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VIRTUAL REALITY FOR URBAN PLANNING. THE PORT OF PALERMO: PAST, PRESENT AND FUTURE.

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Abstract

Virtual reality is proving to be an interesting tool for the visualization of 3d models developed for urban planning. It allows not only interactive visualization, but also the possibility of inserting analogical and informative contents. The case study relates to the development of a 3D model viewable in virtual reality of the Port of Palermo area, of great urban, historical and logistical interest. The system allows the visualization of its current state, historical emergencies and future developments, as well as the comparison between existing services and those planned in the reconfiguration project.

Keywords

Urban Planning, urban 3d model, virtual reality, real time rendering.

1. *Introduction*

The case study relates to the creation of a virtual model of the port area of the city of Palermo, aimed at the interactive visualization of the current state and of the project forecasts, relating not only to the architectural and urban transformations, but also to the reorganization of services and enhancement of historical and archaeological areas.

We want to propose a three-dimensional visualization system of the planning phases, which can offer a service to administrations, planners and citizens and triggers participatory processes in the decision-making process. Provided as an open and implementable system, it can also be configured as a visualization tool for new urban configurations and services.

This work presents the first results of a research coordinated by the authors that takes its cue from the model developed in the degree thesis discussed by Ferdinando Gangemi in the LM4 Architecture course of the University of Palermo (March 2020), entitled *Virtual reality as a planning tool. The case study of the port of Palermo*.

2. *Palermo: A City Always Fit for Mooring it*

«By 3 o'clock P.M., we at least, after much trouble and difficulty, got into horbour, where a most glorious view lay before us. Perfectly recovered from my sea-sickness, I enjoyed it highly. The town facing north, lay at the foot of a high hill, with the sun (at this time of day) shining above it. The sides of the buildings which looked towards us, lay in a deep shade, which, however, was clear, and lit up by reflection from the water. […] Kniep has to-day left me to make my pilgrimages and observations by myself, in order the he might accurately sketch the outline of Monte Pellegrino, the most beautiful headland in the whole world» (Goethe, 1885, pp. 217-218).

Goethe's tale, throughout the story of his journey to Palermo, describes a city by the sea with a close relationship with it and that characterized the real identity of the place.

This is the atmosphere that seduces travelers who visit the cultured and bourgeois Palermo between the late 18th century and early 19th century. In this cultural atmosphere Goethe captures the harmonious ensemble limited to the north by Monte Pellegrino with its elegant line in full light and, on the opposite side, by Villa Giulia, built in 1777 under the regency of Praetor Antonio La Grua and Talamanca, Marquis of Regalmici and Viceroy Marcantonio Colonna, based on a project by Nicola Palma. Goethe defined the Villa as the most beautiful place in the world; and by the suggestions that he obtained from it he claims to

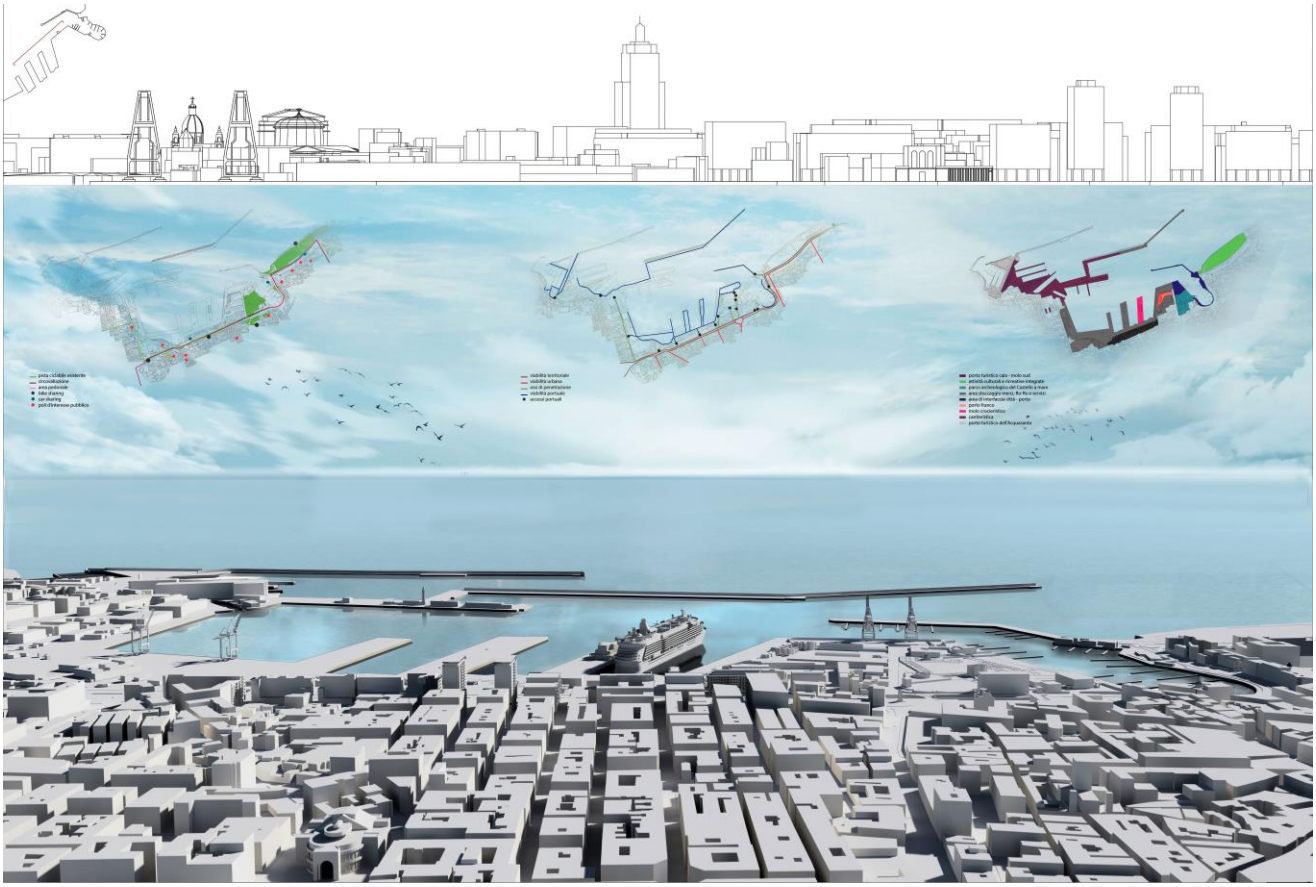

Fig. 1: Area of the port of Palermo. Current situation: high, urban profile seen from the sea, layouts of services, roads and functions. Bottom, bird's eye view of the 3D model (drawings by F. Gangemi).

have found there *Urpflanze* the primigenial plant. A few years later even the imagine of A. Dumas is encouraged by the same. He wrote that nothing is so splendid as this walk, behind a row of buildings, with a communicating gulf in the open sea wrapped and protected by a belt of mountains.

We could mention other travelers who visited Sicily and in particular Palermo in the same period. the image they have passed to us is always be that of a city on the sea, which had its origins from the sea, which found in it an economy.

The study of the city leads to consider the urban form a product of history. What we perceive, the humanized landscape as a whole of natural and artificial elements, is not only what we see but also by the study of the dynamics of interactions between the nature and the society. Observing from this point of view the urban reality of Palermo one of the connections between nature and artifice is represented by the biunivocal link between the city and the sea.

Palermo, from its origin and later during its development, has underlined the complex and articulated connection with the sea (Fig. 1).

Rosario La Duca, an eminent scholar of the history of the city, states that this relationship is at the origin of the choice of the site for the settlement: its topographical position encloses the reasons for its development.

After all, its current name, Palermo, can be traced back to its geographical position. The Greeks baptized it Panormos, the all-port city (De Seta & Di Mauro, 1981).

Over time this relationship has changed. Today a traveler who arrives in Palermo would hardly perceive that image. The reasons are certainly to be found in the urban growth of a city today defined as metropolitan, as well as in the development of the port. Especially in the last two centuries it has assumed an important role both in the shipbuilding part and in the commercial and tourist one within the Mediterranean area.

The waterfront, consolidated in the first half of the 14th century, is conceived as a form that subtends variable contents: aesthetic, as a limit whose perception transmits the unity of the built; socio-political, as a guarantee against enemy sieges; economic, as a place dedicated to trade.

The study of the urban history of Palermo allows us to identify the salient moments of the transformations, the motivations and the consequences that the policies implemented by the various Administrations have produced. It is in the plans and projects, for the whole city or for some limited areas, that we find the answers to the question: why a city born on the sea today is a city that denies the sea?

3. The city grows far from the sea

With the Unification of Italy, the cultural will for a city planning aimed at the overall improvement of urban quality matures. And also, the waterfront becomes the object of project elaboration.

The first ideas are contained in the projects drawn up by the engineer Felice Giarrusso, in the various versions from 1885 to 1889. Within them was planned, for the part of the waterfront of the existing city, the enlargement of the road and the construction of a large geometric garden; for the new city, the expansion, instead, planned the construction of a wide road connecting the historic city with the port and, beyond, the seaside boroughs.

If the first forecasts are not carried out, if not partially at the end of the last WWII with the realization of the current esplanade by filling the stretch of sea in front of the historic city, those relating to the area of the port are resumed in the "Piano di Ricostruzione" by the extensive damage caused by the bombing. It drew a new urban waterfront that could mend the relationship between the city and the sea (Inzerillo, 2017).

Later, with the Master Plan of the 1962, with the "Detailed Executive Plan" of 1989 and with the Master Plan of 2004, a theoretical intent to refound the ideal connection with the sea emerges. Today we can find them only in the part in front of the historical city (Fig.2).

The forecast of connecting the northern part of the city to the sea again, from the old port to the shipyard area, remain just an idea. For a deeper analysis of the transformations that have taken place in this part it is useful to compare with the urban planning projects and policies that over

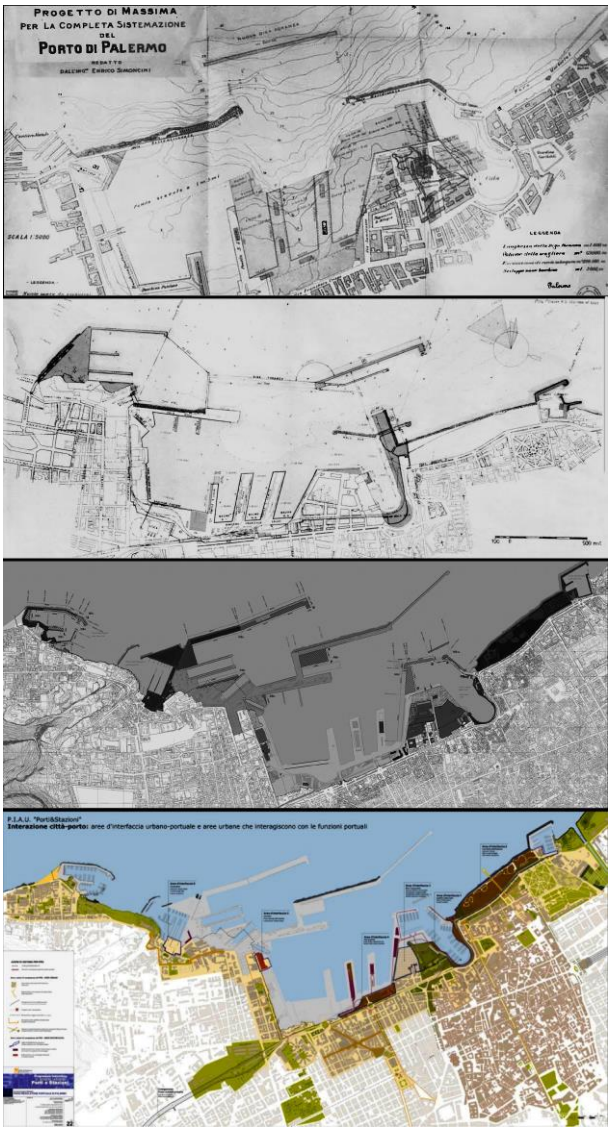

Fig. 2: Area of the port of Palermo: Port Regulatory Plans of 1919, 1964, 2008, 2011.

time have produced the image of the part of the city, subject of this study. The comparative analysis can provide the answers to the questions: why do the city, the neighborhood have a certain form? why have some urban planning and architectural choices been made? who were the actors of these choices?

This method of analysis will also allow us to verify how all the choices have been imposed with a top-down method, relegating the phases of participation, publishing and communication to the only ones provided for by law, limited to the phases of observation by citizens. Moreover, this type of participation, very far from what is intended in the current disciplinary scientific debate, has certainly never facilitated the possibility, on the part of the non-technical citizen,

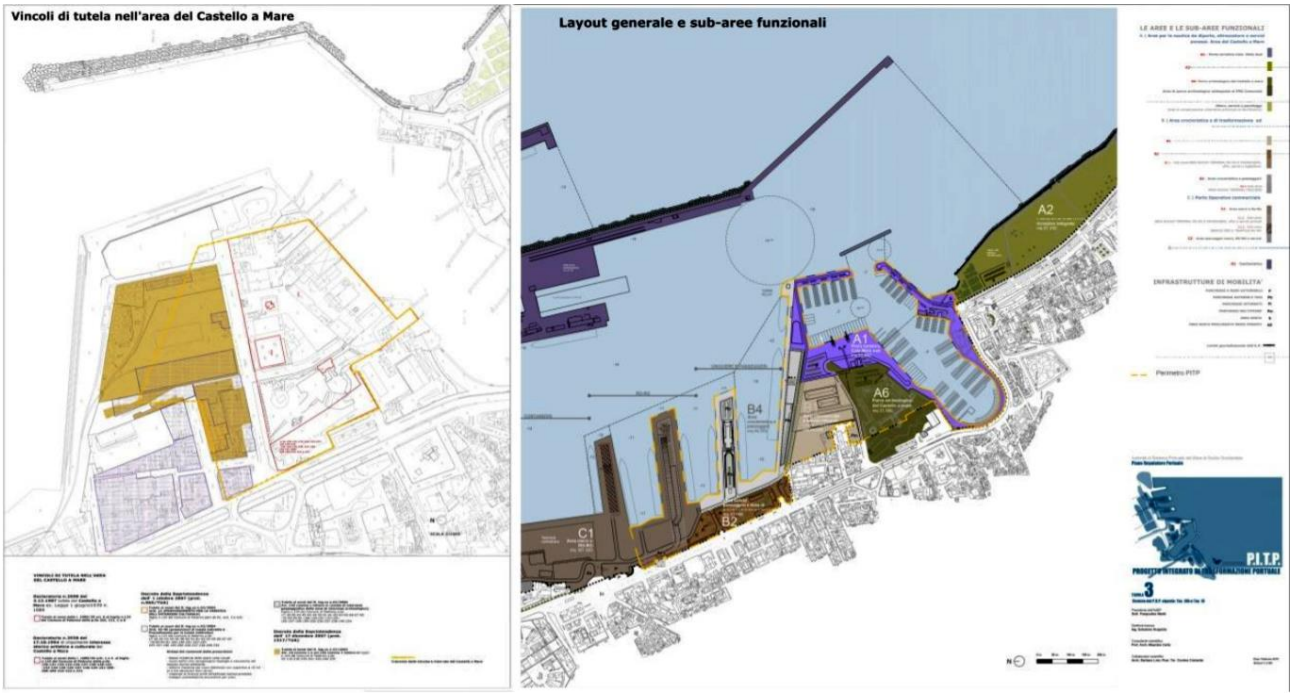

Fig. 3: Piano Integrato di Trasformazione Portuale (2019), Board 3 (from: http://www.adsppalermo.it/).

to understand, to see what would have been the result of the plan proposal or the project.

The need for a new communication policy regarding the forecasts of the different plans towards a participatory, botton-up design process can open new perspectives not only for interdisciplinary research, but also and above all in profession. Among these new techniques, communication techniques, some of which are the subject of this study, will certainly be fundamental.

4. The importance of a participatory design process

Urban studies have already been debating for years on some issues rarely unfortunately connected: the dissemination of participatory practices and cooperation between public and private actors; participatory action research and scientific and professional training for new generations of professionals (Picone & Schilleci, 2019).

If the relationship between participation and research has been widely investigated in recent decades, until the theoretical elaboration of the so-called Participatory Action Research (PAR), its application in professional practice still sees some difficulties to take off. Several scholars have highlighted how participatory forms are excellent test beds for field research (Sclavi, 2006; Kindon, Pain & Kesby, 2007; Cellamare, 2012; Morisi & Perrone, 2013).

Moreover, to date, it cannot be ignored that participatory practices have become an indispensable element in addressing the issue of contemporary governance. Even in Italy, although several years late, there is a growing need to include more and more participatory instruments in its urban policies. In some cases it has been mandatory by law.

In the last fifteen years, in fact, there has been a proliferation of studies on participation in Italy, both with the publication of Guidelines for users and administrators (Bobbio, 2004; Arena & Iaione, 2015), and, sometimes, thanks to theoretical frameworks that can support the use of participatory practices (Ciaffi & Mela, 2006; Cellamare, 2012; Morisi & Perrone, 2013).

In Italy, as participation is increasingly becoming mandatory by law (Banini & Picone, 2018), several Regions have published laws that provide for the use of participatory processes: among them, Emilia-Romagna, Umbria and Tuscany, all Regions with a long progressive administrative tradition, in addition to the very recent case of Puglia.

Fig. 4: Port area of Palermo: current state (modeling and rendering by F. Gangemi).

In Sicily, particularly in Palermo, more or less effective participatory experiences have been carried out for years (Picone & Lo Piccolo, 2014; Picone & Schilleci, 2019) although without precise normative references.

However, despite the media and political interest on the theme of participation many notions are still unclear and easily manipulated, probably because participation is not part of the traditional Italian normative culture (Sclavi, 2014; Arena & Iaione, 2015). This shows how it is essential to multiply not only practical experiences, but also theoretical reflections on participatory practices, if we want to avoid errors, or worse willingness, of manipulation (Habermas, 1981).

Since this is not the right context to examine the participatory techniques, we would just like to emphasize that among them the use of visualization of architecture and urban space, to provide the public with realistic walkthroughs of proposed plans in 3D, is very useful and effective (Levy, 2011). The increasing use of Virtual Reality (VR) technologies, for example, can become a great help for the simulation of urban environments and also an effective means to make all the interested actors understand the opportunities and strategies of a project. This research «considers the need for a digital representation of cities and raises issues pertaining to advantages, barriers and ownership» (Thompson, Horne, & Fleming, 2006, p. 1).

5. A New Communication Policy

Now it seems evident the need for a new communication policy regarding the forecasts of the different plans. A policy that takes into account that the more effective is the communication of the project idea and its physicality to all actors, technical and non-technical, the higher will be the level of the debate that will follow that will lead to a shared and therefore accepted solution. A shared and accepted project produces citizens who are more aware and therefore more responsible, and who can contribute to the maintenance of the city and respect for public space.

The use of virtual reality as an instrument of control, but also of communication, can be a fundamental element of this new policy.

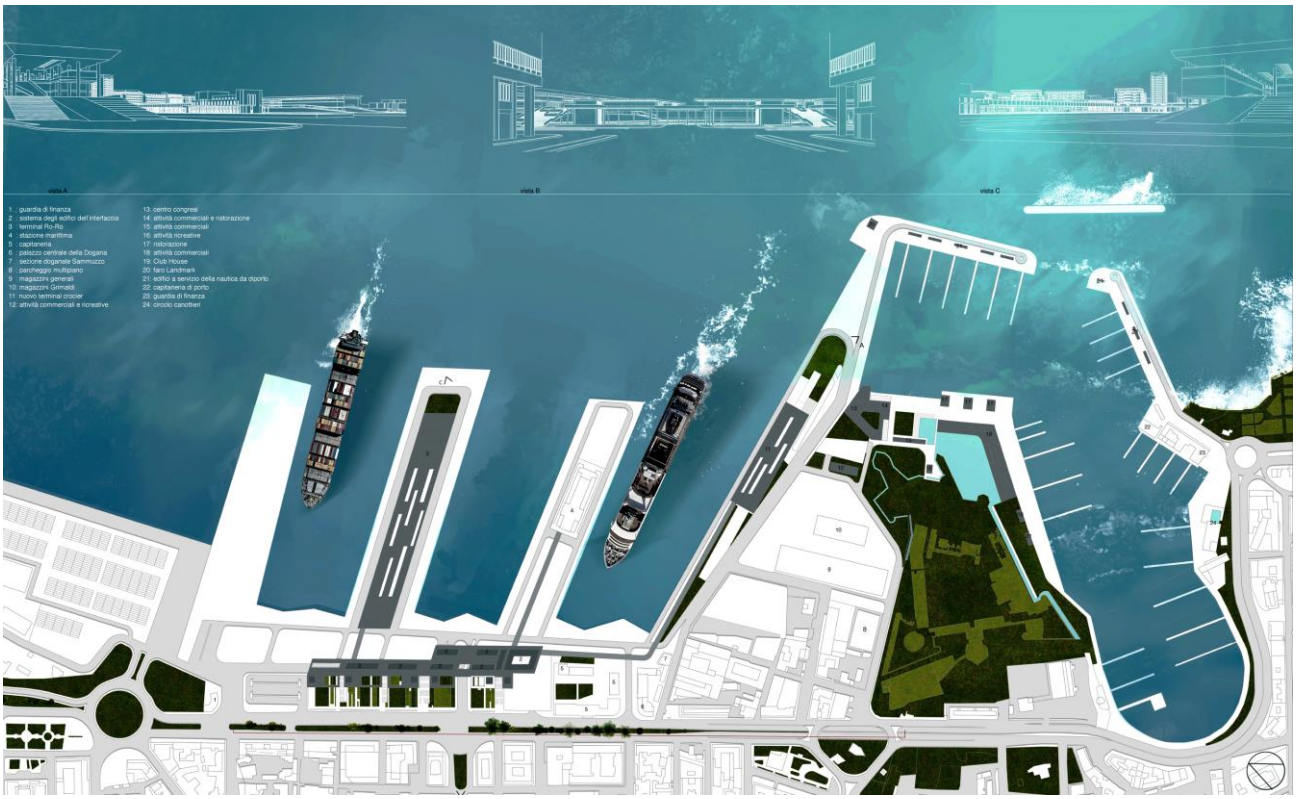

Fig. 5: Port area of Palermo: winning project by Studio Valle 3.0 in Rome (Gilberto, Emanuela, Maria Camilla and Silvano Valle; modeling and rendering by F. Gangemi).

The present work has tried to put this idea into practice. The case study identified is that of the port area of Palermo, a place that in the last two centuries has been the subject of numerous projects. The methodology used has seen in a first phase the analysis of the different plans and projects, realized and not. Then in a second phase to build a model, limited to the forecasts of the Port Master Plan and related projects, of virtual reality, a method that will be presented in the next part.

Let us examine these projects and how virtual reality can help to understand the elements of the plan and the connections with the other tools for city management.

6. Projects for the Port of Palermo

To the end of the 20th century, projects for the port area and more generally for the coast were either produced within the ordinary local planning (Master Plan) or with specific projects that did not contain, however, any indication of possible synergies between the city project and the port activities. The current Master Plan of Palermo, approved in 2004, puts back to specific planning the port area. It emphasizes the clear separation of the two competences: the Municipality for the city and the territory of Palermo; the Port Authority for the Port with a specific Master Plan.

The legislation provides that the Master Plan is adopted by the maritime authority, in agreement with the Municipality, establishing the "Autorità di Sistema" that put a group of ports in system[1].
The current Urban Planning Instrument is the Port Master Plan approved by Decree in 2018 (Fig.3).

The Plan covers a wide area, identified by the Ministerial Decree, regardless of the mere functions related to maritime traffic. The Port of Palermo, in fact, being a historical and urban port, is also an interface area between the city and the sea.

The plan is based on an in-depth knowledge of its various functional parts and their prospects for transformation in the short and medium term. For

[1] Specifically, the Western Sicilian Sea Port System Authority includes the Port of Palermo which is the main port, the Port of Termini Imerese - which was already under the jurisdiction of the Port Authority of Palermo - and the other two ports in Western Sicily, the Port of Trapani and the Port of Porto Empedocle.

each of the functional components of the port the Plan analyzed: the degrees of connection with each other and with the city and the territory; the different levels of autonomy and compatibility with urban activities. The different demands for functional enhancement, flexibility or transformation were also assessed.

The Plan shows a particular attention to the relations between the city and the port, because in a port area of ancient formation such as Palermo, there are areas of margin where port activities are more compatible with urban ones. «These areas, although part of the port system and the maritime domain, are also areas of great attraction for commercial, cultural and leisure functions: they are spaces of interaction and integration, where the new urban centralities related to the redevelopment of urban waterfronts are concentrated» (Autorità Portuale di Palermo, 2008, p. 8).

Therefore, the Plan is aimed at strengthening, enhancing and developing in a competitive way the Port of Palermo, which is designed as a gateway to the regional system and as the main node of the Tyrrhenian Port System. It also increases its commercial and therefore financial capacity. The strategies adopted to achieve this result include: the strengthening of the commercial port and the concomitant maintenance of existing industrial activities; the increase of services for cruise ships; the improvement of the quality of pleasure boating; leisure services related to the enjoyment of the sea; the creation of an interface area with activities for mixed port-city use.

Consistently with the Guidelines published in 2004 by the Superior Council of Public Works for the drafting of Port Master Plans, it has the character of a Structural Plan. It takes into account the fundamental and permanent characteristics of the places to which the plan is related. It examines any existing restrictions, the system of large infrastructures, the importance of connecting each port in an efficient and organic way to the infrastructure system of the territory of immediate reference, of which the port itself constitutes an important terminal and, at the same time, an important intermodal node. It identifies, within the port environment, two port sub-environments: the Operative Port sub-environment and the City-Port Interaction sub-environment.

It also includes the urban connections, aimed at linking the city with the port areas more compatible with urban activities and urban fronts, as the redevelopment of waterfront areas.

All this requires a close relationship with other Urban Planning tools, such as those for Mobility Infrastructure, as well as Ordinary Planning tools.

Following the competition announced by the Port Authority of Palermo, the project was entrusted to Studio Valle 3.0 of Genoa (Gilberto, Emanuela, Maria Camilla and Silvano Valle), which was the winner (Figg. 4-5). The virtual model refers to the project documents, present on the site of the Port Authority of the Sea of Western Sicily[2].

7. Virtual Reality and Planning

Several actions are needed for effective urban planning: analysis of the processes that have produced the current city; use of participatory practices; research of effective and innovative methods of communication; project education.

We believe it is necessary to search for a methodology that links all these different actions. We also imagine the plus that it would have if all the actors of the single phases can talk to each other. And above all, that citizenship can transform itself from passive to active. In order for this to happen, citizens must be made able to understand each project, even if they are not technical. They must be given the tools, therefore, to do so.

Between these tools virtual reality can play a key role, making information from simple texts or two-dimensional drawings into 3D models to be used as communication tools available to the urban planning project.

The result could be to show a place where all the elements describe a common form of life; a place where one finds a sense of the Genius Loci, a right that gives life to places and determines their character or essence (Norberg-Schulz, 1979) [3].

8. State of the art

The application of virtual reality systems to urban design has been attracting interest for several years.

One of the first applications that can be considered as three-dimensional modeling and realization of a VR system is that relating to the city of Bath: in 1991 the CASA (Center for Advanced

[2] The project tables, in raster format, are published on the site http://www.adsppalermo.it/.

[3] Paragraphs from n. 1 to n. 7 were entirely written by F. Schilleci.

Spatial Analysis) of the University College London was commissioned by the City Council of Bath to create a virtual model of the city, in order to visualize the project outcomes in the various hypotheses and to involve administrators and citizens in the choices deemed most suitable for the future of the city. In addition to being an effective tool for controlling the design process, the VR system has made the decision-making process more democratic. Among the desired developments, the designers include some functions relating to: data mapping relating to pollution, land use, energy consumption; integration with traffic simulation software; editing of objects; territorial transformation; links to historical information contained in external databases (Bourdakis & Day, 1997). A detailed description of the project can be found in the Smith, Dodge and Doyle report, published the following year (Smith, Dodge & Doyle, 1998).

The project has aroused a lot of interest and is mentioned by Bhunua, Ruthera and Gainb, who underline how useful the application of VR to urban planning can be, not only for the verification of design choices, but also in the process of communication, sharing and participation of a large audience (Bhunua, Ruthera & Gainb, 2003).

Regarding the role of VR in urban planning, they emphasize its communicative capacity: “The success of "Virtual Urban Design" can be measured in the following ways: it's ability to convince the client (i.e. the public, regulating bodies, and lobby groups), that the proposed urban guidelines can be successfully implemented; it's ability to convince urban designers that models and simulations are realistic and accurate, and that VR can be used as a powerful and useful tool in urban design” (Bhunua, Ruthera & Gainb, 2003, p. 202).

In 2002 Al-Kodmany, reporting some applications on Chicago neighborhoods, describes the potential of an integrated approach to urban design that includes 3D model visualization systems, and already sees the possibility of planning that involves citizens: “The Internet has already proven to be valuable on itsown as a low-cost mode of communication for participatory planning through Web sites, e-mail, surveys,and online conferencing” (Al-Kodmany, 2002, p. 203).

In 2010 a study conducted by the Department of Industrial Design, Art, Communication and Fashion, Politecnico di Milano allowed the virtual reconstruction of Piazza Cordusio, in Milan, which allowed the display of the square thanks to a projection on CADwall. Also in this case, the model allowed access to analytical and service-related data (Ceconello, Spallazzo, 2010).

Another study case that can be considered as examplary is that of the Virtual Newcastle-Gateshead (VNG). It is a project carried out in the UK born from the collaboration between Northumbria University, the City Council of Newcastle upon Tyne and that of Gateshead. The project was managed by the Department of Architecture and Environment built in Northumbria University's Faculty of Engineering and Environment, and the first results were published in 2012 (Dalton, Horne, Morton, Thompson, 2012).

The three-dimensional model allowed the analysis and definition of the design choices of the planners of the two towns overlooking the River Tyne, allowing a unitary urban design thanks to the shared forecasts of the design hypotheses. Administrations had the ability to view them thanks to rendered images of the 3D model, animations and virtual walks of urban areas, in addition to real-time access to technical information. The approach, which proved to be particularly effective, was subsequently expanded and is still being studied to prevent its obsolescence.

9. Workflow

The creation of the virtual model was carried out in various phases: data acquisition; CAD modelling; polygonal modelling; normal verification, texturing and mapping; Meshes optimization and LOD; taxonomic architecture; User Experience; User Interface.

9.1 Data acquisition

The first phase was the acquisition of two-dimensional vector data. For the current state ofthe area, reference was made to the CAD drawings of the Municipal Technical Map, carried out on the basis of the information extracted from the aerial photogrammetric flight of 2007. The report, in DWG format, was reorganized in its structure of the layers and optimized by redrawing polylines and other two-dimensional vectors. The operation was necessary because the original work was produced with a two-dimensional design as the objective, while a planimetric design was needed which could be used as a basis for

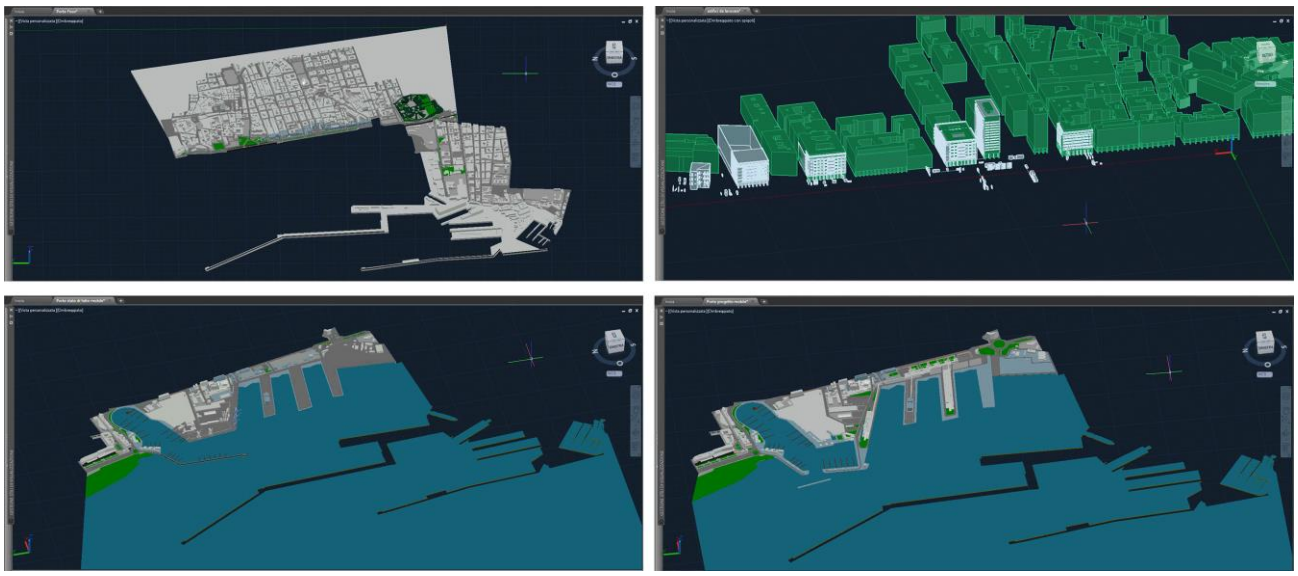

Fig. 6: 3D CAD model: top left, the urban area facing the port, top right, the urban fronts, bottom left, the state of the port area, bottom right the project model of the port. port area (modeling by F. Gangemi).

three-dimensional modelling. The altimetric information was obtained from the satellite survey processed by Google Earth Pro and integrated with dimensional information deriving from photographic survey.

For the project phase, reference was made to Table 7 of the Integrated Port Transformation Plan of Palermo, implemented in 2019, present on the site of the Port Authority of the Sea of Western Sicily; the vectorization of the project table was carried out taking into account the planimetric, morphological and dimensional indications obtained previously.

9.2 CAD modeling

The model, made with Autocad 2019, was organized by layers and editable blocks, categorized by types: roadway, residential buildings, docks, architectural and engineering elements related port activities, to mention only the main ones. The organization in layers and blocks was useful in view of the subsequent editing operations for the virtual model. Three macro-areas have been identified: the urban area in front of the port, the port area in its current state and the same area in the project configuration. The modeling phase took into consideration the future usability in VR and, therefore, the urban fronts which will be visible were modeled with a greater level of detail, while, in order to contain the number of polygons, those of the neighboring streets were realized by reproducing only the general volume (Fig.6).

9.3 Polygonal modeling

The three-dimensional models were subsequently imported into the 3D Studio MAX 2019 software, in which the solids were transformed into editable polygonal meshes, subjected to control and correction of the normals direction. The optimized meshes were subsequently broken down into editable sub-elements for unwrapping and uvw mapping operations (Fig.7).

Two models have been developed: one of the actual state (2,220,000 polygons), and one of the project (2,076,000 polygons), both georeferenced, with the aim of making them separately recognizable in the VR platform.

9.4 Normal verification, texturing and mapping.

The texturing operations were carried out by building maps from high-resolution photographs taken in situ, subjected to photographic straightening and correction of brightness and saturation levels. From the original images, those to be inserted in the bump, displacement, normal bump, ambient occlusion, reflection and opacity channels were obtained.

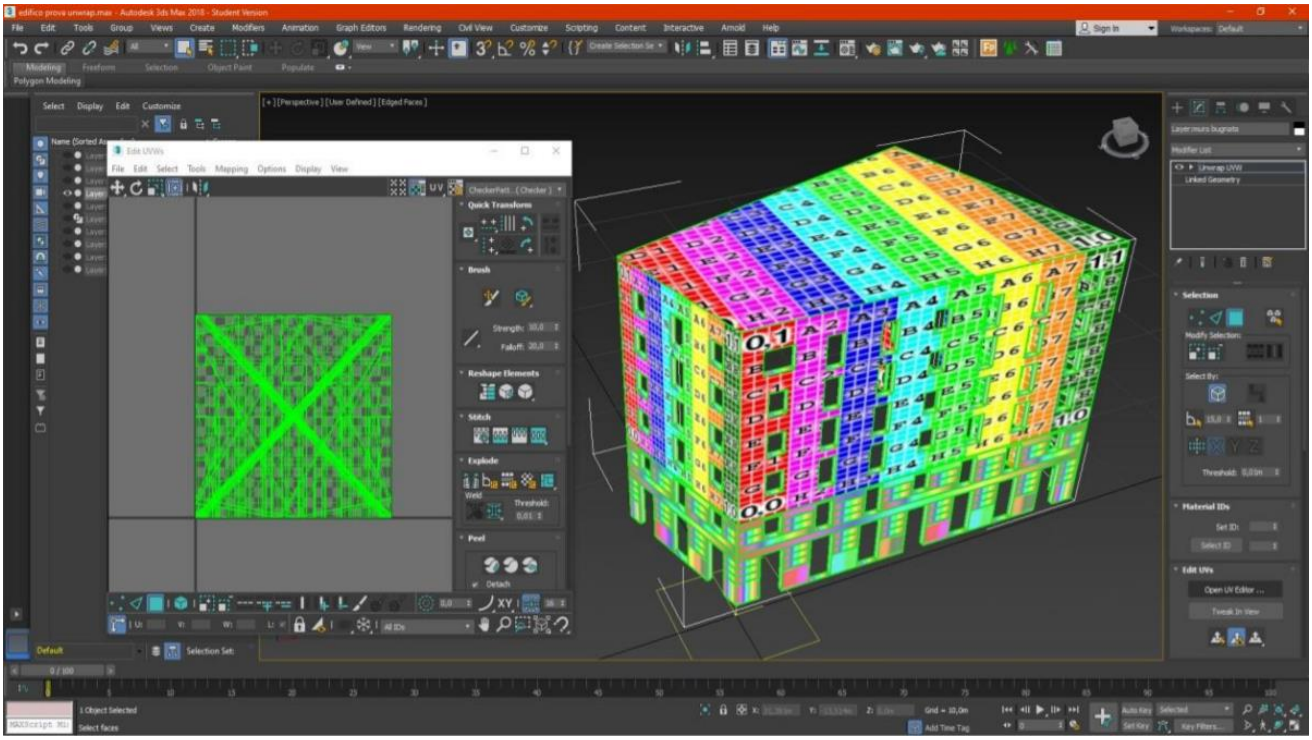

Fig. 7: Surfaces unwrapping of a single building (elaboration by F. Gangemi).

The textured models were subsequently imported into Unreal Engine 4. 24. The import into Unreal was managed by the support of the Unreal Datasmith plug-in, which proved to be particularly effective in the process of reading the file from 3DS Max, keeping the information related to geometries, layers, unwrapping and texturing.

The import phase allowed the correct positioning of the various files of the 3d model, thanks to georeferencing, already providing the possibility of making the two configurations visible or invisible.

The next step was related to a further verification of the normals, in order to avoid display problems in the case of reversed normals.

Once the correctness of the polygonal surfaces was verified, the collisions were inserted, aimed at correct navigation, preventing the crossing of the boundary surfaces of buildings and other physical elements, as well as determining the navigation limits and circumscribing it to the area of interest.

To make some materials that did not need photographic relief, we preferred to process some textures of standard materials inside Unreal (asphalt, plaster, cement, metals), using the Bridge software (produced by Quixel): starting from the default materials, we set the UVW map coordinates on the parent materials, and defined the various channels in the child materials (base color[4], normal map[5], world position offset and pixel depth offset[6], ambient occlusion, specular[7] reflection).

9.5 Meshes optimization and LOD

The last preparatory phase for the study of use was related to optimization. Being in the presence of a model that, in its final version, had almost 9,000,000 polygons, some precautions were necessary in order to make the interactive display fluid and manageable even on commonly used devices. One of the operations was to reduce the LOD for those polygonal surfaces that are in the background with respect to the distance from the camera (Yang, L. et al. (2011).

The reduction percentages may assume three possible values (20%, 40%, 60%) based on the increase in distance from the point of view.

The cull distance volume parameter has also been added to prevent hidden surfaces in the

[4] Equivalent to the diffuse channel.
[5] As it happens more and more often in rendering software, the bump tends to be replaced by normal maps.
[6] The definition of world position offset replaces, in Unreal, the one of displacement.
[7] Equivalent to the reflection channel.

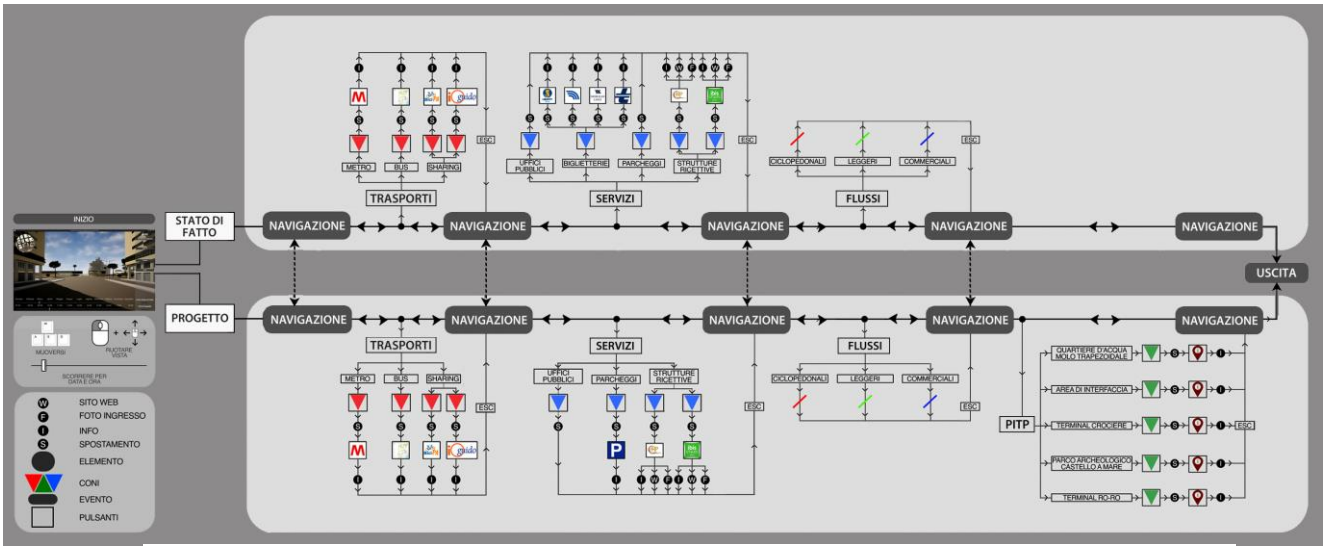

Fig. 8: Taxonomic architecture and User Experience of the virtual model (elaboration by F. Gangemi).

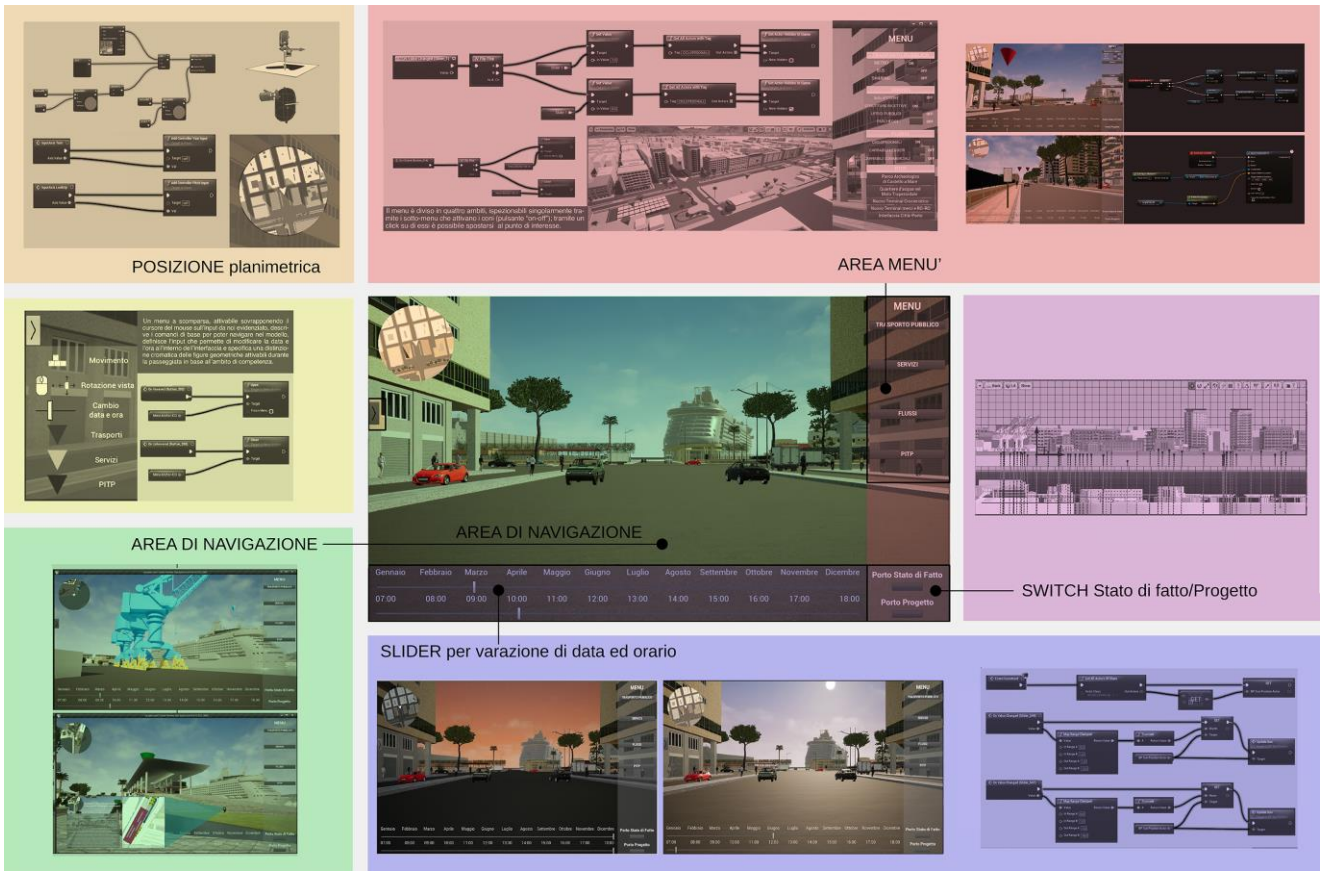

Fig. 9: User Interface of the virtual model (elaboration by F. Gangemi).

current view from being rendered, with a consequent saving of calculation time. Another precaution was to prepare multichannel textures, containing different information on RGB channels, which are lighter in the loading phase and reduce rendering times.

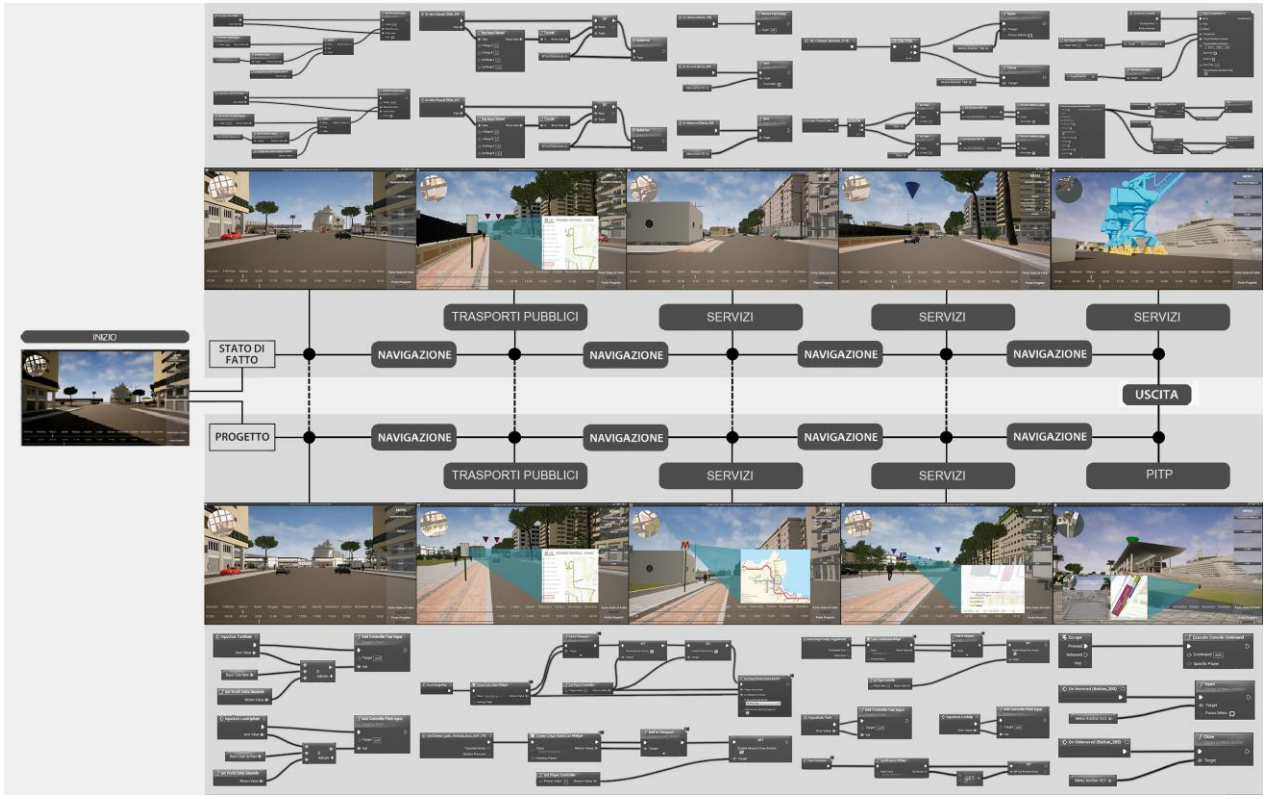

Fig. 10: Synoptic table: taxonomic architecture, User Experience and User Interface of the virtual model. Above and below, the main blueprints for the activation of the functions (elaboration by F. Gangemi).

9.6 Taxonomic architecture

Once the model was optimized, we moved on to the design of the taxonomic architecture, which provides a tree structure, in which the main and secondary functions are organized, as well as the relative access paths. The functions have been inserted thanks to the creation of blueprints, elements that allow you to structure the activation of functions by viewing a system of nodes in which inputs are entered without resorting to computer scripts (Fig. 8).

The blueprints are associated with sensitive areas visible on the screen which are subsequently organized according to the graphic layout: these are the widgets blueprint that allow you to design and implement the graphic interface that will be visible and accessible to the user.

9.7 User Experience and User Interface

The taxonomic structure made it possible to foresee and organize the User eXperience procedures, keeping in mind the objectives of ease of access and clarity of behavior, avoiding disorientation for the user (Shneiderman et al., 2017).

The User Interface was designed to make the available interactive functions easily accessible (Fig.9).

The navigation area occupies the entire screen and the main menus overlap it. At the top right, a small area shows the map with the user's position and the direction of the frame in progress.

At the bottom there is a slider that allows the display of the model in the different months of the

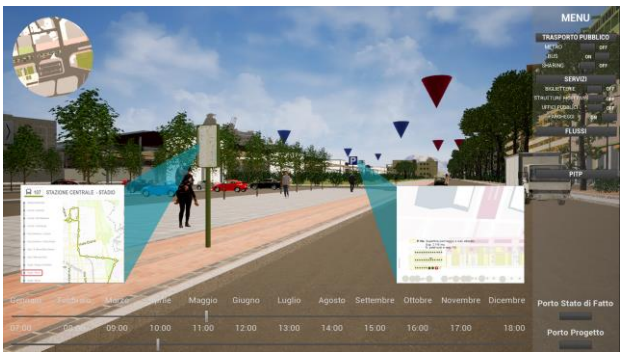

Fig. 11: A navigation frame highlighting some accesses to information on services (elaboration by F. Gangemi).

Fig. 12: Aerial view of the virtual model of the current state with highlighted flows and services (elaboration by F. Gangemi).

Fig. 13: Aerial view of the virtual model of the project with highlighted flows and services (elaboration by F. Gangemi).

year and at different times of the day: since the model is georeferenced, it is possible to observe, in this way, the scenes with the simulation of real areas generated by the buildings on the other buildings and on the ground at all times of the year. Nearby to it, two keys allow to switch between the actual and the project status while keeping the position and visual axis active.

The side panel is dedicated to the menus for accessing some functions and the related submenus. The main functions are dedicated to accessing information relating to Public transport, Services, Flows and PITP (Fig. 10).

The Public Transport Menu allows you to access the individual submenus that display information relating to buses, underground, taxis, car sharing and bike sharing.

The Services Menu allows you to view the main public and private services, such as Public Safety Stations, car parks, ticket offices, hotels, restaurants, etc. (Fig. 11).

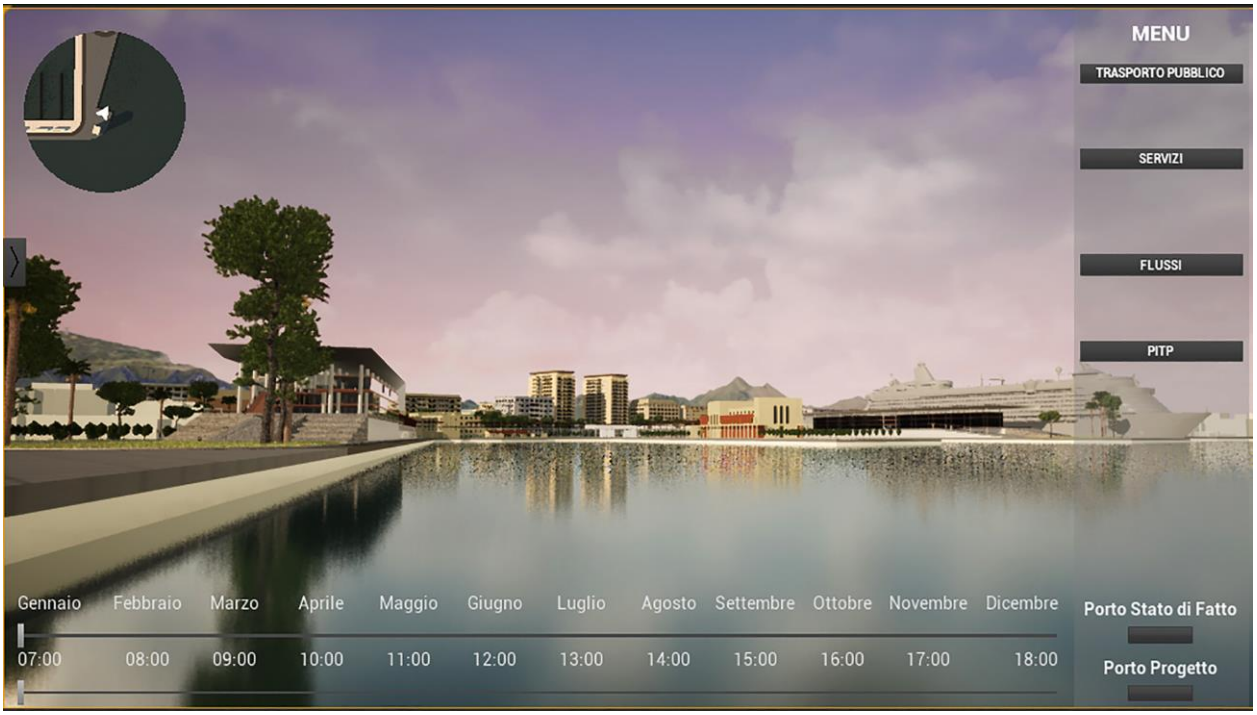

Fig. 14: A frame of the virtual walk: view from the new platform planned in the project (elaboration by F. Gangemi).

The Flows Menu allows the visualization of vehicular traffic, differentiated into heavy, light and cycle traffic. If the function is activated, the flow is displayed with colored tracks highlighting directions and intersections.

During the visualization of the services it is possible, at any time, to switch between the Current state and Project (Figg. 12-14), in order to appreciate, in real time, the outcome of the project operations comparing them with the current state[8].

10.Conclusions

The project carried out is currently an embryo that we intend to develop in the following ways.

With regard to the navigation area, work is already being carried out extending the area to the context of the Cala and Castellammare, an urban hinge between the port and that of the ancient city, and to Piazza Ruggero Settimo, the current heart of the city: here the subway, connecting the square with the port and other nodes of the city, is under construction. The system wants to be an open collector of information, which can be expanded thanks to updates on services, both public and private thanks to the creation of external "access points" allowing the insertion of information on individual productive, commercial or recreational activities.

The approach to urban design with VR systems can be seen as an integrated system for the visualization of spaces, architectures, services. The possibility of being usable by the subjects involved in planning (public administrations, planners, citizens) suggests interesting transformations in the design paradigm. Furthermore, the possibility of structuring open systems suggests the emergence of models continuously modifiable and updateable, which can, over time, become an integrated network of information.

[8] Paragraphs from n. 8 to and n. 9 were entirely written by F. Avella.

REFERENCES

Autorità Portuale di Palermo (2008). *Piano Regolatore Portuale di Palermo, Documento di sintesi. Relazione Generale*. Palermo, IT.

Armenio, E., De Serio, F., & Mossa, M. (2018). Environmental technologies to safeguard coastal heritage. *SCIRES-IT - SCIentific RESearch and Information Technology*, 8(1), 61-78. http://dx.doi.org/10.2423/i22394303v8n1p61

Banini, T., & Picone, M. (2018), Verso una geografia per la partecipazione. *Geotema*, 56, 3-10.

Bhunua, S. T., Ruthera, H., & Gainb, J. (2003). 3-Dimensional virtual reality in urban management. In *Integrated Remote Sensing at the Global, Regional and Local Scale* (pp. 201-204). Denver, CO, USA: ISPRS Archives.

Bobbio, L. (Ed., 2004). *A più voci. Amministrazioni pubbliche, imprese, associazioni e cittadini nei processi decisionali inclusivi*. Napoli-Roma, IT: Edizioni Scientifiche Italiane.

Bourdakis, V., & Day, A. (1997). The VRML Model of the City of Bath. In *Proc. Sixth International EuropIA Conference* (pp. 1-7), London, UK: Europia Productions.

Ceconello, M., & Spallazzo, D. (2010) Virtual city, virtual landscape, enhanced tool for design and planning. In *Proceedings Graphic expression applied to building international conference, X Congreso International Exprésion grafica aplicada a la edificación* (pp. 133-141). Alicante, Spain: Editorial Marfil, S.A.

Cellamare, C. (2012). *Progettualità dell'agire urbano. Processi e pratiche urbane*. Roma, IT: Carocci.

Dalton, R.C., Horn, M., Morton, P.J., & Thompson, E.M. (2012). Virtual city models: avoidance of obsolescence. In *Proceedings ECAADe 30th Conference: Digital physicality/physical digitality* (pp. 213-224). Praga, Repubblica Ceca: Opus V.D.I.

De Seta, C., & Di Mauro, L. (1981). *Palermo*. Roma-Bari, IT: Laterza.

Girgenti, G. M. (2018). A virtual reconfiguration of two destroyed neighborhoods in the Old Town of Palermo. *SCIRES-IT - SCIentific RESearch and Information Technology*, 8(1), 93-104. http://dx.doi.org/10.2423/i22394303v8n1p93

Goethe, J. W. (1885). *Goethe's Travel in Italy*. London, UK: George Bell and Sons.

Habermas, J. (1981). *The Theory of Communicative Action. Lifeworld and System: A Critique of Functionalist Reason*. Boston, USA: Beacon Press.

Inzerillo, S. M. (2017), *Urbanistica e società negli ultimi duecento anni a Palermo*. Palermo, IT: 40due Edizioni.

Kheir Al-Kodmany, K. (2002). Visualization Tools and Methods in Community Planning: From Freehand Sketches to Virtual Reality. *Journal of Planning Literature*, 2(17), 189-211.

Kindon, S., Pain, R., & Kesby, M. (eds., 2007), *Participatory Action Research Approaches and Methods*. London-New York, UK, USA: Routledge.

Levy, R. M. (2011). *Virtual reality: a tool for urban planning and public engagement*. In *12th International Conference on computers in urban planning and urban management (CUPUM)*. Bamff (Canada).

Morisi, M., & Perrone, C. (2013). *Giochi di potere. Partecipazione, piani e politiche territoriali*. Torino, IT: UTET.

Norberg-Schulz, N. (1979). *Genius Loci*. Milano, IT: Electa.

Picone, M., & Lo Piccolo, F. (2014), Ethical E-Participation: Reasons for Introducing a 'Qualitative Turn' for PPGIS. *International Journal of E-Planning Research*, 3(4), 57-78.

Picone, M., & Schilleci, F. (2019). Il ruolo dei processi partecipativi nella formazione dei pianificatori: l'esperienza di Palermo. In *Confini, movimenti, luoghi. Politiche e progetti per città e territori in transizione*, (pp. 527-532). Roma-Milano, IT: Planum publisher.

Sclavi, M. (2006). *La signora va nel Bronx*. Milano, IT: Bruno Mondadori.

Sclavi, M. (2014). *Avventure urbane. Progettare la città con gli abitanti*. Milano, IT: Elèuthera.

Shneiderman, B., Plaisant, C., Cohen, M., Jacobs S., Elmqvist, N., & Diakopoulos, N. (2017) *Designing the User Interface: Strategies for Effective Human-Computer Interaction*. London, UK: Pearson Gobal Edition.

Smith, A., Dodge, M., & Doyle, S. (1998), Visual Communication in urban planning and urban design. In *Centre for Advanced Spatial Analysis Working paper series* (pp. 1-49). London, UK: CASA University College London.

Thompson, E. M., Horne, M. & Fleming, D. (2006). Virtual reality urban modelling - an overview. In *CONVR2006: 6th Conference of Construction Applications of Virtual Reality*. Orland (USA).

Valzano, V., Negro, F., & Lucarella, D. (2019). Otranto Treasures in 3D. *SCIRES-IT - SCIentific RESearch and Information Technology*, 9(2), 17-28. http://dx.doi.org/10.2423/i22394303v9n2p17

Yang, L. H., Sun, X. D., & Zhang, H. B. (2011). Relationship between the Least Mesh Numbers of Models and Distance of Viewpoint in Efficient Real-Time Rendering. *Applied Mechanics and Materials*, 130–134, 213–216. https://doi.org/10.4028/www.scientific.net/amm.130-134.213