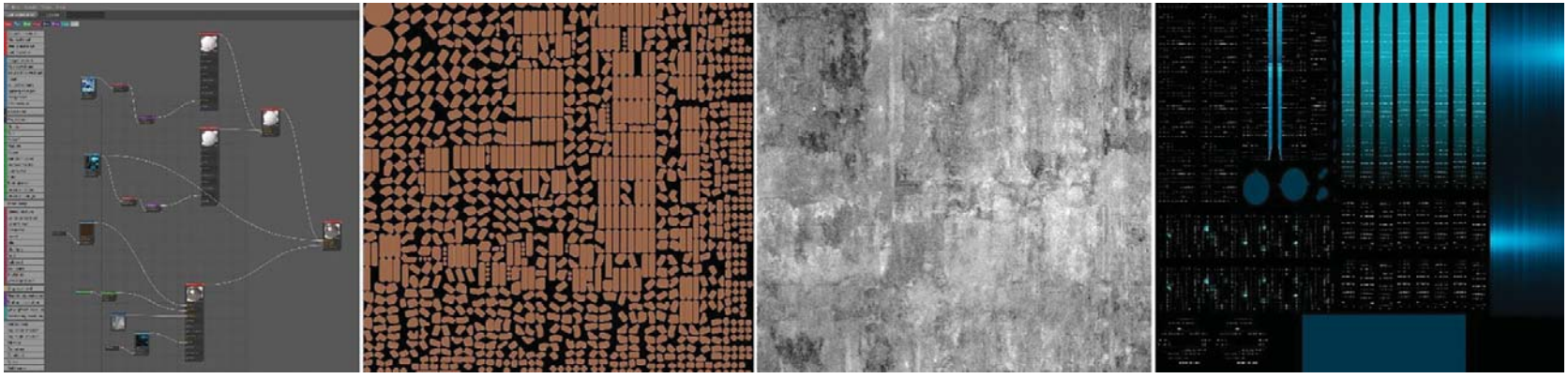

Fig. 13 - Node Editor of the composition of the material that characterizes the main buildings and textures that make up the channel of diffuse, reflection and lighting map.

diffusion and displays the colour variations that are optical effects caused by the particles present in the atmosphere.
Accent lighting, on the other hand, is given in each scene by Area Light, the shape, size, light intensity and colour shade of which can be modified. The light intensities of the scene, managed by the Blackbody Emission, vary from yellow to fuchsia and from orange to blue, so that the futuristic style of the metropolis is highlighted by the luminous contrasts.
Finally, it should be noted that each scene is also managed by the *AI Light* algorithm, which makes the images cleaner and more uniform as the number of samples increases. Assisted by AI Denoiser and Adaptive Sampling, this algorithm, based on artificial intelligence, studies the scene and establishes the sampling of the main samples of light during the rendering of the image.
Another important aspect in each of the scenes was the choice of *Diffuse Material, Glossy Material* and *Specular Material*, characterized by the BRDF (*Bidirectional Reflectance Distribution Function*) [9] factor, and the Fresnel equation for which the surface reflection varies depending on the observed angle and the IOR (*Index of Refraction*) values of the surface.

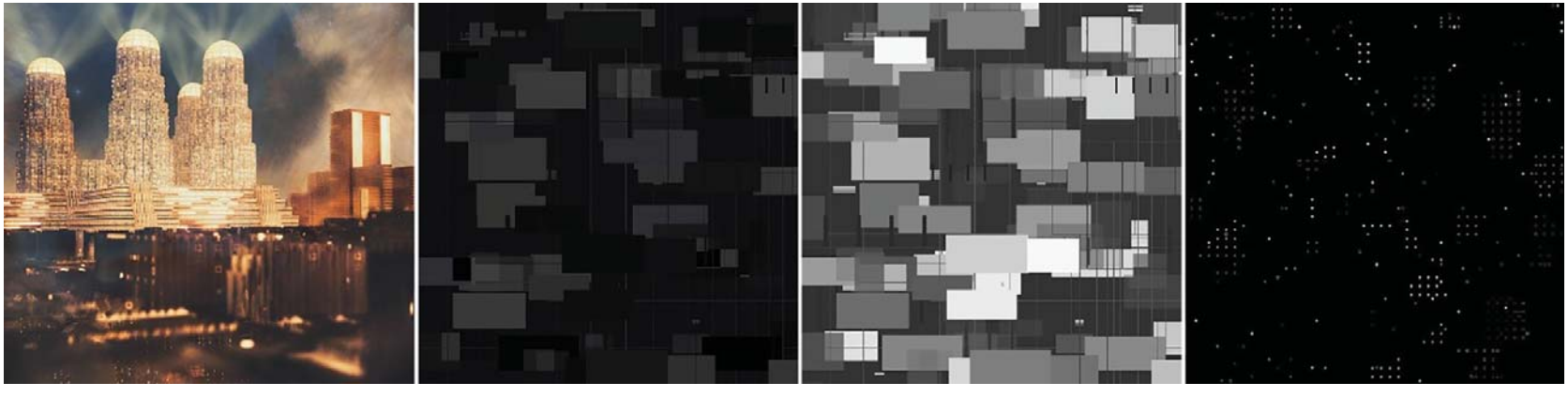

Fig. 14 - Render of "The Art Center" and textures that make up the channel of displacement channel and lighting map.

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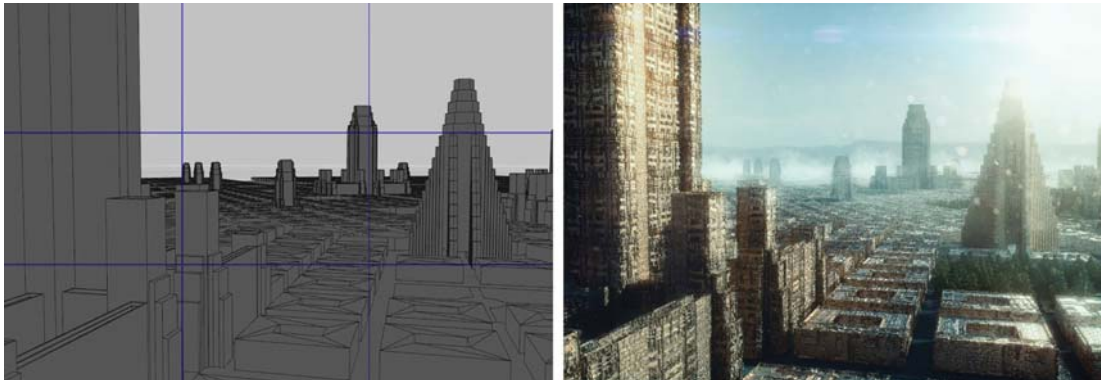

Fig. 15 - View from the terrace of one of the main buildings of the city with the rule of third parties applied to enhance its composition.

Fig. 16 - Some sequences from 1982's Blade Runner, in which Ferris' visionary character is clearly reflected in the architecture and atmosphere of Los Angeles in 2019

Diffuse Material is the easiest to make and is characterized by the presence of maps with non-specular reflection of light rays in all directions. In virtual reconstruction, they are the materials assigned to the streets, for example.The only exception is the view of the Science Center, where Diffuse Material has been combined with a Glossy Material to create a wet effect on the road with textures implemented with color correction and invert channels (Fig. 12).
The second type of material is Glossy, in which the angle of reflection of the light is equal to the angle of incidence. These manage both the amount of reflection on the surface and the force with which it characterizes the surface itself according to Fresnel Theory.
The Glossy Material is the one most used in the scenes of the virtual reconstruction to obtain an effect as futuristic as possible. Most of the buildings in each scene have applied this material, divided into several lighting maps broken down inside the emission channel and projected on the surface of the object (Fig. 13).
Finally, Specular Material is used to create transparent materials such as water and glass, where light hits the object and partly passes through it, while another part is refracted by changing direction. The effect is optimized by the *index of refraction* (IOR), the ratio between the speed of light in air (or vacuum) and its speed in the medium of transmission.
There is also a further type of material used for virtual reconstruction that allows you to recreate a 3D model, from a two-dimensional base, using the displacement channel [10] by composing multiple maps. This is the case of the material that characterizes the city in the foreground in the view "The Art Center" where it was not possible to define a detailed city in the foreground without increasing the timing of calculation. We decided to use an external software (JSplacement) through which displacement, normal and color maps have been generated that have characterized in detail everything in the foreground combined with the lighting maps, reducing the calculation time of the render (Fig. 14).

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Fig. 17 - Gotham City from the Batman comic book. On the left, a scene from the comic book "Destroyer". On the right one of the advertising posters from the movie Batman - The Dark Night.

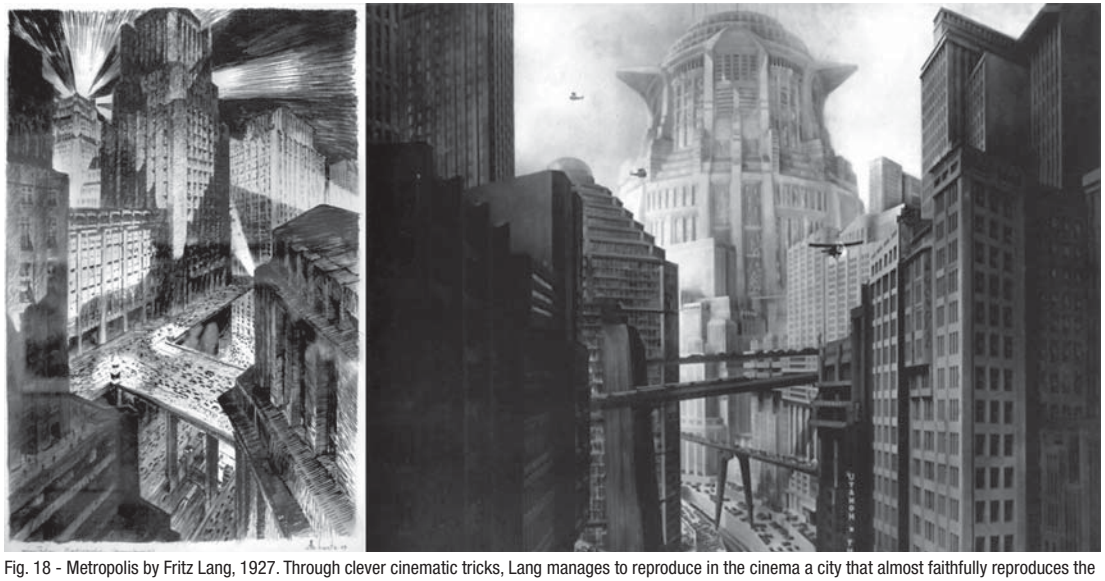

Fig. 18 - Metropolis by Fritz Lang, 1927. Through clever cinematic tricks, Lang manages to reproduce in the cinema a city that almost faithfully reproduces the atmosphere of Ferris more than many other cases

To communicate the feelings and suggestions that Hugh Ferriss thought in his utopian idea of a metropolis in an effective and correct way, were used Physical Cameras to manage the basic parameters of a camera, but also the depth of field (DOF), autofocus, manual focus, aperture of the diaphragm, shutter speeds, perspective correction and the bookeh effect. The technical solutions have been added to the photographic rules of composition of the image: in the bird's eye view where a detail is represented from the average height of a terrace of one of the main towers of the metropolis (Fig. 15) the *Rule of Thirds* [11] is applied to enhance the main focal points and give a greater emotional character to the composition.
What most characterizes the scenes of the city is the presence of clouds, haze and effects of volumetric light, obtained through the channels of *Scattering* and *Absorption*, changing the density, color and structure of the volume.
The option of *Volume Fog* has also been activated, directly from the HDRI or from the DayLight settings, so that the light interacted as naturally as possible with the fog and mist created, obtaining an ever-changing atmosphere.

STATE OF THE ART AND FUTURE PROSPECTS FOR STUDY

The process of image processing in 3D computer graphics is comparable to the work done in film production. To get a high result, you have to think about the goal you want to achieve. The software helps in setting up a rational and well-defined work workflow.
The composition of render must be aimed at exposing a design idea by transmitting to the observer the sensations and emotions set. The difference, compared to the designers before the advent of digital, lies in the techniques used. The study of light, colour and image composition, both in the images produced by computer graphics and

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Fig. 19 - Coco, one of the last Pixar masterpieces, directed by Lee Unkrich, from 2017. The characteristics of the city of the future coexist and blend with the colours and characteristics of Mexican culture to create a unique and complex city of the dead.

in the perspectives of about a century ago, must be governed by a communicative sensibility that, hopefully, has remained unchanged.
To analyse in more detail the suggestions that the visionary American architect wants to communicate with his ideology of futurist metropolis, it was felt the need to create three-dimensional models to which he can apply the technology of immersive virtual reality that allows the user to fully identify with the citizen of the metropolis of the future, perceiving the proportions and spatial dimensions extremely expanded.
Walking along the rigorous infrastructure system divided into several levels, you can get lost among the massive masses that stand out in the geometric grid and well-defined that characterizes the utopian megalopolis that places at the center of his project the man himself, who is however tiny in a city infinitely large and repetitive, as were the Piranesian prisoners.
The result of this process has led to an evolution in the approach to the design of the metropolis, highlighting new ways of use and presentation through the viewer, with which you have the freedom to move freely and see what most catches our attention.
Having the opportunity to see the design model in full scale provides a new perspective on the project itself. An overview of the details in real dimension highlights the various problems that can be found in real world and this ensures the ability to explore the different design variants of a building not yet existing and avoids misunderstandings about the process of implementation within the VR, as happened in the development of the *Metropolis of Tomorrow*.
The virtual reality management of such complex models is a complicated and fascinating obstacle. It is evident that the exploration of spaces, especially through the bird's eye view, would allow a greater understanding of Ferriss's urban and utopian project. In this way the emotional aspect could have been amplified through the use of VFX (for example particle effect in order to simulate rain, fog or smog) and above all through a soundtrack including sounds and noises that would have enriched the 3D model with further evocative attributes of the atmospheres so well represented by Ferriss's work.
The static images produced in this research allow to have a "monocular" vision of all the aspects analyzed, and the complexity of the urban fabric that Ferriss's transmits through dozens of drawings. His visionary thinking went beyond the rigidity of still images and abstract patterns. It is no coincidence that the author bequeaths us only one plan of the city of tomorrow. He wants to delegate his vision not to the abstraction of the two-dimensional image, but to sequences of perspective images that show the city in its complexity as if by air flight over it.
The use of VR is clearly the closest means to Ferriss' philosophy. However, this awareness comes up against the timing and difficulties in being able to exploit the appropriate software (UnReal Engine for example) for the navigable model. Research, at present, has as its first step the transposition of the architect's vision into a three-dimensional model scientifically correct in its choices, philological in its reconstructions, and accurate in its representation, with the awareness that the next step will be the diffusion of VR.
On the other hand, Ferriss's work, first among many at a temporal level, is actually the least studied and least dealt with from the point of view of reconstruction. Its atmospheres can be easily traced in many examples, especially in cinema, which over the decades has recovered those grotesque visions for the imaginary city representations dominated by the futuristic, heroic or evocative aspect.

THE ARTISTIC DIMENSION OF THE METROPOLITAN VISION. INFLUENCE OF FERRISS AND COMPARISONS

Ferriss's refined images are designed to communicate the emotional power of architecture: in cinema, painting and illustrations, science fiction and the desire for an increasingly evolved world have built the metropolises of the future.
The city designed by the visionary American architect is the image, revised in a modern key, from which Ridley Scott is inspired by his vertical megalopolis, shrouded in smog and neon lights, the protagonist of the scene in Blade Runner in 1982 (Neumann, D., 1999): set in Los Angeles in 2019, in a time when the rain is constant, the sun almost

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Fig. 20 - Looking west from the Business Center.

non-existent and reality is gloomy and artificial, where many ethical and philosophical issues are dealt with, which are surrounded by action scenes and supercomputers.
As well as looking to the future, it also feels the influence of the past: for this reason it is described by many as a "retrofuturist" film.
There is a clear reference to Hugh Ferriss's illustrations, both in the elaboration of the setting and in the scenography: both show a megalopolis constantly shrouded in mist and dirty rain, in which the ancient world and the future world coexist (Fig. 16).

The cylindrical towers that dominate the skyline can be linked to the tower buildings that cover the entire metropolis designed by the American architect; the Tyrell Corporation, one of the most spectacular architectures of the feature film, can be traced back to the structure of Ferriss's Art Center, where the base recalls the huge pyramids of the film; the atmosphere inside the police station can be found in the illustration of the interior of the subway station designed by Hugh Ferriss a few years earlier.
Cities are a reflection of the consciousness of those who live in them, until they themselves become a piece of the urban fabric and an incarnation of the city itself. This thought can be found not only in the real world, but also in the imaginary world: this is the case of the drawings in the comics of Batman, the famous superhero who made his alter ego the avatar of Gotham City, the city he swore to protect, which is in turn the representation of the collective urban paranoia of contemporary man.
The comic book cycle entitled Destroyer, with its black and white charcoal drawings of the city, is the one that best interprets the spirit of Hugh Ferriss. The difference between the Gotham City cartoonist, Anton Furst, and the 1920s cartoonist lies in the detail: while the latter focuses on the monumental aspect of the volumes, the former represents architecture rich in detail, even more emphasized by the chiaroscuro that gives it a grotesque character.
Unlike the idea of order and functionality that underlies Hugh Ferriss's megalopolis thinking, Gotham City is the representation of chaos and fear, where crime rules society and corrupts the souls of men. One thing in common with the US illustrator's graphic style is that he only sharply depicts what is of interest. The skyscrapers that dominate the Gotham City skyline seem unfinished, almost as if to symbolize the idea of the city's continuous evolution. The most contrasting chiaroscuro spaces move from Ferriss's street level to the mid-height areas, the abandoned penthouses and the forgotten towers of Furst.
Finally, it should be emphasized that the substantial

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difference between the two megacities lies in the concept behind both of them.
When Furst designed the city of the masked superhero, he gave life to Ferriss's fears: Gotham City was born in chaos and in the combination of multiple architectural styles. Art Deco skyscrapers exclude sunlight from the streets while steel and brick buildings contribute to the city's skyline design.
From an urban planning point of view, on the other hand, there are many examples of Hugh Ferriss' futuristic canons, but the film that most represents his thought and graphic-visual technique is Fritz Lang's Metropolis of 1927 (Bellour, R., 1981) (Gunning, T., 2000).
The vision of Manhattan's skyline at dawn is an inspiration for the film's screenplay, which is set in an inhuman and gigantic city ruled by a slave and mechanized society (Marinetti, F. T., 2016). There are remarkable symbolisms that refer to Hugh Ferriss's illustrations, starting from the presence of archaic structures, as shown by the internal buildings with medieval towers and Gothic churches, to the actual structure of the entire city. The latter, in fact, is designed on several levels and dominated by skyscrapers connected by roads and suspended bridges, where life takes place in a frenetic way (Fig. 18).
The centralized structure of the metropolis is reminiscent of that hypothesized by the visionary architect of the 1920s, with the difference, however, that the dictator's tower is located in the center and not a large green park in which a well-defined infrastructure network connects the main centers of the city.
In more recent times and through the use of digital techniques, The Walt Disney Company has also developed its own version of a utopian and retro-futurist metropolis. It does so in Lee Unkrich's film Coco and, precisely, in the representation of the world of the dead.
Unlike his colleagues in the past, the director uses the bright colors of Mexico to describe atmospheres usually associated with dark and dull colors: the Land of the Dead is inspired by the city of Guanajuato and has a strong vertical development to accommodate its many inhabitants.
As in the perspectives of Hugh Ferriss, it is possible to find references to the architecture of the past and, specifically, to the pre-Columbian origins of Mexico (Fig. 19). In fact, it is evident that we were inspired by the city of Teotihuacan, an archaeological site known for its wonderful pyramids and fascinating architecture. Moreover, it is evident the structure of the city divided on several levels, with city islands connected by improbable bridges to the main bodies, very high towers, of which almost no end can be seen. Plans on overlapping levels poised one on top of the other to form these buildings in which the souls of the dead live. And although the concept of the city of Ferris is kept solid, the most interesting aspect remains the adaptation of this concept to the Mexican canons, which are perfectly incorporated and merged into Unkrich's vision.

CONCLUSIONS

Multiple factors come into play in virtual reconstructions. We often limit ourselves to some aspects, ignoring others. However, the right workflow requires that all aspects are analyzed and that the choices made are consistent and justifiable. In the case of the virtual reconstruction of Ferriss's City of Tomorrow, each developed decision has been weighted, combining graphic information [12] with documentary information. It was a complex research because the initial choices did not always lead to a consistent outcome. So a continuous back-and-forth process was necessary so that the result was the optimal solution, although not the only one, but rational and analytical. There are rare cases in which the reconstruction choices invest an entire city, moreover utopian and therefore not built, with open formal solutions, few dimensional information, perspective images often subjectively modified with respect to the planimetric plant. In addition, it must be considered that the same perspective images provide an infinite amount of details, impossible to model and that they would have made the 3D model heavier. To this end, the wise use of material maps has allowed a representation in accordance with Ferriss's drawings. The work presented is a unicum that currently has no other comparable examples. It links a reasonable and philological virtual reconstruction to render images of great graphic and emotional impact, in order not to lose the original intent of Ferriss himself.

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NOTE

[1] Borrowing from the Restoration the motto of Paolo Marconi.

[2] The Chicago School makes a fundamental contribution to the formation of the Modern Movement. Developed following the fire of 1871 and driven by the strong impulse of technological innovation in the construction sector of the late nineteenth century, it stands out from the European classicist canons in order to seek the optimal form of construction in the skyscraper. Among the greatest exponents we find Daniel Burnham, John Welborn Root and Louis Sullivan.

[3] All Ferriss drawings are collected by The Drawings & Archives Department of Avery Architectural and Fine Arts Library at Columbia University in New York.

[4] At the beginning of the twentieth century the progressive architectural development due to technological progress, led the city of New York to have numerous massive skyscrapers that created dark and airless channels between them. New York thus feels the need for an urban planning law designed to manage and improve the current situation. In 1916 the Zoning Resolution was launched to bring light and air to all roads, adjusting the shape of skyscrapers in direct relation to the width of the road. The building must not exceed 25% of the block's surface and, once it has reached the height of 50 meters from the sidewalk, it is necessary to progressively retreat along a diagonal projected from the center of the adjacent road.

[5] The German photographer Nicola Perscheid to create his most important portraits, photographs with reduced contrasts with very diffuse lights and blurred areas of the image, to give a dreamlike atmosphere, uses the "soft focus or flou effect". It is used to soften the traits of the represented subject hiding the imperfections thanks to the use of a very accentuated glow.

[6] A term used to indicate a metropolis where the ancient world and the future world coexist.

[7] These are images taken with the 32-bit "high dynamic range" technique, which, instead of encoding the colours of the image using 24 bits for each pixel like computer monitors, collect information on the colour through the analysis of three independent channels (trichomatism).

[8] There are two previous models of lighting: OLD DAYLIGHT MODEL that illuminates the scene with a basic spectral radiance while the sun moves on the horizon at a relative distance from the object, and the NEW DAYLIGHT MODEL that is used to simulate full spectrum daylight, providing greater color variation in the sky in relation to the inclination of light rays.

[9] A parameter that allows a reflection as likely as possible to that existing in the real world, considering the interaction between the surfaces and the variable of the micro-facets.

[10] A flat surface is extruded on the basis of a map in grayscale, according to a gradation ranging from maximum extrusion in white to zero extrusion in black.

[11] The Third Party Rule is a compositional rule that assumes a framework divided, by two vertical lines and two horizontal lines, into 9 perfectly equal rectangles. In the 4 intersections between the lines the gaze is concentrated and are the strengths in which to bring together the subjects of the scene.

[12] The realization of the renders of the research has been possible thanks to the precious help and to the direction of the Arch. Alessandro Basso.

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