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Vittorio Giorgini Spatiology–Morphology Architect

D. Ulivieri et al.

Vittorio Giorgini Spatiology– Morphology Architect

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Abstract

Impetuous, versatile, nonconformist Florentine architect Vittorio Giorgini (1926–2010), son of Giovan Battista, pioneer of Made in Italy around the world, built his work on the experimental study of forms connected to the

natural world and on the analysis of vernacular construction, the basis of cultural expression for a community. Giorgini's design process was based on the direct observation of natural structures and the design and construction of models, the fundamental and essential element of all his research. His investigations began with the study of such curved systems as shells and membranes, curiosity about tensile structures and analysis of octahedral and dodecahedral geometrical shapes. Giorgini's urban architectural journey took place within the complex world of "Spatiology", a term coined by Giorgini, where his studies on the interaction between humans, the environment and nature converged.

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Keywords

Vittorio Giorgini
'Spatiology'
Morphology
Thin-shell structures
Octa-frame system

Dear Hans,

... To defend ourselves against a horrendous life that is already underway in our homes, we need to provide new, economical solutions, but ones that are also lyrical and exciting ... light structures that support themselves by shape, that geminate, that group together organically...

Letter from Vittorio Giorgini to Hans Jenny, 1969 (B.A.Co. - Vittorio Giorgini Archive)

Introduction to Vittorio Giorgini: An Explorer Intent on Discovering the World

Stubbornness and tenacity are the two fundamental characteristics that distinguish Vittorio Giorgini's life and work, both qualities developed in the socio-cultural environment in which the Florentine architect grew up. Certainly, the religious education received from his parents, a strict, inflexible Protestant mother and a bourgeois, puritanical Catholic father, also conditioned his choices, both in everyday life and in his designs. His father, Giovan Battista Giorgini, descendant of an ancient, aristocratic family from Lucca, was a pioneer in promoting the 'Made in Italy' label around the world. So Vittorio was taught about beauty, he knew the weaves of the fine fabrics used by the great Italian

couturiers. These weaves recall the forms of the cellular aggregates that would later be a source of inspiration for his architectural work.

Right from childhood, he developed ‘the enjoyment of building things’, the desire to experiment and observe the reality that surrounded him. The originality of Giorgini’s work derives from his wealth of knowledge and various interests: from building model aeroplanes to drawing, sailing boats and geometry. Giorgini obtained his degree in 1957 in Florence, where he came to maturity in the lively, as well as contradictory, cultural climate of the 1950s and 1960s, and practiced professionally and as a teacher, working with Leonardo Savioli and Giuseppe Gori and forming a special spiritual relationship with Giovanni Michelucci.

His intellectual and design studies were focused on building techniques capable of producing housing solutions that were efficient, functional, suited to the needs of everyday life and economically viable.

During the Fifties, but on closer inspection since the beginning of the twentieth century, the observation and investigation of nature, as a resource for architecture, unites the intellectual and design path of some of the most innovative and lively architects, engineers and artists of the time. Antoni Gaudi first and, later, Frank Lloyd Wright, Le Corbusier, Richard Buckminster Fuller, through the wise use of new materials and the optimization of structures, adopt and transfer into architecture the forms that exist in the natural world. Likewise, the works developed by bold engineers and experimenters such as Robert Maillart, Robert Le Ricolais, Pier Luigi Nervi, Félix Candela, Frei Otto, Konrad Wachsmann, to name but a few, start from the fact that nature always reaches its goal with minimum necessary of material, obtaining the maximum static efficiency. This careful study of natural phenomena, applied to technological innovations through experimentation with materials and techniques, has opened up new possibilities for engineering and architecture, which has produced structurally and economically convincing works. Overcoming an academic architecture stiffened through forms taken from organic and inorganic nature is also the aim of artists and architects like Bruno Taut, Herman Finsterlin, Erich Mendelsohn, Friedrich Kiesler, Yona Friedman and André Bloc who conceive new formal explorations.

The roots of research and observations by Vittorio Giorgini (1926–2010), Florentine by birth and education, who migrated to the United States at the end of the Sixties, arise from this rich and multiple cultural context. However Vittorio Giorgini’s intellectual and professional work has been repeatedly misunderstood and hastily labeled as informal and utopian. His design work, relegated to a marginal role, deserves, instead, to be fully recognized.

He was fascinated by the natural world and the heritage of vernacular architecture, which he considered not as a mere repertory of formal solutions, but as an enormous catalogue of building techniques and functions. It was from this that Giorgini coined the term ‘Spatiology’ to define his studies in morphology, where he learned ‘the modes, economies, functioning and thus the relationships between forms and static resistance systems, of the makeup of materials and its functions’ (Giorgini 1995: 20).

Curious and perceptive, he observed and drew natural structures, trying to grasp their static, morphological and functional behaviours. Among other things, he analysed models with double curvature asymmetric surfaces. At the same time, however, he studied modular homes with projecting bodies and in 1957 he built *Casa Esagono*, a pre-fabricated hexagonal house of pine and mahogany on the Gulf of Baratti, a wonderful stretch of the Etruscan coast, for which he also reflected on Buckminster Fuller’s hexagonal *Dymaxion House*, designed in 1929 (Fig. 1). In 1961, a short distance from *Casa Esagono*, he built the *Casa Saldarini*, later known as *la Balena*, for its zoomorphic form, where he had the opportunity to apply the study of the morphology of natural sciences to architectural design.

Fig. 1

Casa Esagono construction works, Gulf of Baratti, Livorno, 1957 (Courtesy B.A.Co.—Vittorio Giorgini Archive)



However, the Florence of the day was somewhat unprepared and disinclined to understand a counter-current architect like Giorgini, who did not design according to the established language ‘derived from a Tuscan revisitation of the modern movement imbued with certain influences from the Japanese school’ (Giorgini 1995: 244). Indeed, the more Giorgini was concerned with these things, the more he became invisible to his colleagues and the Faculty of Architecture.

In 1969 he left Italy and moved New York where he becomes a professor of architecture and planning at the Pratt Institute, where he remained until 1996. He continued to work on symmetrical and asymmetrical shell beams, and further explored the issues dealt with by topology. At the same time, he developed a

series of projects belonging to those ‘conventional techniques, diagrams of straight lines and planes, pertaining to polygons/polyhedra’ (Giorgini 2006).

On various occasions in the early 1970s, he presented the results of his theoretical and design studies, particularly in lectures at the university and accredited institutions.

In 1995 the book *Spatiology. The morphology of the natural sciences in architecture and design* was published, an important account of Vittorio Giorgini’s projects, observations and studies, a work ‘completely consistent with his character as a man and as a professional [...] intensely serious in its scope, thorough in its research and exuberant in spirit’ (Johansen 1995: 7).

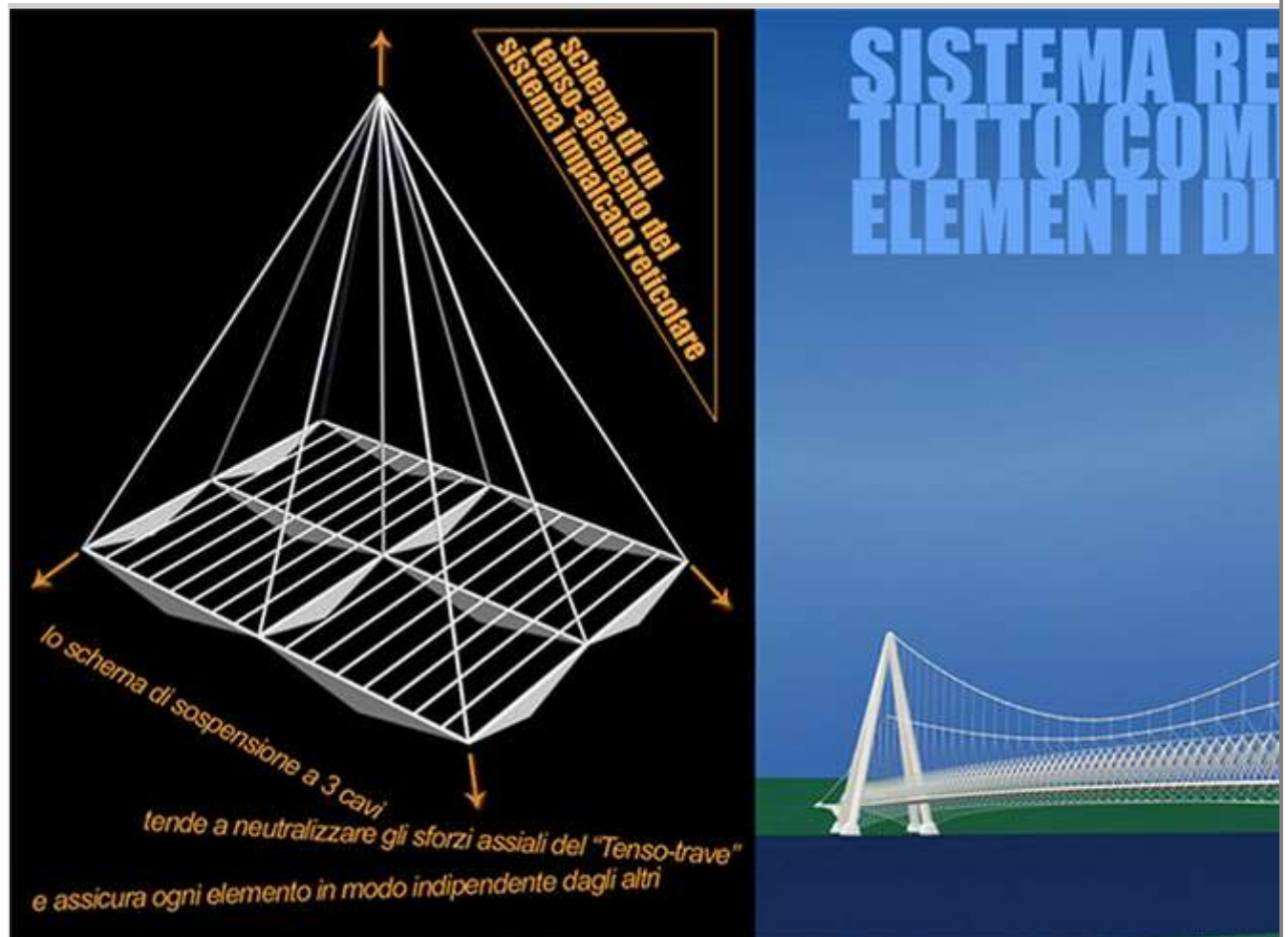
Giorgini’s Experimental ‘Risk’

Over the course of his entire life, Vittorio Giorgini developed his ideas about the ‘question of the model in nature’ and its application in architecture. The aim of his painstaking work of design analysis, testing and development was to find functional architectural shapes able to deliver the maximum static efficiency using the indispensable minimum of material and spatial resources.

Giorgini, like D’Arcy Wentworth Thompson, who, moreover, he quotes several times in his writings, investigated the form as a diagram of loads and thrusts, with the aim of judging or deducing which forces act or have acted on it. In Giorgini’s designs the flow of a structure’s internal forces is explicit and declare the form’s expressiveness. Like Giorgini, his contemporary Sergio Musmeci, a daring and unconventional structural engineer, also held that ‘what we design is not the form but the static balance of the structure from which the form derives’ (Nicoletti 1999: 24). It was, therefore, no coincidence that in 2008 Giorgini won ‘I ponti in tasca’, the award dedicated to the memory of Musmeci’s adventurous design, with the design of a bridge over the Strait of Messina, consisting of a ‘reticular system comprising elements of tension’ (Del Francia 2011: 109) (Fig. 2).

Fig. 2

Design of a bridge over the Strait of Messina, 2008 (Courtesy B.A.Co.—Vittorio Giorgini Archive)



While working on the building of *Casa Saldarini*, Giorgini confessed to not yet having clear in his mind the topological potential and the geometric aspects, but above all to not having the ‘faintest idea of how to test its static behaviours’ (Giorgini 1995: 245). This assertion reveals the experimental and intuitive nature of Giorgini’s design work, similar to the intuitive process that is the basis of vernacular buildings. It is the same ‘experimental risk’ that characterizes all of Giorgini’s research conducted on models and directly in the field rather than in obedience to well-established rules. Experience generates rules: the form, abstracted from experience, becomes widespread culture.

Giorgini’s conceptual process is, therefore, similar to that of the scientist, and above all of the mathematician, in that it is based on a creative exercise in which intuition, imagination and the idea always precede the comparison of conclusions, which are then tested by experiment.

There again, he shares with Leonardo da Vinci, for whom he had nurtured ‘a very strong affinity’ since he was six years old, the idea that *Nessuna umana investigazione si può dimandare vera scienza, se essa non passa per le matematiche dimostrazioni* (No human investigation can be called real science if it does not pass through mathematical demonstrations) (Leonardo da Vinci 15th

c.: I.I.1). After all, the term ‘Spatiology’ was also coined ‘to describe the study of geometry as a mathematical discipline and the backbone of statics, systematic taxonomy and technology’ (Giorgini 1995: 193).

Curved Systems

From a very young age, Vittorio Giorgini engaged in the study of Leonardo’s drawings, making Leonardo’s ‘variation of nature’ concept his own. According to Leonardo, by using the same elements (for example, branches, trunks and leaves) trees are created that are both similar to and very different from one another. Giorgini applied this concept to his research, drawing variant on variant of his buildings, seeking to grasp the static, morphological and functional behaviours of natural structures. He believed that there is more efficiency in nature’s forms and structures than in any other building model, and that nature is therefore the example par excellence to follow in the construction of buildings. It was for these reasons he began to investigate asymmetric double-curvature surfaces. His inspiration, however, was neither formal nor mystical. He considered nature to be a methodological guide where structure, geometry, statics and functional efficiency must be known in order to understand the ‘construction technique’. Moreover, the idea of nature as a source of inspiration for architecture, and as a preferred vantage point for observing examples of form and construction, captured the imagination of the liveliest minds of that time, such as Andrè Bloc, Robert Sebastian Matta, and Friederick Kiesler.

Giorgini was fascinated by ‘Le Corbusier’s lesson on the free plan and sections, as well as construction systems using columns, beams and cantilevers, which became more complex compounded with the expression of static behaviour-diagrams which I was learning from the works of Maillart, Nervi, Candela and others’ (Giorgini 1995: 191). He also admired Le Corbusier’s passage from conventional trilitic systems to that of the non-canonical church *Notre Dame du Haut* in Ronchamp, where curves and sinuous shapes take the place of regular lines and surfaces.

Giorgini had his first real opportunity to study curved surfaces not as elements that circumscribe a space, but that create it, with the design and construction of the *Casa Saldarini* in Baratti, a building with topological characteristics of static elasticity and lightness never before seen in the construction field (Fig. 3).

Fig. 3

Casa Saldarini, Gulf of Baratti, Livorno, 1962 (Courtesy B.A.Co.—Vittorio Giorgini Archive)



The encounter with an enlightened client and environmental heritage superintendent¹ allowed him to put into practice his insight and his studies, focused at the time on the experiments of Dr. Hans Jenny, a Swiss medical doctor and natural scientist, a family friend who spent long periods of time in Tuscany. Jenny was interested in Cymatics, experimented with the ability of sound to create shapes, and proved that vibrations influence matter. Photographs of sonic structures or ‘morphologies determined by vibrations’—geometric shapes, spheres, crystals and spirals—are similar to natural features (Jenny 1967). Giorgini’s reaction to these experiments was immediate: ‘if we could programme these shapes and then organize them, we would have techniques similar to those of nature!’ (Giorgini 1995: 245) Giorgini’s idea was to compile a catalogue of relationships between forms and vibrations so as to be able to

arrange these various parameters to obtain artificial forms similar to those in nature.

As mentioned, Giorgini was also interested in the work of British biologist and mathematician D'Arcy Wentworth Thompson, and in particular his studies on forms and dynamics of growth of living organisms. Giorgini based his architecture on Thompson's concept in which 'the shape of an object is a diagram of forces', Thompson further clarifies that 'morphology is not only a study of material things and of the forms of material things, but has its dynamical aspect, under which we deal with the interpretation, in terms of force, of the operations of energy' (Thompson 1945: 19).

Casa Saldarini therefore represents the concretization of Giorgini's studies and insight, a building which clearly reflects the boldness of his design choices. He created a system of asymmetric double-curved surfaces with morphological characteristics of a topological nature, employing commonly used materials, such as concrete cement and a wire mesh skeleton, in innovative ways. Built without the use of conventional structural inspections,² and based on Thompson's concept of the form as a diagram of forces, the resulting structure is perfectly married to the surrounding environment in terms of both morphology and dimensions. To build the house, Giorgini applied concepts that fall outside conventional architecture, such as the concepts of variable-section curved beams, homogeneity of material in connection points and variations in curvature of the beam. The different radii of curvature employed are engineered in such a way that forces are transferred correctly, without the need to increase the thickness of the parts most subject to stress, as occurs in traditional buildings. The practical problem the architect found himself faced with was the execution of these curved surfaces, since suitable techniques did not exist at that time.

Developments in genetics, electronics and information technology during the 1960s led Giorgini to realize that a type of construction technique different from traditional methods—and thus an approach to design and planning very different from the classic approach based on pier, beam and arch—was also possible. He therefore employed an experimental building technology, that of cement-mesh, which he modified and tested during construction in accordance with the empirical Leonardesque spirit that animated him. The cement-mesh, consisting of a 3 mm thick electro-welded wire mesh, often combined with so-called 'chicken mesh', covered with a layer of cement, made it possible to construct thin, very flexible, elastic membranes, which given the wide curvatures, are able to perfectly transfer forces to the ground (Fig. 4).

Fig. 4

Detail of a plinth on which the structure of *Casa Saldarini* rests, Gulf of Baratti, Livorno, 1962 (Courtesy B.A.Co.—Vittorio Giorgini Archive)

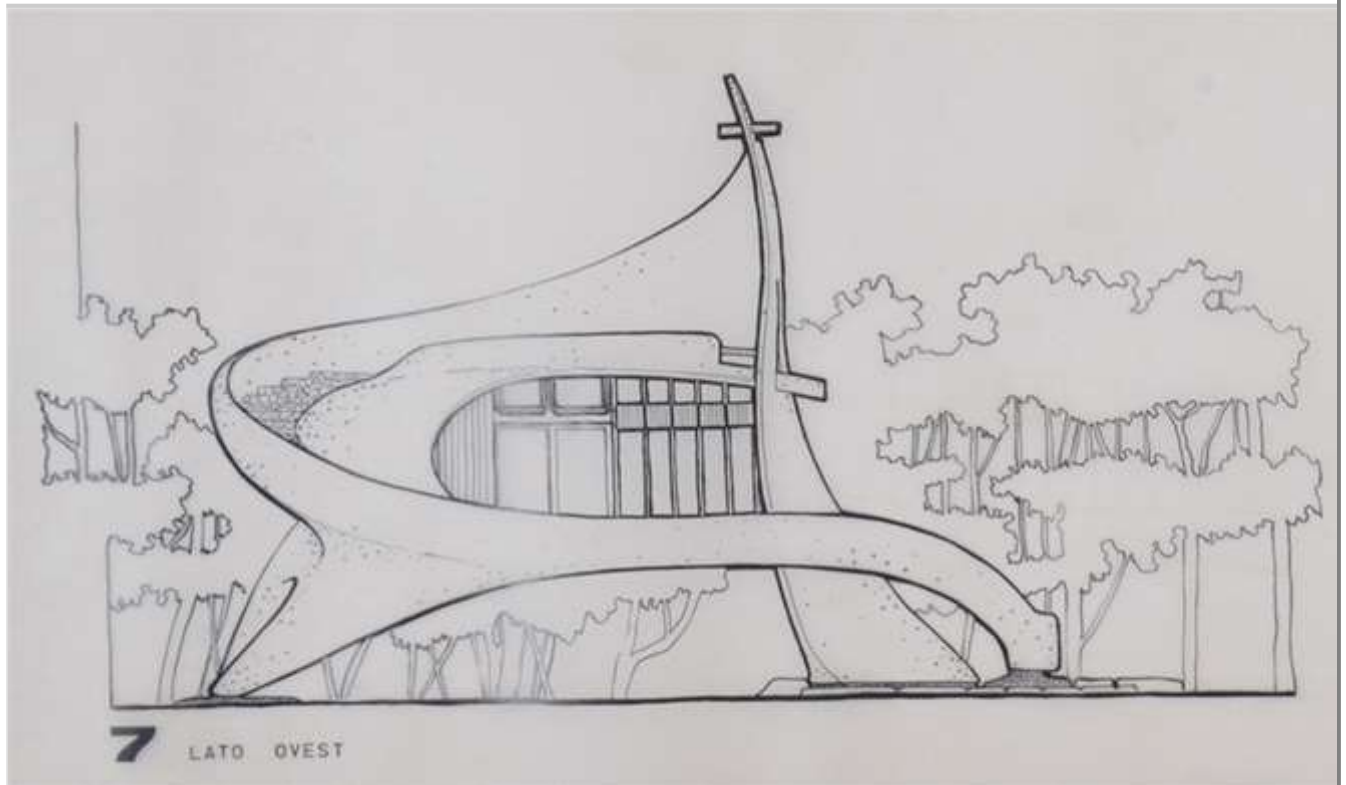


Before applying this new construction technique to *Casa Saldarini*, Giorgini experimented with its use by building a play sculpture and a shower-washtub sculpture in the garden of *Casa Esagono*. The two objects, with zoomorphic shapes, demonstrate an exceptional structural response in the points most subject to stress, a function of the form, materials and the technique employed in their execution.

Casa Saldarini, raised from the ground on only three points, one of which formed by a continuous structure and the two other by hinges, appears as a shell built with a thin continuous membrane of an average thickness of 8–10 cm, which encloses an internal volume of approximately 200 m³. Hooks protruding from the foundations, which comprise two reinforced concrete plinths and a continuous foundation wall, constitute reinforcement of the foundation itself; to these is anchored the load-bearing skeleton of the structure, formed of four superimposed layers of electro-welded wire mesh with different size meshes at the bottom, and two at the top. Once moulded, the wire mesh framework, supported by a wooden frame to keep the shape intact, is covered in a series of stages. First, a 4 cm layer of slow-setting cement is applied from the bottom towards the top, and after 15 days (the time needed for the material to harden) cement is applied from the top to the bottom to prevent dripping (Fig. 5).

Fig. 5

West elevation and section of the *Casa Saldarini*, Gulf of Baratti, Livorno, 1962 (Courtesy B.A.Co.—Vittorio Giorgini Archive)



Later, in the United States, Giorgini would have a number of opportunities to test this building technique, as in, for instance, *Casa Toshiko*, a 1972 an uncompleted project. For four consecutive summers, from 1976 to 1979, he organized an educational workshop with students from the Pratt Institute to design and build the *Liberty Rural Community Centre*,³ a project for a Harlem organization to educate and help inner-city youths (Fig. 6). In this new experience, the architect was able to put into practice all the theoretical and geometric-technological research he had carried out until then (Del Francia et al. 2000).

Fig. 6

Detail of *Liberty*, Parksville, New York, 1976-1979; on the right, Vittorio Giorgini and his students at work (Courtesy B.A.Co.—Vittorio Giorgini Archive)

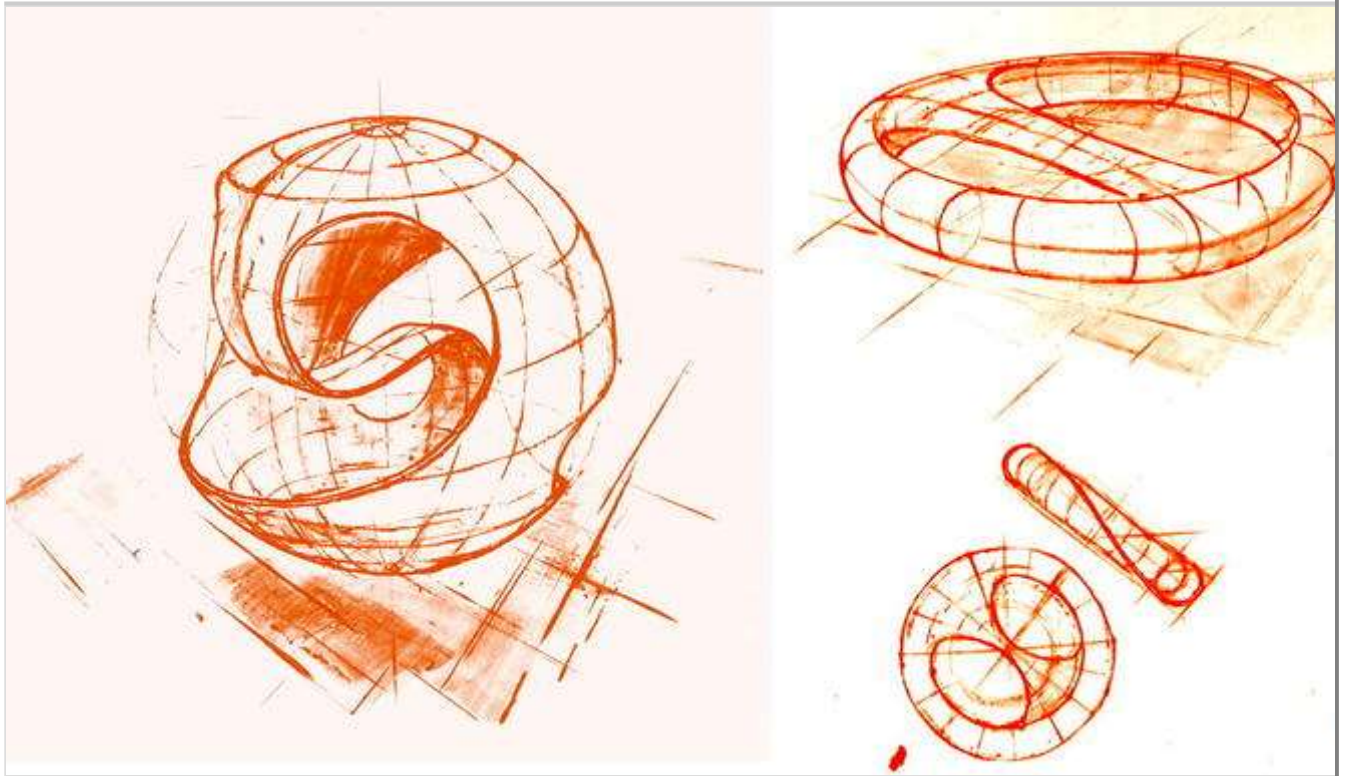


In 1976, the first year of the project, Giorgini and his students laid the foundations of the structure and assembled part of the wire mesh ready for the subsequent phases of the system. Over the next three summers, until 1979, the project continued up to the building of the wire mesh structure, moulded to the shape required with the aid of wooden posts. However, the project was suspended in the fourth year due to lack of funds: *Liberty* was abandoned when only casting cement on the electro-welded wire mesh was lacking.

With the elimination of internal and external surfaces, *Liberty* represented the maximum expression of the architect's research, where starting from basic models such as the Möbius strip and the Klein bottle, he developed new three-dimensional curved figures, such as the *Giorgini Sphere* and *Giorgini Torus* (Fig. 7). By sectioning and curving these figures, Giorgini defined non-orientable and asymmetric shell beams characterized by a wide-radius curve, which can be variable and allows most deformation to be absorbed, thus avoiding an increase in the quantity of material where the bearing stress is greatest (Del Francia 2006: 9–10).

Fig. 7

The *Giorgini Sphere*, on the left, and *Giorgini Torus I*, on the right (Courtesy B.A.Co.—Vittorio Giorgini Archive)



Conventional Systems

Giorgini stated ‘in nature, the trilateral systems used in traditional architecture do not exist, whereas the membrane system exists to an almost total extent’ (Giorgini 1965: 102). Despite the straight line not existing in nature, he was aware that all figures deriving from it are ‘models’, that is, conventional systems through which natural systems can be interpreted more clearly. Giorgini wrote:

...when I started being interested in curved systems (those that characterize the shell beams of Saldarini House) I did not know many things and it was precisely these [curved systems] that were necessary to begin to understand the conventional systems, those related to polyhedrons/polygons. In short, without knowing it, I was taking a backwards route (Giorgini 1995: 244).

Ultimately, this statement reveals the Socratic habit of confessing one’s own ignorance, whereby those who know they know nothing are able to question, and questioning, which springs from not knowing, results in the essentially experimental attitude that characterised Giorgini’s spirit.

Of particular interest is this research path which Giorgini describes as ‘backwards’, or a kind of informed ‘vagrancy’ among curved and conventional systems, which finds its maximum expression in the dynamic approach that characterized his United States period. A far-reaching design phase began in the

1970s, when the formal interpretation of natural organisms consisted mainly of tetrahedral and octahedral meshes, often associated with the use of tensile structures, which demonstrate functional, formal and technological qualities.

He attempted to clarify the ‘relationships between straight and curved lines and the planes and solids that derive from them’, and stated ‘in reality, the forces compound in infinite ways, and the ‘conventional representation contained in the straight line is nothing more than the simplification of what in reality is a generally variable and asymmetric curve’ (Giorgini 1995: 205).

He applied D’Arcy Thompson’s ‘theory of transformation’ to symmetric and asymmetric meshes (Thompson 1945: 1026–1095), using static diagrams to represent the passage from simple models to curved models, that is, the development from linear to bent, according to a given angle, to curvilinear, arriving at a representation of isostatic lines. Ultimately, a structure is a unique phenomenon in which forces and geometry inextricably intervene together. Through the transformation of models, Giorgini demonstrates the behaviour of structures, quantifying the forces that have modified the original model. In so doing, he stated that ‘the nature of the system will be self-explanatory’ (Giorgini 1995: 215). It was the same procedure employed in 1866 by the engineer Carl Culmann of Zurich, who applied the same trabecular patterns found in a section of the head of a femur to the crane arm he was intent on drawing: ‘the anatomical arrangement of the trabeculae ... accords perfectly with the theoretical stress-diagram of the crane’ (Thompson 1945: 978).

Thus Giorgini went beyond Euclidean space, distancing himself from the orthogonality of standard architectural space. During the 1978 Venice Biennale exhibition entitled ‘Topology and Morphogenesis’, he stated that ‘habitual use of the Euclidean space is due to the fact that this was the only geometry we could exploit’, and argued that the aim of architecture is rather to ‘free man from those cages that are his dwelling’ and offer him ‘the space he finds most congenial’ (Vince Masini 1978: 131). Giorgini’s experiment certainly did not take place in the two-dimensional world described in 1882 by Reverend Edwin Abbot in *Flatland*, but rather in that of the other possible geometries implicit in the concept of a fourth physical dimension. The latter, understood as ‘the virtual (potential) force which generates systems when objectified and applied according to a norm’ (Vittorio Giorgini Architecture Archive). In short, Giorgini considered designing to mean organizing and composing the various elements in a space and an environment. Organizing a space means ‘seeing it’, and seeing a space means knowing how to design it.

The idea of topological space, considered in the sense of dynamic space, of space–time, was particularly attractive to Giorgini, as well as to others. Indeed, ‘the topological notions of transformation and continuity intertwine with architectural issues of flexibility, fluidity and dynamism’ (Di Cristina 2005: 130). This also explains his great interest in Maurits Cornelis Escher’s studies regarding topology, and in particular, the dynamic transformation from one tessellation to another. It is obvious that the implementation of the topological way of thinking in architecture had considerable repercussions also on the Florentine architect’s thought and practice.

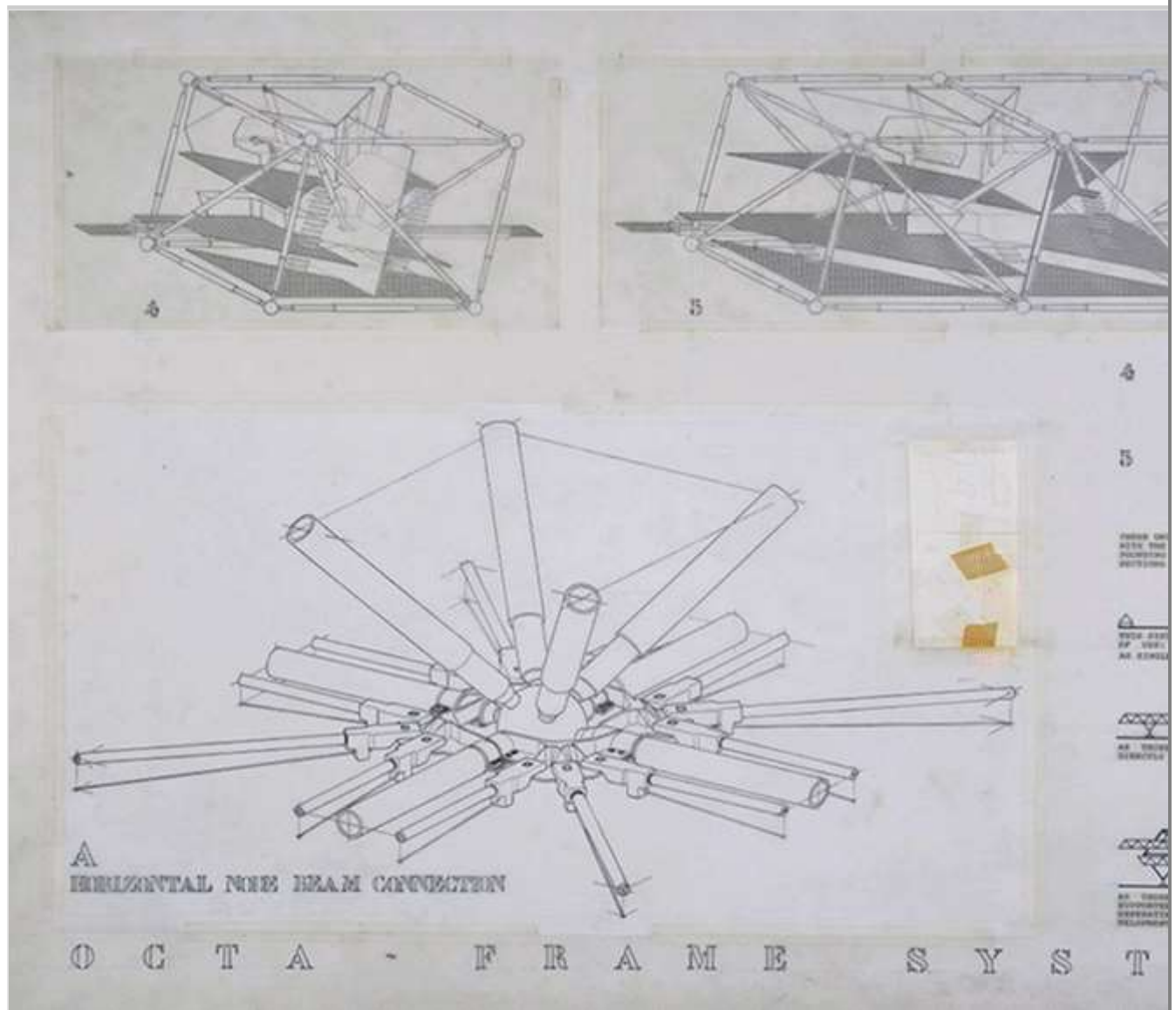
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Giorgini’s ‘knowing how to see’ led to triangular geometries-based building systems and so to tetrahedral and octahedral structural meshes. Indeed, he realized that ‘in the study of nature ... fundamentally, all systems were based on triangular geometries, even those which did not appear to be so’ (Giorgini 2006). After all, ‘[i]n the mechanical side of anatomy nothing can be more beautiful than the construction of a vulture’s metacarpal bone ... The engineer sees in it a perfect Warren’s truss, just such a one as is often used for a main rib in an aeroplane’ (Thompson 1945: 981). ‘The genial, eccentric American inventor’ (Giorgini 2006), Richard Buckminster Fuller, who Giorgini knew personally, stated that the tetrahedron is the ‘*Universe’s minimum structural system*’ (Fuller 1975: 653), or its ‘fundamental prime number oneness’ (Fuller 1975: 333), **and is accepted as a primary geometric configuration**. After all, the tetrahedron and the octahedron are two of the five convex regular polyhedra which Plato considered the simplest elements on which our reality is built, or ‘the most beautiful figure of circumscribable space is a sphere’ (Sala and Cappellato 2003: 14). Like all simple polyhedra, the tetrahedron and the octahedron ‘can be transformed into spheres by continuous deformation’ (Hilbert and Cohn-Vossen 2016: 376–383), similarly, the opposite is also nonetheless true.

Both Buckminster Fuller and Giorgini tried to apply the laws of nature to architecture; ‘We do not seek to imitate nature, but rather to find the principles that she uses’ stated Fuller (Colombo 2008: 25). It was certainly no coincidence that Giorgini’s octahedron mesh ‘Octa-Frame System’, where basic modules are assembled together to form the Octet building unit, recalls Fuller’s Octet Truss system, patented between 1940 and 1943 (Fig. 8).

Fig. 8

Detail of a horizontal node beam connection of the Octa-Frame System. (Courtesy B.A.Co.—Vittorio Giorgini Archive)



It seems that Giorgini lived his time to the fullest, taking part in the artistic and cultural life of the Big Apple, where he frequented and formed a series of friendships with personalities of notable stature. He was introduced by his good friend, the sculptor Isamu Noguchi, to the gatherings at Priscilla Morgan's Upper East Side garden apartment, where he met Mark Rothko and Christo, and discussed architecture with Buckminster Fuller (Sèstito 2009). He developed a close friendship with John M. Johansen, 'the last of the famed "Harvard Five" and widely recognized as one of America's most innovative modern architects' (Johansen 2011), who taught architecture at the Pratt Institute and supported the Florentine every step of the way.

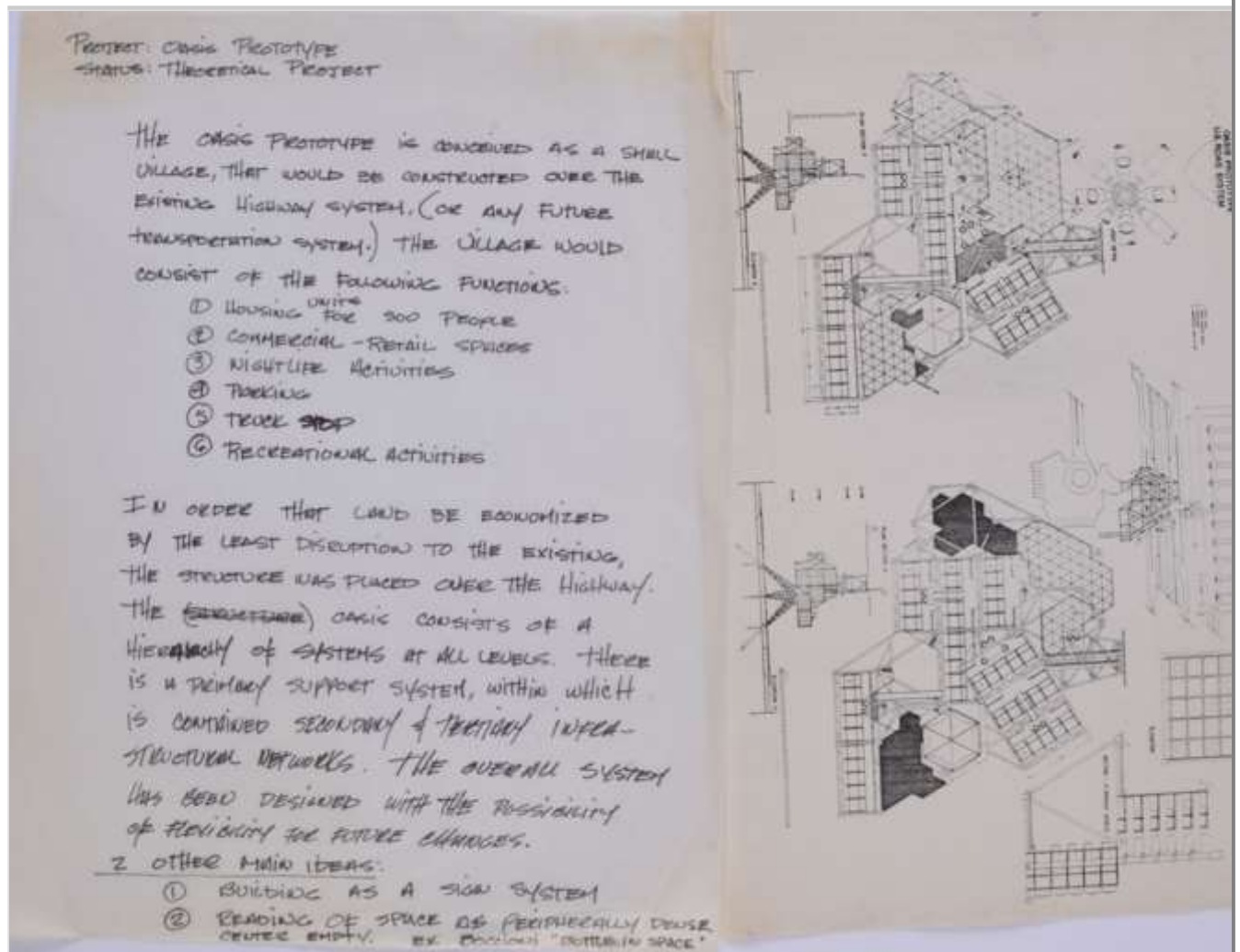
His American projects are paradigmatic of the prolonged research, analysis and design work carried forward by the Florentine architect. They represent the key to understanding the application in architecture of the models and diagrams of static forces that he studied and explained in theory (Giorgini 1995: 237). He specified that these projects were conceived with typical light structure

techniques in mind, that is, with spatial mesh frameworks and tensile structures based on symmetric and asymmetric figures. Giorgini's design work took account of industrialised procedures, and so he looked favourably on the automation of construction processes and the use of robotics for assembly of 'pieces': serial prefabricated modular elements of variable dimensions. His aim was to create 'projects that were easily feasible and even cheaper' (Giorgini 2006). On more than one occasion he emphasized that in nature efficiency is economic, and is attained through appropriate complex structures produced by physiochemical growth and transformation. In architecture, on the other hand, that which is technologically efficient is often economically inefficient. The paradox is served!

In 1973, he formulated the *Interstate Highway Oasis Prototype*, a multi-functional toll road service station and rest stop, a kind of small village, which the architect conceived as a number of staggered levels, each designed to fulfill different functions, arranged in parallelepiped modules and suspended pneumatic structures. The octahedron spatial mesh framework of the service station is raised approximately 40 metres above ground over the existing highway by means of a gigantic reticular tripod, the element of transition between the ground and the structure (Fig. 9).

Fig. 9

Notebook sketches of the Interstate Highway Oasis Prototype, 1973 (Courtesy B.A.Co.—Vittorio Giorgini Archive)



Of particular interest is the question of the node, the most technologically complex element: the fulcrum of distribution of forces, in which three or more variable section metal tubular members converge. Giorgini tested and revised the node many times during his work, finally arriving at the most complex version, described as 'universal connective nodes', during the study of a series of possible combinations of octahedron-tetrahedron modules, the Octa-Frame System. Giorgini was certainly aware of the MERO node system invented by the engineer Max Mengerhausen, and the connector joints designed by Konrad Wachsmann for the United States Air Force. He had already conceived a singular metal joint-hinge system between the pier and the hexagonal reinforced concrete foundation plinth in the *Casa Esagono*, a prefabricated hexagonal structure supported by a system of six cruciform wooden pillars. Anchorage to the ground is by means of a spherical metal node that contains the cruciform socket into which the base of the pillar is inserted (Fig. 10).

Fig. 10

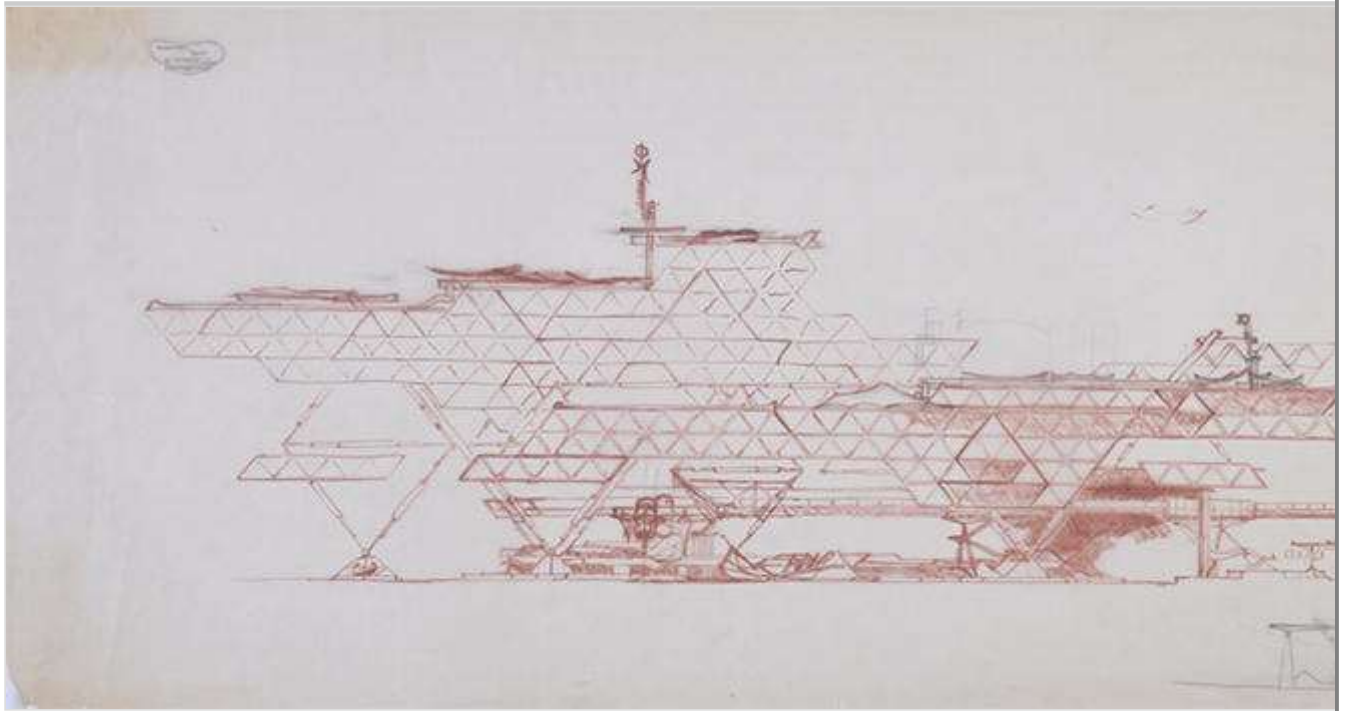
Details of the anchorage on the ground of *Casa Esagono*, Gulf of Baratti, Livorno, 1957 (Courtesy B.A.Co.—Vittorio Giorgini Archive)



Almost all Giorgini's overseas projects, especially *Hydropolis*, *Genesis* and *River Crane*, are based on the Octa-Frame System. After all, given its geometric stability, the triangle-tetrahedron is the most statically efficient figure. As Giorgini explained: 'Taking the tetrahedron as the ideal basis of efficiency, it is relatively easy and certainly more economical to construct a reticular volume. Graduating to an octahedric system, we obtain a mesh that adapts to various uses and criteria' (Giorgini 195: 209) (Fig. 11).

Fig. 11

Genesis, Manhattan, New York, 1984, on the left and *River Crane*, Roosevelt Island, New York, 1993, on the right (Courtesy B.A.Co.—Vittorio Giorgini Archive)



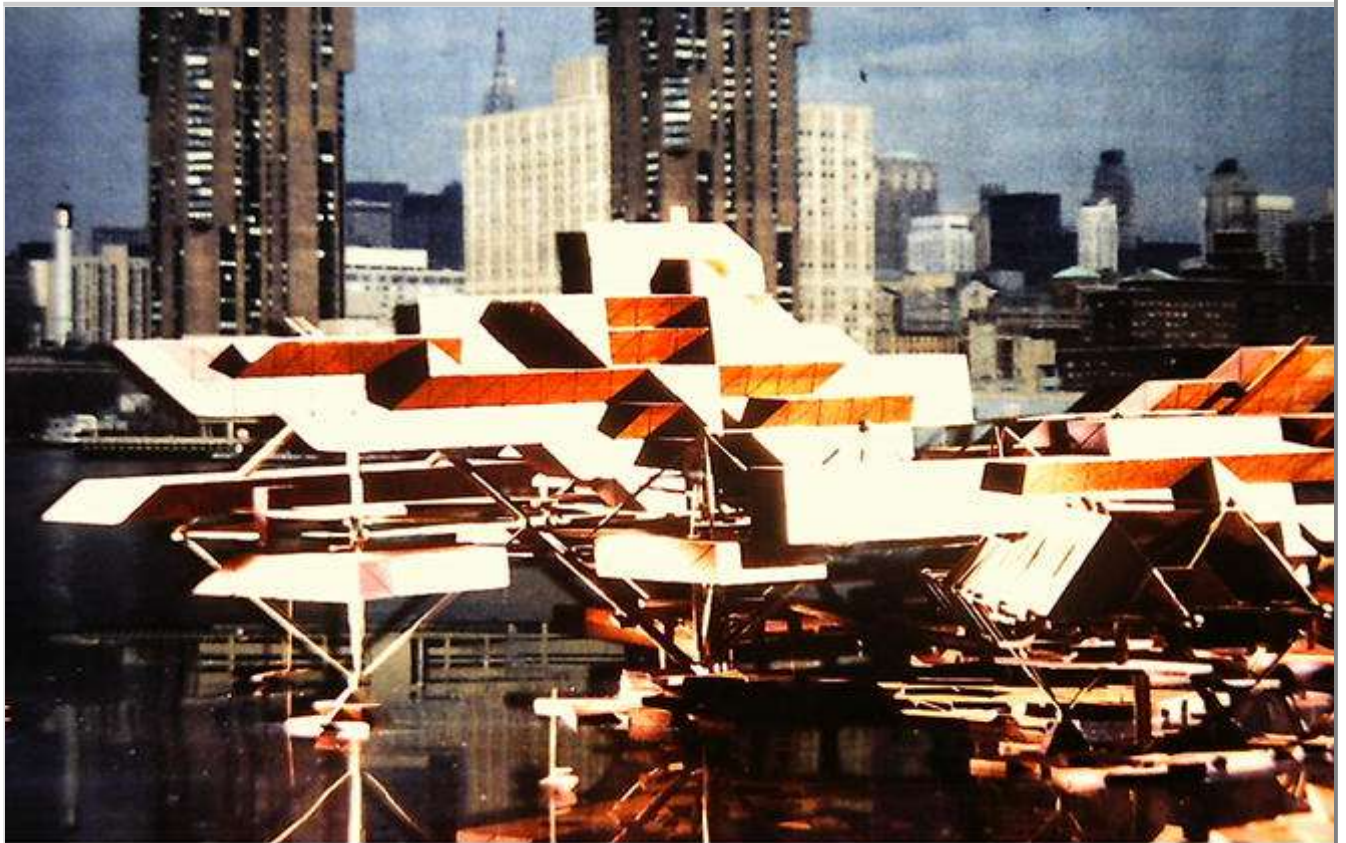
South Street Seaport Center (1978), *Hydropolis* (1981–1982), *Walking Tall* (1982–1983), *Genesis* (1984) and *River Crane* (1993) are projects conceived for New York, particularly for Manhattan, which Giorgini believed to be the perfect example of an environmental equilibrium violated by intrusive building speculation in the areas adjacent to the water (Del Francia 2000: 110). He believed in a different planning approach, one more respectful and respondent to the most elementary needs of everyday life.

A couple of years after the unsuccessful *Liberty* experience, Giorgini designed *Hydropolis*, an unusual neighbourhood on the East River between 16th and 24th Streets, which he proposed as a somewhat controversial alternative to the project which won the competition launched for this area and was harshly criticized by Giorgini. In the Octa-Frame System, the basic module defines a self-supporting structure. Assembled with other modules, it generates self-supporting beams, which are in turn combined to form ‘beam systems on a larger scale’ (Giorgini 1995: 243). These solutions opened architecture in all directions—indeed, he also reflected on the implications of the thinking of the Japanese Metabolists, with whom he had formed personal relationships—erasing every kind of hierarchy between prospects, and allowing a uniform isotropic design, raisable in height and without cumbersome supports on the ground. Giorgini created a dynamic, flexible geometric structure ‘articulated in interdependent modules to form a unitary complex’ (Giorgini 1995: 239), which could be arbitrarily extended to infinity. It was a bridge complex projected over the river and founded on a system of islands dedicated to public activities integrated and organized both in the open and under cover. The ‘cyclopean artificial peninsula’

was raised above the water by a system of inverted tetrahedrons which functioned as *pilotis* or stilts, while the anchor to the ground was the node itself, which in turn rested on a truncated pyramid base (Fig. 12). The staggered, articulated levels above the water performed different functions, while mechanized overhead transport systems connected the structure's various storeys, and linked the island to the land and to harbour facilities for recreational boating. Here Giorgini reflected on the offset planes that decompose the objects in Umberto Boccioni's work *Development of a Bottle in Space*, where the bottle, table, plate and glass are observed in their space–time development. More generally, Giorgini observed the articulated and dynamic geometric decompositions and re-compositions of the Futurists and Cubists, and made notes about them in one of his notebooks.

Fig. 12

Hydropolis, Manhattan, New York, 1981–1982 (Courtesy B.A.Co.—Vittorio Giorgini Archive)

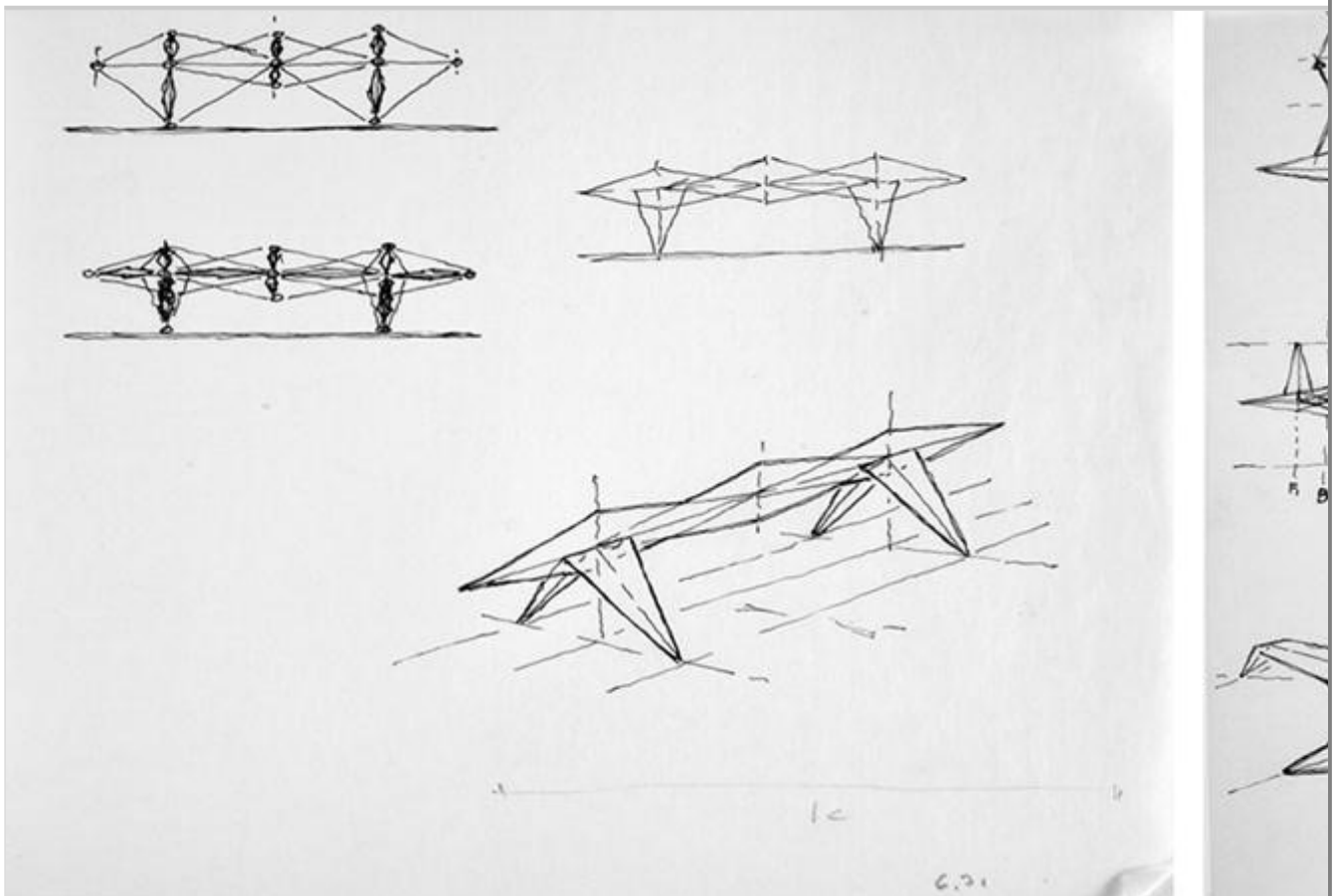


If we let our imagination take hold, we note that the *Hydropolis* village distribution and logistics system calls to mind Leonardo da Vinci's idea of a city based on the street–canal double–traffic system (Leonardo da Vinci 1487–1489: 16 r, 36 r) designed to distribute the city over three levels and organize life there to the best.

The articulated, flexible ‘cyclopean artificial peninsula’, supported by *pilotis*, is none other than the schematic description of the endoskeleton on a quadruped. As D’Arcy Thompson wrote: ‘Standing four-square upon its fore-legs and hind-legs, with the weight of the body suspended between, the quadruped at once suggests to us the analogy of a bridge, carried by its two piers’ (Thompson 1945: 989). Giorgini wrote: ‘If we examine a beam with two brackets on two/four supports, we see that this diagram is the schematic description of a quadruped. Nature is a rich source of examples’ (Giorgini, 1995: 221). Animal and human joints are disadvantageous (class 3) levers capable of resisting great stress without breaking: as such they attracted the attention of Leonardo, and five centuries later, inspired another Florentine (Fig. 13).

Fig. 13

‘If we examine a beam with two brackets on two/four supports, we see that this diagram is the schematic description of a quadruped. Nature is a rich source of examples’ (Giorgini, 1995: 221). (Courtesy B.A.Co.—Vittorio Giorgini Archive)



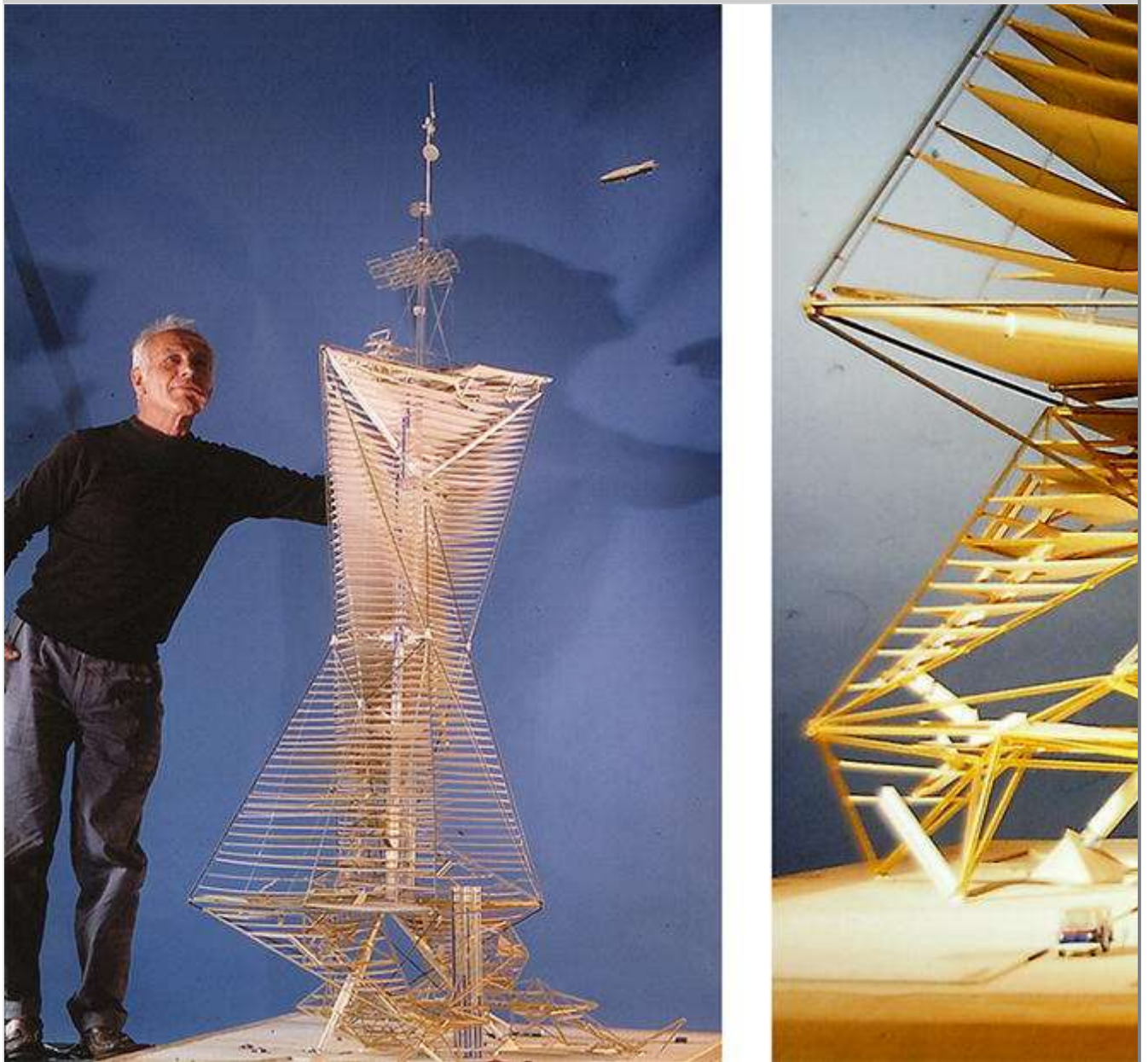
Furthermore, Giorgini proposed an alternative to the usual ‘office towers proposed and then built between 49th and 50th Street and 8th and 9th Avenue’ (Giorgini 1995: 240). *Walking Tall* is a multipurpose 250 m high, 100-storey skyscraper, in short, a neighbourhood that is ‘alive and integrated, functioning

24 h a day' (Giorgini 1995: 240). It is a vertical building where Giorgini fully embraced the possibilities offered by the innovative tensile structure solutions that he would take advantage of on a number of occasions during his career: *Machu-Picchu* (1976), *Patent Port* (1989), *River Crane* (1993). Among the advantages of suspension is 'the elimination of anchorage points, with the consequent benefit of lightening the construction elements ... the greatest advantage of compression/tension mixed systems lies in the ability to move in every direction and compose different symmetric and asymmetric geometries within the space' (Giorgini 1995: 223). *Walking Tall* is a tensile structure formed by triangular sections defined by the 'diagram composed of beams and lever arms, under compression and tension respectively, which organize the building's space' (Del Francia 2000: 77). It is, therefore, comparable with the skeleton of a living being, where the beauty and robustness of the construction lie in the harmony of all the parts suited to traction or compression.

The skyscraper is formed by an oblique pyramid with a convex quadrilateral base, around which winds an articulated composite beam which he described as a 'tetra-prismatic walk' (Giorgini 1995: 240) (Fig. 14). Set on the walk, at the junction of the base polygon diagonals, is an oblique steel mast, which follows both the vertical development of the pyramid and the development of the inverted tetrahedron, with the vertex coinciding with the base of the mast and the base coinciding with the top of the structure. The entire building is raised above the ground by a slender tripod, recalling the long, slender legs of 'mathematician' artist Salvador Dali's elephants. In Dali as in Giorgini, these are elements of transition between the earth and the sky that counteract the absence of weight.

Fig. 14

Walking Tall, Manhattan, New York, 1982–1983 (Courtesy B.A.Co.—Vittorio Giorgini Archive)



As a matter of fact, all of Giorgini's projects, finished and not, are suspended above ground, freeing the soil that is just furrowed by light anchorage points which become an integral part of his architectural language. It is not so strange, therefore, that on more than one occasion Giorgini speaks of boats and aeroplanes, that is, of 'buildings that lack the traditional point of reference, namely, the ground'. Without doubt, he reflected on Le Corbusier's structures on columns that free the walls from any load-bearing function and suspend the volume on *pilotis*, elevating the building on 'pile foundations'. But above all, he reflected on that vast sourcebook of man's constructive logic that is the legacy of vernacular architecture, which 'for reasons of heraldic status' had not had 'until now, access to history' (Giorgini 1995: 227). After all, Giorgini had always fought for an ecological way of thinking, against the squandering of land and resources. Indeed, his projects show a deep respect for Mother Earth on which we build.

Conclusions

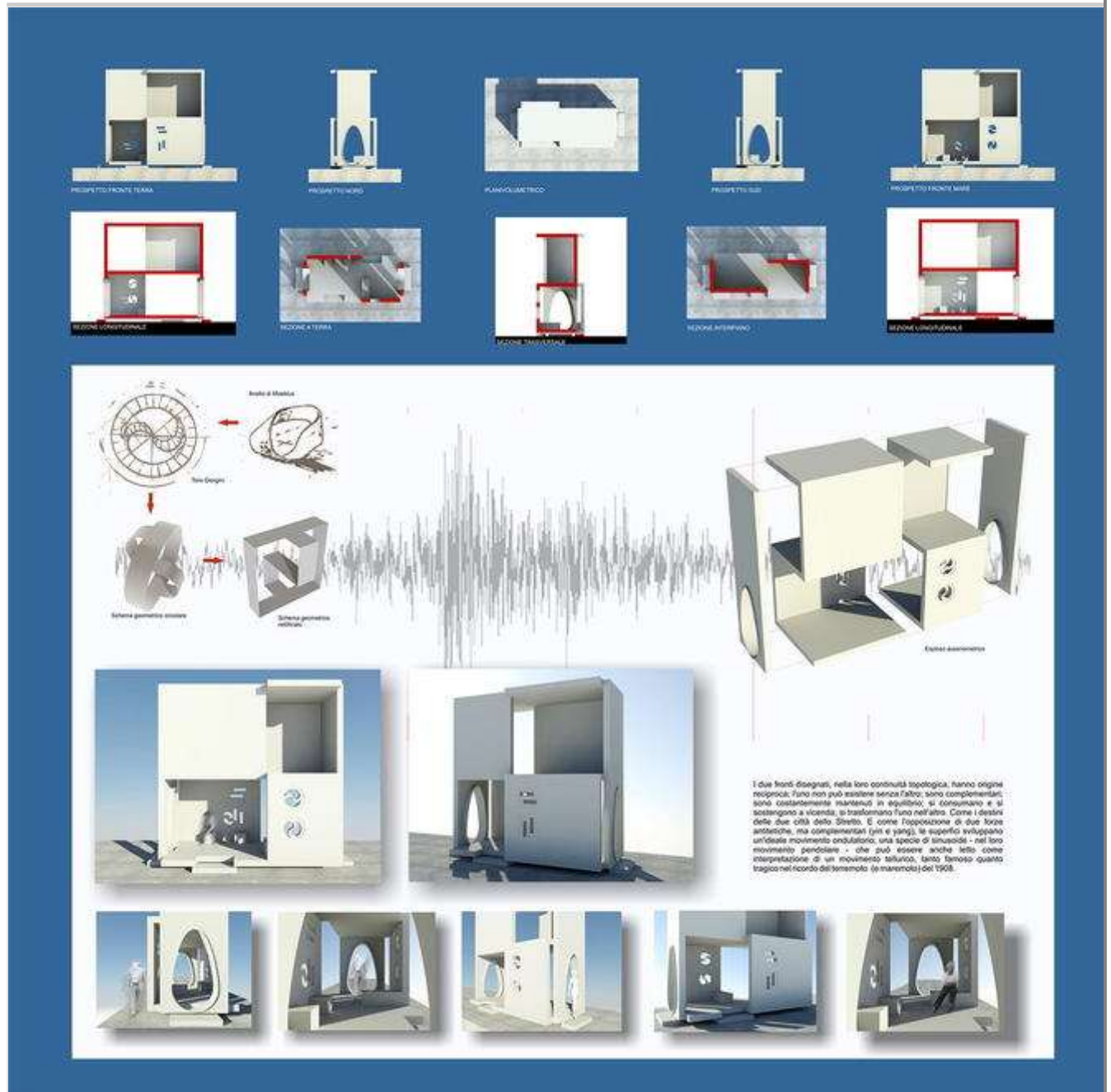
Despite the exuberance and intellectual vivacity of his ideas, visionary and atypical for his times, and even for the present, the ‘Made in USA’ projects have remained on paper. His writings, on the other hand, drafted in a somewhat terse language—he described himself as a ‘non-professional writer’—are sometimes challenging even for those in the profession, and do not fully represent the pioneering character and intellectual significance of his vision of the world. The projects, those completed and those not, relating to ‘curved systems’ were mostly misunderstood and labelled as informal (Drexler 1979). Those involving conventional systems which remained on paper, on the other hand, risk being labelled utopian and science fiction.

The papers in the Vittorio Giorgini Architecture Archive, together with an unpublished autobiography and the last interview given shortly before his death, tell of a life devoted to research, albeit solitary, in an attempt to bring man things similar to those constructed in nature, ‘not so much to copy the forms ... but to obtain more efficient and more effective complex systems’ (Giorgini 2006). Although different in terms of form, the projects employing tetrahedral and octahedral structural meshes are, he frequently stated, equivalent to those featuring membrane structures. There again, topological as opposed to Euclidean geometry allows for elastic deformation of the figures.

His last work—in 2009, in collaboration with Marco Del Francia—in which he designed one of the twenty houses designed by renowned international architects, for the *Palazzata bifronte* to be built on the Lido Nervi Esplanade in Reggio Calabria, sums up this approach very well: ‘The space assigned here is a half cube, which can be transformed into a greater circle with the two minor ones’ (Vittorio Giorgini Architecture Archives) (Fig. 15).

Fig. 15

Palazzata bifronte, Lido Nervi Esplanade, Reggio Calabria, in collaboration with Marco Del Francia, 2009 (Courtesy B.A.Co.—Vittorio Giorgini Archive)



Concurring with Johansen, we can affirm that ‘As well as being a scientist, geometrist, architect, teacher, Vittorio Giorgini is distinctly an artist’ (Giorgini 1995: 183). Ultimately, as G. H. Hardy wrote, ‘[a] mathematician, like a painter or a poet, is a maker of patterns’ (1940: 13–14). So we discover that the activities of a mathematician and an artist are not so different, because they have the objects of their studies and the forms of their representation in common.

A sense of deep disappointment comes through in his last interview: ‘having reached the end of the road’, he was sorry ‘not to have been able to produce more’ (Giorgini 2006). Yet his sketches, projects, drawings, notebooks, photographs and memories are invaluable objects that contain a wealth of ideas not yet completely investigated.

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Acknowledgements

The Authors wish to thank Architect Marco Del Francia for his support and for making available Vittorio Giorgini Architecture Archives. Thanks are due to Professor Engineer Carlo Colombo for his helpful advice and comments.

Author Contributions

Introduction to Vittorio Giorgini: An Explorer Intent on Discovering the World: DU and BT; Giorgini's Experimental 'Risk': DU; Curved Systems: LG; Conventional Systems: DU; Conclusions: DU, LG and BT.

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¹ Knowing Giorgini's work, the then-superintendent (name of the superintendent not found) did not refuse him the opportunity to build on a site subject to special planning controls.

² On 26 June 1967 the engineer Piero Lusvardi carried out a traditional load test, loading a 3 m wide strip of the walkable floor surface with bags of cement weighing 50 kg each, and at subsequent stages of 100 kg/m², up to 300 kg/m². From examination of the indicator values in the various loading and unloading phases, he ascertained that the part of the structure subjected to testing had shown an elastic behaviour with 'marked correspondence between loads and movements' (Test certificate dated August 1st 1967).

³ The name 'Liberty' comes from the small town in New York State where the building was to be located.