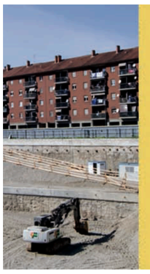

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Urban transformation scenarios for the representation and dynamic control of new design interventions

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Today an absolutely emerging issue for architectural culture is the need for up-to-date representations of urban settings by 3D models, got from real landscapes and characterizing the actual condition of ongoing transformations. These representations could become the urban scenarios for simulations and checks both for master plans and for architectural designs, analyzing their relationships with the built environment.
Some new tools of urban procedural modeling and web resources allow generating urban contexts able to interoperate with software BIM and concept design oriented.
The paper aims on one hand to compare the knowledge and informative capabilities of different new technologies for urban modeling, on the other one, to explore the opportunities (i.e. about shape control, standards verification, energy calculation, etc.) offered by software interoperability using different platforms dedicated to architectural design.

Keywords: urban digital modelling, design simulation, interoperability, Web Map Services, BIM

1. Introduction

Today an absolutely emerging issue for architectural culture is the need for up-to-date representations of urban settings by 3D models, got from reality and characterizing the actual condition of ongoing transformations. These representations could become the urban scenarios for simulations and checks both of master plans and architectural designs in their relationships with the built environment.
Some new tools of urban procedural modeling and web resources allow generating urban contexts that can interoperate with software oriented to BIM and concept design.
In this paper we will compare on one hand the knowledge and informative capabilities of different new technologies for urban modeling, on the other the opportunities (i.e. about shape control, standards

verification, energy calculation) offered by interoperability with other software dedicated to architectural design.

2. Web Map Services and geometric 3D modeling for architectural shape control of interventions in city contexts

An interesting opportunity to enjoy three-dimensional scenarios to simulate different configurations of interventions is offered by one of the most significant products of the "digital convergence" (Ciotti F., Roncaglia G., 2000): Web Map Services, integrated with graphics applications and three-dimensional modeling freely available on the web, which represent a potential evolution of digital cartography. Web Map Services dynamically produce maps of spatially correlated data from geographic information and allow visualization of a large part of the Earth.
The digital mapping has been joined in recent decades with the traditional cartography on paper, thanks to the hardware and software tools offered by the "information revolution". The use of information technology and the simultaneous diffusion of geographic database have resulted in a gradual transformation of the digital maps by simply "drawing" of the territory to "numerical data" base for CAD drawing and "GIS" (Geographic Information Systems) useful for spatial investigations.

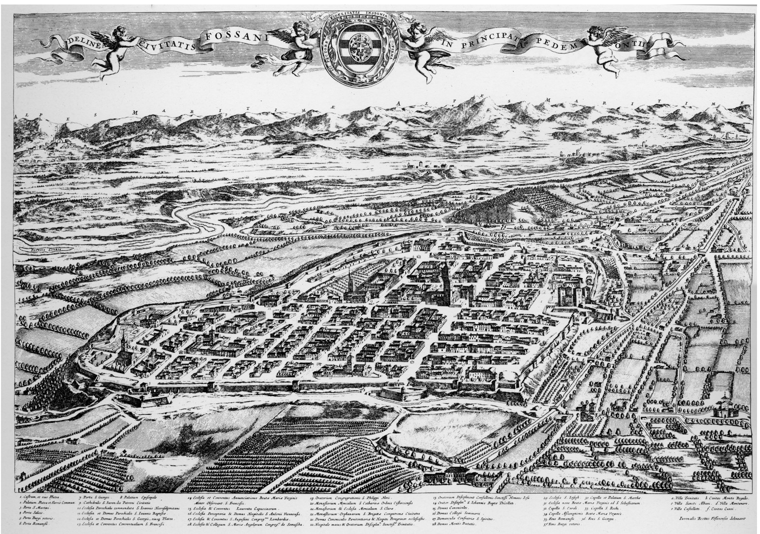


Figure 1. *G. Boetto, Aerial perspective view of Fossano, in Theatrum Sabaudiae, 1682.*

Computer applications, in addition to simplifying the production work of cartography and substantially increasing their knowledge potential, have imposed new models of description and interpretation of reality. From the information point of view, digital maps can recover the prerogatives of celebratory three-dimensional views of the cities and territories (Figure 1) and historical maps of those views adding up pseudo-isometric representations of human settlements to zenith projection (Figure 2). The traditional map offered a two-dimensional static document, while the digital one can be organized into dynamic sequences, consisting of multiple images, allowing views by different orientation, or even immersive experiences, with appropriate devices.
The comparison between traditional map and virtual globe leads Giorda to interesting conclusions: "The 'logic mapping', as it has gradually standardized since 1700 with a progressive path to the static and abstraction, is here reversed in a diametrically opposite perspective, based on the recovery of the variety and abundance of signs of the territory, on redemption of the subjective dimension and not azimuth of vision, on the dynamism of representation. Somehow, it is a return to the landscape, knowing that a new way of seeing also means a new way of looking"(Giorda C., 2006).

The recent uncontrolled proliferation of contemporary cartography, available on Internet, resulted in production by new subjects - private corporations in the computer industry - and an extension in the world, requiring more and more uniform guidelines aimed at avoiding fragmentation, duplication and ambiguous interpretations. This is the reason why the Web Map Services have been regulated by ISO19128 standard[1].

Among the Web Map Services that have the widest geographical coverage, the ability to save and print images and the most interesting features from the knowledge point of view and design, you can now count Google Maps, Yahoo Maps, Bing Maps generally enjoyed by PC or, more generally, devices connected to the Internet. Google Maps, the richest and most versatile platform for the purposes mentioned above, visualizes maps and satellite imagery obtained from terrestrial remote sensing, aerial photography and topographical data stored in a GIS platform.

Additional knowledge is accessible through the installation of Google Earth, free software for three-dimensional graphics, which offers a virtual globe remapping aerial and satellite photography on the three-dimensional surface of the earth, so as to reproduce the orography in a realistic way.

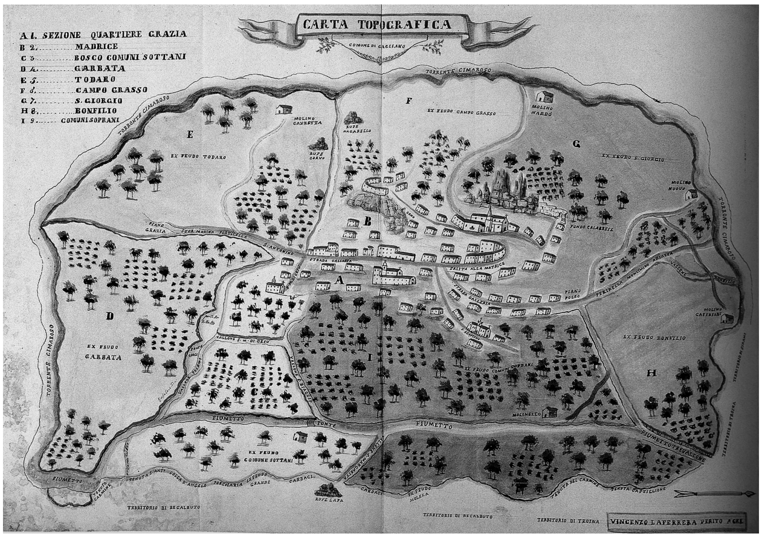


Figure 2. *Topographic map of Gagliano, in Cadastre Borbonico of Sicily, between 1837 and 1853.*

Giorda establishes an interesting comparison between the traditional map and Google Earth highlighting the traditional prerogatives of interactivity dynamic display and reduction of graphic symbols, and concluding that the software "should therefore not be understood as a tool that replaces the traditional map or photography, but as a new type of representation, a sort of hyper-atlas of the landscape that combines elements of both instruments " (Giorda C., 2006, p.249).

Google Earth and Google Maps also allow collaborative approaches in creating of geographic contents by the users. As Borruso observed, they can "add content and build their data, resulting for example from GPS tracks, which can be loaded differently in the virtual globe in Google Earth, or drawn directly depending on your knowledge of the place, and with reference to a base cartographic ready. Freedom permitted by these applications is therefore to free the user from the need to build the base map and focus on new information elements" (Borruso G. 2010).

In particular, Google Earth provides additional potential: on the one hand, to turn on layers that offer thematic consultations: display of roads, some buildings modeled in 3D and delimitation of parks, on the other, to insert signals, polygons and paths, to take measures, to consult previous satellite images and

[1] http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm? csnumber=32546&commid=54904 (last reference 2nd May 2013)

photographs going back into the past. This last documentation can be of considerable interest to reconstruct the spatial transformations due to the intervention of man or even calamitous natural events. Google Earth also allows users to model buildings in 3D using Google Building Maker and SketchUp and place them at the original locations. Photographs of facades provided by the program are applied on geometric 3D buildings and then the models are validated for inclusion in Google Earth (Figure 3).

Figure 3. *3D model of Cuatro Torres Business Area, Paseo de la Castellana, Madrid, realized with Google Building Maker and SketchUp , 2010.*

This kind of representation hybridates products ontologically different in many respects: 3D geometric model and photography.
The model, in fact, is a three-dimensional vectorial entity, whose faces are mostly plans, while the photographs, applied on it, are two-dimensional raster entities that represent different planes projected from a point at a finite distance analogous to that perspective.
However, despite this operation is unacceptable in terms of the science of representation, it has the advantage of generating scenarios freely available for the insertion of planning and designing proposals.
The photographs applied on models allow the users to appreciate a good degree of realism of architectural morphologies and decorative styles of the context, in relation to the architectural shapes of the new proposals. Furthermore, the possibility for the user to move around in a virtual reality in real-time 3D, generates a kind of dynamic photo-montage.
As with other digital features, this method for generating urban and environmental contexts also revealed a rapid obsolescence: on 6th of June 2012, during the event "The Next Dimension of Google Maps"[2] Google announced some changes that are coming to the 3D landscape in Google Earth, starting on mobile devices and later available in desktop version. In particular they unveil a new way of displaying 3D buildings on Google Earth, achieved by building complete cityscapes from the 45-degree aerial imagery used in Google Maps and Building Maker.
One of the biggest challenges in showing 3D buildings in Google Earth has been gathering complete 3D coverage to represent the real world seamlessly and consistently.
This new style of 3D map has generated via stereophotogrammetry from aerial imagery. "Google would one day create better auto-generated buildings, and that time has come"[3].

[2] Craig D. (2012), The Next Dimension of Google Maps, https://groups.google.com/forum/?fromgroups#!topic/3dwh/-GQj7OlZshA (last reference 2nd May 2013)
[3] http://www.gearthblog.com/blog/archives/2012/06/google_announces_upcoming_3d.htm (last reference 2nd May 2013)

The result will be remarkably sharp 3D, in a format that can be more quickly rolled out for large areas. New imagery rendering and computer vision techniques now allow creating an accurate and comprehensive 3D representation of entire metropolitan areas.
Currently many users complain that in some cases, the close-up work done by them may be more detailed than the current model created by the new 3D imagery techniques.
Others acknowledge that unlike the current situation, where many users generated models of varying styles with different lighting schemes collide in a potluck of 3D goodness, the new style map, or the new Google Earth, is modeled as one unified seamless mesh.
The advantages foreseen by Google are that using aerial imagery to create 3D models it enables to keep these 3D versions of the world more accurate and up-to-date than is possible with manually created models. In addition, the new 3D buildings and terrain are all generated from the same high resolution aerial imagery, enabling precise alignment of the new models and a seamless 3D experience across an entire area. It's possible to compare models generated using the two different techniques by analyzing portions of the urban tissue of Rome (Figure 4).

Figure 4. *Piazza Navona in Rome, on the left, 3D model using Google Building Maker and SketchUp, 2008; on the right, buildings generated automatically in Google Earth 7, 2012.*

The manual modeling allows creating models with a high level of detail of geometric shapes and exceptional finishes, in many cases better than new buildings generated automatically, but the new version, however, is more homogeneous.
Undoubtedly, it must be recognized that even the models made automatically manage to have a detail still high and allow the generation and updating of 3D models much faster than the manual modeling.
If we believe the assertion that: "The goal remains to create an accurate, consistent and comprehensive 3D representation of the Earth. With 3D imagery in its infancy, we can’t truly see what the future holds; but the one constant in this fast-paced, high-tech world is change, and further improvements are ahead" (cit. Craig D., 2012), we can imagine that future steps of the research undertaken by Web Map Services alongside those of procedural modeling, which will be discussed further on, more and more will provide accurate, efficient and updated models of settlements in which simulating the project interventions.

3. Urban procedural modeling and BIM technologies for checking the master plan sustainability

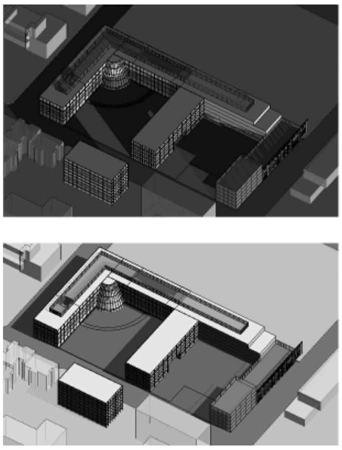
The possibilities offered today by computers allow designers to explore a building in virtual reality, and that is they allow humans to interact with a computer in a simulated domain (Garzino G., 2011, pp 15),. Parametric drawing means that, as opposed to the recent past, these interactions are no longer limited to an analysis of form and shape but permeate all disciplines involved in the art of building.

The latest technologies allow to investigate virtual environments both on a building scale that at larger ones, rebuilding entire urban and territorial structures through the use of procedural algorithms based on the metric information that can be derived from satellite imagery, maps and cartography numerical techniques.
The use of new techniques in design drawings makes it possible not only to render complex forms discrete or to develop customized working procedures (going beyond the prototype stage), but also to reach the full objective of synergies between technical drawings and technical verification of the design.
This synergy is necessary not only in the building field, but this opens the way to new experiments in urban and territorial environment using BIM (Building Information Modeling) technology; for example, the use of the conceptual mass modeling allows to associate to a simplified model the numerical data of built area, making the control of the compliance of urban standards required by regulatory instruments easier. The procedural software allows you to expand the scope of use, capable of handling data relating to real portions of the city.
Some customizations also let you to generate reports for quantitative analysis of urban design, for example for an automatization of quantitative estimates, such as the calculation of constructed area and the relationships between the parties that are automatically updated and instantly applied to entire cities: through the change of a parameter display you can switch from one view to a schematic representation issue, being able to provide reports about the amount expressed in terms of gross floor area, intended for residential, commercial and service sectors. Parametric values can be applied to a single building or entire streets: in analogy to BIM equipment usually applied to the building scale, even the procedural software using a parametric change engine automatically updates the contextual display of color that is the base data to it connected.
The most recent trend of the largest software house working on the territory is to produce some suites (software packages sold in a single solution) containing the different applications dedicated to specific functions: the Infrastructure Design Suite Premium 2014 software (Autodesk) is an integrated and interoperable solution for the territory, the planning and design of infrastructure, including inside applications for the management of roads, dams, bridges and railways. Even in this field the need is to resemble a multidisciplinary collaboration, where the focus of the project is a model shared by all: for example, it is possible to integrate the use of the known AutoCAD Map 3D - Data Manager of GIS and cartographic data in vector format - with applications that can handle the raster cartography, cadastral maps from the Regional Technical Papers, orthophotos from satellite imagery, allowing at the same time the georeferencing of the intervention and the data vectorization.Regarding to territorial data, it comes the need to take advantage of all GIS data available, thanks to the portal OpenGeoData (founded by the homonymous Association that was founded with the primary goal to rid the geographical data of the Public Administration in order to allow the reuse to all professionals working in the area).
In addition to what is said, it is rapidly spreading InfraWorks (a software formerly known as Infrastructure Modeler), which enables the use of CAD data, GIS and BIM to easily create 3D Digital City: thanks to these it is possible to start the preliminary phase with the BIM prerogatives[4].
In combination with GIS data, it is even more topical to manage CAD data and parametric models, and then to have tools that allow to easily design in three dimensions, thanks to the BIM approach. As mentioned, the preliminary stage takes care of the evaluation of alternatives, to minimize cost and environmental impact: at this regard it is crucial the utility of using a single 3D model on which to examine the various alternatives, comparing between them, thanks to the support of quantitative data.
Recently, the current regulation on Public Works has indicated, through the d.P.R. n. 207/2010, (Regulations implementing the Decree n.163/2006 – Codice dei Contratti) the contents for the various design phases. Article 14 refers to the Functional Economic Analysis, specifying in detail the contents, partially returned in the following list:

[4] www.bimacademy.it/gis/ (last reference 2nd May 2013)

- a description of the prior assessment of territory sustainability of the intervention, and the requirements of the designing building, the feature connection with the existing context;
- the integrated analysis of different design alternatives, regarding to the functional, technical, managerial, economic and financial matters.

In particular, the FEA should enable the definition of the cost intervention, drawn from a quantities take-off or on the basis of parametric costs derived from similar interventions.



1_Abaco dei pavimenti edifici SP Fase 1			
Famiglia e tipo	Livello	Area	Commenti
Pavimento: REI 60_ pavimento 30 cm	A_ 0_PT_Calpestio Lab Pesanti (0,00)	849.92 m²	REI 60
Pavimento: REI 60_ pavimento 30 cm	A_ 0_PT_Calpestio Lab Pesanti (0,00)	133.00 m²	
Pavimento: REI 60_ pavimento 30 cm	A_ 0_PT_Calpestio Lab Pesanti (0,00)	222.44 m²	
Pavimento: Pavimento non compartim	A_ 0_PT_Calpestio Lab Pesanti (0,00)	72.53 m²	
		1277.89 m²	
Pavimento: Latero Cementizio - 30 cm	A_0.5_Calpestio Piano primo (4,00)	6.54 m²	
Pavimento: Latero Cementizio - 30 cm	A_0.5_Calpestio Piano primo (4,00)	6.52 m²	
Pavimento: REI 60_ pavimento 30 cm	A_0.5_Calpestio Piano primo (4,00)	143.83 m²	
Pavimento: Pavimento non compartim	A_0.5_Calpestio Piano primo (4,00)	49.58 m²	
Pavimento: REI 60_ pavimento 30 cm	A_0.5_Calpestio Piano primo (4,00)	87.39 m²	
		293.87 m²	
Pavimento: REI 60_ pavimento 30 cm	A_1_ Calpestio Lab leggeri (8,00)	296.00 m²	
Pavimento: REI 60_ pavimento 30 cm	A_1_ Calpestio Lab leggeri (8,00)	612.94 m²	
Pavimento: REI 60_ pavimento 30 cm	A_1_ Calpestio Lab leggeri (8,00)	171.06 m²	
		1080.00 m²	
Pavimento: Pavimento non compartim	A_2_Calpestio Uffici (12,00)	612.94 m²	
Pavimento: Pavimento non compartim	A_2_Calpestio Uffici (12,00)	296.00 m²	
Pavimento: Pavimento non compartim	A_2_Calpestio Uffici (12,00)	171.55 m²	
		1080.48 m²	
Pavimento: REI 60_ pavimento 30 cm	A_3_Calpestio Uffici 2 (16,00)	222.34 m²	
Pavimento: REI 60_ pavimento 30 cm	A_3_Calpestio Uffici 2 (16,00)	725.42 m²	
Pavimento: REI 60_ pavimento 30 cm	A_3_Calpestio Uffici 2 (16,00)	352.25 m²	
		1300.01 m²	
Pavimento: REI 60_ pavimento 30 cm	A_4_Calpestio Test Site (20,00)	1331.94 m²	
		1331.94 m²	
Totale generale: 19		6364.20 m²	

Figure 5. *Energy Center: solar studies and schedule of Ground Floor Area, phase 1.*

Yet it is precisely in the preliminary stage that you need to obtain the consent, not only of the agencies, but also of all stakeholders and residents. The purpose is just to reach every possible segment of the population, to establish a larger level of information. Too often in the past, interventions in the area were presented only in two dimensions, not allowing a deep understanding to the layman. The infrastructure suite has inside the necessary tools for creating movies, animation paths for the camera, the integrations of show titles, captions, points of interest and storyboards, without having to use video for editing software, also being able to share models and projects on the cloud, and even publish them on the Web, along with video presentations. Once again, as has often happened in the past, technology has partially taken "borrowed" from other fields (cinema, game entertainment) and revived in the building / urban sector, for an enlarged spread of new forms of narrative dynamics, control and communication of large scale project.

4. The case study: Functional Economic Analysis applied to Energy Center, Turin

The project that best expresses the reasons that lead to the drafting of a Function Economic Analysis is the so called Energy Center, an intervention financed by European funds for the construction of an exemplary and innovative building in terms of energy savings. The first step consisted in the drafting of the Plan variation, to be expected within the site of intervention. It is expected therefore a plan divided into different time phases that involves the construction of the first part, (the Energy Center) to be followed by future construction of other buildings in order to saturate the amount of free floor area achievable within it (Figure 5). In this regard, the BIM software lets you organize parametric interventions depending on the time variable. Doing that, it has been created an overall master plan containing the maximum heights achievable in individual buildings, with its own car parks (estimated in 40% of the GFA – Ground Floor Area - realized). The whole site has a building capacity of 25000 square meters, (which should equal about 10000 sqm of car parks) divided into three different phases, as shown in figure 6.

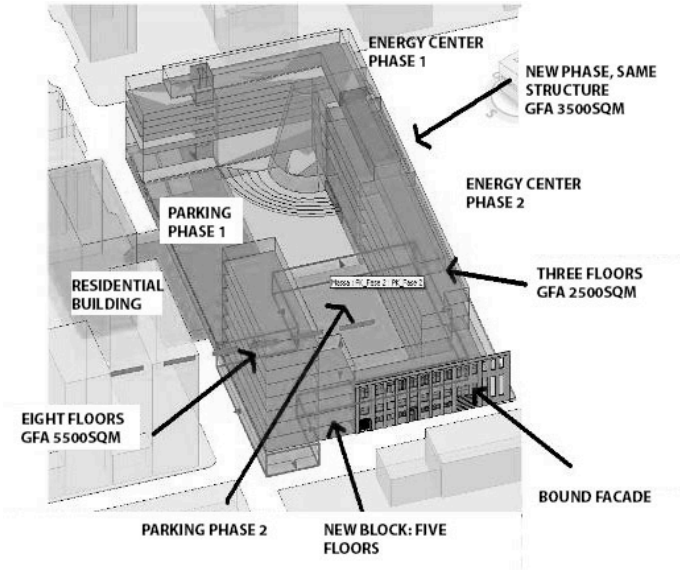


Figure 6. *Energy Center: masterplan with different intervention phases.*

Before reaching the final solution, in agreement with what is explicitly required by relevant regulations, there have been several proposals of distribution, as can be seen from the pictures below [11].
After several meetings that occurred with the heads of the different technical areas (planning, technical services, construction, environment, economic development) it was decided to define a different configuration, as proposed in the image above, next to the volume of the Bellini library (Figure 7).
As previously mentioned, despite the images presented obtained by the three-dimensional conceptual models, it should be emphasized once again the flexibility of these processes that allow correlating heterogeneous information, as a multidisciplinary feasibility study should contain.

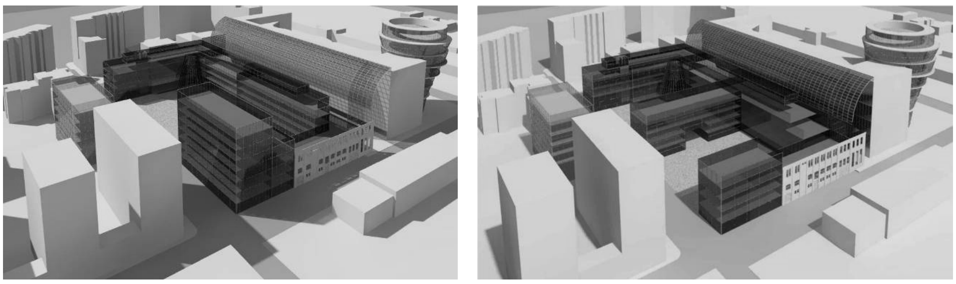


Figure 7. General master plan. First and last version compared

5. Conclusion and future developments

The need for information interoperability is felt both within the working group and regarding to external professionals: In territorial interventions, with regard to the implementation of open standards it is now possible to access the CityGML standard format, already used by many municipalities in Europe for the data of 3D digital city. CityGML allows you to save the entire structure of a city (including detailed 3D models), formed by roads, roofs and technological networks in different levels of detail. So, the addition of support CityGML format agrees to use much more detailed data than ever before.
The scenario is therefore complex: what until recently was a categorization may be too rough or stiff, but able to distinguish between disciplines who see the use of virtual modeling for the control of design thinking from others that serve a purpose in popular divulgation, now see a distinction far from clear,

since the technologies that have immediate impact on the choices of the designers, the different scales, are often tightly integrated with those employed for better communication of design proposals. Concluding, in recent years, digital modeling is thus affecting the entire design process, from conception of an analysis of alternatives, through the monitoring and reporting of the project up to offer tools for subsequent construction activities and management of manufactured goods.

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