ArC città 2

Number 3
january 2018
special edition:
Athens 2016

www.arcduecitta.it

Athens Programme 2016. The Art of Building Cities

POLITECNICO DI MILANO

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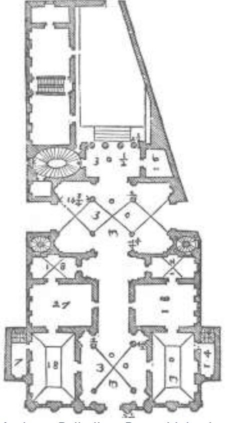
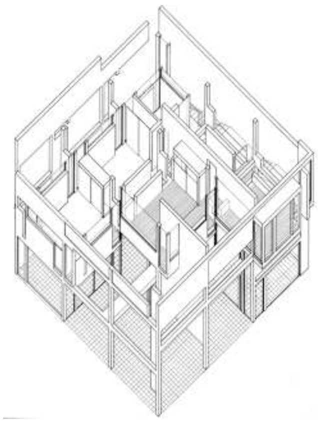


Andrea Palladio, Pyramidal site, from The Four Books of Architecture, Book II-XVII, 1570

THE ART OF BUILDING CITIES. THE CRAFTS OF TEACHING

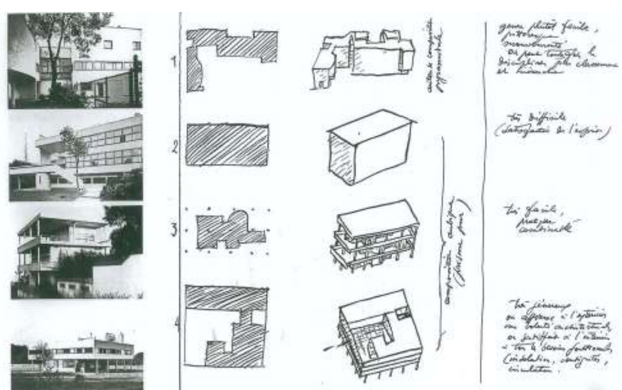
Lorenzo Degli Esposti

The city, conceived in the Albertian sense as a large house just like the house is a small city, can be understood – as a whole or in its components – as the antithesis of two poles: the solid and the void, articulated on one side by an indistinct mass or defined objects, on the other by an open space or delimited envelopes of air. The building, the edifice in general can likewise be considered in dialectical pairs, of a body seen from the outside as a “thing” and of an enclosed and contained space perceivable from within, or in other words of an envelope made up of architectural elements and an inhabitable room. Both the city and the building are therefore readable according to alternative and complementary methods, which are nevertheless not mutually exclusive; indeed the oscillation between them is the richness of the architectural experience. If we consider the building positioned in the city, the ambiguity of each term remains: we can understand it as an isolated object, independent from the indistinct urbanized mass, or in the more rarefied infrastructural landscapes of the contemporary metropolis, or vice versa we can bring together buildings that form groups and continuous perimeters of the blocks, delimiting streets and squares, in turn open-air, circumscribed rooms. This bivalent relationship between the buildings and the city is iconically depicted in the seventeenth-century plans of Rome designed by Nolli and by Piranesi: the former paints in the background undifferentiated urban fabrics carved by the streets and perforated by squares and the interiors of public buildings; the latter orchestrates celibate typologies that paratactically resemble one another, occupying the entire urban space up to occluding the streets in the establishment of an immeasurable architectural forum. Among these alternate but co-present readings is the relationship between building and city, between edifice and fabric, each term able to be considered in its corporeal and solid dimensions, an actor on the urban stage, or otherwise in its void, an area available for use and an inward-looking gaze. It seems useful to address these issues from the particular angle of teaching, which allows for an anachronistic systematicity in our day when treatises and manuals are increasingly unanimously considered outdated or ineffective. The learning and teaching of architectural and urban design are, in my opinion, indeed opportunities to go further into depth and test ideas and methods with a completeness and a methodology that are enriched with respect to the extemporaneousness and adherence to specific problems of design projects and professional work in general. This is possible thanks to the potential that establishes a circularity between design and learning-teaching, or between “doing/understanding” and “getting one to do/getting one to understand,” in the relationship between the design object and its author and in the one between the writing and reading of architecture. With this circularity in the experience, a scalar complementarity coexists between design object or architectural body (architectural design, distinct from residential design and from the design of complex types) and urban design (design of an area, as part of a city), different ways of proceeding in terms of scale and objectives but necessarily united by the intrinsic connection between building and city, in solid-void, body-container, envelope-area relations. This essay will leave aside the treatment of the larger design scales, i.e. the metropolitan, regional, and infrastructural ones, as they are particularly dependent on other considerations, ones related to issues of geography and landscape, ecology and economics, and infrastructure and network in general. Returning to the relationship between the part (building) and the whole (fabric, in turn part of the city), this relationship has been the subject of continuous debate for over five hundred years, as already mentioned in the introduction to this text. Among the authors who took this relationship into consideration, it is useful at this point to compare the positions of Aldo Rossi and Camillo Sitte. In 1889, Sitte published The Art of Building Cities, a book on urban planning, where the exigencies of his time in terms of the art as well as the technique of urban planning are compared with the great tradition of European urban systems, in particular in terms of the role played by the squares around which the city is built. The text was a great success, like other manuals referring to a continuous and compact city, even in the competition with alternative ideas based on the arrangement of the buildings in coeval or slightly successive territories, like in the movement for garden cities, in the research for a rationalist city, and in the proposals for linear (Russian) or territorial (American) dispersion. Sitte claims: “In modern urbanism, the relationship between surfaces with construction and those without is completely upended. At one time, the empty spaces (streets and squares) constituted a closed totality whose form was determined in view of the effect that they were supposed to produce. Currently, however, the building lots are divided according to regular figures, and what advances is called a street or a square. Once, all the unpleasant inequalities used to disappear within the built surfaces. Today, in the composition of regulatory plans, all irregular remnants become squares. Because the golden rule is that ‘from an architectonic point of view, a street system must, first of all, procure good building plans. This is the case of right-angle intersections’ (Baumeister, p. 96). But who then are the architects who get frightened because of an irregularly shaped lot? Only those who do not even possess the most basic notions of the art of drawing up plans. It is precisely the irregularly shaped terrains that always give rise to the most interesting and often even the most sensible solutions, not only because they require a detailed study of the project and thus prevent a mechanical execution of the plan, but also because they allow for the existence of different angles suitable for the use of small secondary spaces within the building.” Let us now consider Rossi’s position in L’architettura della città (The Architecture of the City, 1966) in which he defined “the city as something that arises either at a single point in the city or in an area of the city. In the first case, that of primary elements, the ultimate form is most important; in the second, that of the residential district, the nature of the land seems to be the most important. We must remember that a theory of this type takes into account not only a knowledge of the city in terms of its parts but also its growth, and while it attributes maximum value to the precise empirical experience of primary elements and their urban surroundings, it increasingly diminishes the importance of the plan and the overall pattern of the city.” Also in the second chapter, Rossi defines the three components of his urban theory, that is the study area, the residential district, and the primary elements, with a certain consistency in terms of the aforementioned scales: “This brings us to the concept of the study area. Since we assume that between any urban element and any urban artifact there exists an interrelationship whose particularity is related to a specific city, it is necessary to elaborate the nature of the immediate urban context. Such a minimum urban context constitutes the study area, by which we mean a portion of the urban area that can be defined



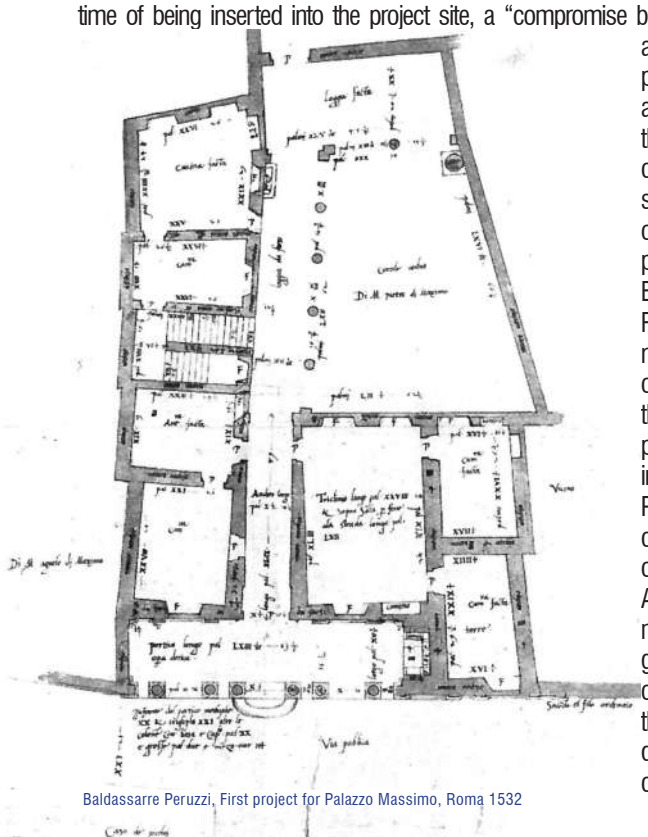
Peter Eisenman, House II, Hardwick, Vermont USA, 1968-70

I would like to thank the people who most contributed to my education and training as an architect and professor: Francesco Gnecchi Ruscone, who initiated me into architecture and followed the progress of my master’s thesis; Aimaro Isola, with whom I participated in my first design competition; Ernesto d’Alfonso, with whom I completed my doctoral thesis, and with whom I subsequently exchanged many reflections on architecture, in the Athens courses and in the magazine ArcDueCittà, as well as in innumerable, convivial meetings; Peter Eisenman, who has “opened my eyes” in terms of design and architectural design, in the context of my doctoral thesis and through numerous projects with Degli Esposti Architetti and Paolo Lazza; Elisa Cristiana Cattaneo for the constant discussions on all of the themes surrounding architecture and landscape. Finally, I would like to thank all of my collaborators in the teaching of architecture, in particular Maurizio Petronio, Daniele J. Zerbi, Davide Borsa, Davide Galletta, and Damiano Flisi, for their constant support and friendly exchange of energy and splendid days.
Lorenzo Degli Esposti, Milan, January 2, 2018



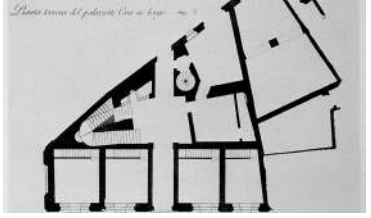
Le Corbusier, Four modalities of composition, 1929

or described by comparison to other larger example, the street system." Later in the study area with that of the residential district, "an urban artifact that in itself is predominant in the composition of the city [...]. The form with which residential building types are realized, the typological aspect that characterizes them, is closely linked to the urban form" and proceeds with the treatment of the "primary element": "to the concept of area must be added the totality of specific urban elements that have functioned as nuclei of aggregation. We have called these urban elements, which are of a dominant nature, primary elements because they participate in the evolution of the city over time in a permanent way, often becoming identified with the major artifacts constituting the city." Before going further into the themes related to the role of the void in urban composition and that of irregularly shaped lots foretold by Sitte's text, we can assume the three definitions of a study area, residential district, and primary elements advanced by Rossi as scales of design and of the teaching of architecture, which with reference to my teaching experience refer respectively to the design laboratories and landscape courses of the master's program and in the theses (urban project and urban design), to the first design laboratory of the three-year degree (architectural design of residences) and intensive Athens courses (urban design and design of complex types).I would like to begin the discussion of such modalities using residential design and that of complex types (hereinafter: architectural design), which share the same scale and methodological approach, even in the diversity of themes, types, and functional programs. Architectural design responds to different demands, which can be grouped into three groups: urban demands, demands on the scale of the block, demands on the scale of the architectural body-object. These considerations are not sequential, but are continually intertwined in the design process, which is always open, even during the construction of the work: I am convinced that the longer the project and the building are prolonged, the more the project will benefit, allowing for a certain amount of verification and rethinking that with a shortened time is inexorably quelled. The so-called School of Milan, the cultural environment in which I was initially educated, has lent a great deal of importance to urban relations in design, which are expressed in analyses of the characteristics of the new building with respect to the site for which it is intended, even at the broad scale that refers to urban alignments or analogical placements relative to some notable point in the area (or vice versa of somewhere else), or which refers to the settlement principle, to the type, to the language, or to the materials. Each project will entail a different degree of alterity from or adhesion to the new in relation to the pre-existing through choices that are not necessarily preliminary and also intertwine with the needs of the client and the inhabitants of the building, the district, and the city. It is possible that the architect might consider one or more elements of the surrounding area in the composition, up to the most complete mimicry by the new with respect to the pre-existing situation, or vice versa that the architect has little or no regard for such considerations with respect to the context, aspiring to create a work of architecture characterized by a maximum level of autonomy. The continuation of my education, as well as of the teaching content of my courses, has progressively been directed towards this latter option, thanks to the study and practice of systematic and serial processes in art and architecture, combined with the development of design and reading techniques through formal analyses of architectural precedents. Referring to the topic of reading techniques of precedents leads us to address the theme of the relationship between type and lot, recalling the seventh chapter of Interpreting the Renaissance: Princes, Cities, Architects, the latest book by Manfredo Tafuri published in 1992 (English translation in 2006), in which the architectural historian treats in an exemplary way the "distinct approaches – corresponding to alternative design options – demanded by irregular sites and by points of juncture able to compromise the regularity of the organisms. In such cases the Albertian conception of architecture as animans, a microcosm realized more harmonico, is endangered." The three modalities in which the type relates to the project lot, in particular if the latter is of irregular shape, are further possibilities of adhesion to rather than estrangement from local conditions, in this case the physical ones. The first modality is the "deformation" of the ideal type at the time of being inserted into the project site, a "compromise between the archetype and accidens": symmetries and parallelisms are skillfully altered, so as to compress the type within the constraints of the available site. Emblematic examples of this mode are the Roman palazzetto for Jacopo da Brescia (c. 1515-19) by Raphael, with the type reduced to a trapezius in order to be distributed into the narrow site, or the first project for Palazzo Massimo in Rome (c. 1532) by Peruzzi , in which the courtyard follows the non-orthogonal sides of the site. A different, antithetical modality is the "more geometrico configuration" of the architectural body, that is, "absolute": the type does not bend to local contingencies, even going



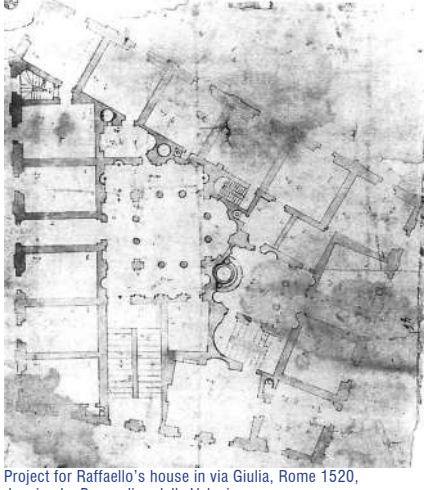
Baldassarre Peruzzi, First project for Palazzo Massimo, Roma 1532

elements of the overall urban area, for chapter, Rossi associates the concept of



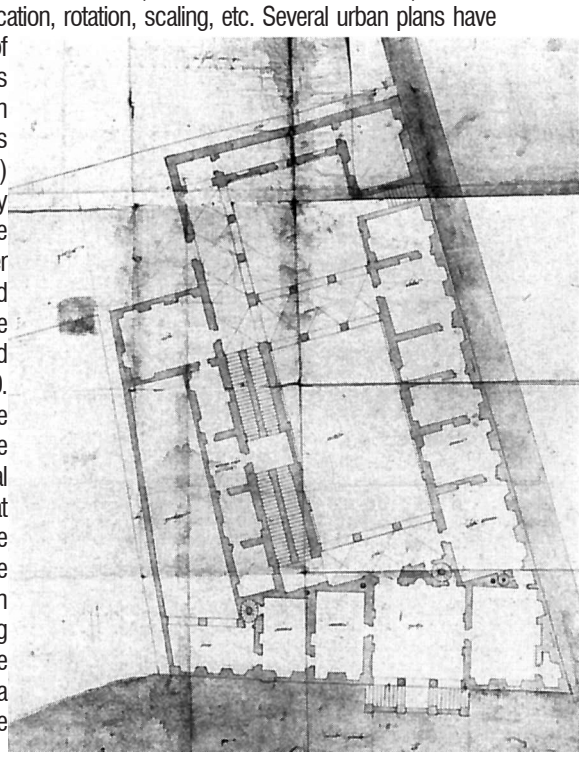
Raffaello, Palace of Jacopo da Brescia, Rome, 1515-19

so far as the amputation of a part, as occurs in the famous Palladian project "for a pyramidal site" illustrated in Book II (1570). Finally, there is a third modality, the most sophisticated, "capable of containing in itself geometrical absoluteness and planimetric elasticity": this is the "sprezzatura," assumed by Castiglione and translated into architecture, the resolution "without apparent effort" of a planimetric difficulty owing to the irregularity of the site. The rotation of the loggia entrance relative to the two rear courtyards in the design of the Venetian palazzo for Vettor Grimani di Sansovino (c. 1527-28), the rotation of the two courtyards of the building on Via Giulia in Rome by Raphael (c. 1520) or the Belvedere courtyard in the Vatican by Bramante (c. 1504-14) connected through the exedra to the Courtyard of the Statues and to the loggia, offset from it, are examples of the possibility of typological invention, of "abuse" with respect to the ideal type of "calculated ambiguity as a compositional tool and an instrument of visual attraction," useful for solving a planimetric problem. The relationship between type and architectural syntax can in turn be meaningfully illustrated in the case of the project for San Francesco alla Vigna in Venice. It is not by coincidence that the well-known story is related in Architectural Principles in the Age of Humanism by Rudolf Wittkower (1949), a fundamental text on the foundational role of the proportional system of neo-Platonic derivation in the setting out of the type and the corresponding elevations in the architectural conceptions of the Italian Renaissance. The design by Jacopo Sansovino for the Venetian church, commissioned by the Doge Andrea Gritti and initiated in 1534, was submitted to a study to establish the measures of the plan, the task of which was entrusted to the philosopher Francesco Giorgi, author of the book De Harmonia Mundi in 1525 and a Franciscan friar of the monastery to which the church was to be placed alongside. Sansovino's design was therefore subject to general scaling, as well as to adjustments between the various parts and elements: this is a pertinent example of the conception of type as a system of distribution and relation between the parts of the building. Giorgi fixed the width of the aisle in 9 steps, square of the number 3, and the length in 27 steps, cube of the same number 3. All of the other dimensions of the design were fixed according to musical proportions (diapason, diapente, diatessaron), so that the entire architectural organism would be governed by harmonious proportions considered of divine origin. Giorgi's study was submitted for an opinion from a trio of experts, composed of Fortunio Spira, Titian, and Serlio, who approved it, demonstrating how the philosopher's beliefs were entirely shared by the intellectuals of the time. The façade of San Francesco alla Vigna was later realized by Palladio (1564-70), who set the width on the repetition of 27 modules, once again the cube of 3 but without direct relations with the internal dimensions. The deferred realization of the façade and the setting of its width at an independent measurement, although motivated by the turnover of the architect, clarify the particular relationship between the type and the syntax within the architectural body with respect to the external syntax, the system of relations that regulates the elevations, the façade, which fulfills the function of representation as it was first theoretically defined by Alberti. This interdependence, which will become a dominant motif in Baroque architecture and in particular in Borromini's projects, or in the twentieth century above all those of Terragni, is indicative of the possible autonomy between typological choices and elevation arrangements, between type and language. The theorization of type continued after the Renaissance, having its culmination during the Enlightenment thanks to the writings and projects of Laugier, Blondel, the Revolutionaries, the Encyclopedists, Quatremère de Quincy, and Durand, whose method illustrated in the work Précis is a forerunner of the modern isotropic grid, even if in a general additive and beaux-art conception of composition. The studies of Anthony Vidler, published in Oppositions, frame the French contribution as the "first typology," referring to the natural origin of architecture (the primitive hut, an echo of Rousseau's ideas), while the subsequent theoretical apex occurs with the Modern Movement, with the interest that shifts to the production process and therefore on a technical and industrial origin of the architectural object. Simultaneously, in the first decades of the twentieth century, the relationship between type and syntax and design procedures in general were subverted, as the sketch of Le Corbusier's four types of composition – a subject that is addressed for the first time in the American lectures of 1929 – in essence represents: the casuistry of the relationship between frame and volume is set out in the articulation of volumes along the promenade architecturale separated from the ground by means of the pilotis, an unequivocal challenge to the Albertian-Palladian type anchored on ground lineamenta, which rise in wall structures on which the coverings are set. Starting in the Sixties, after the disappearance of the masters, the two principal lines of research in architecture are developed, one in the modification of the conception of type, whose origin is now sought in the history of the city through urban studies (primarily in Italian schools, from the studies of Muratori to the research of Aldo Rossi and Vittorio Gregotti, among others: the "Third typology" in Vidler's term), the other in the analysis of architectural syntax, dissecting the combinatorial possibilities of the lexicon and the rationalist methods (here we are referring to the research of Peter Eisenman, and also through the studies on modern architecture based on Colin Rowe's teaching and especially on Terragni, and in general to the work of the Five Architects). This last line of research is based both on design processes and techniques instructed through operations indebted to an interest in the automatic, conceptual, and systematic-serial forms of art of the Sixties (we can consider the publications: Peter Eisenman, Diagram Diaries, Thames & Hudson, 1999; Franco Purini, Una lezione sul disegno, Gangemi, 1996; both texts were the basis of the writing of my doctoral thesis of 2006-08, Operazioni nell'arte. Operazioni nell'architettura, forthcoming), and on techniques of formal analysis, up to the close reading of works of architecture (Peter Eisenman, Giuseppe Terragni: Transformations, Decompositions, Critiques, Monacelli Press, 2003; Peter Eisenman, Ten Canonical Buildings 1950-2000, Rizzoli International Publications, 2008; DEEPmilano, edited by Lorenzo Degli Esposti, SMown Publishing, 2016; up to the more recent studies by Eisenman, on Palladio, published



Project for Raffaello's house in via Giulia, Rome 1520, drawing by Bernardino della Volpaia

in Palladio Virtuel, Yale University Press, 2016, and on Alberti, forthcoming). The outcome of these studies is a recognition of an intrinsic value in going further in depth into the processes and works of architecture in question, captured in their factual specificity and in their generative potentials, as opposed to normative and crystallizing readings. With respect to this frame of reference, the approach to the architectural project, especially as regards teaching, occurs according to parallel activities, the first of which is formal analysis (particularly the close reading, an analysis of the architectural text with specific attention to the compositional particulars in relation to the totality of the artifact), applied to works from the Renaissance to the Modern Movement: in the case of residential works, it is the drafting of drawings and diagrams of precedents such as the Palazzo dei Conservatori in Rome, Palazzo Chiericati in Vicenza, Palazzo Barberini also in Rome, Palazzo Madama in Turin, up to modern architecture, particularly Milanese buildings (Casa Rustici by Terragni and Lingeri, the Corso Italia Complex by Moretti, the buildings on Via Broletto by Figini and Pollini, the building on Via Lanzone by Asnago and Vender, Casa del Cedro by Minoletti, etc.), and the Corbusian villas and residences. Further activity includes the urban study of the surrounding area of the project, undertaken both with a redesign of figure-ground in 1: 2,000 scale – in which the types constructed in the study area are highlighted, their relationships in terms of measurements/alignments/patterns, and urban signs, morphologies, and large public spaces are measured and discerned – and with a model of a part of the study area in 1:200 or 1:300 scale. Parallel to these activities, design is taught using small, free-scale conceptual models, and further models on a scale of 1:200/1:300 to be inserted into the aforementioned model, compositional diagrams based on formal and typological diagrams (parts) and structural diagrams, drawings, and models at various scales executed by hand and on the computer. It is evident that there is an essential need for a combined use of all the tools available to the architect (diagram, plan, section, elevation, digital model, material model) for the development of the design idea, according to a method that combines the value of the theoretical starting point with that of the material and planning practice instructed in the operations of the composing. Such a formal and compositional way of proceeding – of an abstracting, processual, and operational nature – must finally, or from the outset, clash with the technical-constructive data: although the position that sees the autonomous existence of architecture in the drawing and model can be shared, the construction remains the possibility for the author to exist and to operate, in the sharing of part of his or her time. This involves the need to and the enjoyment of combining materials and technologies with the lineamenta, according to a taste that makes the abstract and collective practice of architecture both convivial and individual. Having outlined a possible teaching theory for architectural design, I would like to conclude this text by tackling one for urban planning, distinguishing its more traditional conception of the urbanization of rural land (greenfield) or the redevelopment of disused areas or already previously urbanized (brownfield), with respect to a more "decentralized" concept, relative to the consolidation of a number of critical conditions of the contemporary metropolis, often on the margins of political and cultural agendas: informal settlements, post-rationalist neighborhoods, territories of urban dispersion (sprawl), and the city in contraction. In terms of urbanization or redevelopment design, I would like to go back to the architects considered at the beginning of this text, quoting Rossi who in turn quotes Sitte: "The hypothesis of the city as a man-made object, as a work of architecture or engineering that grows over time [...] is one of the most substantial hypotheses from which to work. It seems that useful answers to many ambiguities are still provided by the work of Camillo Sitte, who in his search for laws of the construction of the city that were not limited to purely technical considerations took full account of the 'beauty' of the urban scheme, of its form: 'We have at our disposal three major methods of city planning, and several subsidiary types. The major ones are the gridiron system, the radial system, and the triangular system. The sub-types are mostly hybrids of these three. Artistically speaking, not one of them is of any interest [...]. All three are concerned exclusively with the arrangement of street patterns, and hence their intention is from the start a purely technical one. A network of streets always serves only the purposes of communication, never of art, since it can never be comprehended sensorily, and can never be grasped as a whole except in a plan of it. [...] Only that which a spectator can hold in view, what can be seen, is of artistic importance: for instance, the single street or the individual plaza." The three formal systems (orthogonal, circular, triangular) identified by Sitte are the support (made of streets and thus of definition of the blocks) of the establishment matrix of a new settlement. Such a geometric matrix, initially isotropic, is also composed through the sizing of the types, their combination and variation, based on considerations related to urban density and morphology, forming minor public spaces: streets, pedestrian paths, squares. This initial pattern, which already incorporates settlement choices and economic necessities, is still a completely technical design, which can at most have a certain interest thanks to the serial permutations of the types, but it is completely abstract, in vitro. The sequence obtained will then have a reaction on the basis of further formal orders, which may include signs (alignments, diagonals, etc., in the form of out-of-scale buildings) or larger public spaces (large voids: monumental squares, parks, etc.) that may be placed into the sequence arbitrarily or according to visual or contextual considerations. The insertion of signs and large voids will cause the reaction of the plot-matrix, according to operations that may include deformations, stratifications, rotations, duplications, scaling, etc. appropriate for making the individual urban design specific and unrepeatable. The urbanization-redevelopment design described remains relevant today in the case of cities with demographic growth (think of the phenomenon of instant cities), or more generally in large cities whose activities are transforming day by day (production relocation, reconversion of obsolete infrastructures, etc.), but it is undoubtedly inapplicable to densely inhabited areas where it would provoke irresponsible and unfair uprooting. Precisely for this reason, the metropolis of the twenty-first century urgently presents further investigative and planning themes, consisting in the consolidation of various forms of already existing settlements, which are often the subject of indiscriminate redevelopment, with the expulsion of settled inhabitants, or which are in any case characterized by critical urban conditions. It above all has to do with the extremely vast areas of informal settlements, among which those that are very close to consolidated urbanization come to be eroded by means of demolition and substitution with social or incremental housing interventions, or worse by segregating large areas into the formation of gated communities, a worrying phenomenon on the rise in many cities of the world (consider David Harvey's research on this subject and in particular the recent Rebel Cities, Verso Books, 2012). Further aggression is that carried out by gentrification in the settlements close to the richest urban areas, which on the one hand does not involve the demolition of entire neighborhoods, but on the other, however, induces the removal of settled communities through dynamics of real estate speculation. Furthermore, urban renewal projects often involve the same previously built housing districts, in order to update building types and housing conditions, but also in this case upon the forced displacement of entire communities. These interventions, in addition to leading to the expulsion of the original inhabitants and often the destruction of the existing building patrimony, in any case do not constitute a solution to the problems posed by the increasing urbanization dynamics, the latter happening at a much faster pace than the former. Explosive urban growth is also accompanied by the opposite phenomenon of shrinking cities, caused by a variety of reasons for which the principal one is the relocation of production activities and the devastation of war. Urban planning, whose necessity is mainly based on the enlargement of the city or otherwise on its transformation according to changed needs but still in a context of economic growth, is notably lacking in the face of shrinking phenomena. Even in these cases, a possible but radical objective can consist in the consolidation of urban parts through architectural overwriting and the abandonment of the remaining parts of the urban: among the design examples to be considered are Oswald Mathias Ungers' Green Archipelago (1978) for a Berlin devastated by war and still divided by the Wall, Franco Purini's Progetti di distruzione (1991) for Rome, up to the most recent proposals of landscape urbanism and ecological urbanism for Detroit. Contemporary urban planning has in any case an urgent need to bring its statutes up to date, in order to cope with these new orders of problems. For consolidation projects relating to informal settlements, post-rationalist residential neighborhoods, sprawl, and shrinking cities, it seems useful to investigate strategies that are no longer substitutive, but additive at discrete points: I am thinking of constellations of artifacts that can be stratified with respect to what is pre-existing, resulting in minimal demolition without the expulsion of inhabitants and looking to integrate public, civil, and collective functions often lacking in the settlements in question. As happens in urbanization-redevelopment design, even in the case of the incorporation of a constellation of new buildings in a part of the city while not harming the rest, the planning theme consists of determining the shape of the new system, with the substantial difference that the former refers to the establishment of a totality on a completely or predominantly vacant terrain, which is necessarily composed of roadways, volumes, open spaces, etc., while the constellation, being stratified over existing already partially functioning fabrics, disregards the definition of a new road network (avoiding the logic of demolition) and the placement of large building volumes (avoiding substitutions and overall urban renovations), instead concentrating on the disposition and characterization of "primary elements" in an already urbanized reality. At the methodological and processual level, there are great similarities between the layout of the disposition diagram of such a consolidation project with respect to the setting of the already mentioned settlement matrix of the urbanization project, as both are based on pattern that can be orthogonal, radial, or triangular, induced to react with signs and voids (arbitrary, visual, or contextual) through operations of deformation, stratification, rotation, scaling, etc. Several urban plans have already shown the possibility of these types of discontinuous punctual establishments, starting in the Seventies with the Joice's Garden by Bernard Tschumi (1976) and the project for Cannaregio by Peter Eisenman (1978), up to the most recent projects on the border between art, activism, and architecture by Marco Casagrande or the manifesto on Assisted Squatting by Yona Friedman/AUFO. It is no coincidence that all these precedents, in focusing on the urban scale, look at the architectural scale and vice versa, for a city that is a large house and for a house that is a small city: this is one of the most enduring things that persist in architecture, for which the going beyond, and in which forms, is the agenda of a radical proposal for a teaching method and for the architectural project.



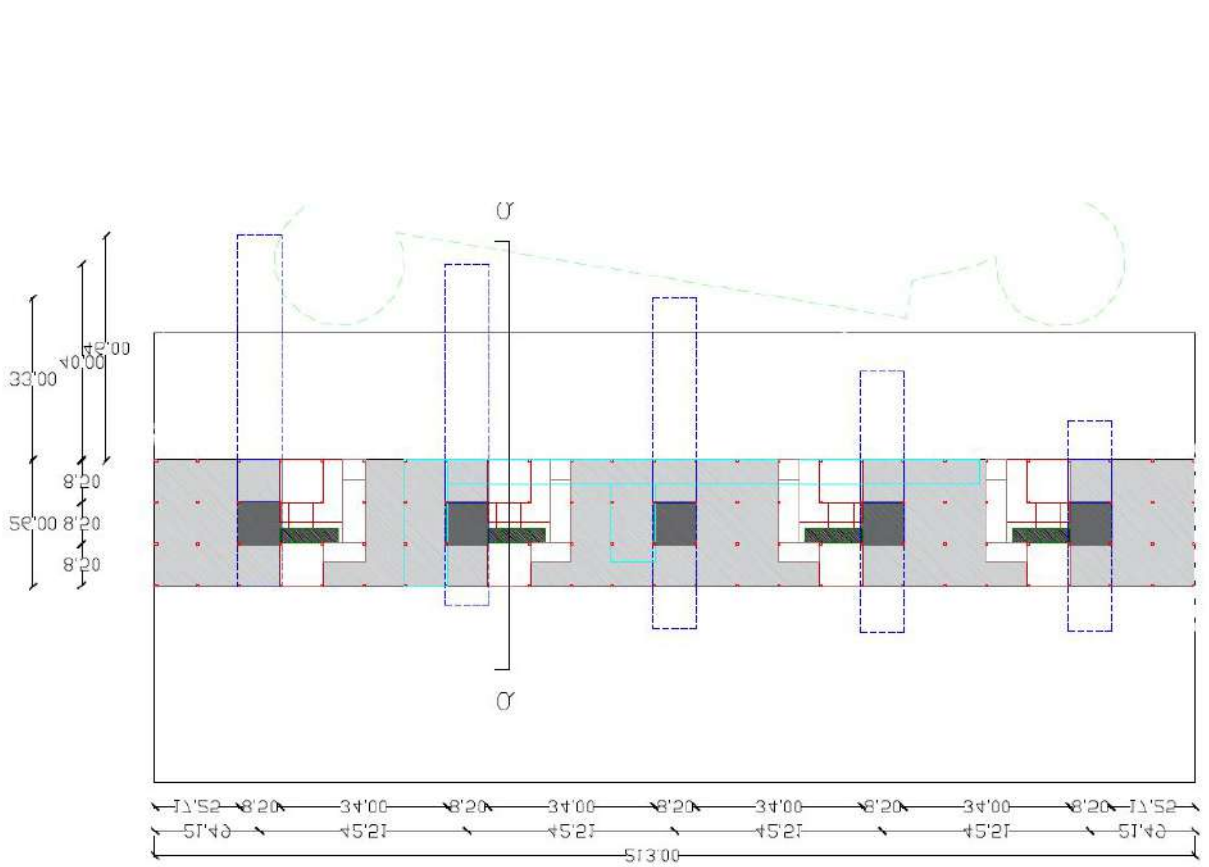
Jacopo Sansovino, Procet for a palace for Vettor Grimani, Venezia 1527-1528

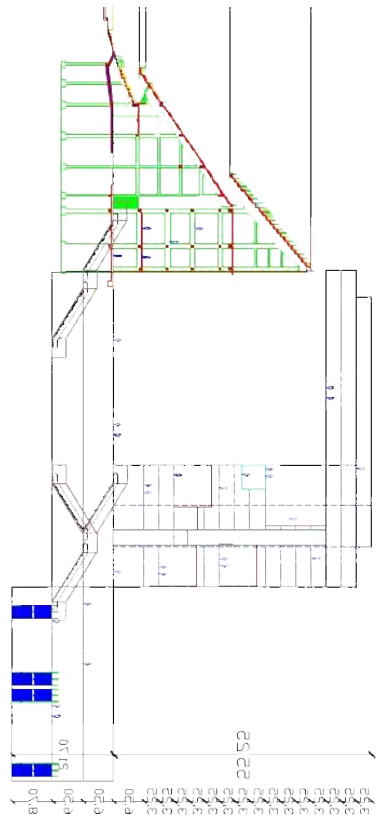
THE PHYSICAL FORM OF STRUCTURES FOR ARCHITECTURAL DESIGN

Claudio Chesi

The teaching of Structural Mechanics, as it is offered in Architecture Schools, suffered and is still suffering of an excess of formalization of knowledge. As a result, the deductive reasoning is privileged, in order to introduce these concepts not only in a correct way, but also as formally refined as possible. This approach – starting from purely theoretical premises – lacks of any specific relation with real construction case studies. On the basis of such premises, given the clarity of the logic rigour and the refinement of the deductive principle, the inductive process is completely disregarded - despite its historical relevance. An inductive approach - based on experimental evidence - drove, with time and effort, to the formulation of the theories explaining the physical behaviour of constructions: more precisely, the structural response to environmental actions. The comprehension of these concepts, presented according to a deductive criterion, implies an attitude to abstraction that fits the mind of who is devoted to studies in physics and mathematics, but it's scarcely compatible with the mental set of an Architecture student. The latter is used to reflect on tangible aspects of a visible reality, directly perceivable with senses.

Unfortunately, this ineffective planning of teaching methods is typically applied to one of the main issues in Structural Mechanics: strength verification. The scientific approach to this problem, indeed, is based on the concept of stress - i.e., the physical quantity which represents the stresses exchange between the particles constituting the construction material. A theoretical premise is essential while discussing about this topic, since the debate on physical implications refers to phenomena which - taking place inside the solid matter - are excluded from the possibility of any direct perception. The starting point of the rigorous studies on this subject was set by Galileo, in parallel to the formulation of the scientific method. This consisted in the analysis of a simple physical model: a cantilever beam supporting a weight at the free end. The popular "Galileo's formula" for the evaluation of the cantilever capacity was partially incorrect, due to a wrong assumption on stress' distribution. The progresses of the scientific research led – in the span of two centuries – to the precise statement of the issue and to the development of a general theory regarding the state of stress inside structural elements. As already mentioned, teaching this discipline will probably be unsuccessful if the starting point for the discussion is set inside the inaccessible world of the solid matter and based on a purely mathematical formulation of the stress issue. An easier understanding of the problem would rather be achieved by looking at the stress effects as they can be directly perceived, in terms of deformations of solid elements. Deformation, indeed, through the description of the changes occurring in the materials' shape and volume, provides a tangible evidence of the effects of these stresses. This could therefore be adopted as a useful reference to develop a theory on the issues caused by propagation of forces inside materials. Inferring the concept of stress from deformation - based on the pure observation of experimental evidences - might therefore be a more effective way of understanding the physical issues. Experimental evidences, indeed, directly lead to the formulation of the stress-strain relationship - i.e., the material constitutive law, that characterise the material response at all the stress levels, up to failure. Given the concept of stress and the capability of computing its values as well, the issue of the strength of materials can be faced, in order to assess both deformation and load transfer capacity. Again, the design implications of the issue are effectively outlined by Galileo when he acknowledges that a suitable structural configuration must be directly associated to the correct sizing of structural members. Well defined minimum dimensions have to be assigned to every structural element, as a requirement imposed by strength limits. The inner duality of the design process becomes clear: conceiving a correct structural scheme has to go with the precise evaluation of the cross sections prescribed for all the structural components. Going back to the main issue – understanding the stress states which generate inside the material and their characteristic limit conditions – it is interesting to recall the Principle of Virtual Works as a charming an effective way of providing a further insight into the concept of stress. The equivalence between the calculation of external and internal work, indeed, sets a relation between the external view of the problem - which is clearly perceivable in terms of forces producing displacements - and the internal world of the solid matter. Here, under the effect of external loads, local stresses, which generate deformation of solid particles, are displayed, since they perform work in the same way as in the external world. The mathematical statement of the Principle of Virtual Works, therefore, reflects the correspondence between two parallel visions of the same problem: the first regarding the view of the structure from outside, and the second that unfolds the relations between the internal parcels of solid matter. Here the interaction among solid particles is defined in terms of stresses and strains. As a conclusion we can state that - with reference to the Mechanics of Solids, a key topic for both Civil Engineering and Architecture Schools - wide possibilities still exist for the development of more effective teaching criteria, suitable for both faculties. These should allow an in-depth understanding of the physical phenomena which characterize the behaviour of structures, in order to build a fruitful dialogue between the architectural and engineering expertise, at the base of any design process.





THE CHOICE OF A STRUCTURAL SCHEME.

Claudio Chesi

A suitable structural scheme has necessarily to be identified with reference to the main peculiarity characterizing the design proposal. This has to do with the long span values which are required for the cantilever portion of the building (46 m). Also in the design variant by which supports are present at both the beam ends, the span values are still very long; the design problem, therefore, is more typical of bridges than of buildings. Based on such a consideration, a logical sequence of concepts leads to the definition of all the structural details, starting from the construction material and the structural typology.

The building material

As to the material choice, reinforced concrete will necessarily be used for cores hosting stairs and elevators and acting as the main bracing system for the building; for long span beams, the two basic options which are normally considered in the design of bridges refer to steel or pre-stressed reinforced concrete. In the case of a building structure, however, due to weight considerations, the recourse to the use of steel is highly preferable.

Global equilibrium and structural implications

The presence of a long span cantilevering portion of the building results into a lack of regularity in the spatial distribution of weights corresponding to the building single portions. In this situation stability has to be verified with respect to global overturning. This can be easily done with reference to a simple global scheme (see fig. 1) reproducing the correct distribution of volumes and relative weights. The analysis of global equilibrium gives evidence to the stabilizing effect produced by the main building block and the possible need for a foundation system of suitable shape and mass. Last but not least, through this simple analysis the propagation of loads through the structure can be highlighted, showing the increase in the compression levels in some regions and the possible presence of tension forces in some other parts. Within the examined cases, when the maximum length is considered for the cantilever portion (46 m), the weight of the main building block is not enough to counterbalance the overturning effect due to the cantilever; consequently, an anchoring foundation block is required on the building opposite side. In terms of load propagation, this implies extra-compression on the façade close to the cantilever portion and tension on the opposite one (see image 1).

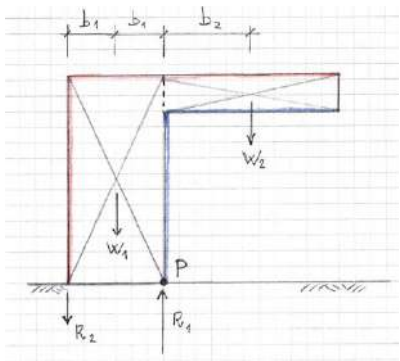


Image 1 – Static scheme for the analysis of global equilibrium.
Blue indicates compressed elements, red indicates the ones subject to tension.

The adoption of a structural typology

The need of covering long spans necessarily leads, in terms of the structural scheme, to the use of truss systems. This kind of solution, indeed, is normally employed in buildings whenever special problems arise producing irregularities in the normal mesh of beam and column elements or requiring longer spans. As in the case of bridges, a considerable height is required to the truss beam if spanning over a long distance; namely, one or more inter-storeys are included in the beam thickness. In the examined case, the beam height is 10 m and includes three storeys. The structural scheme, in this situation, acquires a dominant role in the design, with a marked influence on the building final appearance and usability.

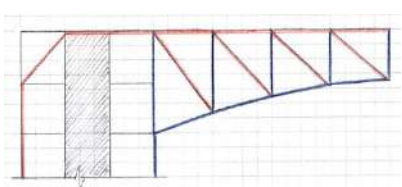


Image 2 – The truss scheme adopted for the cantilever beam. Minimum thickness is 10 m.
Blue indicates compressed elements, red indicates the ones subject to tension.

Advantages and peculiarities in the truss scheme

A truss scheme, as it is known, necessarily implies a considerable transversal size; at the same time, it provides a very light structural solution, being derived from the reduction of the traditional beam to the main load propagation lines. This implies, in addition to top and bottom longitudinal chords, the presence also of connecting elements arranged along both vertical and inclined directions (i.e., diagonal elements). The adoption of a truss scheme results, in any case, in a very flexible solution, also in consideration of the possibility of varying the transversal size, following the bending moment variations.

Primary and secondary structures

Typical proportions in the design general layout are such that relevant values are present for the distance between primary structures as well; for instance, between parallel cantilever beams (34 m). As a consequence, the adoption of the truss scheme is extended form primary to secondary structures, corresponding to transversal beams. Also in this case, the beam thickness corresponds to the inter-storey height; diagonal elements, therefore, go across the inter-storey space. In the building main portion one of the examined design variants is based on this structural solution. Each truss beam, indeed, provides support to a couple of storeys; in this way, diagonal elements are present at every other inter-storey. In this way, usability conditions at the different floor levels are determined by the adopted structural scheme.

From structural typologies to sizing of resisting elements

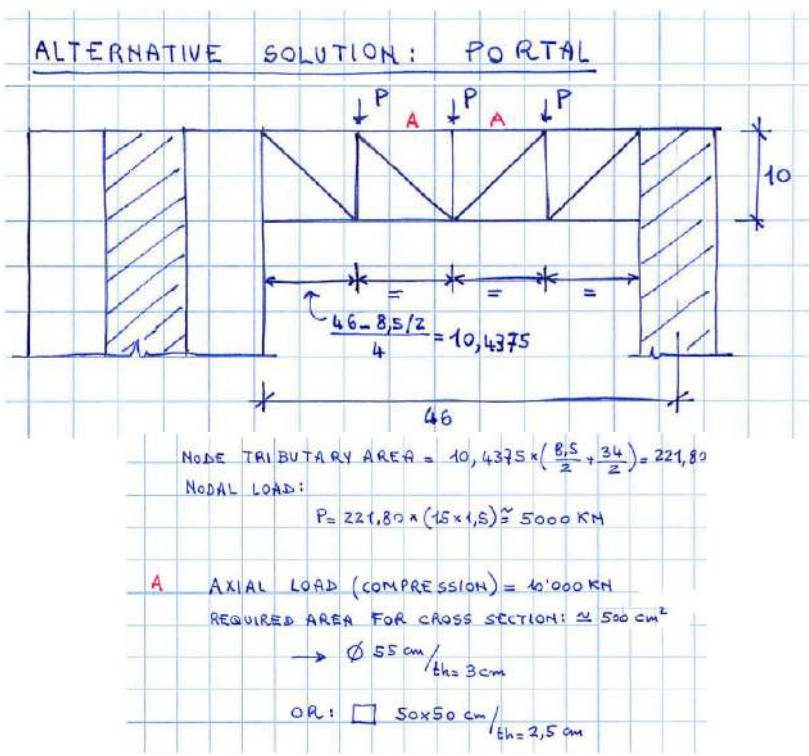
Once the load propagation path has been defined throughout the structure, single structural elements along this path can be considered for the cross section sizing, in line with the material resistance properties. In the case of primary structural elements, sizing criteria depend on simple rules: in the design of truss beams, where bending dominates, a good balance has to be achieved between the beam total height and the top and bottom chord cross section. In the case of long span beams, it may be of interest varying the beam height according to the bending moment value, keeping the chord section constant. In façade columns, where high compression values are present, capacity may be strongly reduced by instability; design aims, in this case, at a proper choice of both shape and size for the column cross section.

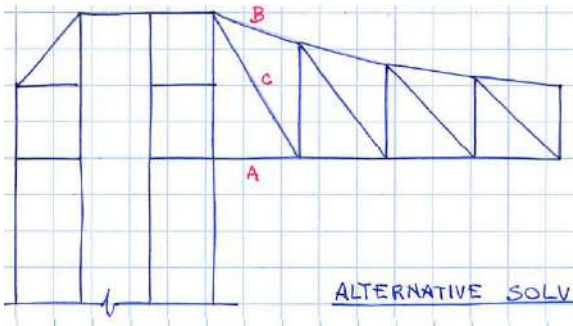
Characterization of construction loads

The design of single resisting elements necessarily follows the characterization of the design loads which, in the presence of long spans, must be reduced to minimum values. This applies to both permanent and variable actions; as to the first, use conditions of different areas have to be carefully examined and suitable values assumed for the corresponding loads; as to the permanent loads, technological solutions allowing for maximum lightness should be adopted both for slab and façade elements.

Structural deformability

The design of structures is normally based on both resistance and deformability requirements. In case of reduced span structural elements, design is conditioned by resistance, whereas the opposite applies to the case of long span elements. Truss systems typically exhibit high stiffness properties, not exempting, however, from the numerical characterization of displacements. Due to inherent computational difficulties, this check is often skipped in preliminary design, and postponed to the working plan phase of design.





ALTERNATIVE SOLUTION

A AXIAL LOAD (COMPRESSION) = 25'300 KN

B AXIAL LOAD (TENSION) = 18'834 KN

C AXIAL LOAD (TENSION) = 15'068 KN

CANTILEVER BEAM:

LOADS ON THE BEAM, COMING FROM 3 FLOORS:

FLOOR	SLAB	PERMANENT	LIVE
ROOF	1	0,5	3
MAIN	1	1	5
SERVICE	1	0,5	2
TOTAL	3	2	10

TOTAL LOAD FROM 3 FLOORS: 15 KN/m²

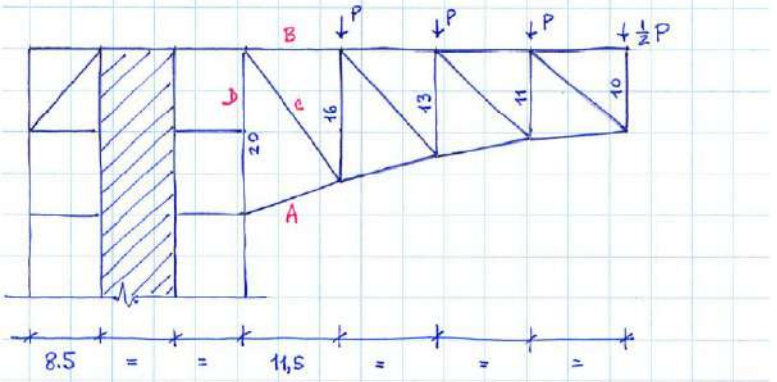
LOADS TRANSFERRED TO BEAM NODES:

NODE TRIBUTARY AREA = $\frac{4{,}6}{4} \times \left(\frac{8.5}{2} + \frac{3{,}4}{2}\right) = 24{,}38\ m^2$

NODAL LOAD:

$P = 24{,}38 \times (15 \times 1{,}5) = 5'500\ KN$

↑ γ FACTOR, FOR U.L.S. DESIGN



A AXIAL LOAD (COMPRESSION) = 26'787 KN

REQUIRED AREA FOR CROSS SECTION: ≃ 1200 cm²

→ 1 ϕ 100 cm / th = 4 cm

OR (BETTER): 2 □ 60×60 cm / th = 2,5 cm

B AXIAL LOAD (TENSION) = 17'789 KN

REQUIRED AREA FOR CROSS SECTION: ≃ 600 cm²

→ 1 ϕ 50 cm / th = 4 cm

OR (BETTER): 1 □ 60×60 / th = 2,5 cm

C AXIAL LOAD (TENSION) = 12'869 KN

REQUIRED AREA FOR CROSS SECTION: ≃ 420 cm²

→ 1 ϕ 45 cm / th = 3 cm

OR (BETTER): 1 □ 45×45 cm / th = 2,5 cm

D AXIAL LOAD (COMPRESSION) = 10'450 KN

REQUIRED AREA FOR CROSS SECTION: ≃ 600 cm²

→ 1 ϕ 50 cm / th = 4 cm

OR (BETTER): 1 □ 60×60 cm / th = 2,5 cm

URBAN EPICENTRE FOR MESTALLA.
Reflections on a design journey.

Federico Marani

This is the resume of a journey starting from the counteroffer regarding the project of demolishing the historic stadium in Valencia, Mestalla Stadium. The counterproposal has been developed during a Master Thesis having the title: “HUE: Hybrid Urban Epicentre for Valencia Dinamiza Stadium – discussed by Federico Marani and having Professor Lorenzo Degli Esposti as tutor and Professor Ernesto d’Alfonso as supervisor. The main character in this sequence of events is the football club, having the property of the sport centre, whose aim is to demolish the stadium in order to favour an ambitious real estate project. This plan – known with the name of Valencia Dinamiza – has the purpose of balancing a remarkable debt the Club incurred in. The same debt brought the football club to be purchased by two different buyers, from 2008 to now. The goal of the project is to re-establish the role of a remarkably vast urban presence – like a stadium – giving it the tools to distinguish itself as a urban epicentre. As an epicentre, the building must be able to communicate – from an architectural point of view – with the urban_territorial scale, thanks to the underground high-speed train station and – on a telematic level – with the entire networks, in virtue of its role of media_container par excellence. The archetype of the stadium entails the action of looking, overlooking and observing. The starting point of the design derives from these actions: the aim is building two twin-buildings popping up from the long and short sides of the stadium and continuing until they touch the tribunes of the stadium itself. The constructions have a strong relation with both soil and public spaces. The paths flowing from the subterranean metro stations meet in two vast squares, shaped the buildings and the stadium. When the public squared are covered the spaces becomes more intimate – due to the presence of two eaves, drawing a stripe of blue sky visible from the square. Thanks two these eaves the actions – implied in the concept of square - of looking and overlooking are completed. Shows, meetings, collective actions and events can take place in the square – following the traces of the role of the stadium. The building hosts a various selection of functions -characterizing the building and defining it as epicentre. Above all, the special residences - in the external boundary of the eaves - are the spots where the design intent is displayed: these residences are overlooking the football field – focus of the scenic space. This was a design exercise exploring the role of the urban epicentre and the possibilities it offers, especially inside a contemporary metropolis. Creating an epicentre – grafting into the city – is one of the tasks of the art of building a city, this is where the name of the international workshop comes from – Athens Poli 9 – The art of building the city, hosted by Politecnico di Milano and curated by Professor Lorenzo Degli Esposti. The possibility of unfolding this design topic – as main theme of the workshop – has been used as a pretext to set a discussion about the project and its compositional nature. The project, indeed, contained a superficial thought on the structural aspects. From this weakness raises the proposal of Prof. D’Alfonso of re-discussing this aspect, accomplishing it through a prolific cooperation between architectural and engineering skills. The research acts a posteriori on the project proposing a more articulate and complete vision of the main topic. The intensive seminar has been a precise scenery to experiment the design solutions evoked by the research. Having this as the main topic of the workshop has been an occasion to re-discuss the project and its compositional character. The project indeed embedded a summary reflection on constructive themes The study and the in-dept analysis took place at Arc2Città Laboratory and involved two groups, one specialized on the constructive issues and the other focused on the architectural issues. The first group has been guided by Prof. Claudio Chesi and doc. Valentina Sumini. The second group is represented by Prof. Ernesto d’Alfonso and Degli Esposti, with the procious help of Damiano Flisi, Margarita Petrova, Marta Scaccabarozzi e Federico Marani. Such a research has its roots far from physical places concerning the project, since it aims to re-establish a binomial structure-space and to demonstrate how difficult is – especially in the academic world – to find a balanced synthesis between these fields. The doctorate thesis by Valentina Sumini concentrates on the structural analysis of buildings and develops a deep study on them. These are examples where the relationship architect-engineer brings to a brilliant result. The analysed building comprehend the Torre Velasca, Pirelli skyscraper, the Marina Tower in Chicago. In these case studies il clearly visible the outstanding partneships: Ponti-Nervi and Roger-Danusso. The latter represent historical, and design, moments where the architects and the engineer used to cooperate to reach the same aim. This is an evidence of the communication that has been undertaken, during the 50s and the 60s between the engineering and architectural field – the efficiency of this communication is still a reference to get inspired from. It’s also compulsory to mention an other Italian architect – who must be annotated among the masters of the relationship space_structure: Luigi Moretti. The Roman architect – in whose experimental studies can be found an investigation on a model for a curved stadium – demonstrates a sharp will of engaging structural issues to use them as guide lines in the design. Moretti’s work has been underestimated for decades, though recently – due to further studies and applications of parametric architecture – some of his masterpieces have been recovered as valuable examples of parametric architecture. Inspired by the culture of the 50s in Milan, the research continues showing contemporary examples where structural issues came along with architectural ones. CCCV Tower by OMA in Beijing is a clear example of a structural skin – followed by the competition proposal by Richard Meier, Peter Eisenman and Steven Holl for the World Trade Centre. The headquarter of the municipal transportation network of Madrid proposes a structure composed by slabs hanged to a long archway. The project by MVRDV, presented during the competition for the Intesa San Paolo Headquarter in Turin, deals with a building lifted dozens of metres from ground level. These are some of the main case studies which influenced definition of the structural typologies chosen for the designed building. The work itinerary resulted in five case studies that interlace three structural solutions and two typological-distributive solutions we are going to unfold in the following paragraphs.

Model for a stadium, Luigi Moretti, 1960

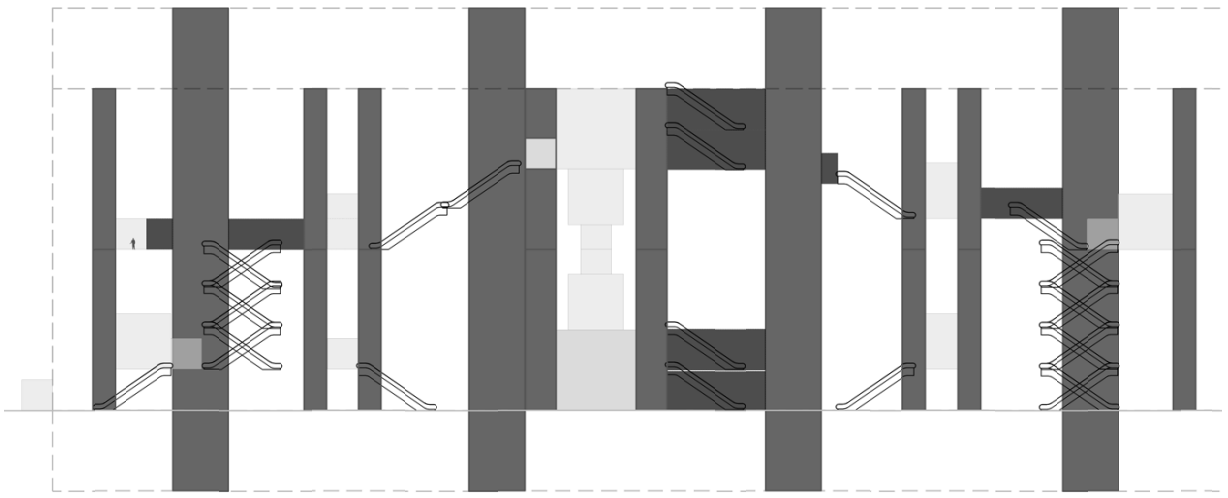
Proposal for the competition for the World Trade Center, Richard Meier, Peter Eisenman, Steven Holl, 2002

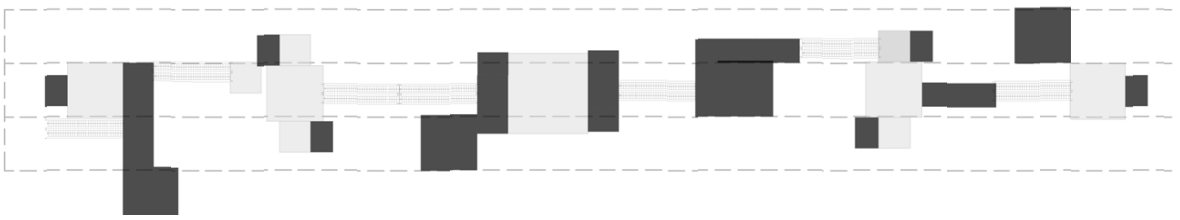
Section of the path to Rocca Paolina, Perugia

FIVE VARIATIONS ON THE SPATIAL-TYPOLOGICAL ISSUE.

Federico Marani with Margharita Petrova and Marta Scaccabarozzi

1 This topic has been tackled by the thesis project adopting a morpho-typo solution – unifying the linear and the plate typology. Inside the morpho-typo the functions are merged inside a big hybrid container in which a public path longitudinally crosses the inner part of the container and shifts the public space from the city level – the street – to the top of the building. This design solution is inspired by the theory on the cave by Michael Jakob: according to Jakob the cave is a possible solution to fluxes issues inside a mega-form_mega-hybrid-container. Rocca Paolina in Perugia offers an exceptional spark: an entire street is carved into the mountain to secretly connect the rooms of the Papal Palace and the outer walls of the city. The sequence of rooms carved in the stone – an internal architectural space becoming an urban element – is an example of the creation of a space from the pure matter, having a strong urban relevance. This is the perfect example for the thesis project. Looking at more contemporaneous examples we can mention the work of Kurt Schwitters and the experiments by Merzbau – this is where Steven Holl took inspiration for the project of Simmons Hall in Boston. The American architect during his career largely explored the theme of the 'path inside mega-forms'. It is visible in some of his Chinese projects, from the Linked Hybrid to the Vanke Centre. From our point of view these are interesting references but still not a completely satisfying answer to the equation city-distribution-functions. In the Linked Hybrid project there's no specific connection with the city: on the contrary the paths and the distribution network are shifted far from the street level. Another solution to the same issue – the connection of different functions - is proposed by the Hollandaise Embassy Building, designed by Rem Koolhas. The internal routes spins around a vertical nucleus that continuously connects the street to the upper floors of the building. After a deep analysis of the distribution typologies, we tried to insert the into the design for a more harmonious articulation of routes-functions. This creates new layouts for the distribution and for the internal paths. The first compulsory step was the definition of the constrains in the design: the limits in the volume, the alignments with the city and the internal rhythm of the building. In order to accomplish this first task a modulus has been set – defined following the harmonious mathematic series of Fibonacci. To reveal the design process is necessary to underline the fact that the energy generating the project comes from the tension between the underground_high speed train station and a commercial plateau having a vast garden on its top. For a better comprehension of this topic we favoured the section as architectural tool. Sections allowed us to have a diachronic reading of what is happening in the building in its dominant dimension: length. Sections also permitted a synchronic reading on how the tension relates to the highness. In order to compose an harmonic building we detected the main features: routes, pause_spaces, functional blocks. A fundamental step was the introduction of connective elements – called ganglions – whose dimensions have origin from the already mentioned mathematics series: the chosen numbers where 5, 9, 13. The measurements have been used purely and in some cases they have been modified - following the 1° 3° 2° 5° proportion – taken from jazz music. The ganglions are used as musical notes and disposed in plans and sections as if they where on a pentagram. The scores and the reading trials come from this musical operation. Section and plan become a staff of an orchestra director on which, if we trace a vertical line, we can define a "musical section" of what the performers are playing in that precise moment. This reading comes from the inspiring book by Yona Friedman " The complicated order" - this deeply helped us while articulating the distributive solutions. When the studies on the ganglions have been completed, the last task was to unfold all the possible branching of the internal paths. It is clear from the beginning that an organic vision is offered to us to define the fractal and capillary development of the routes. The fractal series – useful to be developed in the regards of a building as inside a path's scheme – meets the necessity of creating diverse shades of intimacy according to the typologies present in the building: from the main path, with a strong public identity and connecting the shared facilities, the user should be able to reach its apartment crossing spaces that gradually brings him to a domestic dimension.

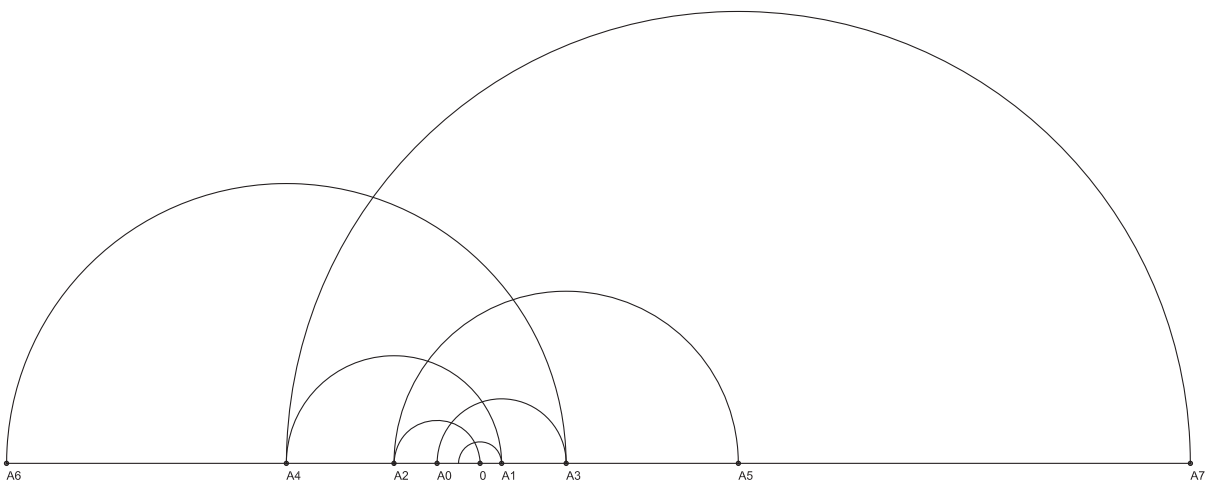




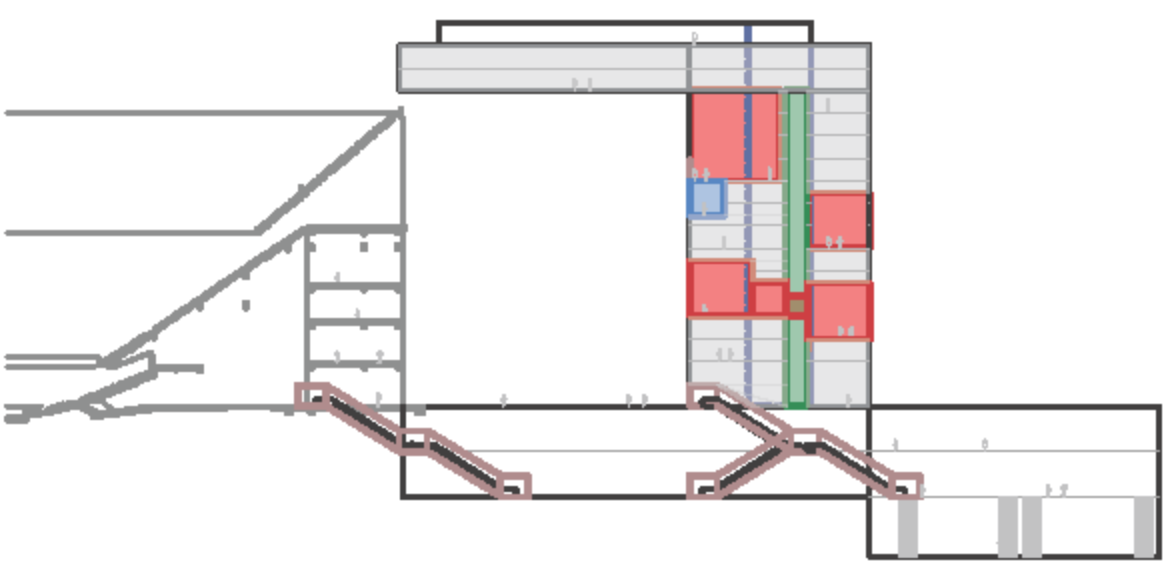
A similar mechanism is recognisable in urbanism, where a main arterial path ramifies connecting vast squares. Other smaller street derive from the same path and connect to smaller squares – allowing the user to reach the door of its apartment. The effort in this design exercise aims, as already mentioned, to unfold the possibility of bring a part of public space, the street or the entire city, inside the project. Peter Eisenman proposes, in the project for a cultural centre in Santiago de Compostela, to embed the pattern of the historic Galician city inside the design. The suggestion proposed from this research is to bring a part of the city in the section of the construction. The development of a city plan helps comprehending the harmonic and conceptual effort done while drawing the mentioned section. But still it isn't enough. The fast internal paths have the same dignity of the slow ones. The fast vertical circulation are organised following the same logic. Public elevators are located in the nucleus hosting the emergency stairs, service elevators and technical pipes.

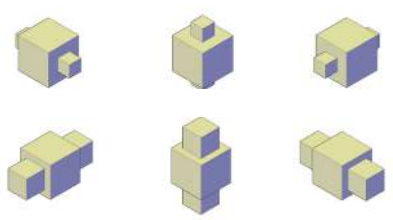
2

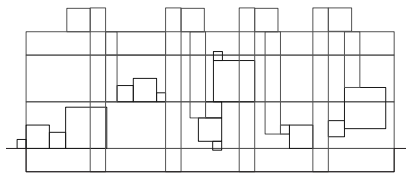
The chosen structural typologies have to solve the constructive problem of the building itself together with the support of the large structural plateau on the top of the construction. The traditional frame, the structural skin, the truss blocked in the vertical structural nucleus and the structural arch are founding elements in the composition. Inside this composition many variables have been introduced: routes and vertical circulation, which became interdependent elements. The melange between these fundamental and interdependent features raises a recurrent question: are the routes and the vertical circulation only a functional element in the project? Of course they are not. Paths represent the constrain, while the interstitial spaces creates a vast range of shades, occasions, cases that enrich the utility and the value of the design. Building typologies have to be declared a priori but we can't define them or affirm they are settled until they reach an accord, harmony and consonance inside our musical selection – both on a diachronic and synchronic level. The pentagram – having as protagonists the ambients, of movements and relax, the typologies and the functions foreseen by the program and distribution – revealed five design layouts. These five solutions have been chosen between millions of possible solutions – they represent a demonstration and a starting point for a cultural itinerary that is still alive and its aiming to set the spotlight on the parametric values of some synthesis found by Arc2Città.

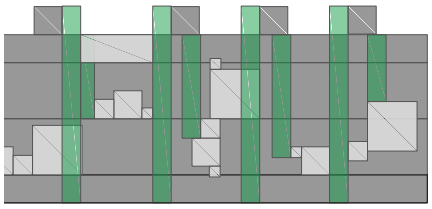


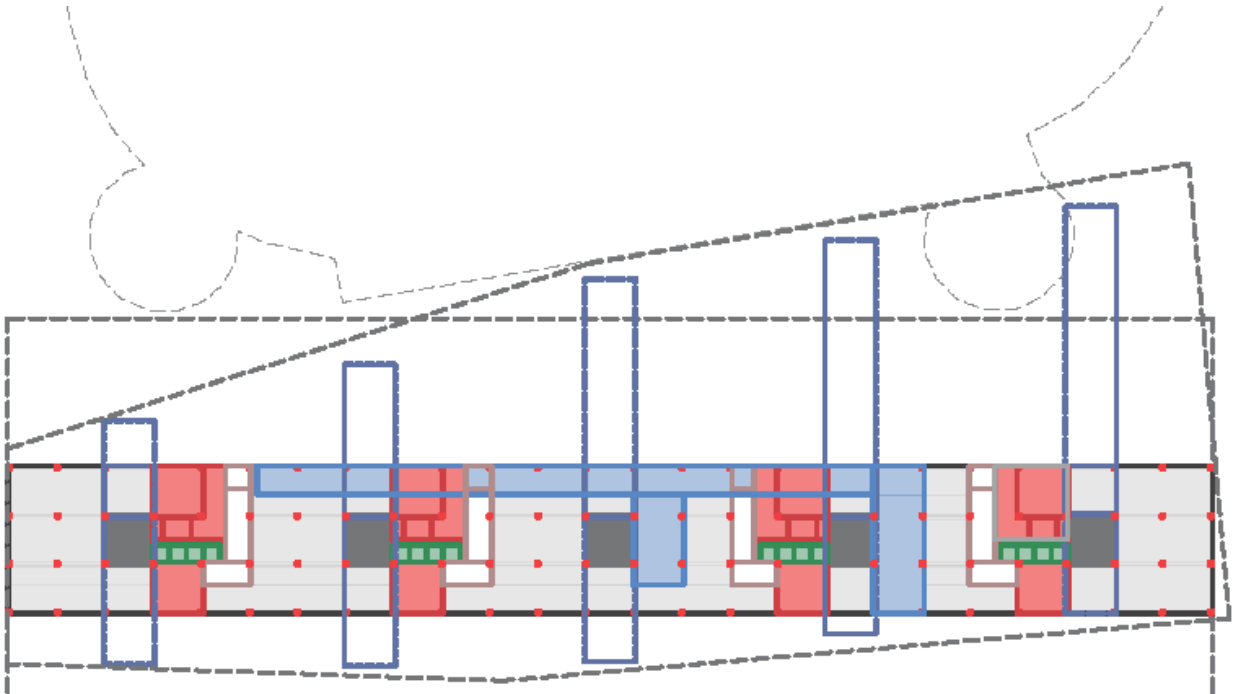
Mezbau, Kurt Schwitters, Hannover, 1923-44

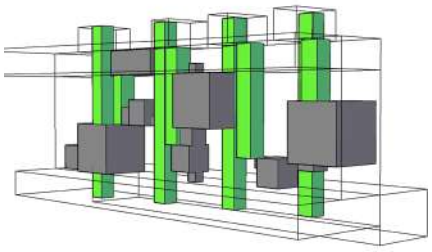


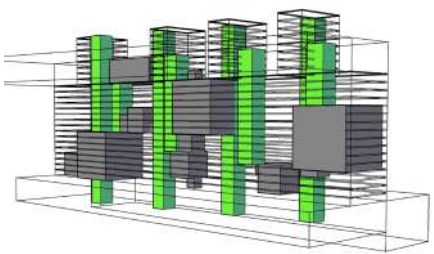






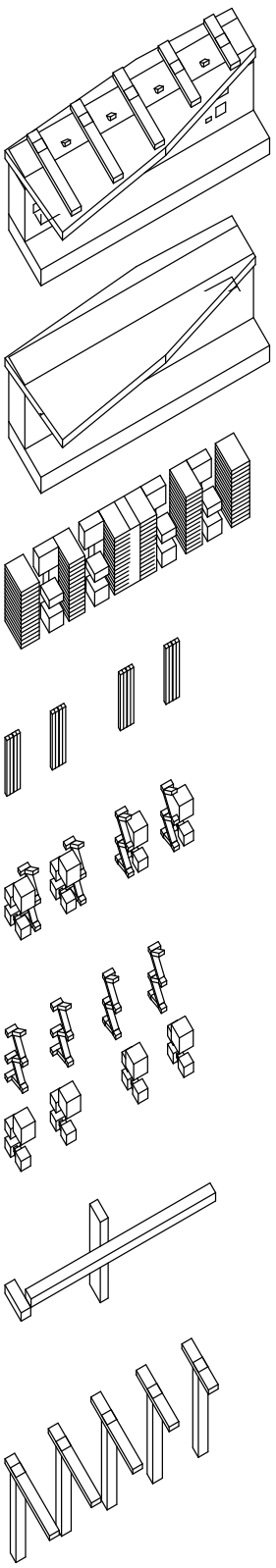


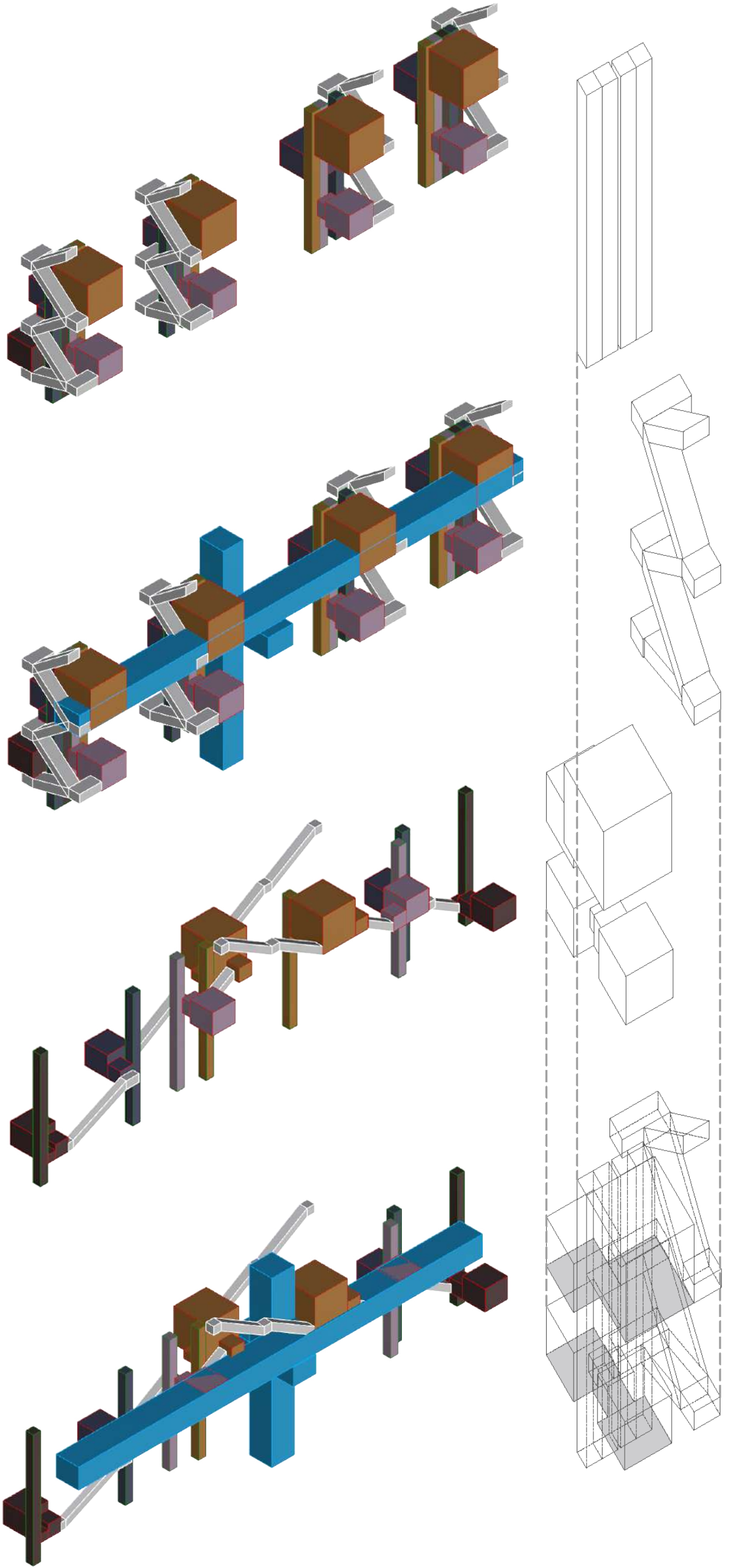


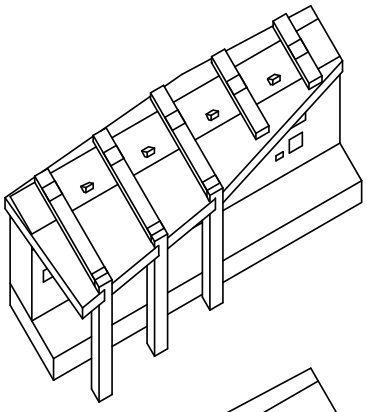


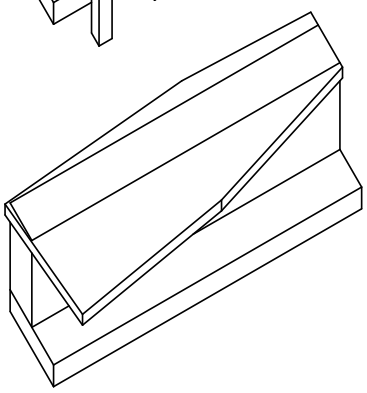
CASE 1 Frame + cantilevered beam = isolated functional volumes + solid vertical circulation

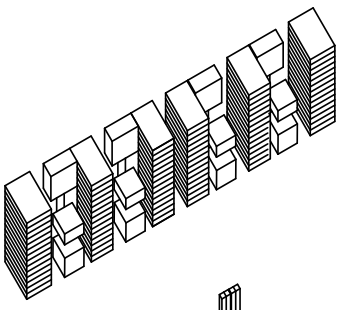
The equation displays the output and input elements. This case has a traditional connotation – since the architectural typologies are contained in independent volumes in which the slabs are overlapped and supported by a frame. The architectural volumes are separated from the vertical circulation blocks, located into a distinct volume. The connecting elements inside the volumes – architectural and distributive – that just like two large tunnels link all the mentioned elements and cross the building , transversally and longitudinally. The success of the relation subsoil_sky is entrusted to every distributive volume that, even maintaining a direct contact with light, separate the different layers of connection, allowing a complete enjoyment of the building.

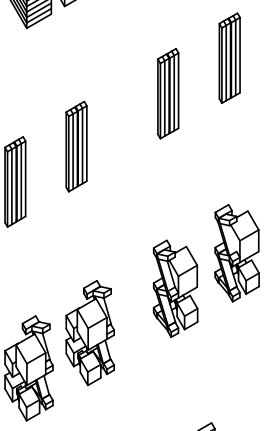


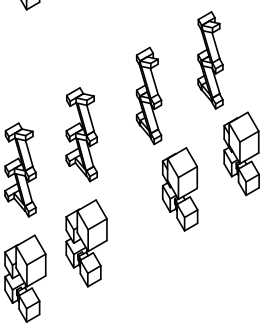


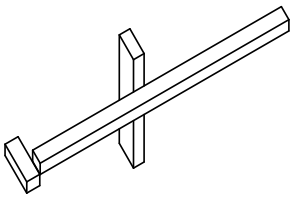


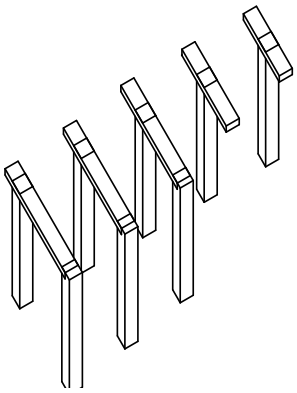








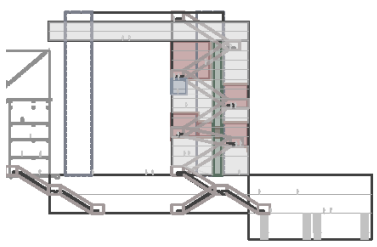


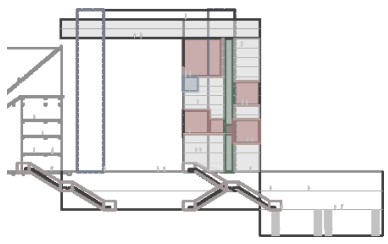


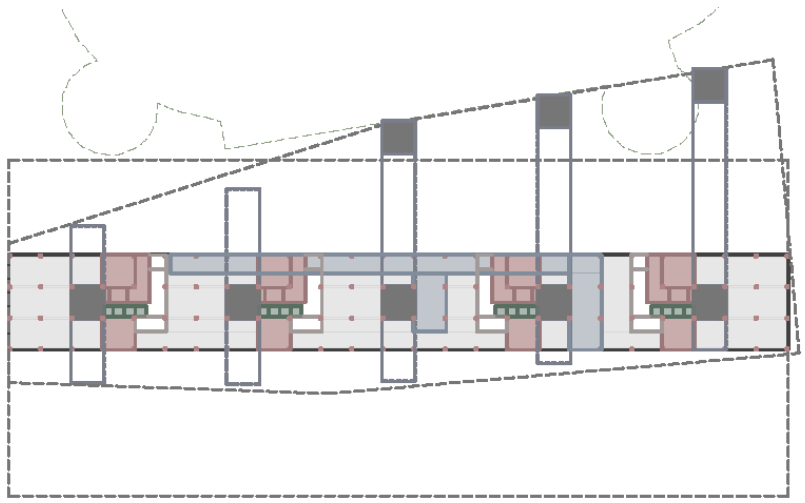
CASE 2

Frame + beam supported by an arch
= isolated functional volumes +
solid vertical circulation

The second equation takes from case 1 the organization of the architectural typologies, the structural solution used, the compact system of vertical circulation. The main difference stays in the structural solution used for the plateau on top. Here a structural archway, one for every vertical circulation block, is chosen as the best structural solution. This is supported by the nucleus containing the vertical circulation and the emergency stairs – inside the building – and by a second nucleus external to the construction. This arch, conducted outside the perimeter of the building and outside its volume, unfolds new relations with the subterranean plateau, the square and the stadium. This volumes is a faster and private way to reach the private layers, nevertheless it is useful to connect square_subsoil_top plateau. Here the arch creates a new relationship







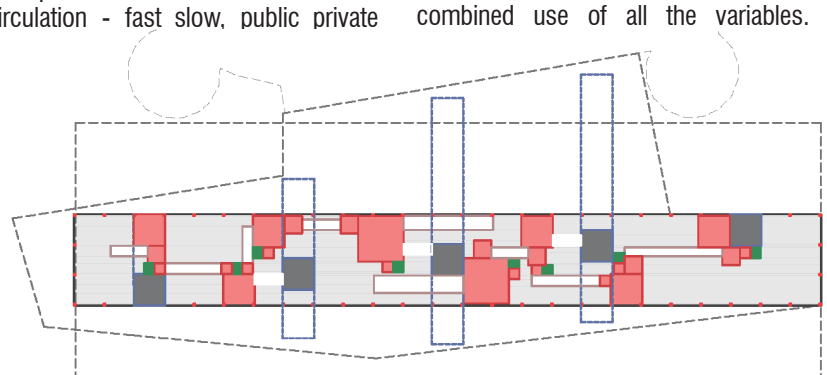
CASE 3

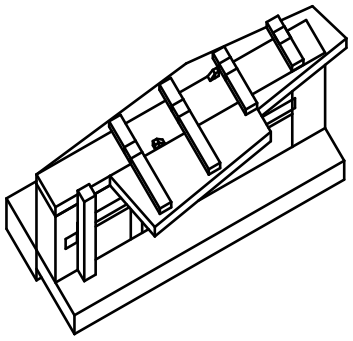
Structural skin + cantilevered beam
= composite functional volumes +
diffused vertical circulation

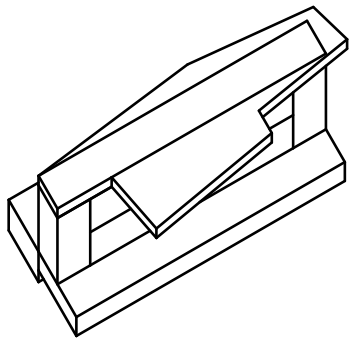
This case displays an important difference if we compare it to the others: the structure is placed on the perimeter. As already mentioned, the choice of every element of the equation triggers severe implications during the architectural phase. The organizational change of the architectural typologies is a consequence of the structural changes.

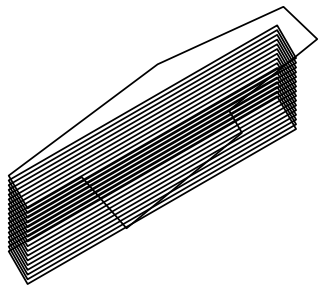
In case 3, the volumes contained in the typologies are moving on a staff, spaced out by the vertical circulation blocks and the paths - moving, freely as the music does, inside the section, giving place to backgrounds, rhythms and to a global harmony. The breakdown of private routes into fast vertical circulation - fast slow, public private – offers a set of variables (private_fast; private_slow; public_fast; public_slow) that displays to the designer as musical notes. The ganglions are the grafts where the urban articulation becomes more fluid and functional.

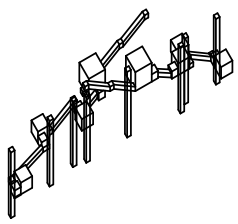
The relationship roof plateau_subsoil changes. The public slow routes are two, each beginning at the ending of the building and moving with an ascendent movement towards the centre. They reach the top of the building only when they interlace each others. This contact point offers a precious crossing occasion that instantaneously connects al the energy lines of the building: vertical, horizontal, diagonal. In this solution the slabs can be more easily shaped and carved. Among these five cases, case 3 displays a richness of composition solutions, offering the combined use of all the variables.

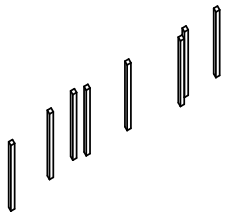


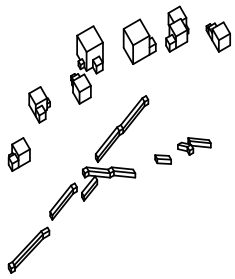


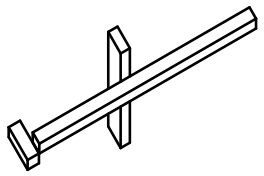


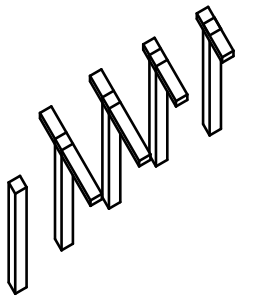












A TYPOLOGICAL RESEARCH.

A reflection on the path

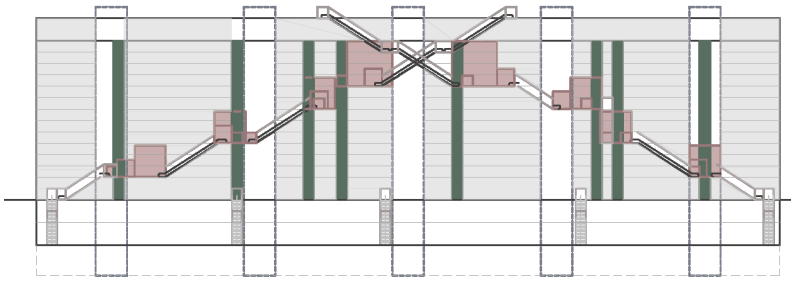
Margarita Petrova, Marta Scaccabarozzi

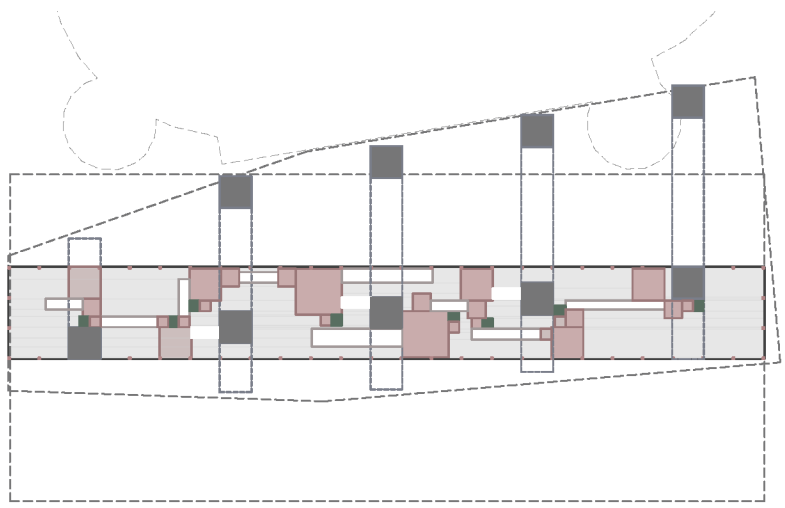
The workshop "The Art of Building cities" - having place inside the course Athens/2016 – has been an occasion to test the synergy, during the conceptual phase, between different research fields. In particular, during the workshop the spotlight has been placed on the relation between architecture and engineering: a partnership that – starting from the necessities of both disciplines – gives harmony to the design. This was the initial proposal when we started studying and analysing Federico's thesis – focused on urban epicentres. Urban perspectives have also been tackled, since such a big scale project can't only deal with architectural aspects. The first issue we faced was the deep comprehension of the main topics involved in the thesis. The research based on a fixed program, taking into account: horizontal circulation, the various scales of velocity of the connections with Valencia, and vertical circulation – which characterise the building itself and the block it defines. In order that the project could work as urban epicentre, the design has to be originated by its own connections. A basic knowledge and use of Grasshopper – as a useful device for parametric design – allowed to modify the structure in order to display numerous layouts and dimensions of the structure. The structural grid, defined by engineers, together with parametric design lead to the selection of five case studies dealing with urban epicentres. Four of them are defined by the same structural grid, the difference stays in the vertical circulation layout - which is slightly but significantly changing. The connection's nucleus – hosting stairs and elevators – are arranged according to a layout that follows the structural grid and gives it stiffness [case 01]; organized as if they were the musical notes on a pentagram [case 02]; doubled following the previous schemes, safeguarding stability and a better circulation of the users. The fifth case was supposed to be realised according to a triangular grid: the structural intersection points would have supported most of the weight – this would have guaranteed more freedom during the design. The schemes - supporting the design – allowed the synthesis of a complex work: this enabled the project to be presented to an audience not aware of these thematics. Starting from the given set of constrains, the groups of students started reasoning on different topics – arrangement, organization and connection – having in mind the goal of the workshop: designing an urban epicentre. The limited amount of time – a week – must be considered for the conception of an architectural_urban project. The support and guidance of Prof. Ernesto d'Alfonso have been crucial: first during the morph-typological research – both regarding urban and architectural design; afterwards to deepen the knowledge of the case studies and, at last, for his precious contribution during the design exercise.

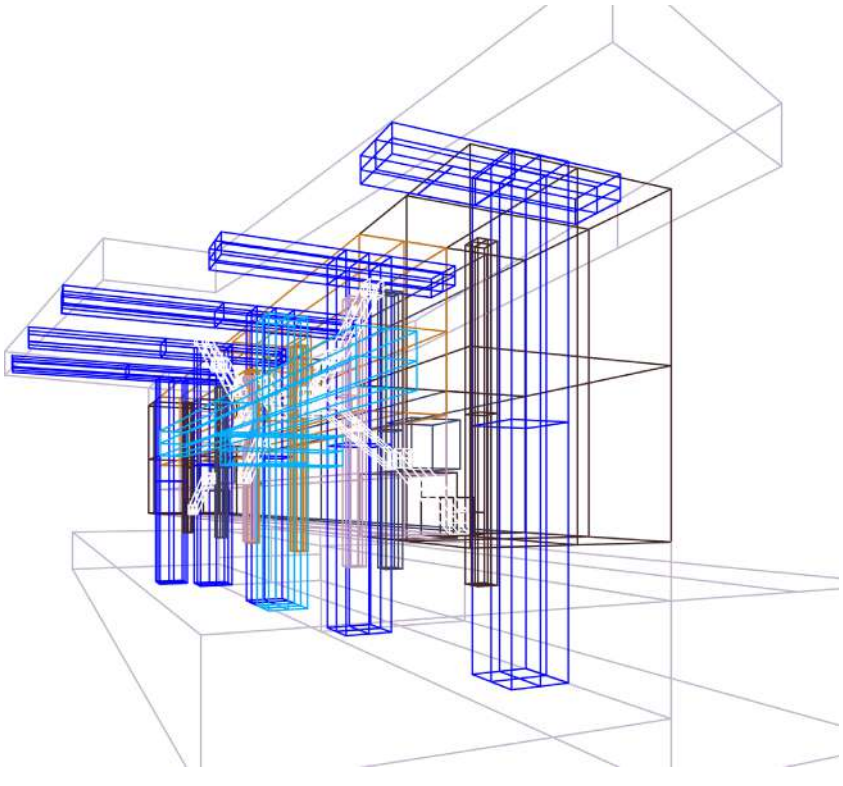
CASE 4

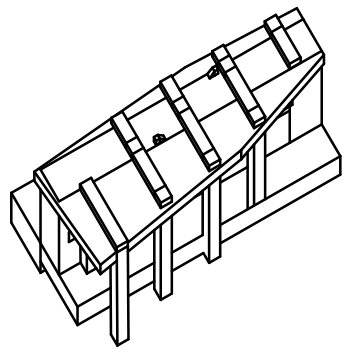
Structural skin + beam supported by an arch = composite functional volumes + diffused vertical circulation

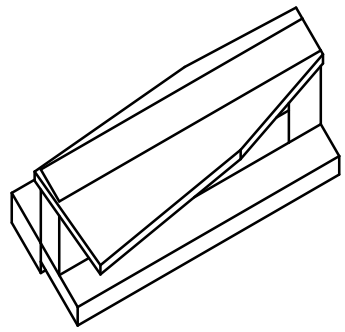
Case 4 comes from a mixture of the mentioned cases. In this solution the paths are enhanced: together with the transversal crossing of the building here we have fast vertical circulation, located in the external structural volumes.

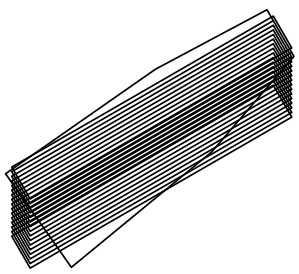


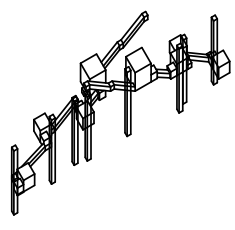


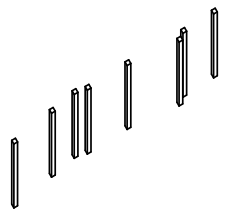


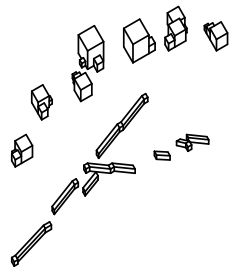


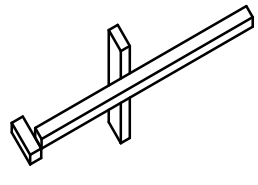


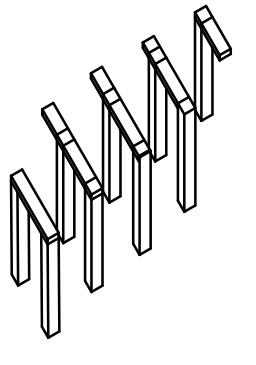












Workshop program

POLI9. Politecnico di Milano the ATHENS programme Nov 14th-18st 2016

THE ART OF URBAN COMPOSITION INTENSIVE COURSE

The Art of Building Cities: Planning a city in the XXI century: architecture/engineering in a project of urban epicenters at a contemporary city scale.

professors responsible:
Ernesto d'Alfonso, Claudio Chesi, Lorenzo Degli Esposti, Valentina Sumini

participating professors and researchers:
Greta Andreoni, Davide Borsa, Claudia Consonni, Damiano Flisi, Michela Florio, Federico Marani, Marco Morselli, Margarita Petrova, Marta Scaccabarozzi.

course location:
PhD room

course content:
1. The problem of time in the living style of citizens in XXI century. Zeroing the time by webnet and consumption of time in daily actions. The principle of temporal equivalence between different kinds of transportation or equivalent temporal proximity.
The principle of equal time proximity as a multi-scale rule of megalopolis and regional net-city. The interlacement of nets and the complexity of poles. XXI century urban bodies: Megaforms, Urban Morphotypes, Hybrid Buildings, Heterotopias.

2. "Spontaneous" phenomenon of transformations of cities or Contemporary Growing and Shrinking Contexts

3. Structuring processes of "spontaneous" transformation: web communication nets interweaved with transportation nets.

4. Integration epicentres of urban formations at contemporary scale. Development process in the contemporary city: a, spontaneous urban sprawling; b, communications / transportation nets development; c, installation of few cores that organise and integrate the ensemble.

5. Examples of London, New York, Beijing in the first decade of the new millennium which define the character of urban epicentres.

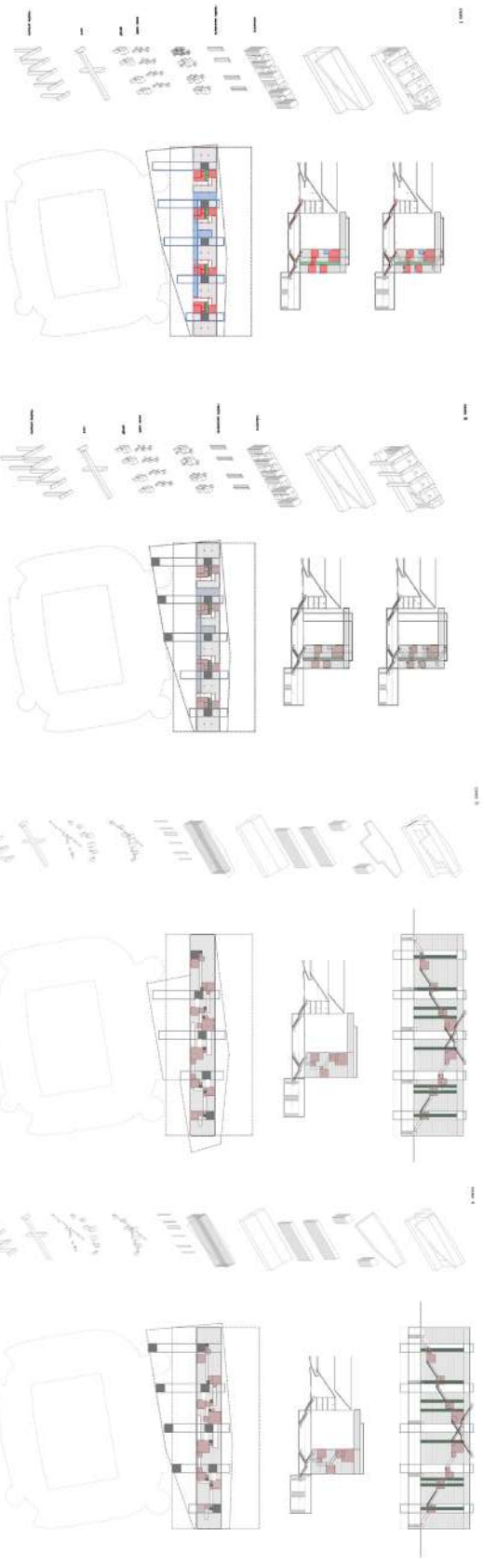
6. Static constraints and architecture of engineers.

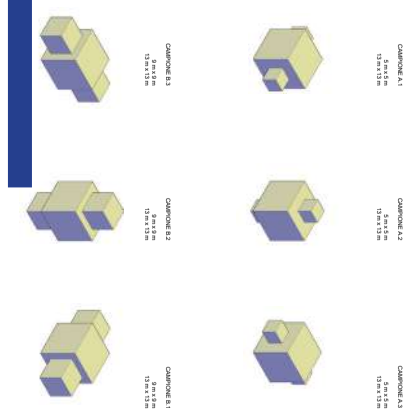
7. Hybrid integration operated by urban morphological paradigms inserted into (miniaturized) the new typologies (urban epicentres) to determine the efficient interaction (hybridation) between more differentiated typologies condensed together.

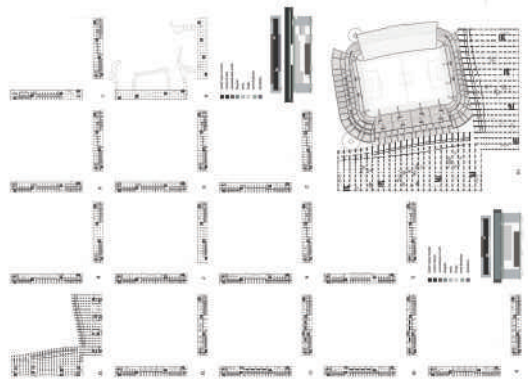
8. Amplitude of architectural freedom permitted by static constraints in multiple options of static setting.

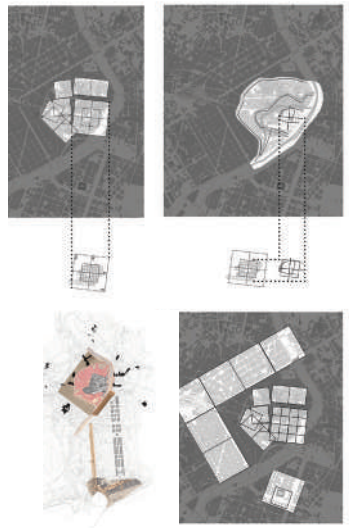
course calendar:
Monday, nov 14th 2016 (room B2.1.11, via Candiani)
morning 9:00/11:00
Introduction and guide lines of the course
prof. d'Alfonso, prof. Degli-Esposti
CLASS 1: Landmark, Groundmark, Timemark: Interior Landscapes and Static
Choice. Prof. d'Alfonso
morning 11:00/13:00
CLASS 2: City – Building – Function - Syntax. Prof. Degli-Esposti
lunch break
afternoon 14:00/15:30
CLASS 3: Functional Program and Composition of Volumes,
Distribution, Circulation, Fire Escapes
Teaching Staff
afternoon 15:30/19:00
ATELIER: Team constitution, case study assignment and teamwork
Definition of design proceeding phases.
Tuesday, Mar 15th 2014 (room B2.1.11, via Candiani)
morning 9:00/11:00
CLASS 4: Primacy of static setting in fundamental architectural choice.
Prof. Chesi
morning 11:00/13:00
ATELIER: Teamwork
lunch break
afternoon 14:00/15:00
CLASS 5: Lecture via Skype
Prof. Sumini
afternoon 15:00/19:00
ATELIER: Teamwork
Wednesday, Nov 16th 2016 (room B6.2.4, via Candiani)
morning 9:00/10:00
CLASS 6: Envelope design: façades, roof design
Teaching Staff
morning 10:00/13:00
ATELIER: Teamwork
lunch break
afternoon 14:00/17:00
ATELIER: Teamwork
afternoon 17:00/19:00
ATELIER: Intermediate Review (with public PowerPoint presentation of the works)
Thursday, Nov 17th 2016 (room CS09, via Cosenz)
all-day 9:00/19.00
ATELIER: Teamwork
Friday, Nov 18st 2016 (room B2.1.13, via Candiani)
morning 9:00/13:00
ATELIER: Teamwork
lunch break
afternoon 14:00/17:00
ATELIER: Final Review (with public PowerPoint presentation of the works)
Evaluation of the Programme

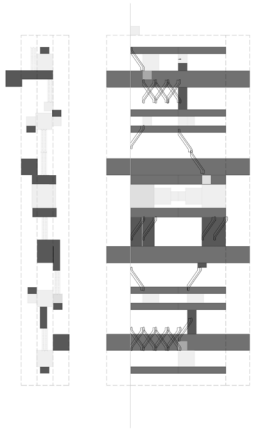
Workshop inputs

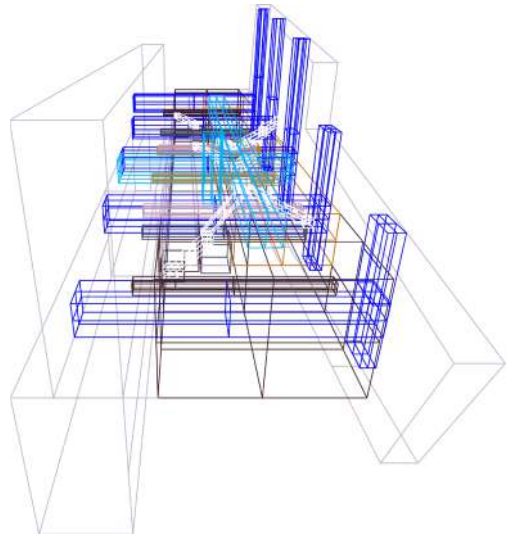


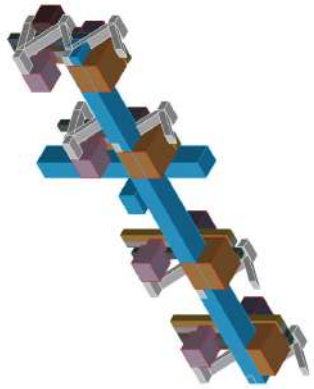


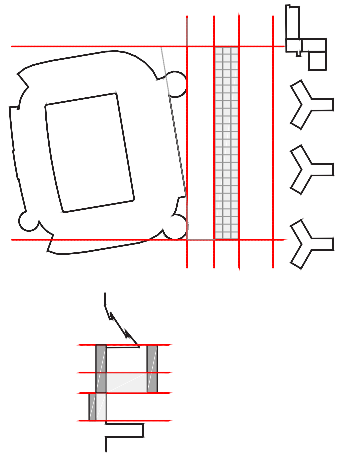


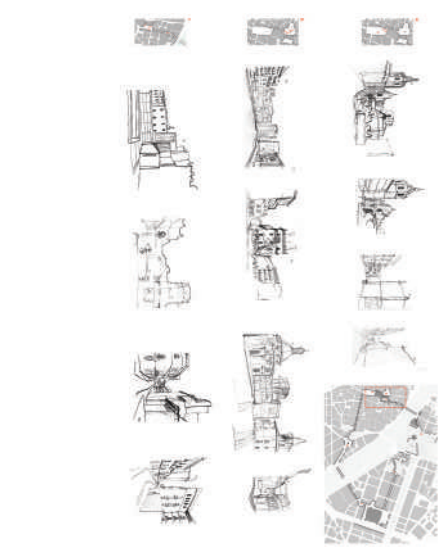


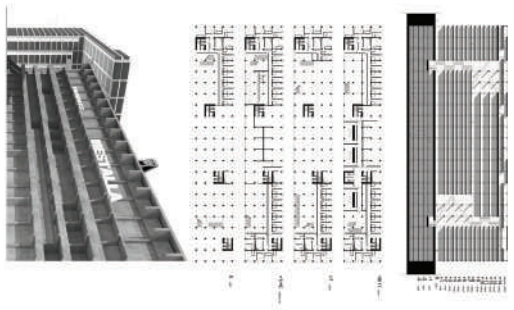












Lecture 14.11.16
PROF. ARCH. ERNESTO D'ALFONSO

IDEAS FOR THE 2016 WORKSHOP.

Ernesto d'Alfonso

Introducing the course on the art of building a city, during an academic year in which we perceived the necessity of examining in depth the technical aspects of the method. The discussed topic – the epicentre that constitutes the point of arrival of the fluxes space – indeed is contemplated by the citizens provided with sophisticated computer devices, for a planning of their time that requires a captivating implication which qualifies it as a 'reflexive individual'. The awareness of being in circumstances demanding for a deeper knowledge of the self, is today inadequate. As a result, the phenomena of structural transformation of the city we are witnessing - abandon, denial, urban sprawl - are a perceived as temporal disorientation, a sort of incongruence between space and time – happening simultaneously towards the past – traditions - and the future - ignored innovations. This goes together with the intuition – frequently unconscious – that the urban paradigm is inadequate compared with the potentialities that every individual could develop. A reflection is required on the relation – set in the inhabited spaces - between the spiritual time and urban time. In this sense we can also observe a changing in the relation between subject and world.

1. In the unscrupulous use of the inner self and of the body.
2. In the spectacularization of everyday life.
3. In the way world geography is unfolded – according to the mentioned spectularization.
4. In the unexplored confrontation between the life styles, the way of knowledge_communication of the different regions.

This process is assisted by mobile phones, computers and all the new functions undertaken by televisions.
In this sense there's an increment of gathering opportunities – both work and leisure related. This increases also the uses of the scheduling activity - that calibrates the relation between inner time and world time. Starting from the schedule time that dictates the tasks of everyday life, the moment has come for an internal loading in order to be punctual at the meetings: this triggers the theme of fluxes' space. The interlacing of these complexes times can be considered: the so called real time. Time for communication nets, meaning time for phone communication, social media communication – time for instant participation to events happening in every part of the world or times of immediate sharing of our participation to a certain event, time for online connection, just in time. This process activates a zeroing of time between here and all the places that are connected - in every direction – in a intimate and instant proximity through the telematic device: his screen, his power of reception_projection of the time between east and west which produces a spectacularization of living hours.
This counterposes to the travelling and displacing time, approaching time that entails proximity with everything that has always been inaccessible through transportation nets. Meeting spaces with elsewhere places and with other spaces – that behave in a completely unknown manner, even though they preserve the same rules of the 'fluxes space'. The weaving of these spaces is summarised in the principle of equivalent proximity – topic that has to be taken into account in the field of urban design. This is particularly true while considering the existential relationship between humans biography and urban biography, key research fields of urban design – both regarding townscapes and landscapes. Considering what has just been said there's a need to contemplate the relation between existential behaviour style [a] and urban transformation style [b].

[a] existential behaviour style – nowadays
- The city of fluxes / meetings' style
- Global / local
- Earth_continents_regions_cities_neighbourhood
- The multiscalarity of the local - for itself and in the global overview

[b] urban transformation style - nowadays (critic modernity, XXI century)
- Spontaneous forms of growth: sprawl
- Half-planned forms of growth: telematic networks
- Planned forms of growth: transportation nets
- Public space forms: remarkable places_urban epicentres_public gardens

The latter constitutes a fundamental architectural topic regarding modern cities as urban epicentres, the multiscalar and multifunctional megaform that is set as an attractor in the competition between cities - destination of the fluxes_virtual/global meeting. Here is where the topic of the workshop comes from: the epicentre set in a dismissed urban area included in a middle sized city – for example a football field. Question: what is the place of this virtual - or even scheduled – meeting, which as epicentre of spectacular and public life tends to become outdated when it comes to the telematic city? The ancient football field, which – being place able to host dozens of thousands of people every week – has an elevate urban accessibility. Is it worth it to demolish it to substitute the stadium with residential buildings – in order to get back the real estate capital from an exclusively financial point of view? This is where the topic comes from. A case faced by the Architect Federico Marani, in 2016, was the exaltation of the Messalla Stadium in Valencia – Spain, as operation of multiscalar enhancement of an existing building - a stadium - to a multifunctional epicentre: the sport arena equipped as pluri-spectacular field; a vast hanging surface that overlooks the bleachers belonging to a special residence. This hosts an extensive garden supplied with receptive functions (cafe, restaurants...) The structure is constituted by a hanging structure supported by elevator blocks that distribute also the main buildings – other multifunctional containers; a broad gallery that introduces the visitors to every side of the arena or of the other multifunctional buildings; in the basement – that runs lengthwise to the gallery – under the highway, the AVE station and the underground. The topic required to the student to face, during a five days workshop, a large scale definition of the building type from an architectural point of view. At the same time a structural project was compulsory to be started. Nowadays the structural intuition plays a core role in the expressive originality of architectural design.

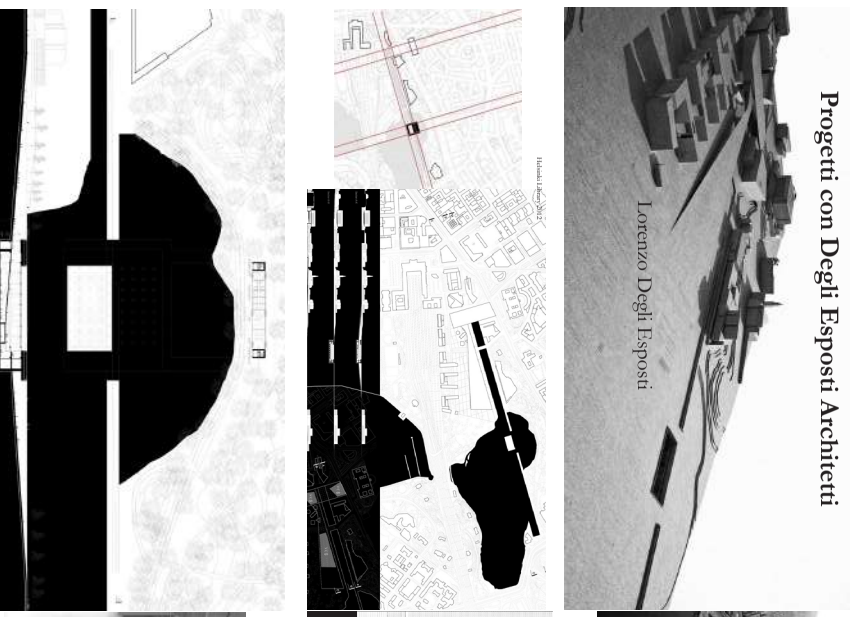
A THEORICAL CLARIFICATION : drawing on the panel and on the screen

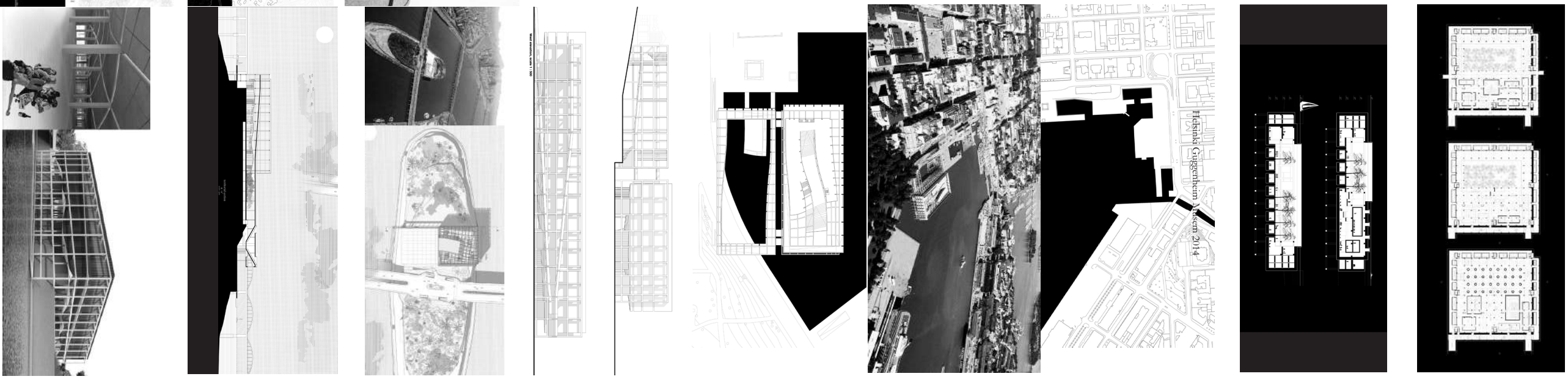
Ernesto d'Alfonso

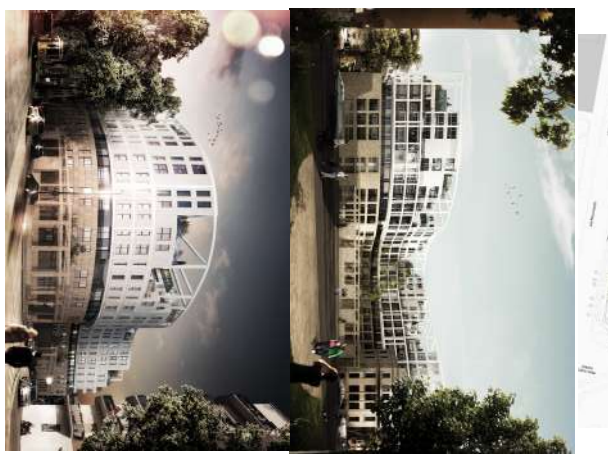
A further investigation on the main tool is needed: the drawing paper and the role of the computer screen, supported by sophisticated design softwares. Shaping forms in the unworldly. Shaping the enclosed space only accessible by the building technology. [see the papers from Prof. Claudio Chesi]The difference between space and 'surrounding environment' as a sector to unfold. Space is a concept, the surrounding environment is a fact. Space is explored as the open that doesn't obstacle neither the sight nor the displacement of bodies – as it is invisible matter between bodies we call it transparent. The body's space that stays the same while moving and captures sectors of open space space during its movement, hasn't the characteristic of transparency, we call it tectonic. Supposing that its microscopic parcels are hold together in a complete proximity that implies an internal attractive force, that makes them lasting and indivisible. The space we mean – not the open space used by the form of the moving body while moving – has an internal tension that fights the forces who assault him. In order to destroy this internal tension, in example the one of another moving body that crushes into its trajectory, displays another manner of being a space. Both these two spaces are considered during the architectural design process. This process actually only shapes the transparent space, as typical of the constituted bodies. Indeed, since the design process, takes advantage of the drawing sheet (a surface) to display shape's figures in the drawing, what is sketched on the sheet's surface, that has no thickness, it's only what unfolds the non transparent space, the tectonics: architecturally-wise the "space in between" - this was the meaning of the latin word spatium, meaning separation between bodies, walls or columns. This long digression enables to go back to the drawing paper – and the screen – as surface that shows a spatial concept in the manner that accesses to the world's experience, the visual experience. According to the visual experience space is transparent and transparency permits to encounter the bodies, only from far, and having knowledge of the space only as the element that lies in between the bodies. The drawing paper displays this fact recalling a spatial concept that confers to the transparency its virtual reality of null thickness – that equals infinite: the concept of spatial-temporality – the possibility of crossing - of that thickness. Given these facts, as architects, we can't be satisfied from studying, modelling, measuring the transparent, the open space we consider inhabitable. We have to acknowledge the specific nature of the enclosed space. This annotation witnesses the necessity of a deeper knowledge about something that became inexplicably separated from architecture: building construction and the related technologies – nowadays these terms belong only to engineering.The mentioned knowledge - in a period in which computer_softwares gives us the possibility of using advanced mathematics able to penetrate the infinitesimal - becomes essential. That's why we conceived this workshop, as a stirring for ourselves through the passion of our students, to examine in depth architectural sciences.

Lecture 14.11.16

ARCH. PHD. LORENZO DEGLI ESPOSTI







Lecture 15.11.16

PROF. ENG. CLAUDIO CHESI

The problem of conceiving a structural scheme in the design process: a task for architects or for engineers ?

“Structure”: the system to provide resistance towards all actions due to the interaction with the surrounding environment.

→ First of all: gravity loads

The purpose of the structural scheme: providing structural loads with a path from their origin to the restraint system.

In the following:

1. Modalities for load propagation: the bending mechanism
2. Structural solutions: cross section shape, from beam to truss
3. The problem of defining suitable dimensions
4. Defining structural loads – chosing the structural material
5. Solutions to the specific design problem
6. Examples of similar problems int he literature

Il trasferimento del carico:
i meccanismi fondamentali di propagazione delle forze attraverso gli elementi strutturali dal punto di applicazione della forza al sistema di contrasto
(→ i meccanismi fondamentali di “funzionamento” delle strutture)

Si presenta una serie di casi, differenti per complessità della situazione e per impegno del materiale.

Caso 1 - La situazione:

La forza F, applicata in A, deve essere trasmessa in B. Il verso della forza punta da A verso B.

E’ il caso della **compressione**: l’elemento strutturale rettilineo disposto fra A e B è “schiacciato” dalla forza F e dalla forza reattiva – F (in B). Si parla di **puntone**.

Caso 2 - La situazione:

È quella del caso precedente, con la differenza che F non punta verso la sua destinazione (B), ma dalla parte opposta.

E’ il caso della **trazione**: l’elemento strutturale rettilineo disposto fra A e B è “stirato” dalle forze F e – F. Si parla di **tirante**.

OSSERVAZIONE:

I due casi, apparentemente molto simili, danno luogo ad un impegno molto diverso del materiale:

• nel caso della compressione le forze in gioco hanno la tendenza ad “aggregare” il materiale. Tutti i materiali sono adatti a questo scopo: pietra, muratura, legno, acciaio, calcestruzzo, …

• nel caso della trazione la trasmissione del carico attraverso l’elemento strutturale tende a “disgregare” il materiale; solo alcuni materiali (resistenti a trazione) sono adatti allo scopo: legno, acciaio, …

Si presenta quindi spontaneamente una prima **classificazione dei materiali** dal punto di vista dell’impiego a scopi strutturali:

- materiali resistenti principalmente a compressione,
- materiali resistenti indifferentemente a trazione e compressione (materiali a *comportamento simmetrico*)

Caso 3 - La situazione:

La forza F, applicata in A, deve essere trasferita ai punti B e C.

E’ possibile sagomare un elemento strutturale curvilineo che trasferisce il carico da A a B e C per **sola compressione**. Questo elemento strutturale è un **arco**.

A è la **chiave** dell’arco;

B e C sono le **imposte** dell’arco.

NOTA: la sagoma curvilinea dell’arco è determinata da F e anche dal peso degli elementi che compongono l’arco.

Il peso dei conci dell’arco fa sì che, scendendo verso le imposte, **la spinta tende a raddrizzarsi** (dalla combinazione di S_1 e P_2 nasce S_2, che è più inclinata di S_1)

Caso 3-bis - La situazione:

È la stessa del caso precedente, ma speculare rispetto ad una linea orizzontale.

L’elemento strutturale è una **fune** ed è impegnato a **trazione**.

In entrambi i casi dell’arco e della fune il metodo grafico del **poligono funicolare** consente di individuare la linea d’asse dell’elemento strutturale in modo che sia soggetto a sola compressione (arco) o trazione (fune).

NOTA: nel caso dell’arco il percorso del carico comporta **una deviazione di 90°** rispetto alla direzione della forza F.

NOTA: Le forze di reazione alle imposte dell’arco possono avere una direzione diversa dalla verticale e presentare quindi due componenti orizzontali uguali e contrarie. Si dice che l’arco “spinge”alle imposte.

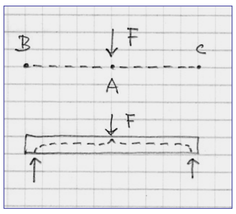
La predisposizione di un tirante (una **catena**) teso fra le imposte dell’arco consente di assorbire le spinte orizzontali e trasferire al sistema di contrasto solo forze verticali.

Caso 4 - La situazione:

La forza F, applicata in A, deve essere trasmessa ai punti B e C.

Il percorso del carico comporta **una doppia deviazione di 90°**: la prima in A, la seconda nei punti di appoggio, B e C.

E’ il caso della **flessione**: l’elemento strutturale (la “trave”) è disposto perpendicolarmente alla direzione della forza.



La teoria della flessione mostra che **la trave inflessa è soggetta simultaneamente a trazione e a compressione**.

Appare quindi chiara la distinzione fra travi:

• in legno o acciaio → materiali ideali per la flessione
• in pietra → solo travi “tozze”
• in calcestruzzo armato → presenza di barre d’acciaio dove si localizza la trazi

Caso 5 - La situazione:

La trasmissione del carico, che genera trazione nelle tre piastre, avviene anche attraverso il perno di sezione circolare: all’interfaccia delle piastre il carico viene trasferito per intero dal perno.

La sezione del perno è interessata da due forze ad essa parallele. La sollecitazione è di **taglio**.

NOTA: se le piastre si allontanano, il perno continua ad essere sollecitato a taglio, ma è soggetto anche a flessione.

QUINDI: la trave inflessa è comunemente soggetta anche a taglio.

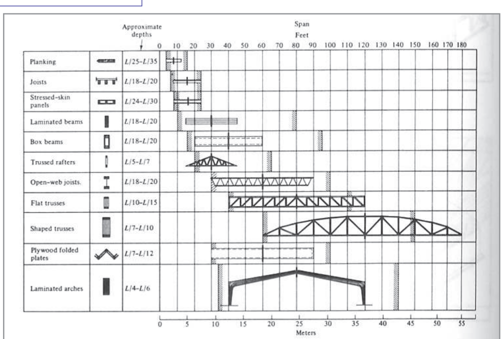


FIGURE 15-3 Approximate span ranges for timber systems. In order that typical sizes of different timber members can be relatively compared, the diagrams shown of the members are scaled to represent typical span lengths for each of the respective elements. The span lengths that are actually possible for each element are noted by the “maximum” and “minimum” span marks.

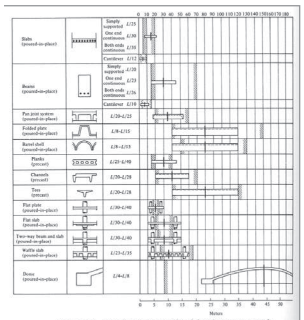


FIGURE 15-5 Approximate span ranges for reinforced concrete systems. In order that typical sizes of different members can be relatively compared, the diagrams shown of the members are scaled to represent typical span lengths for each of the respective elements. The span lengths that are actually possible for each element are noted by the “maximum” and “minimum” span marks.

part III / PRINCIPLES OF STRUCTURAL DESIGN

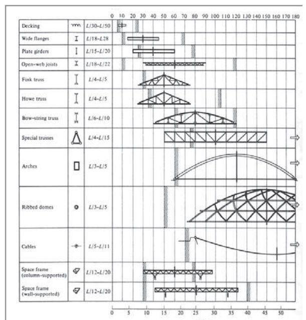


FIGURE 15-7 Approximate span ranges for steel systems. In order that typical sizes of different members can be relatively compared, the diagrams shown of the members are scaled to represent typical span lengths for each of the respective elements. The span lengths that are actually possible for each element are noted by the “maximum” and “minimum” span marks.

Mechanical characteristics for hot rolled steels

Caratteristiche meccaniche degli acciai impiegati per i prodotti laminati a caldo.				
(Riferimento normativo) Classe di acciaio	Spessore nominale dell’elemento t espresso in millimetri			
	$t \le 40$ mm		40 mm $< t \le 80$ mm	
	f_y [N/mm²]	f_u [N/mm²]	f_y [N/mm²]	f_u [N/mm²]
(UNI-EN 10025-2) S 235 S 275 S 355 S 450	235 275 355 440	360 430 510 550	215 255 335 410	360 410 470 550
(UNI-EN 10025-3) S 275 N/NL S 355 N/NL S 420 N/NL S 460 N/NL	275 355 420 460	390 490 520 540	255 335 390 430	370 470 520 540
(UNI-EN 10025-3) S 275 M/ML S 355 M/ML S 420 M/ML S 460 M/ML	275 355 420 460	370 470 520 540	255 335 390 430	360 450 500 530
(UNI-EN 10025-5) S 235 W S 355 W	235 355	360 510	215 335	340 490
(UNI-EN 10025-6) S 460 Q/QL/QL1	460	570	440	550

Parisi, Bernuzzi, and Chesi, 2011-12

Tabella 3.1.II - Valori dei carichi d’esercizio per le diverse categorie di edifici

Cat.	Ambienti	q_k [kN/m²]	Q_k [kN]	H_k [kN/m]
A	**Ambienti ad uso residenziale** Sono compresi in questa categoria i locali di abitazione e relativi servizi, gli alberghi. (ad esclusione delle aree suscettibili di affollamento)	2,00	2,00	1,00
B	**Uffici** Cat. B1 Uffici non aperti al pubblico Cat. B2 Uffici aperti al pubblico	2,00 3,00	2,00 2,00	1,00 1,00
C	**Ambienti suscettibili di affollamento** Cat. C1 Ospedali, ristoranti, caffè, banche, scuole Cat. C2 Balconi, ballatoi e scale comuni, sale convegni, cinema, teatri, chiese, tribune con posti fissi Cat. C3 Ambienti privi di ostacoli per il libero movimento delle persone, quali musei, sale per esposizioni, stazioni ferroviarie, sale da ballo, palestre, tribune libere, edifici per eventi pubblici, sale da concerto, palazzetti per lo sport e relative tribune	3,00 4,00 5,00	2,00 4,00 5,00	1,00 2,00 3,00
D	**Ambienti ad uso commerciale** Cat. D1 Negozi Cat. D2 Centri commerciali, mercati, grandi magazzini, librerie…	4,00 5,00	4,00 5,00	2,00 2,00
E	**Biblioteche, archivi, magazzini e ambienti ad uso industriale** Cat. E1 Biblioteche, archivi, magazzini, depositi, laboratori manifatturieri Cat. E2 Ambienti ad uso industriale, da valutarsi caso per caso	≥ 6,00 —	6,00 —	1,00* —
F-G	**Rimesse e parcheggi** Cat. F Rimesse e parcheggi per il transito di automezzi di peso a pieno carico fino a 30 kN Cat. G Rimesse e parcheggi per transito di automezzi di peso a pieno carico superiore a 30 kN: da valutarsi caso per caso	2,50 —	2 x 10,00 —	1,00** —
H	**Coperture e sottotetti** Cat. H1 Coperture e sottotetti accessibili per sola manutenzione Cat. H2 Coperture praticabili Cat. H3 Coperture speciali (impianti, eliporti, altri) da valutarsi caso per caso	0,50 secondo categoria di appartenenza —	1,20 —	1,00 —
*	non comprende le azioni orizzontali eventualmente esercitate dai materiali immagazzinati			
**	per i soli parapetti o partizioni nelle zone pedonali. Le azioni sulle barriere esercitate dagli automezzi dovranno essere valutate caso per caso			

3 AZIONI SULLE COSTRUZIONI

3.1 OPERE CIVILI E INDUSTRIALI

3.1.2 PESI PROPRI DEI MATERIALI STRUTTURALI

Per la determinazione dei pesi propri strutturali dei più comuni materiali possono essere assunti i valori dei pesi dell’unità di volume riportati nella Tab. 3.1.I

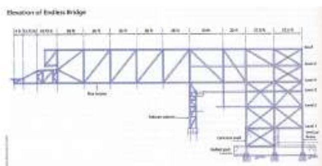
↓

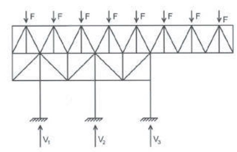
… da impiegare anche per il calcolo dei *carichi permanenti non strutturali*

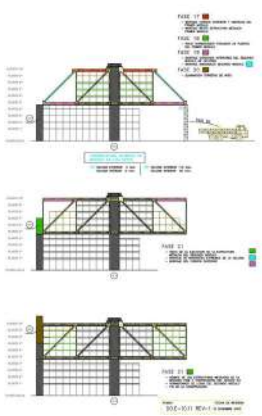
(tamponature esterne, divisori interni, massetti, isolamenti, pavimenti e rivestimenti del piano di calpestio, intonaci, controsoffitti, impianti …)

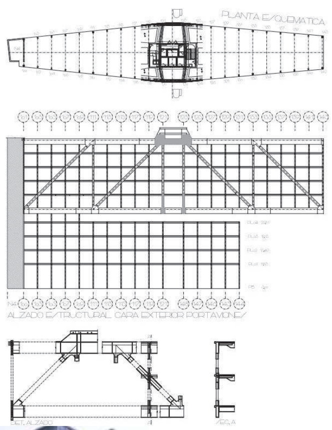
MATERIALI	PESO UNITÀ DI VOLUME [kN/m³]
Calcestruzzi cementizi e malte	
Calcestruzzo ordinario	24,0
Calcestruzzo armato (e/o precompresso)	25,0
Calcestruzzi “leggeri”: da determinarsi caso per caso	14,0 ÷ 20,0
Calcestruzzi “pesanti”: da determinarsi caso per caso	28,0 ÷ 50,0
Malta di calce	18,0
Malta di cemento	21,0
Calce in polvere	10,0
Cemento in polvere	14,0
Sabbia	17,0
Metalli e leghe	
Acciaio	78,5
Ghisa	72,5
Alluminio	27,0
Materiale lapideo	
Tufo vulcanico	17,0
Calcare compatto	26,0
Calcare tenero	22,0
Gesso	13,0
Granito	27,0
Laterizio (pieno)	18,0
Legnami	
Conifere e pioppo	4,0 ÷ 6,0
Latifoglie (escluso pioppo)	6,0 ÷ 8,0
Sostanze varie	
Acqua dolce (chiara)	9,81
Acqua di mare (chiara)	10,1
Carta	10,0
Vetro	25,0
Per materiali non compresi nella tabella si potrà far riferimento a specifiche indagini sperimentali o a normative di comprovata validità assumendo i valori nominali come valori caratteristici.	

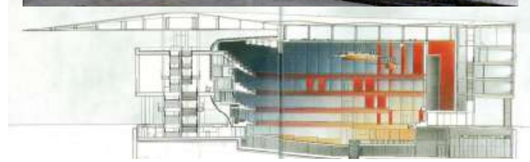
Tabella 3.1.I - *Pesi dell’unità di volume dei principali materiali strutturali*







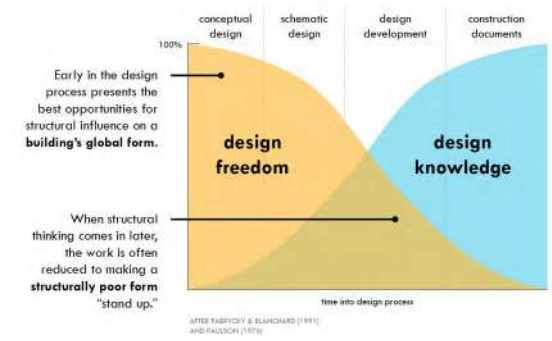




Lecture 15.11.16

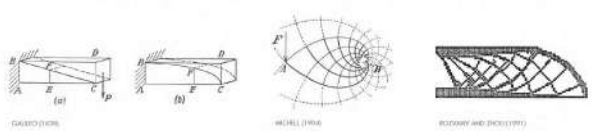
ARCH. PHD. VALENTINA SUMINI

Structural influence needs to occur early



How can we link geometry to performance?

(Classical) Structural Optimization moves beyond feedback …



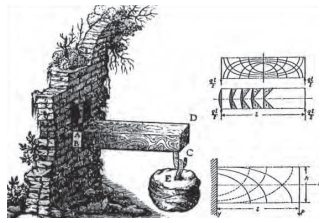
… but has had very **little impact in practice.**

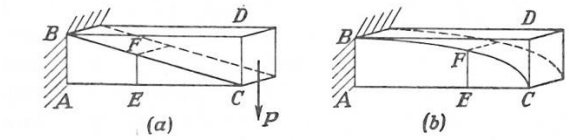
Galileo Galilei

The history of structural optimization can be traced back to **Galileo Galilei (1564 – 1642)**, who in 1638 determined the minimal-material shape of a cantilevered beam subjected to a point load at its free end.
(Timoshenko, 1953; Heyman, 1998)

By finding the **parabolic profile** Galileo showed that **mathematics can be used to find forms that use material as efficiently as possible to support a given load**.

For many years since, this has been the goal of structural optimization.





Drawings from Galileo's Dialogues Concerning Two New Sciences (1638), showing in (a) an incorrect linearly varying solution for the minimal-material shape of a cantilevered constant-width beam supporting a point load at its tip, along with (b), the correct parabolically varying solution (Timoshenko, 1953).

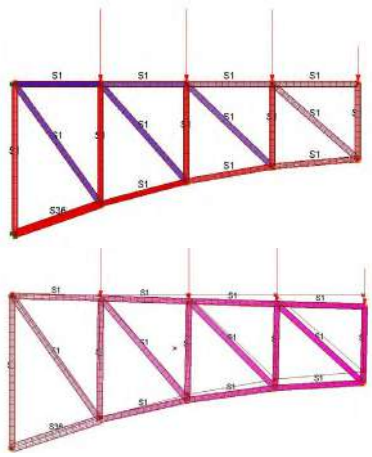
Case 1 : cantilever beam

MANUAL CALCULATION
Steel truss structure

Loads applied on the upper nodes [5500 kN and 2750 kN according to different tributary area]

Stress distribution and qualitative deformation

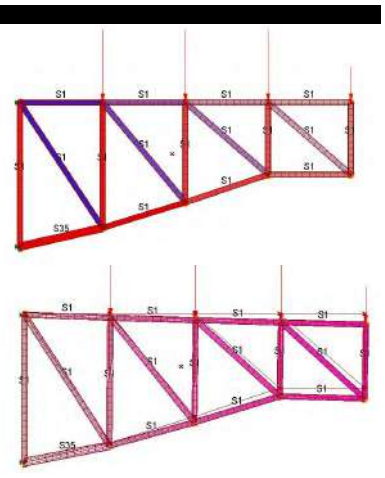
FINITE ELEMENT MODEL
Quantitative stress values
Detailed information about deflection
Max displacement: 6.67 cm



Case 1 : cantilever beam

OPTIMIZATION VARIABLES
Vertical coordinates of the nodes located in the bottom part of the truss

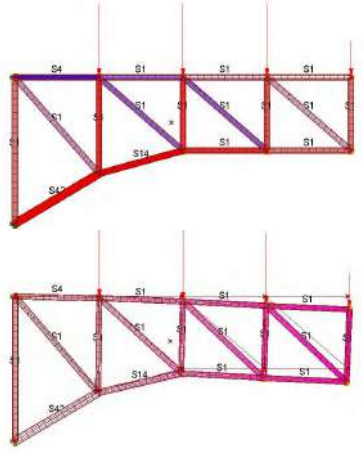
OPTIMIZATION OBJECTIVE
Minimizing the structural **volume**
Max displacement: 6.41 cm



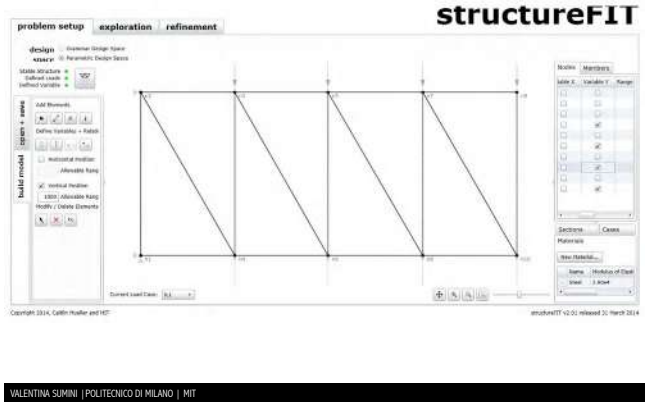
Case 1 : cantilever beam

OPTIMIZATION VARIABLES
Vertical coordinates of the nodes located in the bottom part of the truss

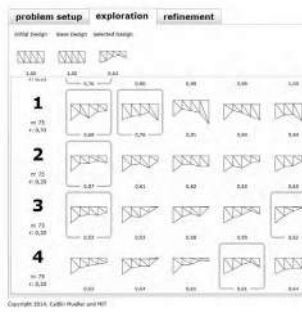
OPTIMIZATION OBJECTIVE
Minimizing the **displacement**
Max displacement: 8.65 cm



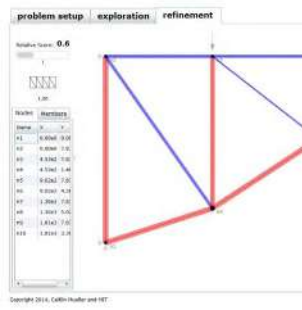
Case 1 : cantilever beam



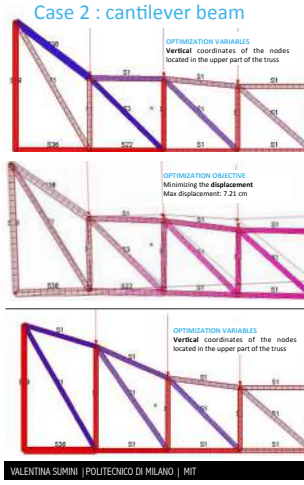
Case 1 : cantilever beam



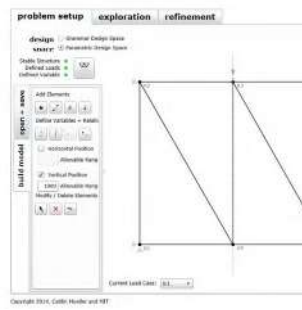
Case 1 : cantilever beam



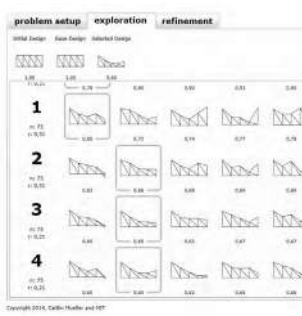
Case 2 : cantilever beam

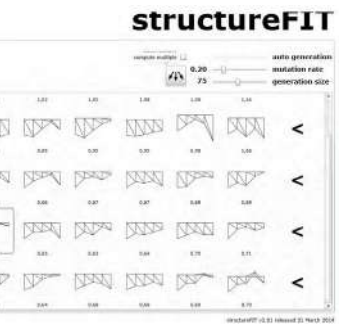


Case 2 : cantilever beam

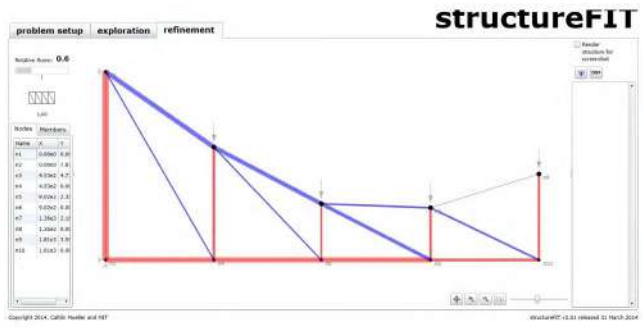


Case 2 : cantilever beam

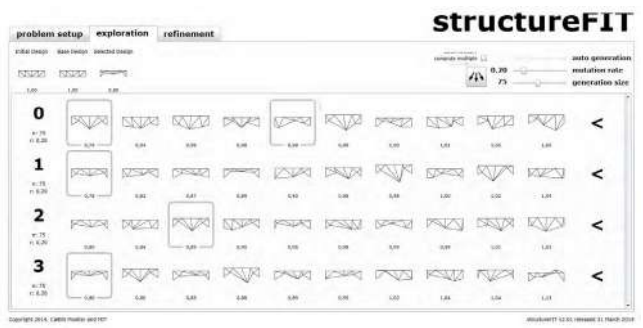


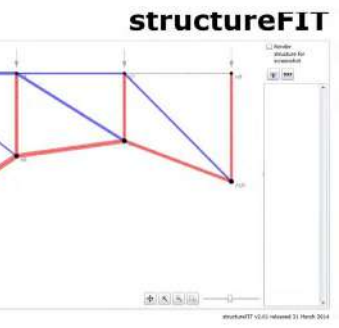


Case 2 : cantilever beam



Case 3 : portal beam





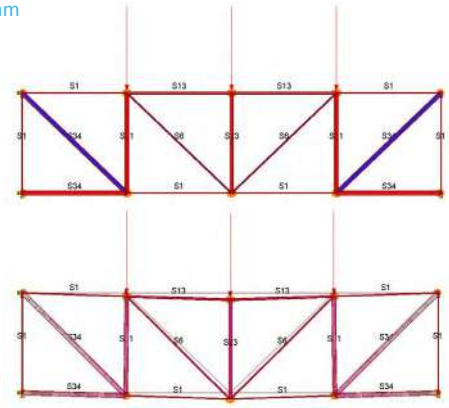
Case 3 : portal beam

MANUAL CALCULATION
Steel truss structure

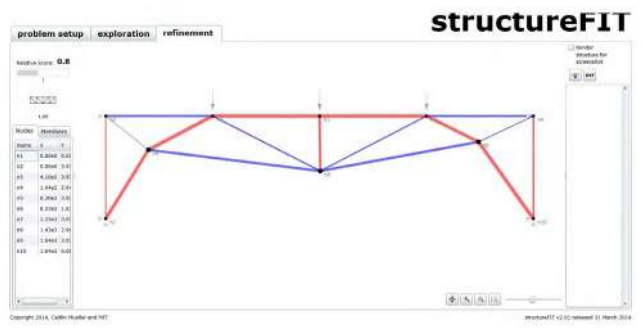
Loads applied on the top nodes [5000 kN according to tributary area]

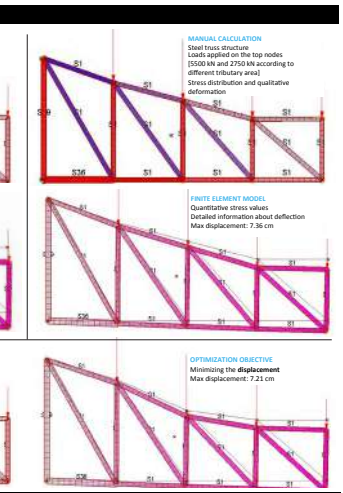
Stress distribution and qualitative deformation

FINITE ELEMENT MODEL
Quantitative stress values
Detailed information about deflection
Max displacement: 1.7 cm



Case 3 : portal beam

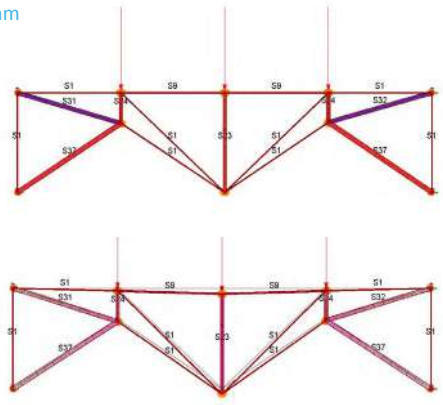




Case 3 : portal beam

OPTIMIZATION VARIABLES
Vertical coordinates of the nodes located in the bottom part of the truss

OPTIMIZATION OBJECTIVE
Minimizing the structural **volume**
Max displacement: 1.3 cm



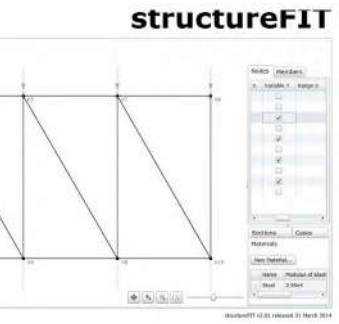
Conclusions

A population of possible design solutions for the 3 beams have been explored according to different optimization strategies and, therefore, different computational tools.

Case 1

Case 2

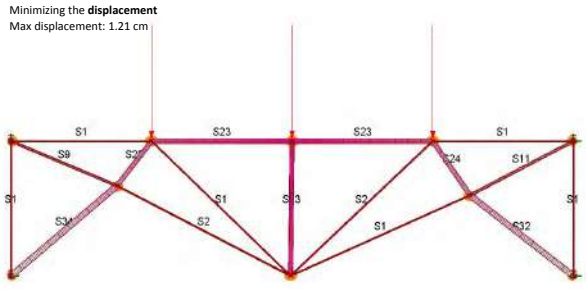
Case 3



Case 3 : portal beam

OPTIMIZATION VARIABLES
Vertical and **horizontal** coordinates of the nodes located in the bottom part of the truss

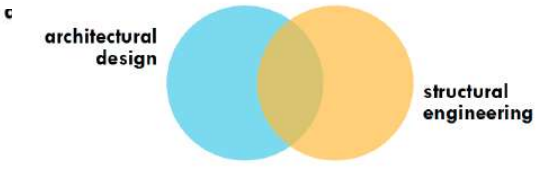
OPTIMIZATION OBJECTIVE
Minimizing the **displacement**
Max displacement: 1.21 cm



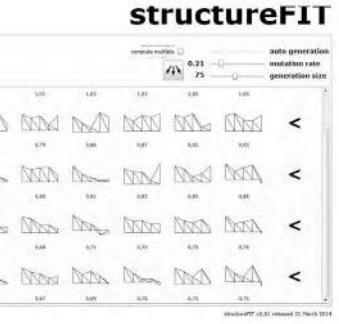
"The loftiest and most difficult problems arise in architecture from the need to realize a synthesis between opposing sets of factors: harmony of form and the requirements of technology, heat of inspiration and the coolness of scientific reason, freedom of imagination and the iron laws of economy."

— Pier Luigi Nervi in Structures, *1956*

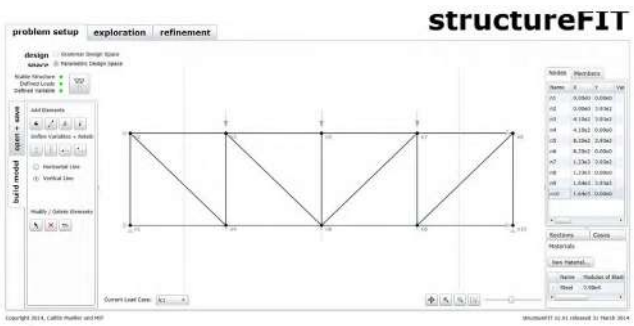
A variety of computational methods can help integrate structural performance into the early design process….



Thanks for your kind attention!



Case 3 : portal beam



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Politecnico di Torino & Politecnico di Milano

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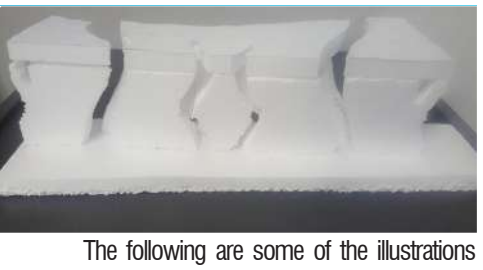
Postdoc Researcher at Politecnico di Milano
Dept. Architecture Built Environment and Construction Engineering
Development of operational guidelines for the evaluation of seismic vulnerability of existing structures

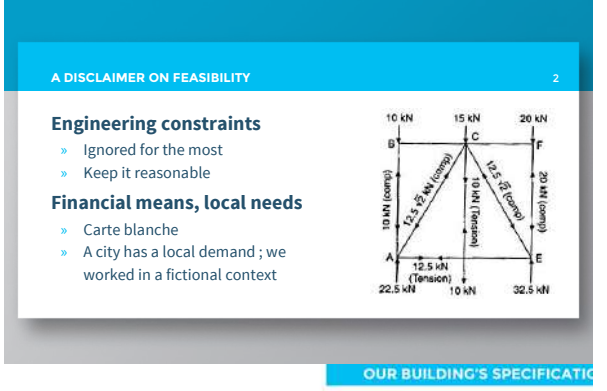
MIT Postdoctoral Fellowship
MIT - Massachussets Institute of Technology – Dept. of Civil and Environmental Engineering
Project title: Moon exploration habitats using 3D-printed in-situ resources

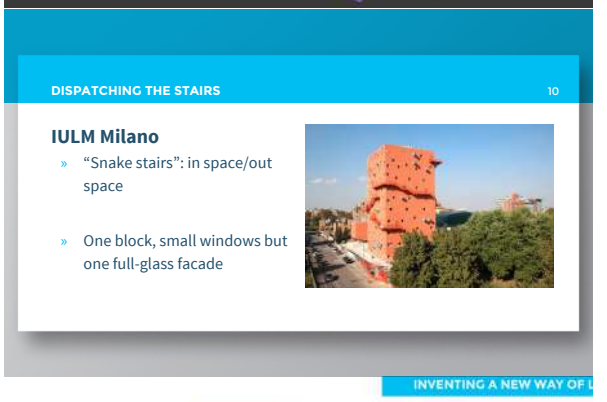
Mid-term review

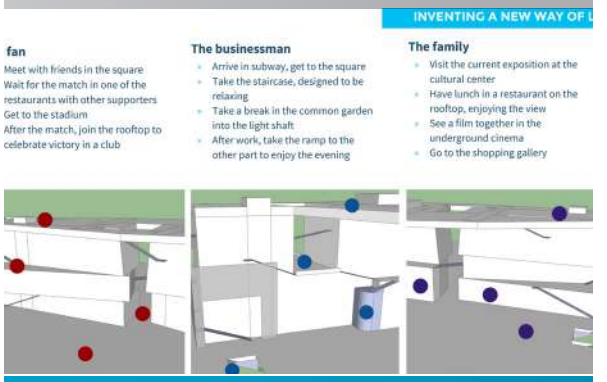
Annotation: At the end of the review, happened on the 15th of march, we decided to propose to the engineer a contribution about the shape_design. This is made starting from the concept of design that was less pertinent to the topic of the workshop: the design of the WAVE group, inspired by the Jean Cocteau Museum - designed by Ricciotti.

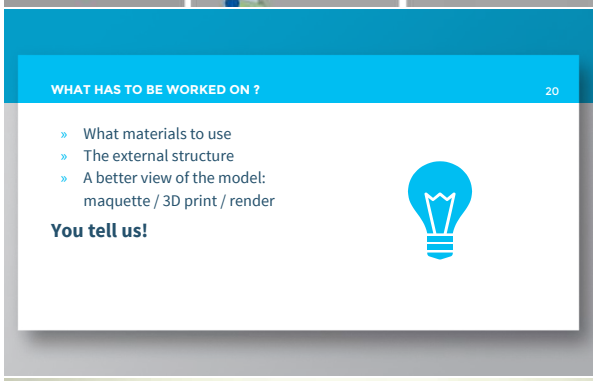


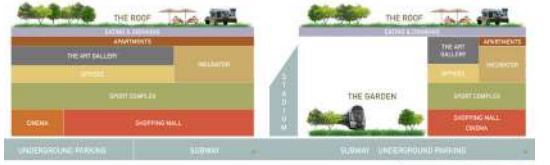
The following are some of the illustrations comprehended in the material presented by each group during the mid-term review.

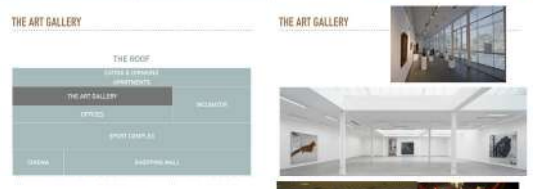


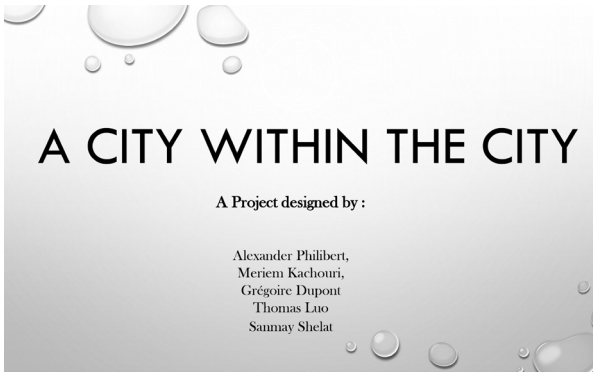


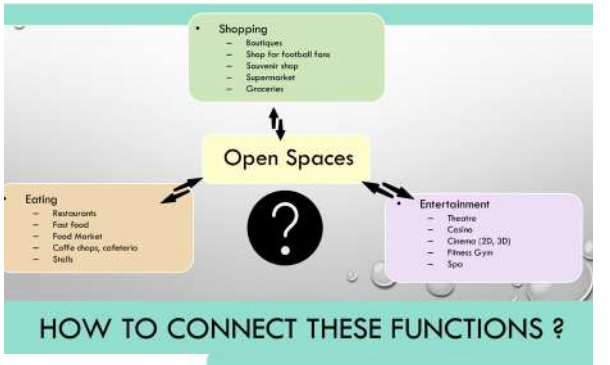


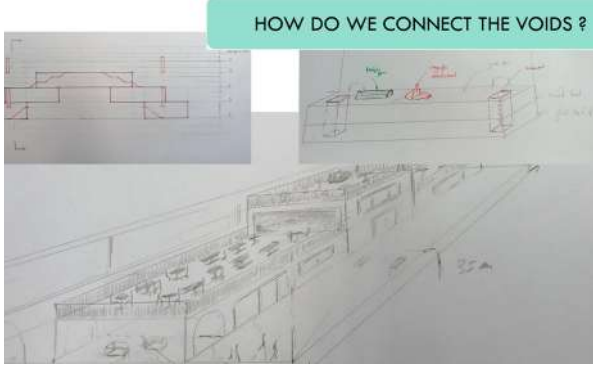








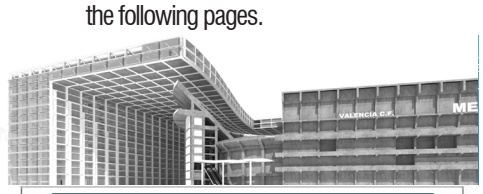


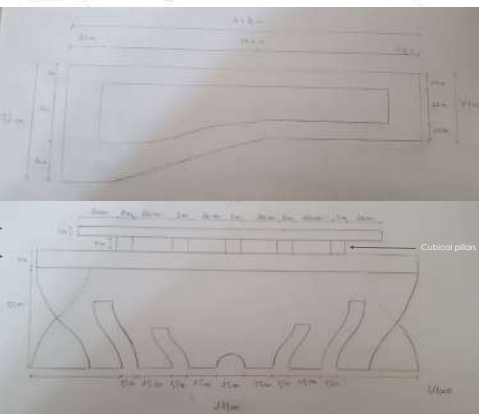


Engineer enrichment

FORM-FINDING PROCESS BY V. SUMINI

The integration between architectonic and structural form is essential inside such an expressive architectural research. Here comes the request made to the architect_ engineer: proposing her own methodology of form-finding. The answer can be found in the following pages.

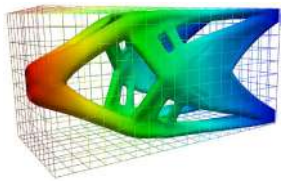


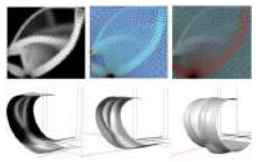


Form-finding process through topology optimization for Wave Project

Topology optimization could be defined as a mathematical approach that optimizes material layout within a given design space, for a given set of loads and boundary conditions such that the resulting layout meets a prescribed set of performance targets.

Topology optimization is used at the concept level of the design process to arrive at a conceptual design proposal.





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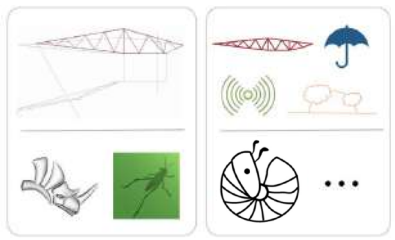
Topological optimization tool

Rhinoceros + Grasshopper + Millipede



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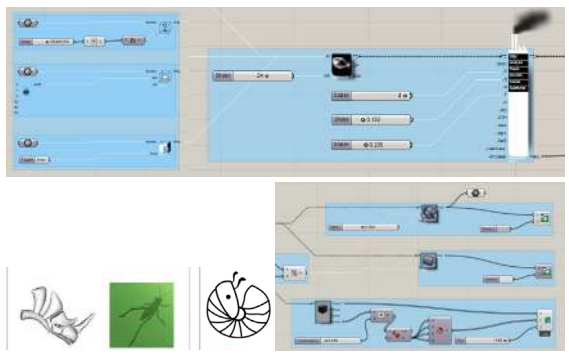
Millipede



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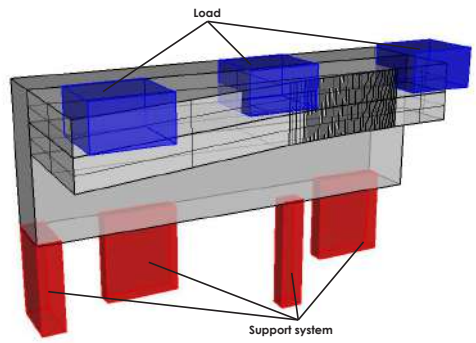
Constraint definition



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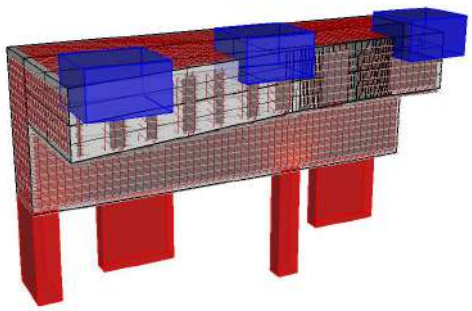
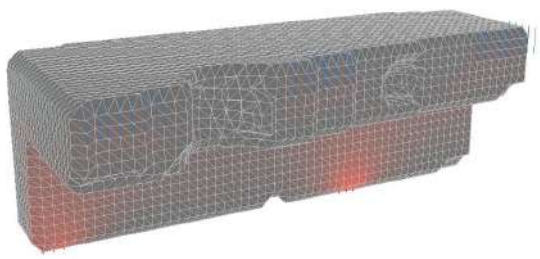
Analysis output



Minimizing the material according to the stress path (C#)



Step 1

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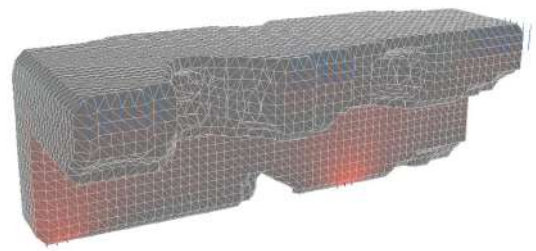
Minimizing the material according to the stress path (C#)



Step 2

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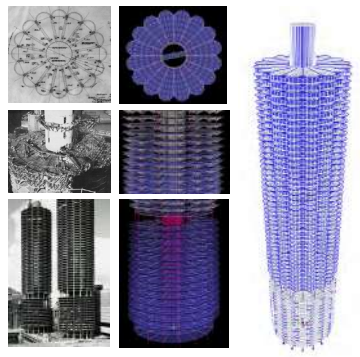
Today safety verification through Finite Element Models



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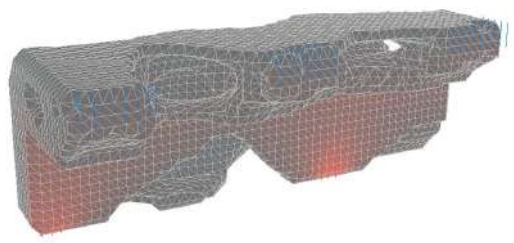
Final configuration



Step 4

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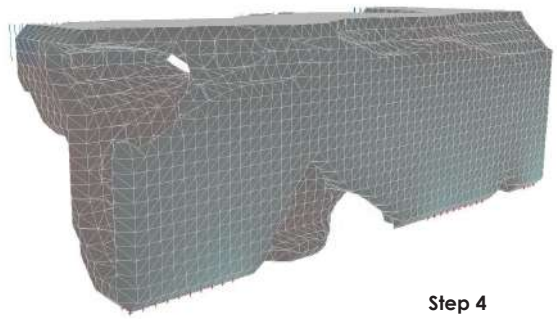
Final configuration



Step 4

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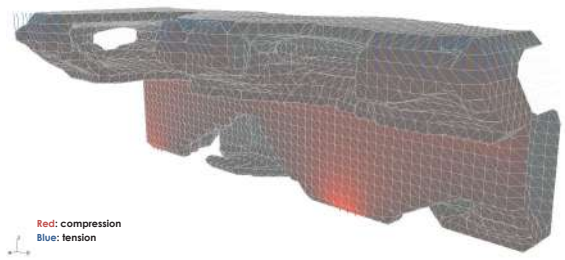
Final configuration



Step 4

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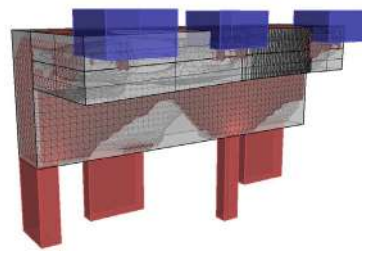
This method could be efficiently used in conceptual design as it takes into account the stress path inside specific boundary conditions.



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Workshop results

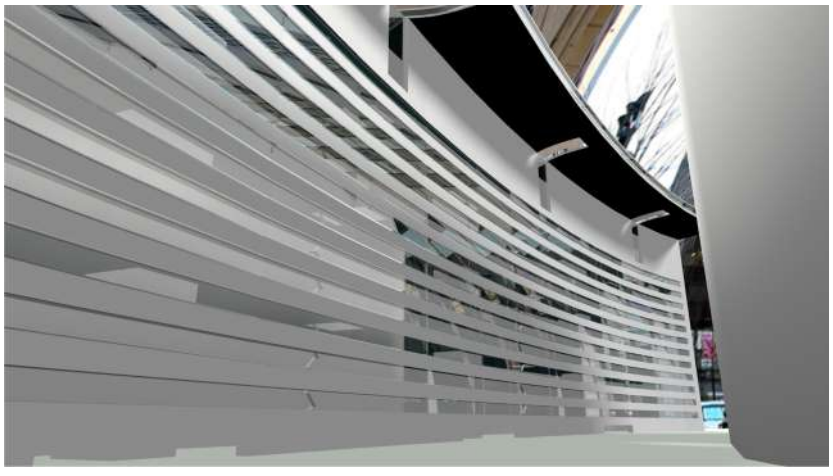
SODOSOPA:

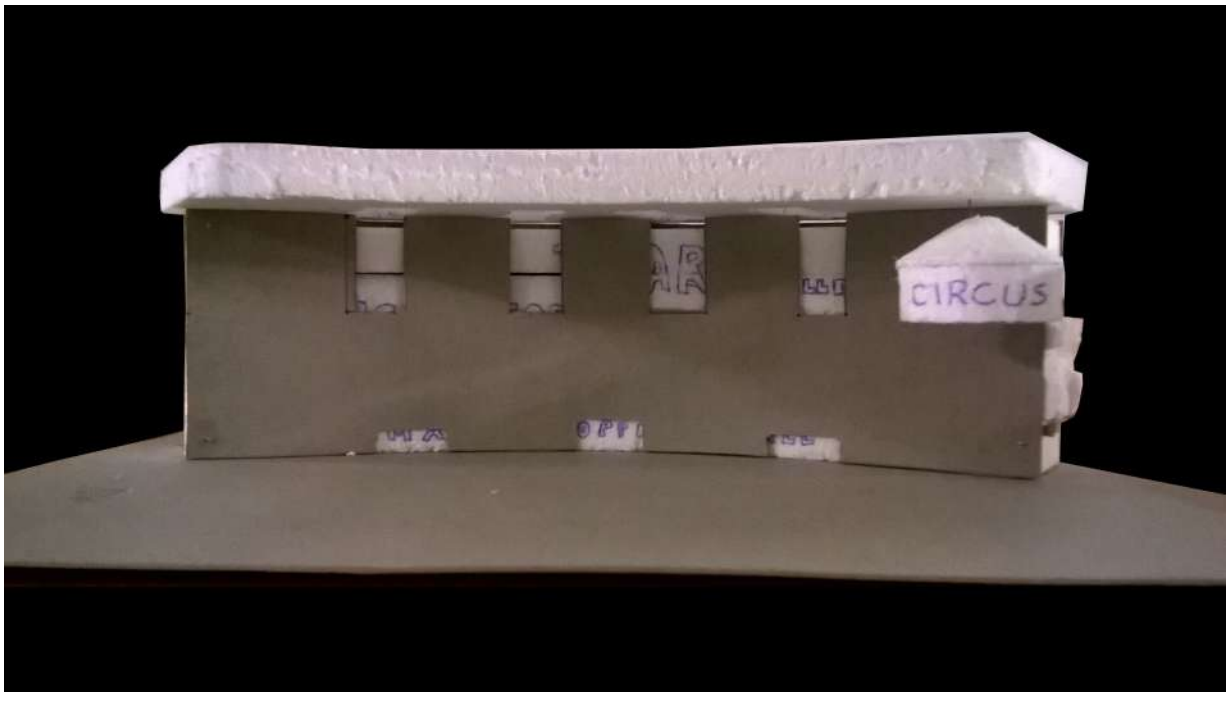
Alexis Bauvin, Axel Mathieu, Pierre-Alexis Thoumieu, Dimitri Tuaz

PRESENTATION SODOSOPA

Damiano Flisi, Federico Marani

Directly facing one of the main viability axes of the Spanish capital, the Caixa Forum by Herzog e de Meuron is the result of one of the rare cases of urban industrial architecture regeneration. The intervention by the Swiss architects appears even more interesting if we consider the spatial arrangement of vertical spaces. At the ground floor the stone base has been demolished, creating a vast free space in the preexisting building and creating a covered expansion of the volume in the square; this enables the public space to penetrate directly in the building making it "fluctuant", thanks to the nucleus of the concrete structure which host vertical circulation: stair and lifts for goods and people. While the ground floor is mainly occupied by the public square, the top floor hosts a cafè which offers a privileged view on the city; this solution has been recalls the one that the architects chose for their well known rehabilitation project: the Tate Modern Museum in London. The rusted iron panels – covering the upper part of the building – are wisely pierced in some points letting the daylight filter inside the spaces. The project provides also underground addictions, two floors hosting the service spaces and an auditorium integrated with a foyer. The analysed case study aims to create a functional mix inside the building, while the juxtaposition of the volumes is supported by a traditional frame structure. As happens in the Caixa Forum, the elevated part assumes a great importance, also iconographically; on its top the design tries to "embrace" and lightly touches the existing sport complex. Light – as in every project from the Swiss architects – is on of the key elements of the design; the attention to lightening who drove to the laser-cut facades in the project designed in Madrid, here the studio carved the skin of the building to give light to the underlying square. This public space is also integrated with the building becoming a key spatial element.



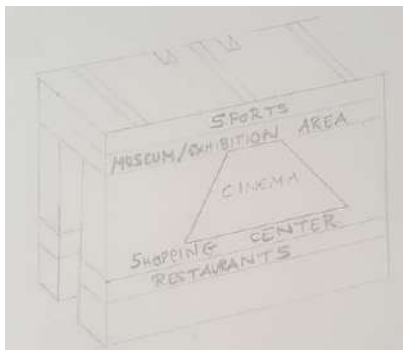


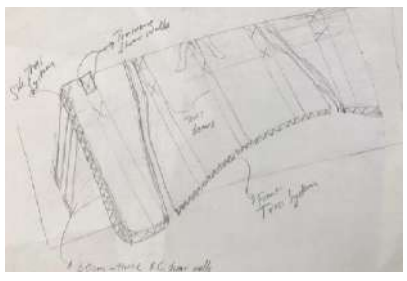
WAVE:

Mathieu Ainsa, Ismaïl Bernoussi, Cem Kurum, Marie Pierruand Emmanuel Vacher

PRESENTATION WAVE

Damiano Flisi, Federico Marani





The design of the case study entailed the creation of an iconic and easily recognizable building – which could be a new outstanding urban landmark, not trying to be mimetic with the surrounding blocks and representing a characterized architectural elements.

Ricciotti's poetry well suits this design solutions, in particular the Jean Cocteau Museum shows several similarities with the topic took on by this research - even if in a smaller urban scale.
As many of the projects signed by the French architect Rudy Ricciotti – the Jean Cocteau Museum has a statuesque and well recognisable design.

Inspired by the personality of the poet_ artist Jean Cocteau, Ricciotti disegned a massive and compact building: a single volume with carvings_cuts starting from the roof and having their end in the façade. These subtractions, happening on the surface solid volume, become massif but sinuous columns running long the facade

The massif skin, made of concrete, contains the glazed volume - hosting the spaces that house the museum's exhibition – and creates a covered walkway running long the outer limit of the building.
The chromatic contrast - obtained with the juxtaposition of bright walls and dark windows – intensifies the visual impact of the tiny city museum, giving it an unusual majesty for a two storeys building.
The carvings – continuously running on the façade till the roof – create wise light/shadow games that underline the sculptural attitude of the building.

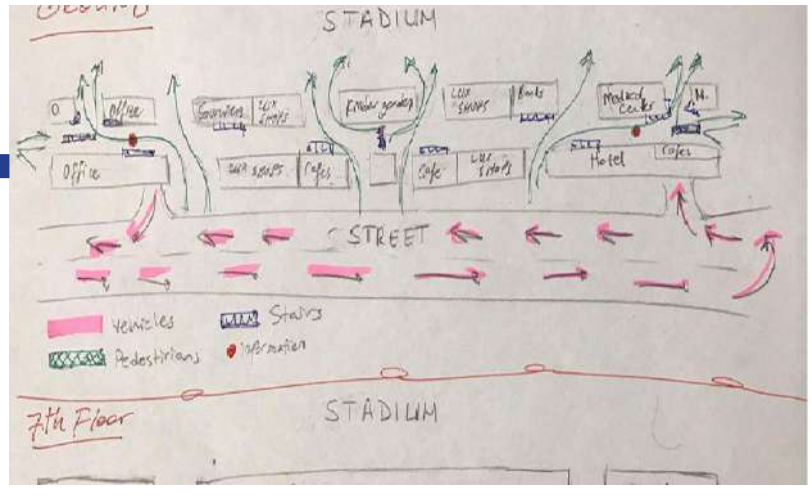
The external landscape is projected in the inside spaces, through the wide glass walls; at the same time it is enclosed by the external wall partitions: this design solution turns the paysage into a stage, creating a strong visual relationship with the surroundings.

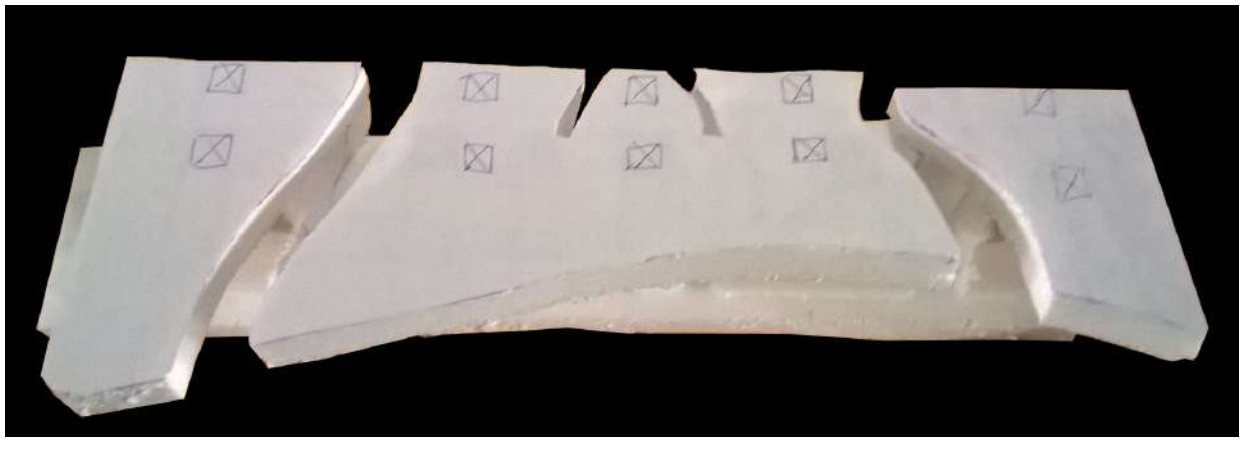
The research on the external skin of the building is characterising Ricciotti's work: through this element he realises recognisable and effective constructions, his projects are able to became landmarks, without any mimesis of the context.

The bond between architect and engineer - in this studio project - undertakes an enormous importance; the structural solution, constituted by a structural skin and an hinged beam, integrates with a design which considers the external shell as a sculpture – interrupted by wide linear carvings running until the top of the beam.

It isn't possible trying to draw and design the structure and the external shell separately: these two aspects – while needing to be constantly monitored and confronted - attempt to reach a precise balance in the façade.
The constructive solution allows to create new relations in the internal spaces: the light coming from the cracks - designed on the shell - becomes an important architectural element of the internal volumes, completed by squares and gardens.

The functional blocks are hosted in the structural shell and served by the nucleus containing the vertical circulation - contributing to give stiffness to the structure.
The spaces created between the facades are conceived as an internal path: a public walkway that enhances the permeability of the building at the ground level and allows the functional blocks to be linked through boardwalks, crossing the central void.
The design proposal elevates the city to a paradigm – being shaped on the city itself: this gives the linear cracks a strong urban significance.



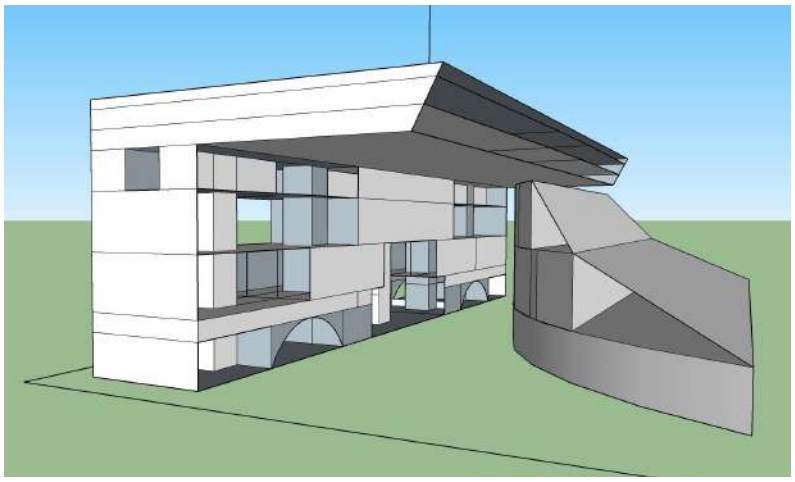


Workshop results

A CITY WHITIN A CITY:

Alexandre Philbert, Meriem Kachouri, Grégoire Dupont, Thomas Luo, Sanmay Shelat

Overview



PRESENTATION A CITY WHITIN A CITY

Damiano Flisi, Federico Marani

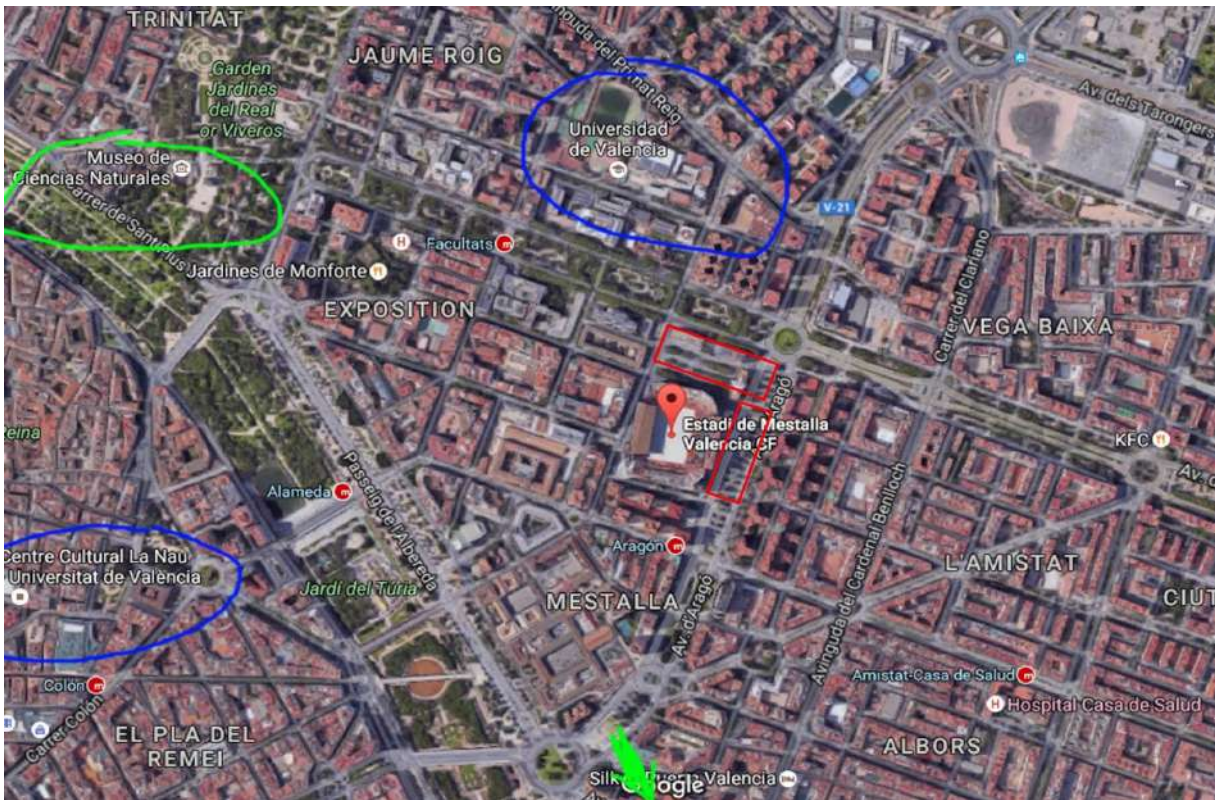
The Mirador in Madrid by the architecture studio MVRDV, is a reflection on density and on the contemporary way of living spaces; the building is divided in small neighbourhoods, hosting the residential blocks, 165 apartments divided into nine typologies, interconnected trough a continuous circulation system. The connection areas have a fundamental role in this project: they both separate and unify the residential blocks, also on the façade, furthermore they are immediately recognizable thanks to the colour scheme used.

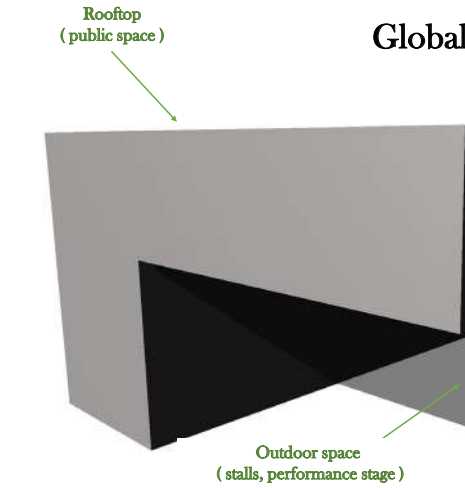
The building mixes different residential typologies, to be as much flexible as possible within the real estate changes. The heterogeneous disposition of the construction is also visible in the façade where the use of different materials and chromatic scales enhances the presence of nine main blocks and the connection paths. A big empty space is embedded in the Mirador: the half-public square, only accessible to the residents. The initial design prescribed the construction of a big escalator to access the vast public space inside the dwellings – this was the expected outcome of the previous project.

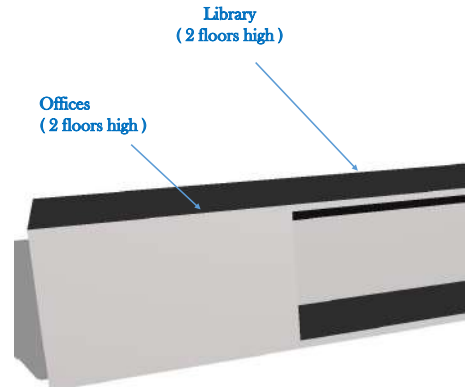
This project have been taken into account because of its ability of connecting and combining the residential blocks through continuous paths – not pretending to be anonymous or mimetic but having a big impact on the overall design. These outdoor itineraries – easily recognisable – become the spine able to sort different fluxes and users.

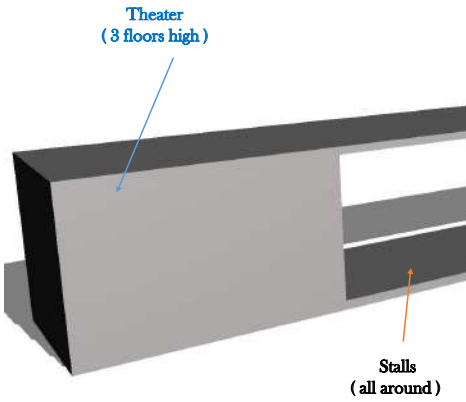
The design tries to neatly organise fluxes and indoor activities: every functional block is preceded by a vast public space. The continuous sequence of public spaces displays similarities between the mentioned building and a bridge. The volumes' distribution is completely symmetric, using the structural grid in a traditional way. The cantilever part in the roof plays a crucial role since it hosts two residential storeys whose façade is continuing the façade of the stadium.

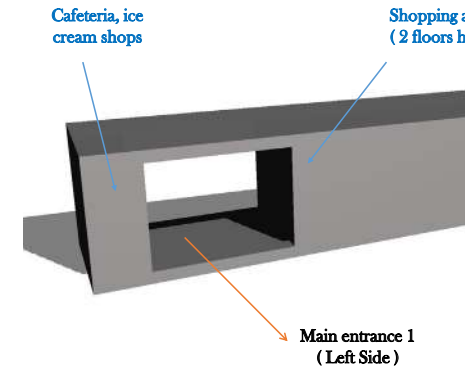
A Quick Reminder





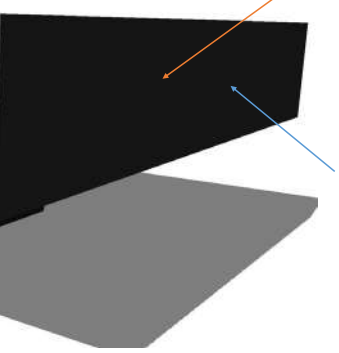






l View

Hotel Reception
(12th floor)

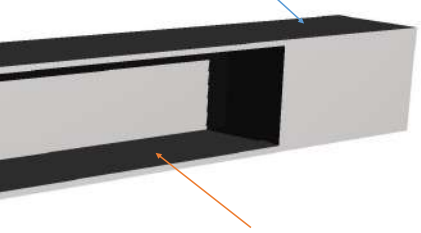


Conference
Rooms
(12th floor)

Lobby

Residential area
(2 floors high)

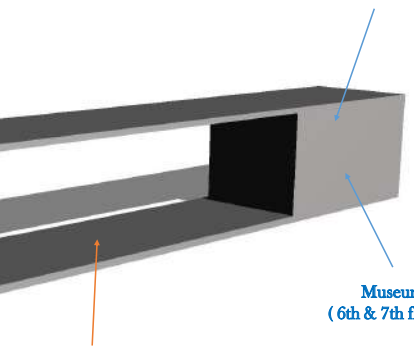
Stadium



Café, working

Lobby

Fitness Gym
(8th floor)

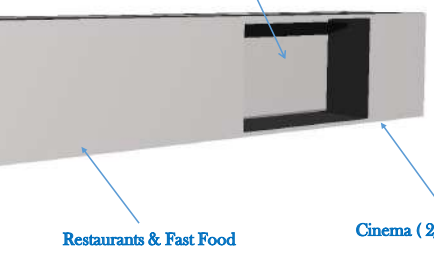


Museum
(6th & 7th floors)

Art Exhibition
(7th floor)

Lobby

Bar for Football Fans
(Right Side)



Restaurants & Fast Food

Cinema (2/2)

Lobby

Stadium

area
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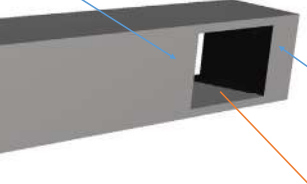
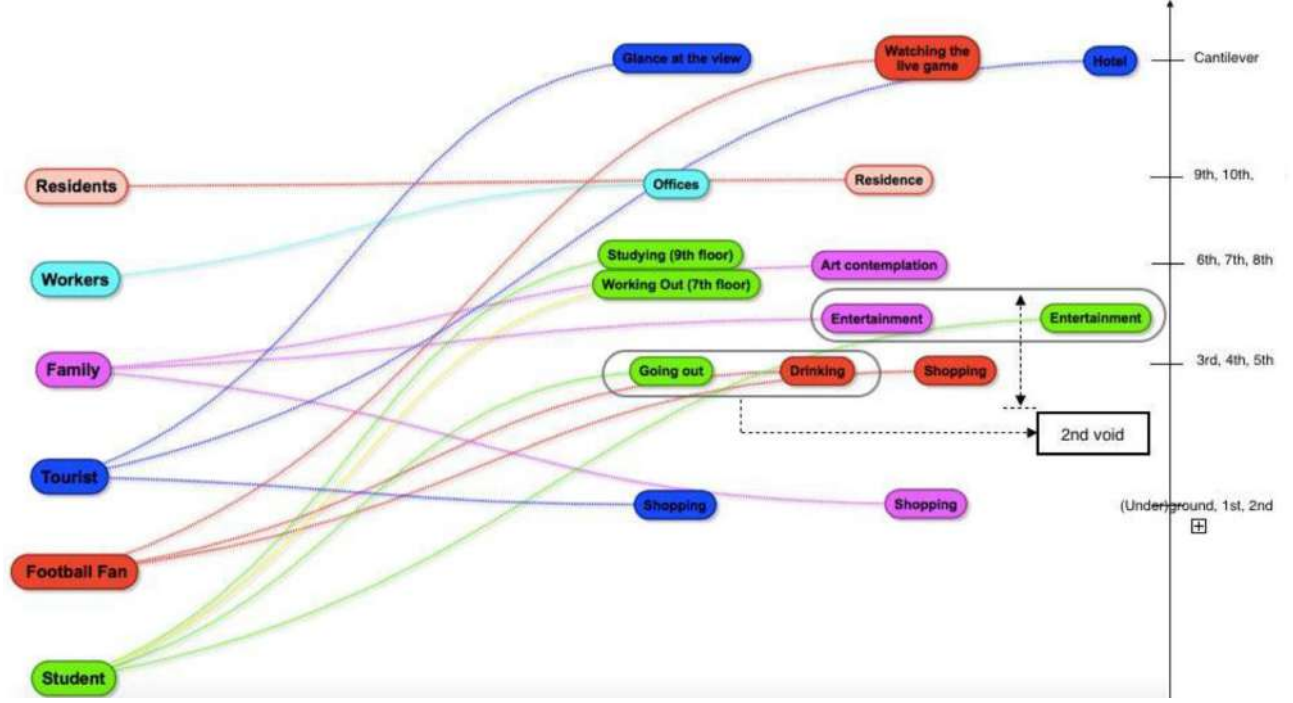
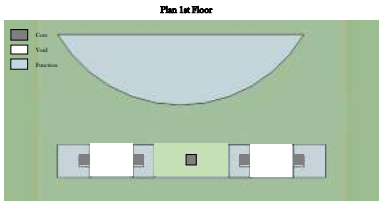
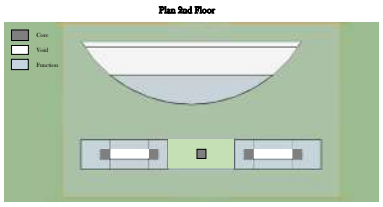


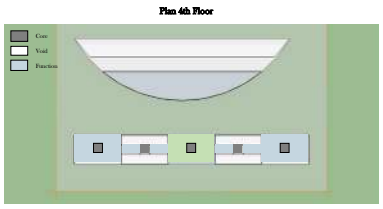
Cinema (1/2)

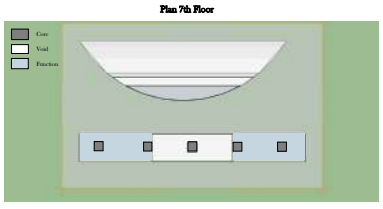
Main entrance 2
(Right Side)

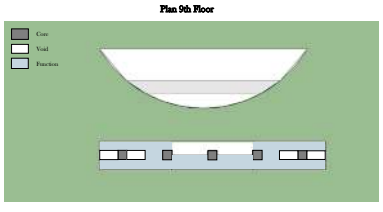


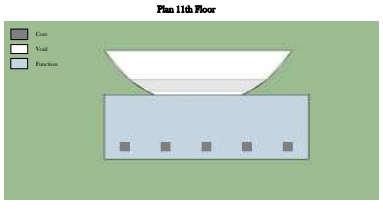


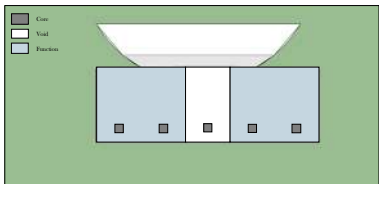


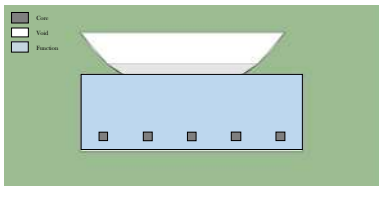


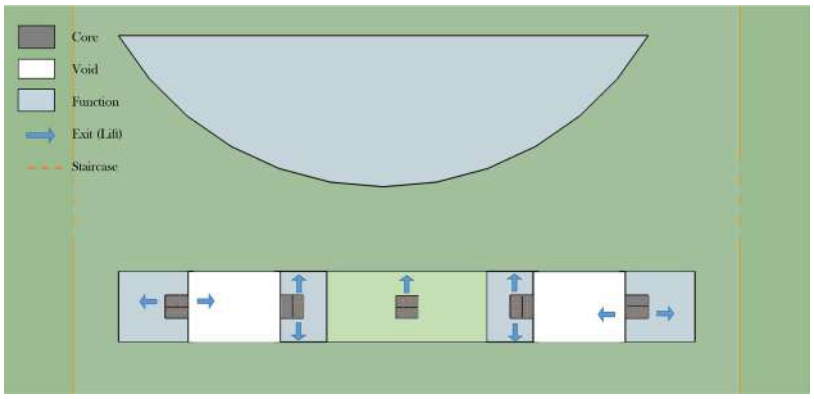


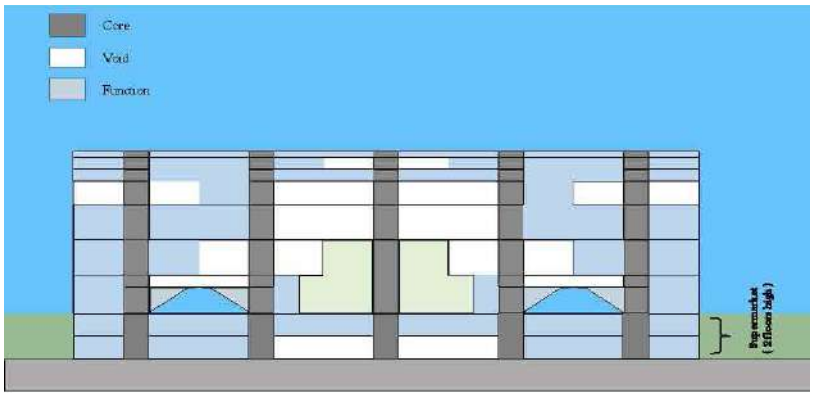


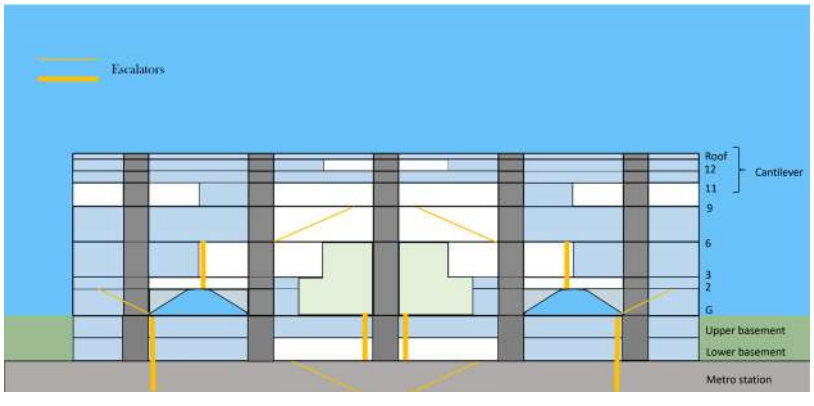












Workshop results

G3:

Léon Chassetuillier, Arthur Pasteau, Paul Duverneuil, Pierre-Marie Ageneau, François Desrichard

PRESENTATION G3

Damiano Flisi, Federico Marani

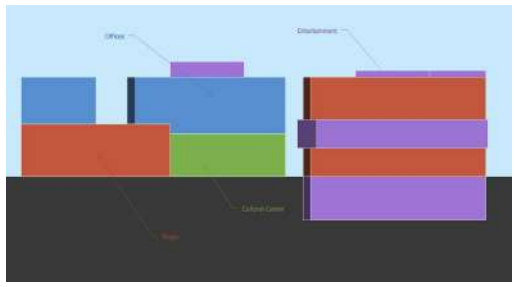
References:

1. Concert Hall – Jean Nouvel

The Concert Hall in Copenhagen seems like a parallelepiped covered with cobalt blue metallic nets. Videos and short movies are projected on the surface and the metallic elements trace the perimeter of the geometric form. The outer shell reveals the internal spaces, whose perception changes while time passes. The simplicity of the external volume counterposes to the complexity of the internal spaces – the architect declares: "This relationship between complexity and simplicity is at the base of the design process. The four main rooms – which, together with the foyer at the ground floor, constitute the internal space of the Concert Hall – differ both in dimensions and materials.

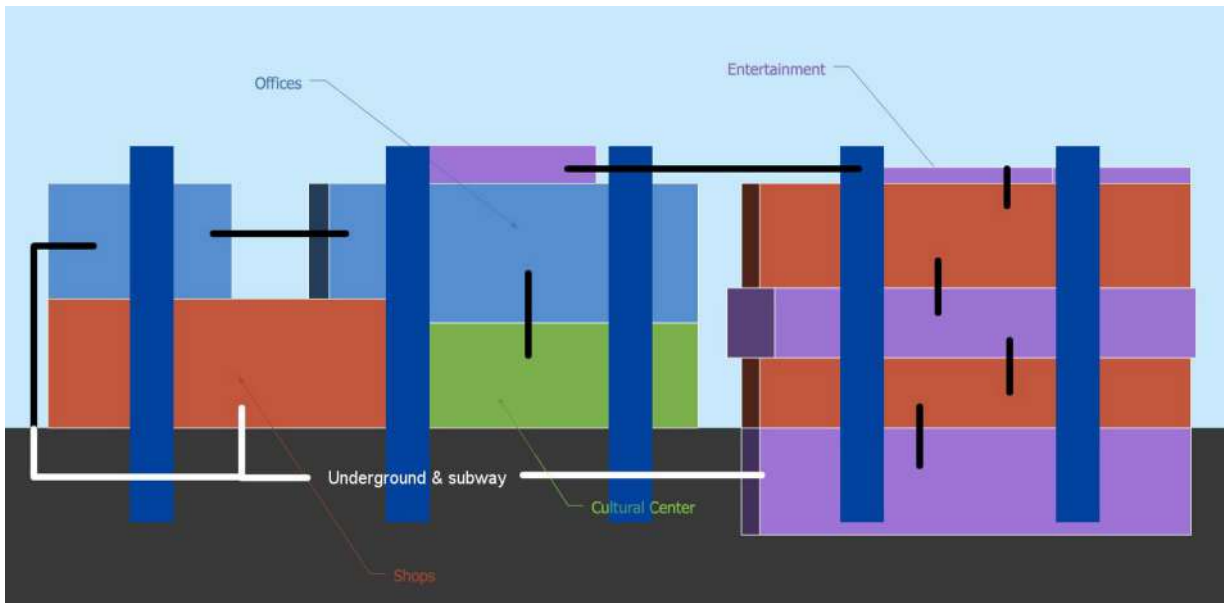
2. Moriyama House – Sanaa

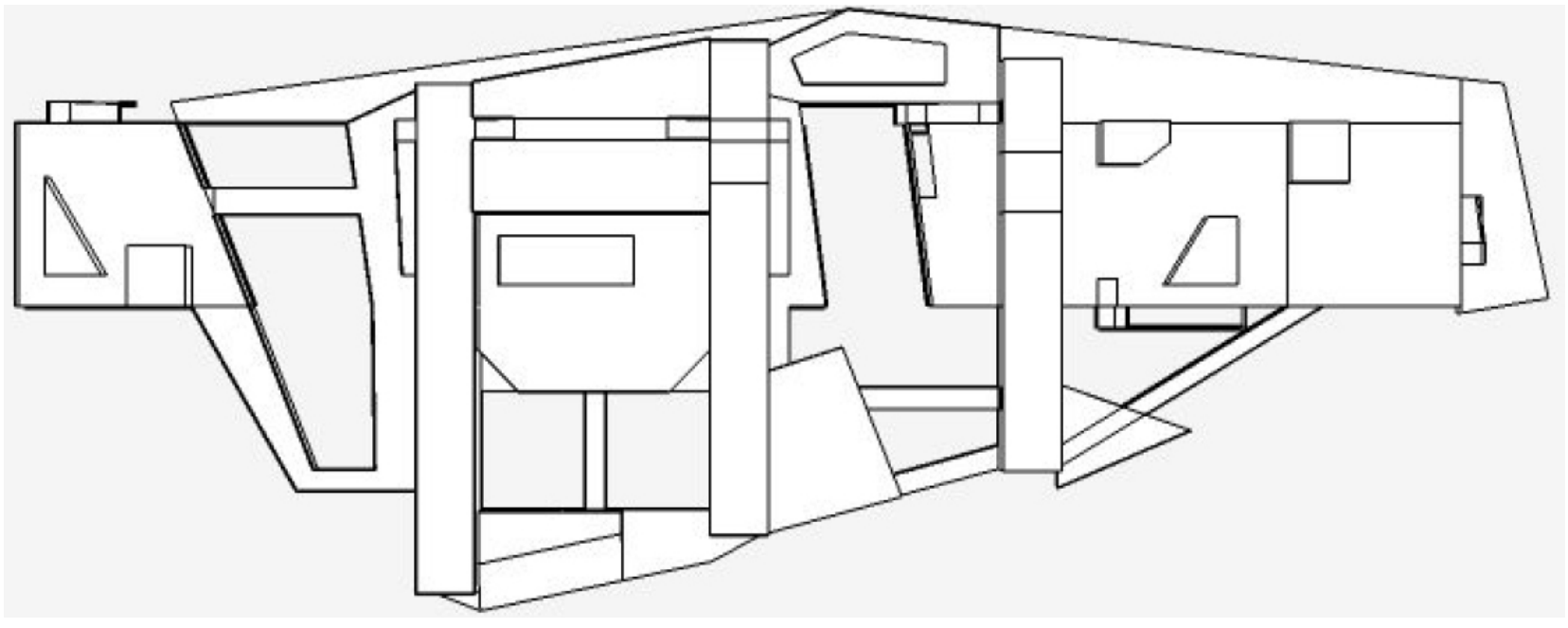
In a typically Japanese context – characterised by the repetition of buildings having small openings – rises a house made of seven different separate and independent volumes, signed by Sanaa studio. Every volume, having a maximum of three storeys, has a precise role. Four of these modulus – bedroom and studio, kitchen and storage, living room, bathroom – belong to the owner; a modulus belongs to the housekeeper while the others are rented: this creates a small community. The modulus can be interchanged basing on the demands of the owners. Gardens and internal paths, in the spaces among the modulus, are opened toward a half-public space, dematerialising the ephemeral threshold between public and private property. This solution allows to obtain a feeling of inclusion_integration of the project with the city of Tokyo, avoiding the enclosure of the project. Starting from the given references, the case study found a way to include in the building different boxes containing various and heterogeneous functions; the constructive solution is traditional: the role of vertical circulation and of the cantilevered beam are enhanced. The complex and articulate disposition of the volumes – containers of the functions – allows to create a carve in the volume, both horizontally and vertically – that lets sunlight inside the building. The result is an intricate labyrinth distributing the interstitial spaces. Terraces and Piranesian escalators connect the functional boxes. The interstitial space is the element allowing to focus on the vertical movement - this aspect has been maximised in the facade facing the stadium.

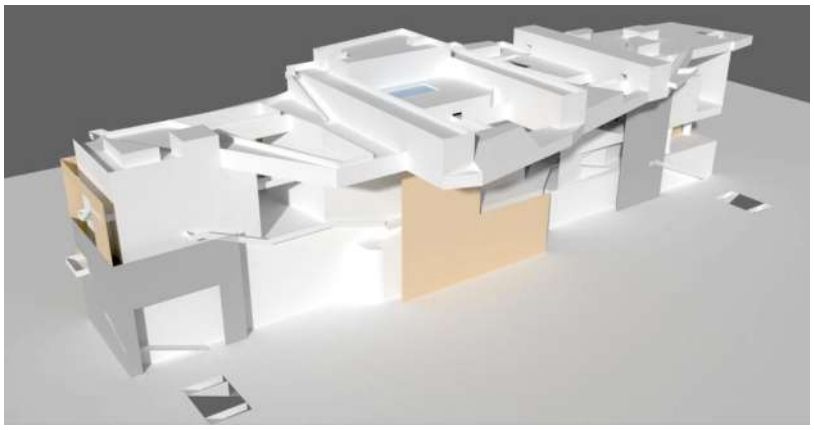


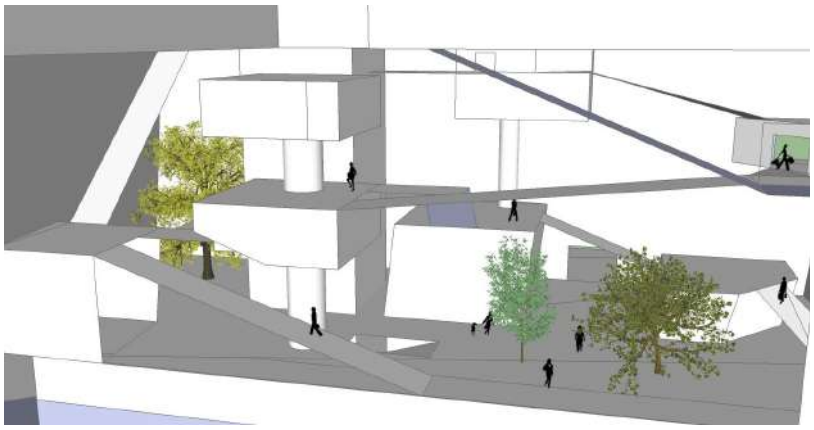
Note:

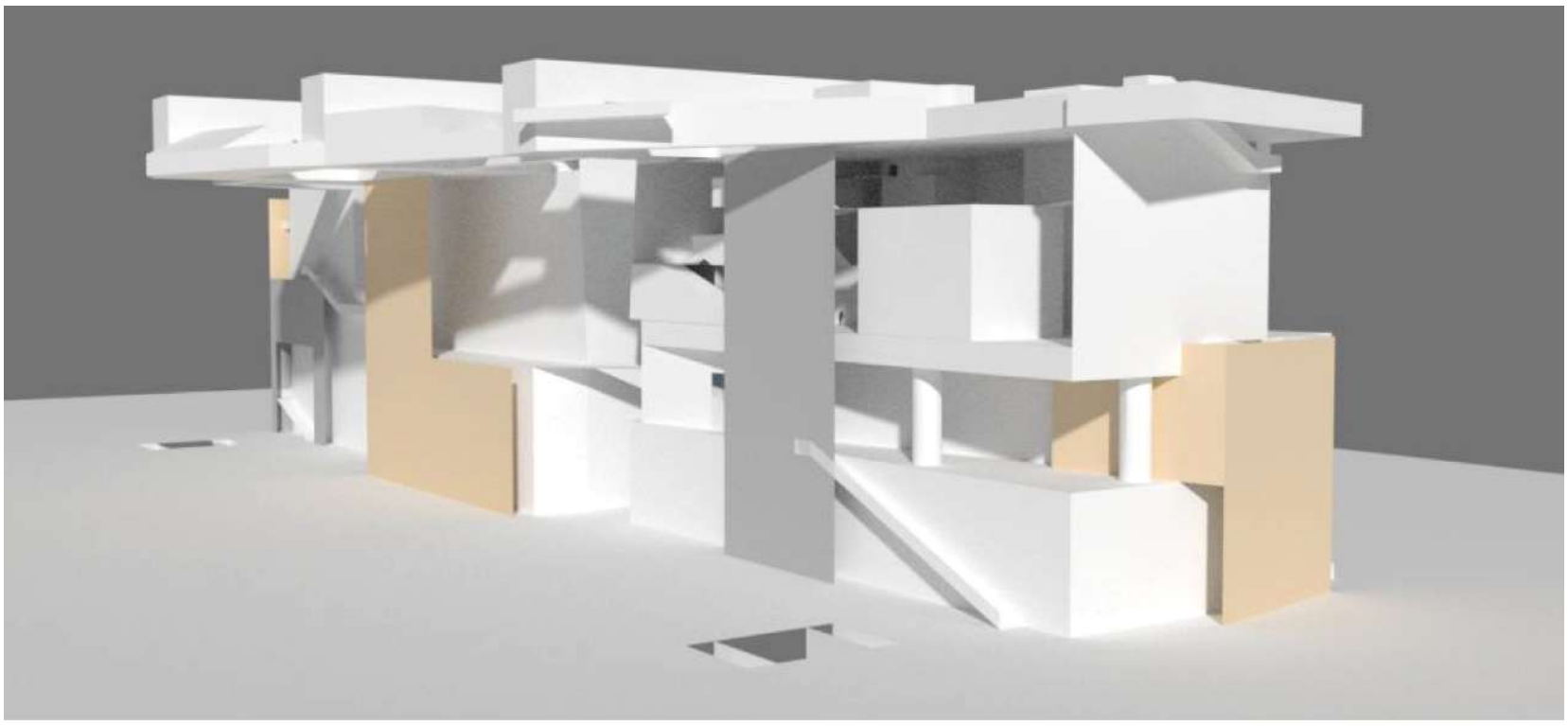
The secret of this composition stays in the juxtaposition of non-consecutive volumes, this arises from the will of proposing an explorable building, rich of paths, internal views and viewpoints of the city.

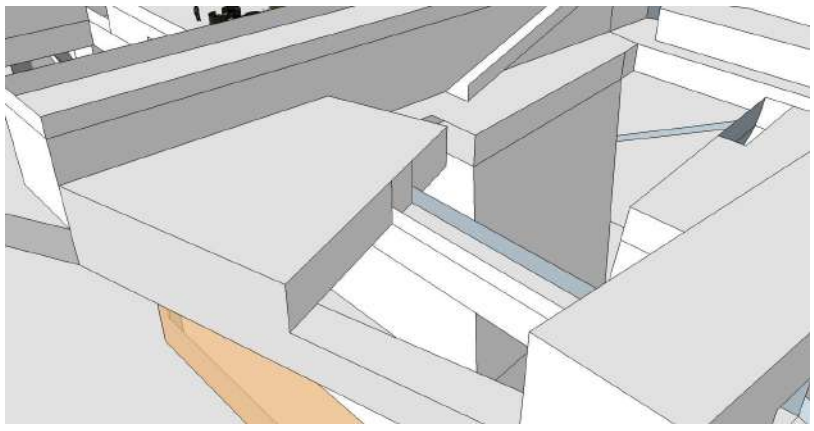


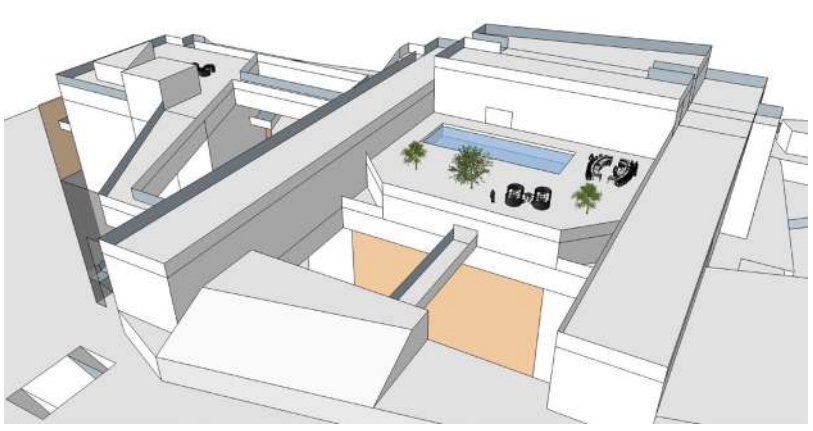


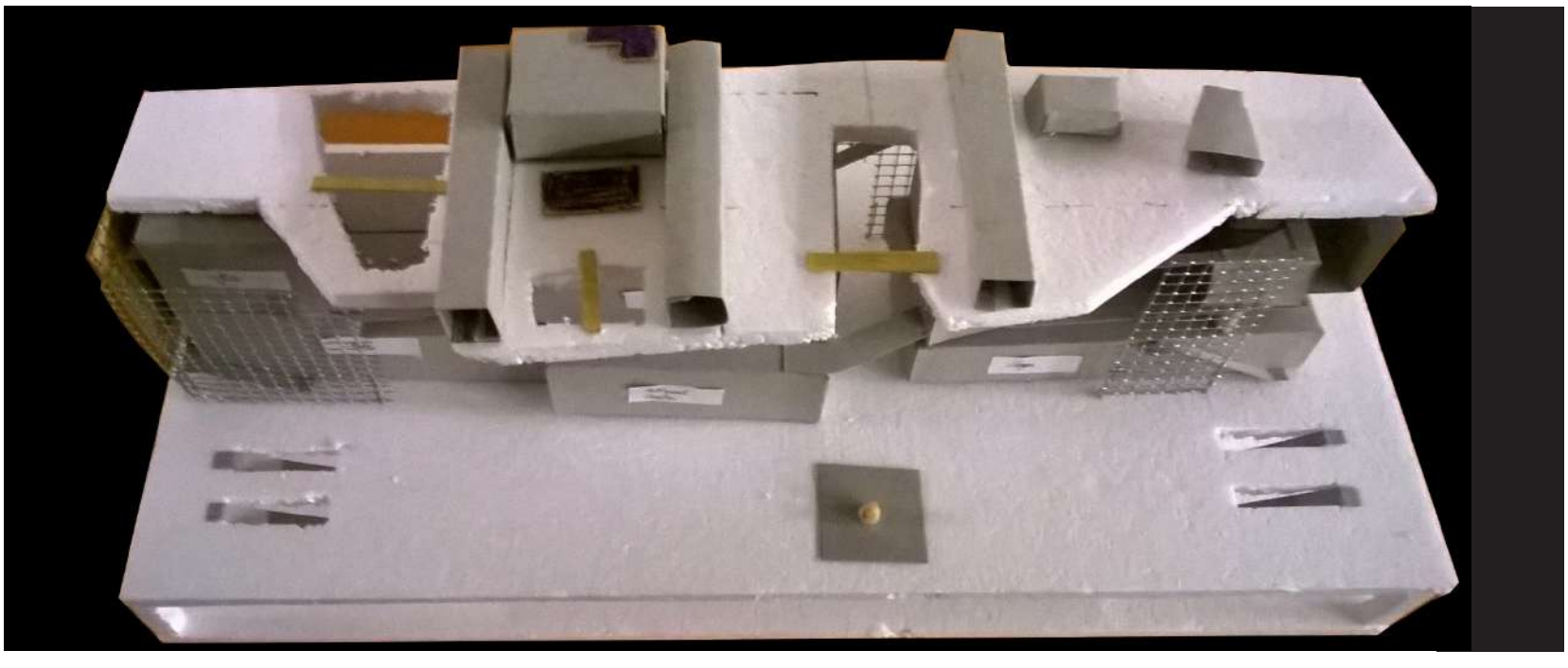












Annotations on architectural theory

Ernesto d'Alfonso

1. Drawing paper and figures on computer screen.

I discussed about the drawing paper and the conceptual completion of descriptive_projective geometry – which mirrors the projection, scaled in the first case and prospectively for the other. As ancestor of the screen displaying the operations dictated by digitalization – setting algorithmic "languages" for assisted design. The knowledge of both the techniques is mandatory to mentally manage the operations accomplished by the files in behalf of ourselves. Only through this knowledge we can obtain any form of architectural expression. This depends on the ability of using the available tools. A fact must be underlined: assisted design files posses the algorithmic "code" of the drawing processes – which produce images on the screen. Therefore the code operates through digital controls and translates them into a geometric_mathematic procedure in a virtual space – having the mentioned virtual as measure. While saying "procedure" I mean something really close to shaping. Given its relation to the process of shaping, it gives this operation a tactile character – so the act of modelling can be in a way compared to a hand moving on the paper. Since it isn't sensitive, it can be identified – not as somatic human sensibility – but as mental sensibility. This is something that can't be said. It can only be shown by a modality of displaying that is only intelligible by a mind. This corresponds with the mathematics geometry -previously defined as the space "language" - in a Galileanous manner. Actually Galileo declared that nature is defined in mathematical terms. I think he meant that the intelligible space of mind is written in mathematical terms. The latter supplies the calculus needed for the shaping of forms in the transparent. Especially when the substance of this moulded quantity is thought inside the enclosed somatic space of the "manufacture". In order to think about this a virtual penetration in the inside is needed. This is the way the science of Building construction performs – even thought it is nowadays neglected in the architectural field where it belongs, see Brunelleschi. Relatively to this topic I want to recall the 50s and the award given to the engineering masterpieces (bridges, aqueducts, hangars and mega_structures I general) constituting the fist examples of morpho_typologies of the enormous containers, ancestors of the epicentres and of the hybrid typologies deriving from them. The latter resort to multi_modal crossways or multiple airport transportation cruxes, railways, highways and cities. To enlarge the field of theoretical discussion that supports our workshop, we are going to consult the architect who forerunner of the modernity and his experiment to unfold the "tectonic of spaces". This concept of tout court space is the space we imagine both when we draw on a paper or we type on our computers.

2. Scaling and tectonic of transparent space.

I am now dealing with the experiment done by Brunelleschi and his subsequent discover: the notion of abstract_virtual space, the "tectonic of transparent space" on which we base our mental procedures on space. Brunelleschi – through its experiment – bust the myth the mirror, abstracting the user from the perception he has of it, in the legend of Medusa and Narcosis – the stiffening of death. He made a tool out of it. Radicalising the stiffening to establish all the metric coordinates relative to the mirroring in the perfect instant of the experiment. As an excellent artisan he was able to confine it on a panel. This gave origin to a sequence of exact observations that compare the portrait to reality. "Scientific". The bar that he painted represented a mirror in the upper part. The lower part is painted with a view "printed" on an openable surface (door or window).The experiment of the Florentine master is exposed to the witness of a contemporary author – he showed it to him. He took in his hands, as he says, two mirrored surfaces: the first was painted in the lower part, the second had a mirrored background. He was staring at them and he could see the first mirrored in the second. Since he was a renewed artist_artisan, Brunelleschi performs the atelier's secrets, and he doesn't divulge his procedures, intuitions and calculations. We have no clue of the evolvement of its experiments. We must be satisfied by the biographer. Of course the panels by the artist haven't been conserved. We can only re_think the steps of his experiment following the narration of a witness.

The thought goes to the way he reached the discovery of the virtual space – oriented from mind and thought in such a way that it can be "manipulated as virtual substance". From the manipulated substance, figures of forms, that belonging to the computer can be three-dimensionally reproduced in appropriate material by adequate devices – 3d printers. Going back to the experiment that "put in the hand of thoughts" a formal space, uninhabitable but still provided with its own reality, different from the somatic reality of places. Here is legitimate the artificiality belonging to the calculations needed to verify the static conditions of a manufacture: the tangible inhabitable reality that constitutes the objective of every design process.

On the other hand, the operation of re_thinking the steps done by Brunelleschi entails a reflection on the validity of the mental/virtual operations that we do as architects while designing. In that precise moment we are using the drawing paper and the logics displayed by the algorithms that enable the transformation of a though into a space. It's worth thinking to the virtual space genesis while we utilize it – as if we were interacting with one of the places in the world. In this case it is contextualised in the present, in the "now" that we want it to collaborate with, clarifying the design operations that we are doing as architects. The first contextualization is ideally absorbing between two portions of space, the mirrored one – generating a descriptive – and the real one between the facades – necessary to the projection.

Architects can't stop using the drawing paper or the computer screen. The second contextualization concerns the natural scaling into an ordinate sequence. In the moment when the sequence unfastens in the square between the monuments whose ends are both before the first and beyond the other. These "actualising" operations allow to support the non_identity of the somatic space and the mirrored space. It also permits to verify a scientific law, regarding pure form. The mirrored space is intrinsically three-dimensional: not only due to the fact that on the mirror the measure of the non_transparent body gets smaller proportionally to their distance from the focus point (centre of the receiving mirror), but also since due to the mirroring, a three-dimensional spatial unit stays between two mirrors that make its presence real: the receptor and the projector. This is the distance proportional to the real distance - meaning the ratio of the scaling. The scale divisor/multiplier. An extremely relevant fact for architectural design is the use of both the drawing and the screen. They usually forget this, thinking that the measures on the screen are naturally real.

On the other side, can be verified – in the same moment when we unfold the tectonic of transparency, today universally known as 'the space', the somatic tectonic is removed and neglected. Though it is determinant as the other verifications. Having no traces of its real existence in the world's space, indeed, measures and calculations couldn't be effectuated. This means that the first manner the space manifest itself, the somatic one, becomes worth of a deeper study. It could be the real study topic of modernity: his inner way of being. This can only be studied through its manifestations on the surface and verified through an intuition in the transparent of the inner space – as if they were working hypothesis, verified in a second time with calculations and measurement, functioning due to use instructed devices.

3. A declaration of intents.

As a conclusion I want to mention a principle: if the world isn't written in mathematical terms, the space – meant in its transparent mode – is. Architects must be acquainted about this. The Milanese school can't ignore this, too. It I well promoted the Milanese school, to underline its ancestries, it wasn't to counterpose it to the Roman school – since I deeply celebrate its "modern" master: Borromini. The point was to endorse the necessity of Italian architecture schools to recover the higher mathematic and geometry studies. The research on materials belongs to the higher current research in architecture, it demands it. As nephews of Cattaneo, we cannot forget the examples of Leonardo da Vinci – the architect_engineer - in Milan. Therefore scientist.

It comes as a consequence of the methodology of vision, the specific discipline of architectural design theory and urban science. Its scientific and theoretic fundaments can only be found in the virtual space discovered by Brunelleschi. The code of the geometric_mathematic "language" used by Brunelleschi has been invented by Alberti as "concinnitas", a conlocatio that descends from finitio and numerus inside the lineamentum.

When the difference and coexistence of two modalities of space is verified and a plurality of worlds is unfolded, there's a need to postulate that the somatic space is, for all the human beings, a verification of this coexistence. Following the other modality, the deceptive one, it can be existential and verify the cohabitation with the somatic_existential space.

Therefore, in the moment when we verify the tectonic manner of the somatic space – and a tectonic truth (deceptive, scientific and algorithmic) of the transparent space – the necessity of an improvement of the knowledge on deceptive modalities becomes visible.

An in-depth analysis on the existential modalities of interpreting the world's phenomena and implying the somatic_existential reality is also required.

So, beyond the studies of the discover_invention of virtual space, and the operations on the scaled space that employs its powers, it is needed to deepen the circumspect_somatic experience that tests the natural scaling.

These three experiences, indeed, in the synchrony that connects them, require a thought on virtual space of transparency and the operations done in the latter. They are fundamental for a design exercise. The verification of its veracity stays in the act of inhabiting the built space. And in its way of being inhabitable.

ArcDueCittà

Number 3
January 2018

Editing
Arc2città

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Autorizzazione del Tribunale di Milano n° 326 del 17 Giugno 2011

price
8 dollars

Web site: http://www.arcduecitta.it/