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Article

Gaetano Vinaccia's (1881–1971) Theoretical Work on the Relationship between Microclimate and Urban Design

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Abstract: Because of his classification as a minor architect, Gaetano Vinaccia's (1881–1971) role in the history of architecture has not been studied in depth. Despite the fact that his impact on the debate about rational architecture was limited, the depth and scientific accuracy of his theoretical contribution to the field of microclimatology in relation to urban design issues deserve to be highlighted, especially today when environmental and bioclimatic questions arise strongly in architecture and planning. Thus, this work aims to reconsider this figure by describing the—unfavorable—context in which his work evolved, by bringing to light his most brilliant statements, by reading his scientific productions, and by starting to consider the validity of some of Vinaccia's intuitions and their actual correspondence with contemporary research. The question of whether Vinaccia can be considered as an innovator (or not) largely derives from the point of view of architectural criticism and the fact that he did not have a well-defined discipline in which to be classified. Despite the fact that his *The City of Tomorrow* (1943–1952), which is the first complete treatise on the subject, reveals that he was an absolute pioneer, he has had no chance to influence architecture and urbanism until today.

Keywords: Vinaccia; urban design; microclimate; polisclimatology; sustainability; architecture; environmental design

1. Introduction

Gaetano Vinaccia's (1881–1971) contribution in the history of architecture has not yet been studied in depth. The point of view of architectural criticism, which classified him as a minor architect, still prevents appreciation of his theoretical contribution to the field of microclimatology in relation to urban design. Today, when environmental and bioclimatic questions arise strongly in architecture and planning, Vinaccia's work may have more influence. Nevertheless, in order to evaluate the real brilliance of his intuitions we need to describe the—unfavorable—context in which his work evolved, both for political and cultural reasons. Then, by reading his scientific productions and by checking their actual correspondence with contemporary research, we bring to light his most forerunning statements. Despite the fact that his theory has no chance to directly influence the urbanism of today, his most important book, *The City of Tomorrow* (1943–1952), which is the first complete treatise on the subject, reveals that he was an absolute pioneer in founding a new discipline between microclimatology and urban design [1].

1.1. Illness in the Working Class

According to the statement of the leading critics, the first aim of the whole Modern Movement was a radical reform of the relationship between architecture and the building process. Driven by the desire for a more equal society, the architects of the early decades of the twentieth century moved the center of the discipline from a super-structural dimension to the performance of a deeper role in urban and social transformation. Looking at housing as a social need rather than as a consumerist good, the new architecture aimed to have a new role in defining the lifestyle and conditions of the working class.

The leading role played by Gropius and Meyer's Bauhaus in the diffusion of the Neue Sachlichkeit [2] spirit is well known: goods, furniture, houses, and cities should be built as a result of a production process through an optimization of shape, materials, and functional needs. The building program became more responsible for social goals, and architects were involved directly (both as planners and as managers) in urban development. The topic of the healthiness of buildings, first set out by Friedrich Engels in his text *The Condition of the Working Class in England* (1887) [3], had already been addressed at the turn of the century, but it had never been faced with such a scientific and methodical approach before. The work of Hannes Meyer, Mart Stam, Walter Gropius, Erns May, and Alexander Klein on Existenzminimum, "minimum dwelling", which was the focus of the CIAM II in Frankfurt am Main, aimed at reducing building costs (including the cost of land consumption) by a reduction of the worthless surfaces of houses. Furthermore, the balance was moved so as to see man as a biological entity that requires rest until the following working day. Nevertheless, research on typology reached some standard formulations of the new working-class building environment, in which the amounts of daylight, fresh air, heat, and silence were radically maximized. Carlo Aymonino noted that the illustrations associated with the statement expressed by the authors during the CIAM conference did not describe any quality of space, but only the organization of space [4]. All demands for the representation of social rank as well as tastes, preferences, and differences were considered an aspect of the bourgeois social heritage and thus abandoned. This ideology-driven approach, led by Walter Gropius, aimed to break up the structure of contemporary society (based on differences between social classes), making it easier to establish a socialist one. However, the studies on modern housing units were not sufficient to support their political plans, so the next year the focus moved from the house to the city. During the third CIAM congress (Brussels, 1930), Siegfried Gideon [5] defined the goal of the so-called Modern Movement as that of reaching the most efficient formulation for a typological scheme for building on a different scale. The mechanical precision used in measuring the houses' space was applied to urban design. The proposal for new neighborhoods based on linear high-rise blocks, which was developed in the early 1920s in Germany, became the standard. In 1919, Theodor Fisher (1862–1938), who was the first chairman of Deutscher Werkbund and professor at the Technical University of Munich, realized a plan—Alte Heide—in which each block is at a distance from others twice its height, in order to prevent façade shading [2]. Five years later, Otto Heasler (1880–1962) developed the principle in the Georgsgarten Siedlung. This rule, later called Heiligenthal after R.F. Heiligenthal (who, in 1921, published his book Deutsche Städtebau—"German city planning") [6] (see Figure 1), became the Neue Sachlichkeit's standard approach for housing climate control between 1925 and 1933. The linear high-rise blocks were south–north oriented in order to ensure maximum and equal insulation for the apartments. Gropius's diagrams, shown at CIAM III (1930), aimed to define a new universal typology for new settlements, while simultaneously achieving three goals: first, to ensure a more efficient building process for a new socialist society, which should level class differences; second, to define a minimum standard requirement for human space, both at the housing scale and the urban; and third, to take over every form of private and public space that had been directly or indirectly linked to the models of the past (squares, boulevards, parks, streets), which were considered expressions of bourgeois society. In 1927, Ludwig Hilberseimer published his *Großstadtarchitektur* [7]. The author, starting from a criticism of the Siedlung, offered his own point of view on modern architecture and his open opposition to all traditional architecture that did not interpret, radically, the new spirit. Application of standard housing units along a line, repetition of the same floor plan to achieve best performance in terms of costs and land consumption, serial and regular deposition of blocks, orientation along the solar path, suppression of every hierarchy in the shape of public space, breakage of any direct relation between the building and the streets, and the repeatability and universality of typological schemes all entered the mainstream of architectural thought. Furthermore, the traditional opposition between the city and the countryside was easily overcome. Clearing the ground from blocks and streets allowed houses to establish a direct relation with nature, providing a large increase in buildings' healthiness. In this way, the countryside became part of the city, and, conversely, the urban landscape changed in the direction of increased openness [5] (p. 725). The manual *Architect's Data* [8], by Ernst Neufert, first published in 1936, aimed for the ultimate standardization of the whole of the human environment. Following the Heiligenthal approach, Neufert also added diagrams in order to help architects find the right building orientation. *Architect's Data* was an enormous success. It was translated into 18 languages and went through several editions. Nowadays, it is still generally the most consulted building manual.

Le Corbusier and His Contemporary Sources on the Heliothermic Axis

Aiming to narrow down his whole theory for the "civilization machinist", between 1922 and 1930, Le Corbusier set the standard for the new modern urbanism. In 1922, at the Salon d'Automne, he presented his Ville contemporaine de 3 millions d'habitants, in 1925, his Plan Voisin for Paris, and in 1930 the Ville Radieuse, which was shown at the third CIAM in Brussels [9,10]. Among the main objectives of the latter project was providing better access to the sun in the building blocks [11]. This goal was fulfilled through the urban grid's rotation of 19° northeast according to the heliothermic axis theory developed by Pidoux, Rey, and Barde, published in 1928 in *La science des plans de villes* [12] (Figure 2). Despite the fact that Rey's theory was never directly cited by Le Corbusier, it became "l'armature du tracé urbain". In fact, the Pidoux–Rey–Bardet theory supported Le Corbusier's passionate urban renewal, providing some scientific evidence for the architect's ambitions for building layout [13].

Figure 1. Heiligenthal, R.F. *Deutsche Städtebau*, 1921 [2].

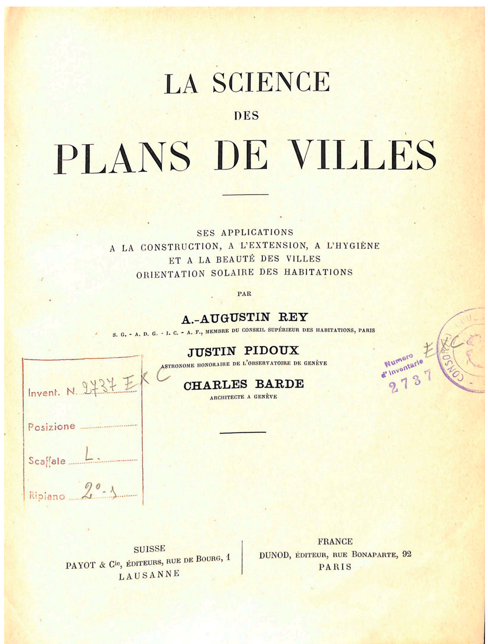

Figure 2. Pidoux, J., Rey, A. and Barde, C. *La science des plans de villes*, 1928 [12].

According to Pidoux-Rey-Bardet's theory: "L'axe principal [of a building facade or city grid] au lieu d'être dirigé au sud est dévié vers l'ouest sous l'influence de la température qui est plus élevée l'après-midi que le matin et qui contribue à favoriser les valeurs héliothermiques de la deuxième moitié de la journée […] Cette direction partage l'insolation totale en deux parties inégales et la valeur héhothermique tota1e en deux parties égales. Si nous supposons un bâtiment ou une suite de constructions alignées suivant cette direction, les façades tournées à l'est et celles tournées vers l'ouest jouiront de la même valeur héliothermique, savoir pour chacune la moitié de la valeur totale" ("The axis [of a building façade or a city grid] instead of being directed to south is deflected westward under the influence of temperature. [The latter] is higher in the afternoon than in the morning and that raises solar thermal values of the second half of the day [...]. This orientation splits global exposure into two unequal parts and heliothermic total value into two equal parts. If we consider a building or a series of buildings, that are aligned along this direction, the façades that are oriented to the east and the west oriented ones shall have the same heliothermic total that is the half of the total value each") [12] (p. 22). Rey's studies concerned both the facade's sunlighting and temperature. The main purpose of the heliothermic direction was to ensure, during the day, the same thermic values on the west and east façade of a building. Obviously, it varied according to the geographic location of the place (19° for Paris). Rey drew both the "solar axis" and the "thermal axis", pointing out a discrepancy of 45° caused by the delay in the temperature's trend, which reached its maximum values about three hours after midday (14:00–15:00). Thus, the heliothermic axis ensued from the bisecting line of the solar and thermal axis and, according to Rey's thought, it would have taken advantage of the maximal annual solar radiation.

The heliothermic theory, which had a dramatic influence on architects of the following generation, was disputed during the 1940s; it opposed the "hygienists", the partisans of east–west exposure, to the "climatologists", advocates of south exposure [14]. Among the latter were Bardet (1943), Vinaccia (1943), Hermant (1943), and Leroux (1946) [13] (p. 23). Vinaccia's criticisms mainly concerned the heliothermic unit's validity, the results of thermic measurements on building surfaces, and the lack of interest in other façades (southwest and northeast). He declared the futility of this tool, considered it "one of the best devised hoaxes", accusing architects and planners of using it more for its novelty than its effectiveness [15].

Even though Vinaccia did not have available contemporary tools to demonstrate the correctness of his opinion, it is interesting to highlight that recent research has confirmed the inefficacy of Rey's theory. A study conducted in 2005 by Harzallah *et al.* [14] verified the heliothermic assumptions by comparing the temperatures and sunlighting values, deduced from a building sample, for the two orientations: north–south and 19° (Paris's heliothermic axis). The results showed that the heliothermic tilt actually causes a temperature increase of about 2 °C on the southeast façade, except in summer, and a decrease on the northwest one of 1–2 °C, throughout the year. Conversely, the heliothermic balance is reached for the north–south orientation. Therefore, "L'égalité thermique moyenne, recherchée par les partisans de l'axe héliothermique, n'est donc réalisée que pour les façades exposées parfaitement à l'est et à l'ouest, c'est-à-dire pour un immeuble orienté exactement nord–sud. Toutes les autres orientations entraînent une dissymétrie thermique qui s'accroît au fur et à mesure que l'on s'écarte de l'axe Nord–Sud" ("The average thermal equality, sought by proponents of the heliothermic axis, thus, is reached only for the façades that are perfectly east and west exposed, that is to say for a North-South oriented building. All other directions may cause thermal asymmetry that gradually increases as one moves away from the North-South axis") [14] (p. 7).

In 2006, an analogous study on the effectiveness of the heliothermic axis in *La Ville Radieuse* by Le Corbusier was carried out by Steemers, Montavon, Cheng, and Compagnon. They compared both the daylight potential of Le Corbusier's urban blocks (business and residential blocks) for two different orientations: north–south axis and heliothermic axis (19°, Paris) and the daylight potential of these with two different urban blocks in Paris at the time (~1920). In this case, too, the project's assumptions about providing better access to the sun did not produce the results sought. Despite the fact that daylight potential varied with the block typology, and showed little increase in winter performance, generally the authors asserted that "the effect of the heliothermic axis is negative as it results in smaller total illuminance" [11] (p. 6).

1.2. Urban Climatology Research in Europe until World War II

According to Fionn MacKillop, publications on microclimatology and the urban climate increased significantly from 1960 onward [16,17]. Nevertheless, in terms of the emergence of the discipline, in the early century, the first significant peak was in the 1930s. Rudolf Geiger (1894–1981), who was a German meteorologist and climatologist, is still considered as one of microclimatology's founders. Between 1930 and 1939, he worked with the Russian climatologist Wladimir Peter Köppen (1846–1940) on the *Handbuch der Klimatologie* in Fünf Bänden, which, despite never being completed, had wide resonance in scientific debate in the 1930s. In 1927, he published his *Das Klima der Bodennahen Luftschicht*, translated in 1950 as *Climate Near the Ground*, which is still considered a milestone in micrometeorology. The treatise describes how temperature, wind, and light may vary under the influence of ground shape, vegetation, daylight, topography, and interrelations between humans and the microclimate. The German-born climatologist Helmut Erich Landsberg, who developed his career in the U.S. after moving from Germany in 1934, considered Father Albert Kratzer's book *Das Stadtklima* (1937) the origin of the scientific debate on microclimate [18]. Nonetheless, Landsberg noted that in *Das Stadtklima*'s first edition, Kratzer had already cited 255 papers. Analyzing in depth the bibliography of its first edition (1937), some issues needs to be highlighted. Most of the cited works are climatic reports and statistical surveys, and some are more related to fog, dust, or pollution prevention. Nevertheless, there were a significant number of contributions in which urban planning, climatic issues, and wellness are clearly interrelated. As for the remainder, there are several papers dating to around the 1930s, but a few are dated earlier. Light and shadow distribution on buildings had already been investigated by Heiligenthal in 1921 and Benndorf and Brausnitz in 1926 [19]. The relationship between meteorology and architecture was discussed by Schmauss in *Meteorologische Grundsätze im haus un Städtebau* (1914) [20], and Kassner's *Die meteorologischen Grundlangen des Stadtebauliche Vortrage* even dated from 1910 [21]. Furthermore, a large percentage of the quoted papers were written by German or Austrian scientists, a group of whom worked in Munich before 1934. As a consequence, we can assert that two phases can be distinguished. The first period dates from the late nineteenth century to the late 1920s. During this beginning phase, studies worldwide aimed to contribute by describing the relationship between cities and climate, and by highlighting modifications provoked by each other. The state of the art in the urban microclimate discipline in the early 1930s was far from well established. There was no complete treatise, except some dissertations on specific topics. Most of the contributions came from Germany, with a lesser number from France, England, and Austria. In the second period, up until World War II, climatic urban planning was looking to become an autonomous discipline. Treatises became, gradually, more specific and systematic. However, despite the success of the topic among meteorologists, architects and planners (with the exception of Kratzer in his book) showed no sign of a comprehensive attempt to make connections in this emerging discipline. Moreover, the Bavarian monk was neither a planner nor an architect. The contents of *The Climate of the Cities* only provide one direct suggestions for urban design. In relation to the topic of the solar exposure of the city block, Kratzer mentioned Bernhard Christoph Faust's city plan drawn up in 1824. "The residential streets", said Kratzer, "run E–W, with all house-fronts facing south, so that each house may get as much sunlight as possible". In fact, Faust (1755–1842), aside from discussing building orientation, mostly referred to ancient Roman settlements. Despite the fact that he was a physician, he expressed his point of view through his Sonnenbaulehre theory. According to Plessner [22], who was Kratzer's source, Vitruvius largely inspired Faust. His Sonnenbau system (described in Faust's *Andeutungen über das Bauen der Häuser und Städte zur Sonne*, [23]) aimed at providing as much sun as possible to houses by planning settlements on a north–south oriented grid and by ensuring the right distance between the blocks. The Sonnenbau theory was supported by the Bayern architect, Gustav Vorherr (1778–1847). In 1818–1821, Vorherr designed the so-called "Sun Road", on the border between the ancient city centers of Munich and Ludwig. The road is strictly south oriented. In conclusion, led both by scientists and by architects and planners, Germany was generally the center of the debate on urban climate planning. Even if the topic was to be addressed more distinctly after World War II, history shows a rich and growing debate that can easily be found in documents dating back to the nineteenth century. Furthermore, the scientific approach to research shown by architects in the early 1920s and the interest of meteorologists in urban issues together provided the opportunity to establish a common ground to contribute to future cities' development. The influence of German culture abroad, even in this field, is well known; nevertheless, some heterodox figures, such as Gaetano Vinaccia, may reveal a more complex framework.

1.3. The Debate in Italy

After 1925, Fascism changed its political organization, moving from being a social and political movement to a more organized structure coinciding with the central state. The Fascist Party, as an institution, required physical representation. Italian architects, divided between traditionalist and rationalist, engaged in a cultural war in order to capitalize on this opportunity. According to Manfredo Tafuri (1935–1994) [24], in 1926 the so-called "Gruppo 7" was founded. It can be considered one of the most inspired teams of the Italian Modern Movement. In 1928, the MIAR (Movimento Italiano per l'Architettura razionale, "Italian Movement for Rational Architecture"), held the first exhibition on rational architecture. Three years later, the Tavola degli orrori, a collage of the worst traditional architecture of the past, was shown. Both *Quadrante* (director Bardi) and *Casabella* (director Pagano) magazines supported this attack against the old architecture, aiming to convince Mussolini to adopt the modern (international) style for public buildings [24] (p. 280). Nevertheless, the conservatives strongly opposed this attempt to change. In Milan, Muzio, Greppi, and De Finetti kept following their personal interpretation of the bourgeois city, led by Camillo Sitte's teaching [25], leaving no room for international-style theory. In Rome, Giovannoni, Foschini, Fasolo, and Del Debbio tried to remove any reference to foreign experience. Magazines such as *La Ronda*, *Architettura e Arti decorative*, and *Valori Plastici* promoted the national cultural heritage. The bombastic praise of "Italian being" was taught in the architecture faculties. The scientific and pragmatic approach to building was methodically neglected to advance research on archaeology and antiquity [26].

The dualism between modern and traditional architecture was, apparently, overcome by Marcello Piacentini. To give one example "Siamo d'accordo", he wrote: "ma i grandi monumenti romani e tutta l'architettura della Rinascenza […] Non furono razionali, tutt'altro che razionali, decorative, formali, belli perché belli" ("We agree", he wrote: "but the great Roman monuments and the whole architecture of the Renaissance […] were not rational, far from rational, decorative, formal, beautiful just because beautiful") [25] (p.135). Later, in his book *L'architettura di Oggi* (1930), he wrote "Il moderno in Italia si è fermato alle sole teorie semplificatrici. […] Da noi l'ambientalismo e il carattere locale prendono il sopravvento sul tipo di edificio. […] Si confonde l'appellativo di –Italiano- con quello di "antico"; nella stessa maniera che si vuol far passare per straniero ogni tentativo di modernità" ("The modernism in Italy stopped on some simplified theories. [...] Here the contextualism and the local character take over the building type [...] People confuses the epithet -Italian- with that of "antique"; the same way each attempt of modernism is considered as foreign") [25] (p. 136). Both Piacentini's cultural duplicity and his capability in interpreting the conservative will of the Fascist party enabled him to become the keystone of public policies on building, so that the so-called "School of Rome" monopolized the best opportunities and occupied the key positions in cultural debate. Despite his ignorance of modern architecture, his huge influence on contemporary architecture prevented Italian research becoming linked to the most advanced experiences abroad, and thus Rome's cultural conditions became hostile to the idea of Neue Sachlichkeit. The advance of this damaging and reactionary front was partially interrupted by the publication of Giuseppe Samonà's book, *La Casa Popolare degli anni'30* (1935) [27]. Samonà, who later became Dean of the Venice School of Architecture, tried to focus on international research on public housing. The topic, which in Europe had led his contemporaries to build the most inspiring architecture of the early twentieth century, would have had the same success in Italy. Samonà praised Gropius's approach to new settlement planning and approved of Klein's research on minimum dwelling. Nevertheless, the book was largely ignored. Despite the political context, his explicit apology for the socialist Karl Marx cannot explain such a general repulsion towards his work. In fact, the book contains, and methodically organizes, some concepts that would have destabilized the mainstream. The prerequisites of Gropius's vision could not be applied to a society that was going along a very different route. Moreover, the organization of the Italian Architecture School could not facilitate a scientific approach to the matter.

The last chances for Italian rationalist architecture to be linked to the modern international movement were the E42 Exhibition Masterplan and the Milano Verde plan for the Sempione area in Milan (Albini, Pagano, Gardella, Minoletti, Palanti Predeval, Romano, 1938 [24] (p. 280). The first was completely managed by Piacentini, who designed monumental old-style scenery in which Rational architecture would have only been tasked with defining a sparkling image. The Milano Verde plan has generally been considered the most important Italian contribution to European modern urban planning prior to World War II. Despite the direct reference to Hillberseimer and Gropius's approach, the master plan in Milan did not have the same explicit contents. The proposal did not have any ideological character or the same social perspective. The radicalism of the German architect's design was tempered. Nor was open space distinct from buildings in the MM's plans. Seeking a balance between the garden city models and linear high-rise buildings, the urban design actually looked like a restyling of Sitte's bourgeois city. Repetition of standard typological configurations was not completely adopted. Conversely, variety was desired and promoted. Relatedly, the Milano Verde plan oriented the grid perpendicular to the Corso Sempione, which is oriented NO–SE. This means all of the blocks are NE–SO oriented. Nonetheless, apart from applying Heiligenthal's rule, the project did not mention any research on the microclimate of space and wellness [24] (pp. 260–261).

1.4. The Rational Vernacular

The theme of rationalization, standardization, and optimization of housing and urban transformation, which was characteristic of the 1920s in Europe, was expressed in Italy in a local manner. *Der Untergang des Abendlandes* (1918–1922) by Oswald Spengler [28], which was translated into Italian by the Fascist ideologist Julius Evola, described the West as though it were in the phase of its decay. The German philosopher also looked both at the metropolis and at materialism as the causes of this decline. Influenced by Spengler's works, in 1927 Mussolini started his anti-urban policies, aiming at shaping Fascist society based on the family and the craft guilds, reducing cities' growth. Several new towns were founded to provide a workforce both for the mines (in Sardinia) and the countryside after land reclamation (in Lazio). Italian colonies in Africa also provided a new opportunity to explore spatial organization. The exhibition *Architettura rurale nel bacino del Mediterraneo* (1936, the VI Triennale di Milano) moved the focus onto the vernacular architecture, seeking suggestions that would have led to a new Italian way towards rationalism. Pagano, who was the director of the exhibition, tried to interpret the spirit of the time, showing the architecture of the local past as genuine and practical. The main evidence for the rational approach of these buildings was offered by their perfect orientation and climate control [29]. "L'architettura rurale presenta evidenti legami con il suolo, con il clima, con l'economia e con la tecnica. Ne scaturiscono forme astratte e plastiche" ("The rural architecture has clear links with the land, the climate, the economy and with the technology, [from that] abstract and plastic forms arise") [24] (p. 262). This can be read as the last attempt to provide a local version of the Neue Sachlichkeit without the application of any industrial process.

1.5. Climate and Design in Early Italian Manuals

Irenio Diotallevi and Franco Marescotti, who were both Pagano's apprentices, are still often considered the Italian forerunners for the topic of building-related illness. In *Costruzioni-Casabella*, they published some evidence for the relation between wellness and housing. These articles, which were grouped together in Ordine e destino della casa popolare (1941), aim to directly link illness and the shape of buildings, focusing on the lack of insulation and ventilation as the main factors for the onset of disease in the working class. After World War II, the rebuilding phase offered the opportunity to reclaim the idea. In 1946, *Il Manuale dell'Architetto*, written under Mario Ridolfi's supervision, was published for the first time. In 1948, Diotallevi and Marescotti resumed the matter with *Il problema sociale, costruttivo ed economico dell'abitazione*. In both manuals, it is easy to find a connection with the German experience, and the issues of orientation and ventilation of building were largely explained with graphics and diagrams. In Ridolfi's work, the scientific and pragmatic approach prevailed. In this, it appeared similar to Neufert's *Bauentwurfslehre* (1936), which was published in Italy in 1946 as *Enciclopedia pratica del progettare e costruire*. In this manual, architecture had no direct social role; it was simply a problem of technical knowledge [30]. Conversely, Diotallevi and Marescotti's manual wanted to focus on the relation to moral issues. Even if the authors knew the work of Klein, Gropius, and Hillberseimer well, their aim was to move the Italian debate on housing on to more advanced issues related to human health.

2. Vinaccia: An Innovator or an Outdated Architect?

Because of his classification as a minor architect, Gaetano Vinaccia's biography has not been studied in depth. Even if only modest information is available, it may help to explain both the person and his scientific contribution. According to Cesare Silvi [31], who had direct access to Vinaccia's archive, Vinaccia was born in Naples in 1889. Due to the travails occurring in his family, his formational experience was acquired in the field. However his career was not localized. In 1909, Vinaccia was awarded a high school diploma at the Brescia Technical Institute. In 1917, he achieved the qualification of Professor of Architectural Drawings. Between 1919 and 1926, he published some minor books relating to historic heritage, antiquity, and archaeology. Furthermore, a minor work opportunity in Rome (on the Via Monteverdi, Rome, 1918) [32] suggests an approach that would hardly have had any chance to be recognized in the complicated framework of Italian architecture in the 1920s and 1930s. Silvi also reports Vinaccia's graduation in civil engineering, achieved in 1926 at the University of Freiburg, and his stay in Rome, in 1930, when he was appointed as a teacher of technical drawing at a local high school. As Vinaccia himself reported, it was during his stay in Rome that his interest in insulation radically increased. Thus, between 1935 and 1943, he published several works in which he attempted to take up a role in the international debate. Examining Vinaccia's productions, we can recognize four different phases. In the first period, from 1919 until 1926–1927, he applies his knowledge to the field of architecture, achieving only mediocre success. The second, from 1926 to 1930, which corresponds to his stay in Freiburg, can be considered as the more fruitful experience of his life, due to the opportunity to be linked with the most advanced research in architecture, in meteorology and in civil engineering. The third occurs during his stay in Rome, when, as a board member of the architectural magazine *Case d'oggi*, he tried to influence the debate on typology led by rationalist architects worldwide. The last phase was during his attempt to lead towards an Italian approach to urban microclimate design, and closed with the publication of his most cited work, *La Città di Domani, Come il clima plasma la forma urbana e l'architettura: la sanità e l'igiene cittadina,Vol. 1* (1943) [15] (see Figure 3). The stay in Freiburg was, certainly, a turning point in Vinaccia's career. Despite revealing that his interest in building insulation started in 1930, he was dramatically influenced by the German cultural environment during his studies. The Bavarian milieu offered many suggestions, both in the field of the urban microclimate and of modern architecture, because of the presence of personalities such as Schmauss, Köppen, Geiger, Kratzer (the meteorologist), and Theodor Fisher, who, as mentioned before, was a professor at the Technical University of Munich and the leader of Deutscher Werkbund. Therefore both Fisher's *Alte Heide Plan* and Otto Heasler's *Georgsgarten Siedlung* should have been well known to Vinaccia as a student. Moreover, his knowledge of the German language could have given him direct access to the reading of Heiligenthal's *Deutsche Städtebau* (1921). At the time of his return in Italy, three CIAMs had been held. As stated, the second was on typology, and the third on urbanism. Not surprisingly, Vinaccia's published productions developed following the same order. When the Italian cultural climate changed to a more local interpretation of rationalist hypotheses, Vinaccia tried to put into practice his knowledge of antiquity and his capability in the field of engineering to support an Italian path towards modern architecture. Despite the fact that Vinaccia's works, both as an architect and as an *ante litteram* microclimate urban designer, have been largely ignored, they reveal an exciting modernity. In fact, his pioneering spirit was always mixed with a proud sense of belonging to local architectural traditions. This intermediate position could not have had any appeal for the European Modern Movement's inner circle, nor even for the more up-to-date Italian magazines. Conversely, his scientific point-of-view would have sounded obscure to most Italian architects, whose academic approach on architectural issues was by no means inclusive of technical contents. Therefore, it was between the 1930s and 1940s, when Piacentini's leadership radically emerged in the Italian debate, that Vinaccia started to find room for his proposals. Nevertheless, after World War II, the Roman cultural circle, which revolved around Piacentini's controversial personality, was blamed for Italy's alleged backwardness in relation to international Modern Movement innovations. Thus everyone who could be considered to be making compromises with the past started to be ignored. Moreover, the general interest in microclimate effects on buildings dramatically declined, until the 1970s, when the international oil crisis forced it back on the agenda. Therefore, the question of whether Vinaccia can be considered as an innovator or not largely derives from the architectural criticism point of view. In order to look at Vinaccia's role in history from the right perspective, we may consider that, until World War II, his contribution did not have a well-defined discipline in which to be classified.

According to MacKillop, the first organic treatises on urban microclimatology are Oke's work and Landsberg's *The Urban Climate* (1981). Moreover, neither of these were architects, so they had no chance to dramatically influence architecture and urbanism. Therefore, when, in his *La Città di Domani, Vol. 1* (1943), Vinaccia coined the definition "Polis-climatologia" (from the Greek πόλις [pólis]-κλίνω [clìno]-λόγος [logos]), he was an absolute innovator. In this way, he aimed at founding a new approach to urbanism that would have been driven more by scientific concepts than by theoretical or political ones. Therefore, it was his singular nature that did not allow him to be taken into account as he deserved. Nonetheless, he was fully aware of his professional fate when, in 1936 he wrote [33]: "É utile nei riguardi dell'urbanistica fare alcuni raffronti concreti, fra i vari tipi di case, quelle di oggidì e quelle che auspichiamo per un domani molto prossimo, quando la forza delle cose trionferà ineluttabilmente sul misoneismo e al solito i misoneisti si daranno aria di precursori speculando sul frutto dei pionieri che diventeranno per essi dei passatisti" ("On urbanism we should take into account some comparison between different house typologies, all those of today and all those we wish for in the immediate future, when the strength of things will inevitably win over misoneism and [when], as usual, the misoneists will strut around their forerunners, taking advantage of the fruits of those pioneers who will be considered by them as past-lovers".). In 1936, Vinaccia had not yet written the best of his scientific productions, so that his statement cannot be considered as an end point in his enthusiastic attempt at founding a new discipline. The point is that Vinaccia clearly knew that, in the framework of the Italian condition, he had only one option: to convince the establishment that his scientific theories did not contrast with the mainstream, but could conversely support the Fascist rhetoric of the supposed superiority of Roman civilization. From this perspective, Vinaccia's works on microclimatology applied to architecture and urbanism are absolute astonishing.

2.1. Vinaccia's Most Important Publications

During his stay in Rome, Vinaccia started his attempt to influence the cultural debate through several publications both on typology and urban planning, focusing on the topic of relations with the microclimate.

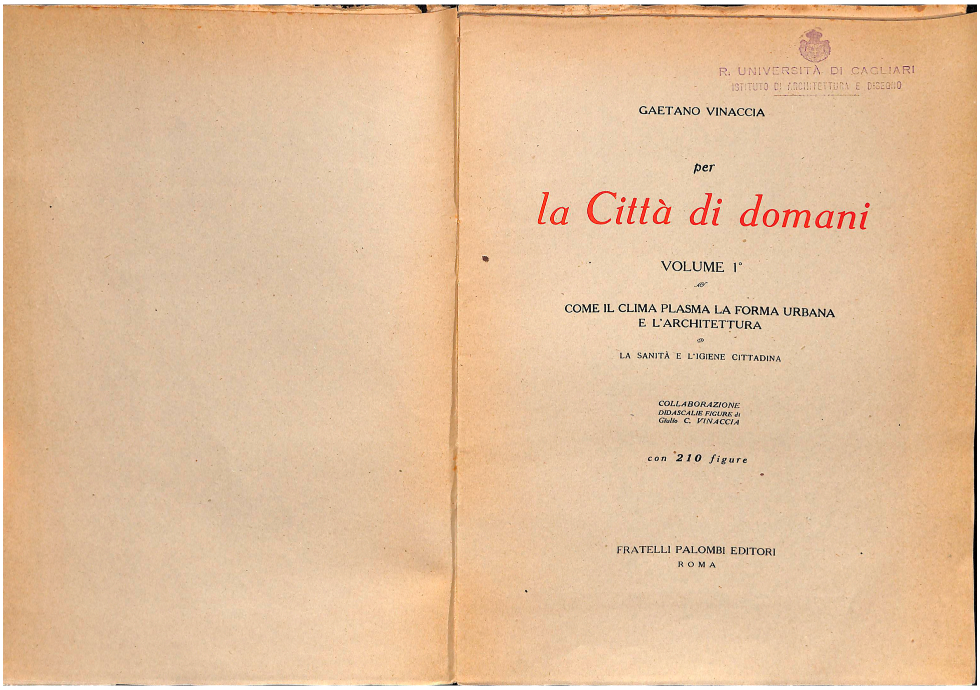

Figure 3. Vinaccia, G. *La Città di Domani*, Vol.1, 1943 [15].

2.1.1. The Star-Shaped Building (1932–1936)

In 1936, in the magazine *Case d'Oggi*, Vinaccia illustrated his scheme for the pentagonal and heptagonal star-shaped house (see Figure 4). The project appeared previously in *L'Architettura Italiana* (1932) with the title "Progetto di casa economica" [34]. The earlier purpose was to rationalize internal building space in order to gain economical, aesthetic, and hygienic advantages. Concerning the economic issue, the star-shaped building offered the possibility to build a single staircase to serve 10 (pentagonal) or 14 (heptagonal) apartments per floor, reducing cost per unit. Thus, the money saved could have been invested in building aesthetics. Moreover, the star-shaped plan guaranteed three different exposures for each flat, taking advantage of inner natural ventilation and sunlight.

The adoption of a glass skylight on the roof would also have contributed to entrance hall and stairwell ventilation and lighting. The effectiveness of the skylight had already been confirmed in Vinaccia's previous, successful work in Rome (1918: house in Via C. Monteverdi, no. 20). The urban advantages of Vinaccia's typology were confirmed after seven months. The author compared the urban layout made up of star-shaped buildings with some others, which were composed of different building typologies. The comparison also took account of planning fees and construction costs. Here, Vinaccia clearly refers to Le Corbusier's cross-shaped skyscrapers, but his proposal aimed at a technical development of the concept. Nevertheless, the author supports the Modern Movement theory of urbanism in proclaiming his preference for high-rise buildings.

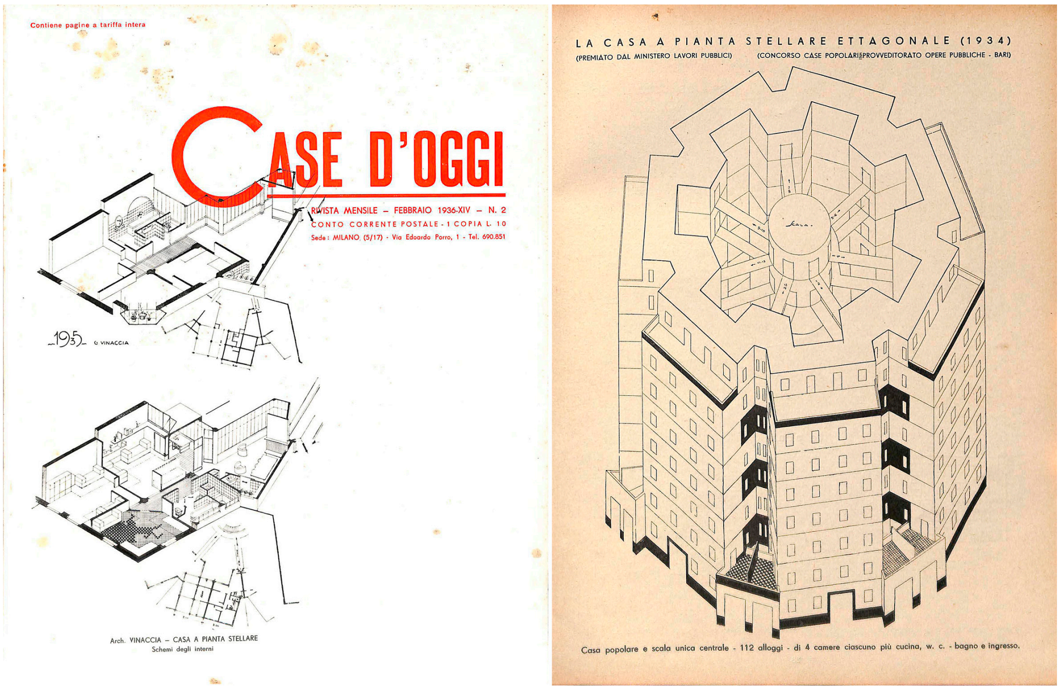

Figure 4. The Star-Shaped Building in the journal *Case d'Oggi,* no. 2 (February 1936) [35].

2.1.2. Sun Path in Architecture and Urbanism (1938)

According to the author: "Scopo del presente studio è quello di richiamare l'attenzione degli edili sulla necessità della esatta conoscenza del moto apparente del sole per razionalizzare in unione alla attinometria ed alla tecnica dell'illuminazione e dell'isolamento termico, l'urbanistica […] dando seria base scientifica ai regolamenti edilizi, spesso arbitrari ed irrazionali" ("The purpose of this study is to call architects' attention to the knowledge of the sun's illusory motion in order to rationalize urban planning […], giving a serious scientific basis to the urban codes, often arbitrary and irrational") [36]. The book is structured in six sections. The first three are characterized by more technical contents. The book offers graphics that provide basic information on sun path (trajectory, height, and azimuth), sunlight of building surfaces, and related thermal effects. The fourth and fifth chapters deal with sunlight in planning and architecture, defining both the best orientation and proportion for each in the "Urban Program for Sunlighting". The latter is imposed by the local climate and latitude. Vinaccia also examines the effects on the sunlight/shading of building surfaces caused by street grids in different orientations and ratios (H/W ratio) at different latitudes. An in-depth examination of 30 Italian cities with an "*equisolare plan*" [36] (p. 228) (see Figure 5) closes the urban section. Concerning the studies on the urban block, the author investigates the orientation and internal arrangement of buildings in relation to the sun path and building function. The last section deals with the use of solar heat in agriculture (solar greenhouses) and in domestic central heating systems. The study is innovative for its time, providing interesting reflections on energy and economic gains relating to the passive exploitation of the sun in those countries that are located in advantageous climates such as Italy and the African Italian colonies of the past. What emerges from the text is the author's up-to-date technical and interdisciplinary knowledge. The bibliography mainly presents texts on meteorology, physics, and astronomy, but Vinaccia's attention to global studies noticeably emerges, expecially French research on the heliothermic axis by A. Rey and Brooks's studies (Berkeley, California) [37].

2.1.3. Rationality of the Romans' *Castra* (1939)

The manuscript [38] deals with the orientation of ancient Roman settlements. In particular, the author claims that religious dogmas and rituals did not determine a city's position. He states that the N–S and E–W directions of the city axes originated from rational reasons more related to the need for protection from annoying, unhealthy winds, and to the need for the best sunlight exploitation. Referring to classical writings (Vitruvius, *De Architettura*; Vegezio, *lnstitutorium rei militaris ex commentariis Catonis, Celsi, Trajani, Hadriani et Frontini*; Varrone, *De Re Rustica*; Columella, *De Re Rustica*; Hygini Gromantici, *De Castris Romanis*), Vinaccia highlighted the ancient Greeks' and Romans' knowledge of various effects at different latitudes, both of the wind and the sun on cities' level of comfort. For Vinaccia, the Romans' attitude to managing these issues both in urban and architectural design is surprising. With regard to the urban-scale analysis, the author noted that Roman-founded Italian cities show a deviation of about 30° from the N–S axis. According to his studies, this deviation was to protect from both the cold winds from the N–NW sector and the unhealthy, wet winds from the S–SE. Moreover, this orientation guarantees sufficient sunlight on all four building surfaces. With regard to the building-scale analysis, Vinaccia's work is confined to the heliothermic theories contained in Vitruvius' writings [35], in relation both to the inner deposition of space and the execution of customary activities. By his reading of this work, the author's attempt to show Roman settlement as the most rational clearly emerges. The references to Vitruvius' writing and the other classics allow him to be accepted by the cultural mainstream. Nevertheless, his deep development of technical issues makes him comparable to contemporary scientists.

2.1.4. The City of Tomorrow (1943)

The book is the first of the two volumes that constitute *The City of Tomorrow* [15] (*La Città di Domani*). It includes previous studies on microclimate and urban design. According to the author, the text aims to promote city-planning awareness in order to instruct technicians both on design and health-related building issues. Therefore, the planning and the microclimatology should leave room for a new discipline: "polisclimatology". The new discipline would have supported architects both in the correct choice of the location for the city's foundation and in modeling the urban form. With this purpose, Vinaccia analyses the main meteorological phenomena. For each of them, he highlights the physical causes, the benefits for and harm to human health, the relations with the built environment and the solutions used in the history (contained both in vernacular examples and in ancient documents such Vitruvius, Hippocrates, *etc.*).

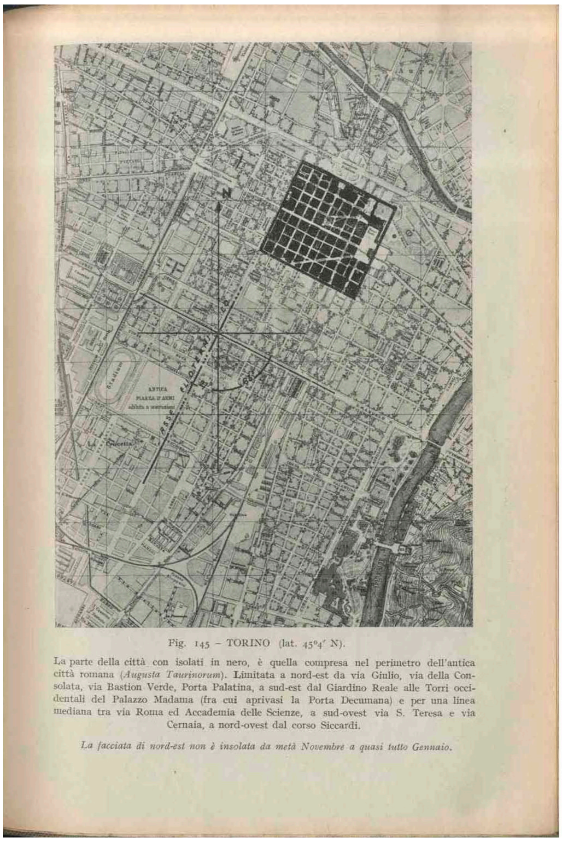

Figure 5. The "equisolare plan" of the Romans' *castra*. The case of study of Turin (Italy). (Vinaccia, G. *Sun Path in Architecture and Urbanism*, p. 229) [36].

In addition to solar radiation, the issue of which had already been developed in previous publications, Vinaccia analyzed the effect of atmospheric moisture, fog, rain, atmospheric pressure, winds, the electric field, and the ionization of the air on man and the urban environment. With regard to wind, the wish of the author was for the foundation of "Urban Anemometry", an approach that would have been able to provide reliable data about the speed and frequency of winds in urban areas. Concerning the sun, the author introduced new control tools for effective sunlight (the *poliseliometro* and the photographic survey). Vinaccia resumed his "Urban Program for Sunlighting" in relation to the three recognized climates (equatorial, intertropical, and temperate) and, finally, he expounded his theory on "*Vinaccia equisolare orientation*" for the "equalization of sunlight among all the four sides of a cubic block" [15] (p. 60), clearly in opposition to the heliothermic axis theory of Rey, Barde, and Pidoux (1928), left also by Le Corbusier from the 1940s. The text ends with a chapter on the microclimatic benefits of green areas in urban space and an annex on more specific topics, such as the quality of the soil, drinking water, sewerage, and building codes. Concerning the latter, Vinaccia expounds the need for an upgrade of the code with regard to health and local climate. Several plates on applied "polisclimatology" round off the text.

3. Innovation in Vinaccia's Thought

As stated previously, Vinaccia played a minor role in the history of architecture. Nevertheless, the contents of his works make the author extremely contemporary. There are several reasons to reconsider this figure. Among these, emerges Vinaccia's contribution to the founding of "polisclimatology" as a link between planning and microclimatology. However, the cultural and historical background was not favorable to its dissemination. Moreover, after = World War II, the "bioclimatic" approach was overwhelmed by the large-scale use of technology in building. This trend went on until the 1960s, when important research on vernacular solutions and architectural regionalism was published (Rudofky, 1964 [39]; Olgyay, 1963 [40]); but it would only be in the 1970s–1980s, during the international oil crisis and the looming environmental disasters (global warming, 1986; hole in the ozone layer, 1985, *etc.*) that "bioclimatism" caught on. It seems interesting that Lansberg, in 1981, still declared a lack of dialogue between planners and meteorologists, which began, according to Givoni [41], only in 1998. In light of this, Vinaccia appears as a pioneer. In fact, although most of Vinaccia's theories were already known in distinct international scientific sectors, he was perhaps the first to organize these into a systematic approach, also thanks to his education as an architect, which contributed to a more humanistic idea of architecture and planning. From this perspective, urban microclimatology represents only an additional scientific subject to take into consideration in urban design. Despite the fact that most of Vinaccia's theories could not achieve the in-depth scientific analysis that current research has, Vinaccia seems to reveal in advance several important issues related to microclimatic urban design. In order to explain his urban theories, Vinaccia referred to technical and scientific knowledge that appears to be innovative at the time (and up-to-date even now), acting as a linking point between the past and the future. Actually, most of the technical notions contained in Vinaccia's writings (which concerned physics, astronomy, and meteorology) have little to offer that is ground-breaking. These notions, in fact, were well known until ancient times, and were included in fundamental texts such as Hippocrates' *On Air, Water and Places* and Vitruvius' *De Architettura* and, thanks to the scientific progress of the last 50 years, these can be considered today as "starting points" in the development of the current "environmental design". Among these axioms are the following considerations:

- The loss in sunshine duration in urban areas caused by the sky's turbidity (air pollution and haziness). The importance of the sky's clearness for a city's healthiness had already been affirmed by Vitruvius. Following the Industrial Revolution, the desperate condition of the city's pollution induced scientists to study the effects of pollutants on solar radiation, revealing the weakening of its intensity and the shortening of its daily duration. Quantitative studies on this topic were contained already in Kratzer's *Das Stadtklima*, in 1937, and exhaustive studies were conducted later by physicists and meteorologists, as seen in the work of Chandler (1965) [42] and Landsberg (1981), and this work is continuing today. Contemporary research includes, for example, "the extinction coefficient" of Givoni [41] (p. 268) and the urban studies carried out by both Tsangrassoulis on solar short-wave radiation and by Santamouris on the city's thermal balance, which are contained in *Energy and Climate in the Urban Built Environment* [43].
- The effect of latitude on the total amount of solar radiation received on building surfaces due to the different sun paths. As stated before, Vinaccia's studies focused for a long time on sun path and solar radiation. These produced useful measurements and tools, mainly collected in his text *Sun Path in Architecture and Urbanism* (1938). Today, the study of local sun paths and the tilt angle of sunrays are among the first procedures in the environmental design. Nevertheless,

architects and planners have at their disposal sun charts, which show both the sun's height and azimuth graphically, and collection of meteorological data about the intensity of solar radiation in the function of the location [44,45].

- The consequence of both topography and the orientation of surfaces for a building's microclimate. It is interesting to highlight Vinaccia's knowledge of design's "good practices", which originate from local weather and orographic conditions. The author was already aware, during the 1940s, of the environmental factors that cause fog and increase moisture in the urban area, such as the proximity to water surfaces (sea, lake, river, *etc.*) and the thermo-hygrometric conditions of the ground. He knew very well the effects of topography both on the formation of the "cold side's rain" and "hot side's rain" on slopes, and the wind's speed and alterations of direction (the Venturi effect). These, and many more types of information, were used by Vinaccia to move urban and architectural design in the direction of a more "environmentally-aware" shape. Among the solutions, he identified the south-facing slope of a hill as a suitable location for ensuring the building's healthiness. This position takes advantage of the direct solar radiation and better natural ventilation, avoiding the mutual shadows of buildings and the stagnation of fog and moisture. Most of Vinaccia's statements hold true even now, and can be found in most of the later research. Examples can be seen in Oke's *Boundary Layer Climate* (1978) and Givoni's *Climate Consideration in Building and Urban Design* (1998), both reference books for most current scholars, which restate, almost 40 years later, most of Vinaccia's points with a scientifically in-depth analysis. The microclimatic advantages of building on the south-facing slope of a mountain are also confirmed by several contemporary authors, who suggest this location, especially for temperate climate.

3.1. Three Tools for Architects

According to Vinaccia's thought, architects and planners have three main tools to pursue the city's healthiness (also intended to secure man's physical and psychological wellbeing): the appropriate settlement location, the accurate choice of building morphology, and the correct use of both the building's materials and the exterior's textures. With regard to these, it is possible to observe the astonishing modernity of Vinaccia's thought, taking into consideration some of his main statements.

3.1.1. The Appropriate Settlement Location

As asserted previously, in the opinion of the author, the suitable location of a city is a function of local microclimatic factors and topography, which contribute to defining the appropriate, local environmentally-friendly architecture and urban form. Both the necessity for different design in relation to latitude and the refusal of universal solutions of architecture and planning led Vinaccia to define his "Urban Program for Sunlighting" according to local climatic specificity. Vinaccia's program was also developed in relation to his research on vernacular architectures in different climates, such as the Arab city in the hot climate, the courtyard house in temperate zones, and the villa in a cold climate. Certainly, the national attention directed towards vernacular architectural solutions (Pagano and Daniel's exhibition, the VI Triennale di Milano, 1936) and the colonial expansion of the twentieth century, strongly contributed to Vinaccia's interest in the equatorial-tropical climate and vernacular architectural shapes, as proved by Vinaccia's drawings [15] (pp. 50–59). These studies allowed him to suggest low-tech and low-energy-cost architectural solutions as far back as the 1940s. This remains a contemporary topic even now. After the Oil Crisis of the 1970s in fact, numerous studies also approached this issue, aiming at re-evaluating past lessons and practices of *bio*-architecture in order to contribute to global energy-saving and environmental goals. On this issue there exists a wide bibliography. Contemporary examples are contained in the writings of Steemers [46] and Azami [47] on the "environmental" lessons coming from the past traditions. On a similar topic, the research of Oliver [48], Vellinga [49], and Fernandes and Matheus [50] on the "sustainable" practices of vernacular architectures, and the work of Caltabiano [51] on Matmata dwellings and Sicilian traditional architectures are worth considering. Finally, climatic features couple with energy perspectives in the works of Coch Roura [52], Gallo [53], and Los [54] on traditional habitat and architectures.

Concerning the link between urban form and its environmental context, Vinaccia examined the role of the urban canyon, taking into consideration the relationship between the building's height and the street's width (aspect ratio), and the street's and building's geometry in relation to solar radiation's penetration (sky view factor). These latter are considered today as two of the most common shape ratios in environmental analyses. The author used them to study urban ventilation and sunlighting in relation to latitude and altitude, in order to identify the most suitable and effective orientation of a building; such orientation would be able to ensure appropriate natural ventilation and sunlighting of inner and outer building's spaces, protecting the latter from cold wind and insalubrious gases. According to Vinaccia, the best orientation for sunlighting means to guarantee, "on equal sunlighting, the shortest distance among buildings and the greater height of these, thus the greater building density" [16; p.57]. As stated before, efficiency of land use was a fundamental issue during the Modern Movement and it has continued to be central after the 1960s. Important research has been conducted by Martin and March [55] at the University of Cambridge on land-use optimality, which has recently been extended to broader environmental questions by Steemers, Ratti, and Raydan [56]. The scientific essays of Pont and Haupt [57], and Reale [58], also include important contemporary studies on density, urban form, and anti-sprawl strategies.

Furthermore, images and theories contained in *La Città di Domani Vol.1*, suggest that Vinaccia was aware of several technical issues, such as the "vertical air-film" developed in the proximity of the building's surfaces. In his drawings, he referred to the "street's cross -ventilation due to sunlighting" [16; p.89], highlighting the circular motion caused by the surface's temperatures, and the street's orientation. The scientific progress of the last 60 years has allowed this to be verified through quantitative analyses and measurements of place. In this regard, the latest studies of Santamouris [43] (pp. 74–75) and Erell [59], on air-film on a building's façade, are significant

Finally, it is important to highlight that Vinaccia was a pioneer in the use of technical tools in support of urban design, and for the study of the sun's path and direct solar radiation. He suggested two useful systems to consider the site's annual sunlighting: overview photographs, shot every half-hour during solstices and equinoxes, and the *poliseliometro*, "a device specifically created to test building models through artificial sunlighting" [15] (p. 45). This tool was useful to the author for understanding the sun's profile on building surfaces. Today, this role is entrusted to software, and there exists an abundance of reference literature on this topic, among which are Robinson [60], Beckers [61], Badea [62], and Lim *et al.* [63].

3.1.2. The Accurate Choice of Building Morphology

According to Vinaccia, it is possible to achieve important microclimatic goals by working on building morphology. The interdisciplinary knowledge of the author allowed him to connect physical theories to architectural practice. He knew the "Beer–Lambert Law" and the "Cosine Law" (both still included in Oke's writings 35 years later), recommending both the surface's inclination and its geometry as additional design strategies to limit the intensity of direct solar radiation and, thus, decrease the surface's temperature (see Figure 6). On the basis of these studies, the curved surface improves the radiation's dispersion, decreasing sunlight's thermal effects. Compared with a flat surface, the reduction ranges from 0.50 in the case of a sphere to 0.58 for a horizontal cylinder [15] (p. 58).

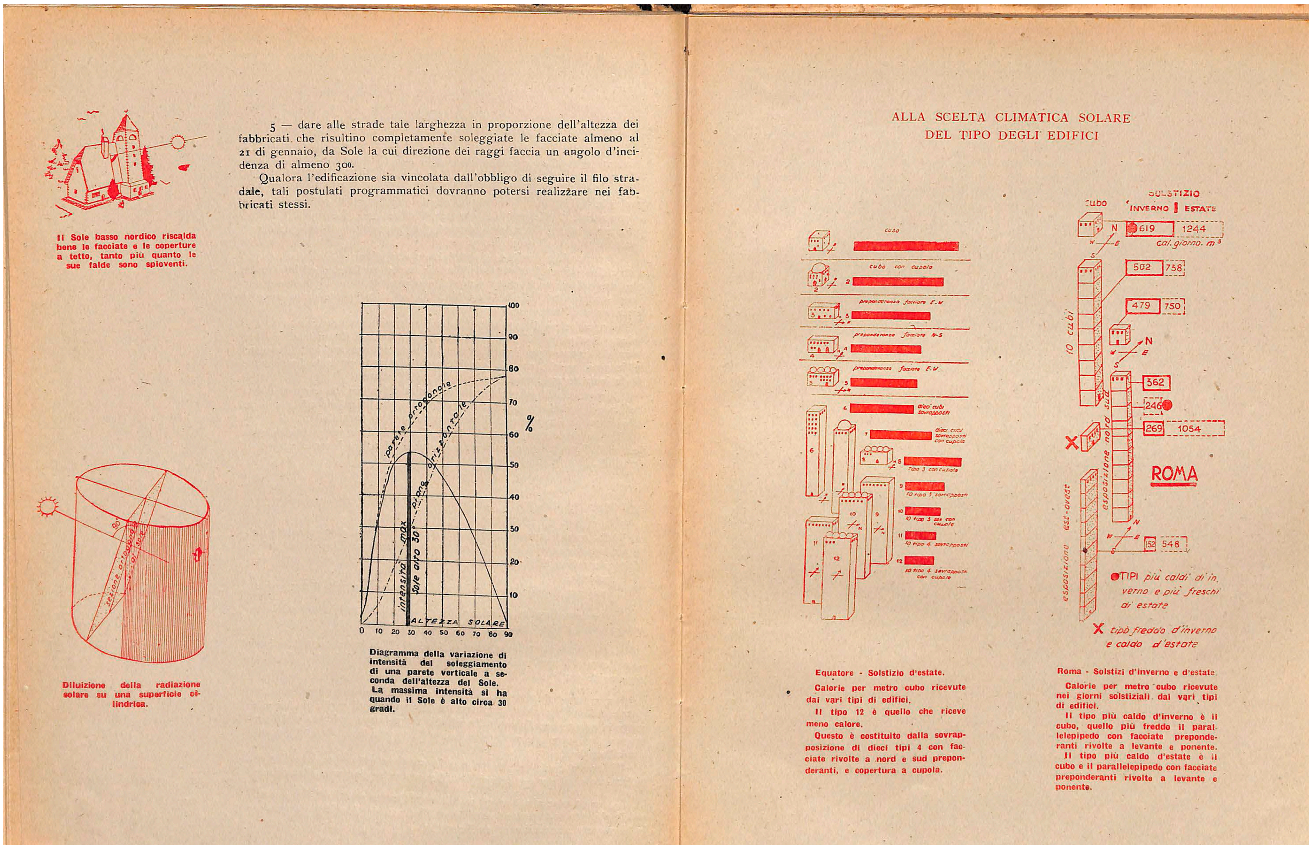

Figure 6. The influence of building's morphology on seasonal sunlighting. (Vinaccia, G. La Città di Domani, Vol.1, pp. 52–53) [15].

"The question of what shape a building should be is one of the most fundamental issues that confronts an architect" [64]. As already affirmed, during the Modern Movement, attention was directed to the city's healthiness. The main goal of the modern architects was to ensure an appropriate amount of sun, air, and light in buildings. After the 1960s, the question changed to the issue of what shape architecture and city should have to become "efficient", or rather, to pursue energy-saving goals and pollution containment. Studies on this issue were, and are even now, numerous. During the 1980s, research and design contests related to the sun's passive exploitation increased quickly (Design for 1000 Solar Houses, 1982). In 1984, Gupta [65] compared the solar efficiency of archetypal building clusters, taking into account the solar exposure of building surfaces. Some years later, in 1987, the same clusters were evaluated for their thermal efficiency and thermal comfort [66]. Gupta's studies referred also to Knowles's work on the "solar envelope" [67]. The American researcher published *Sun Rhythm Form* [68] in 1985, with the aim to study the link between "building groups and the resultant solar shading from the point of view of maximizing winter solar heat gain while minimizing it in summer" [67; p.115]. Knowles's reasons for studying solar access, which concern the support of and increase in quality of life (also in the sense of wellbeing), appear to meet at some points with Vinaccia's thought.

In 1986, S. Owens analyzed the link between energy sources and the city's spatial structure, recognizing urban setting, orientation, layout, and density as significant variables in a building's energy behavior [69]. Finally, the diverse ways that alternative building shape can exploit solar heat was also analyzed some years later by Hawkes in his work *The Environmental Tradition* (1996) [64].

During the last 20 years, scientific progress both in computer science and CFD systems has produced useful technological tools with which researchers can evaluate and compare the environmental behavior of different buildings and urban forms, including airflows and human thermal comfort. Literature and international research programs on this topic are plentiful [70–75].

3.1.3. The Correct Use of Materials and Exterior Textures in Buildings

As a third tool, Vinaccia suggested the correct use of the building's materials as a way to take advantage of its properties in order to improve (or reduce) the surface's thermal effect caused by solar radiation. The author was well aware both of the albedo as a theoretical and practical construct, and the characteristics of materials that affect radiation's thermal absorption or emission, such as surface colors and texture. Concerning this latter, in fact, Vinaccia's reported studies had already stated the contribution of the façade's roughness to the reduction of surface temperature due to the greater shading.

In Vinaccia's writings, the attention to the surface's materials and the corresponding albedo values extended to the building's context. On this topic, the example of Cefalù (Sicily), which was used by Vinaccia to illustrate the influence of the surrounding environment on urban microclimatic behavior, appears interesting [16; pp.46-47]. Specifically, the small Sicilian city is situated against a high grey rock face that reflects sunlight and heat onto buildings, year-round. In Vinaccia's opinion, in order to enhance urban comfort, it is necessary to change the face's albedo, covering the rock with a greensward and exploiting the local sea breezes during the afternoon.

Similar research and recommendations are very widespread today, and entire book sections are dedicated to the characteristics of the materials and the comparison of albedo values. Both Santamouris [43] (pp. 160–179) and Givoni [41] (pp. 107–132) devote important sections to the thermal properties of building materials. To these, several further studies can be added, and the albedo value has become a central parameter in the study of urban energy balance and heat mitigation strategies (Santamouris [76]; Taleghani *et al.* [77]; Giridharan and Kolokotroni [78]).

In conclusion, two more brief points about the reasons to consider Vinaccia's work as pioneering may be offered. The first concerns the influence of green areas on the urban microclimate. In his work *La Città di Domani*, Volume 1, he already asserted the cooling action of vegetation due both to the metabolism and the low albedo values of greenery. This theory has been extensively proved, from the 1970s until today. Reference studies of the 1980s are contained in Oke's *Boundary Layer Climates*

("Clothesline-effect", "Leading-edge or fetch effect", and "Oasis-effect" of vegetation) [79] and Landsberg's *The Urban Climate* [18] (pp. 131–134). Moreover, contemporary research includes the work of Erell [59] (pp. 165–188], Santamouris [43] (pp. 145–157), and Costa and Loures [80].

Finally, Vinaccia noted the lack of climatic data in urban areas, data that are indispensable for urban design and planning. In particular, he encouraged the collection of airflow data in urban spaces. This is an issue still debated today, through the slow increase in data collection through surveys (local measurement campaigns) and database implementation such as GIS (Niachou *et al.* [81]; Tsouchlaraki *et al.* [82]).

4. Conclusions

In light of the facts, the common classification of Vinaccia as a minor architect largely derives from the comparison of his professional work with the more advanced experiences of the time, and from an ideology-driven, critical point-of-view. Furthermore, the—unfavorable—context in which his studies evolved prevented him from being recognized as the founder of an Italian pathway to environmental design. Even if only modest information is available on Gaetano Vinaccia's biography, it is possible to state that his period in Germany can be considered as the most fruitful experience of his life, due to the opportunity to be linked with the most advanced research in architecture, meteorology, and civil engineering. After his return to Rome, he attempted to lead an Italian approach to urban microclimate design, publishing his most cited work, *The City of Tomorrow* (1943–1952). This latter, which is, without a doubt, the first complete treatise on the matter, marks him out as innovator, even if his influence on architecture and urbanism has not been considerable. Even if the validity of Vinaccia's intuitions and their actual correspondence with the most current research are still to be investigated in subsequent studies, today we can state that the contents of his better known theoretical works seemed to reflect full awareness of the main issues relating the topic as early as the 1940s. Therefore, the most brilliant contribution of Vinaccia's work was both his determination in founding a new discipline, which he called polisclimatology and which would have changed the general approach to urbanism, and his attempt to put in relation architecture and town design with urban physics. Despite the fact that the theories cited by Vinaccia were already known in the scientific community and some were well known until ancient times, he was able to collect them in a complete essay. He gave architects the chance to link their work to microclimate, comfort, and illness—topics reinforcing a humanistic idea of architecture and planning. From this perspective, the urban microclimatology does not represent just an additional scientific subject to take into consideration but a different theoretical approach to human environmental design. Today, when environmental and bioclimatic questions pose themselves with great force in architecture and planning, Vinaccia's revaluation could contribute both by influencing architectural debate on sustainable development and urban growth and by filling the gap in the dialogue between planners and meteorologists that Lansberg, in 1981, still decried.

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Author Contributions

Both authors contributed equally to this work. Both authors conceived and drafted the paper. Giovanni Chiri analyzed the historical background and Vinaccia's biography. Ilaria Giovagnorio examined Gaetano Vinaccia's main works and his correlation with the latest studies on microclimatic urban design. Both authors wrote, reviewed, and commented on the manuscript. Both authors have read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

References and Notes

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