High Resolution Architecture: Ornament as a Generative Force

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Abstract

The rapid progress and development of information technologies that occurred during the last decades led to our current condition where it is ultimately possible to collect, store and process previously inconceivable amounts of data. The new scientific framework that is inevitably formed – described by the somewhat ambiguous term 'Big Data' – is combined with the ever-increasing computational power and the emergence of fabrication technologies such as 3d printing. That leads to a new understanding of architecture and its formation where large amounts of detail – which we are now able to control – appear as an opportunity for investigations towards new forms of expression and are defined by new architectural vocabularies.
In that context, the concept of resolution emerges as a factor that can affect and alter our understanding of the architectural creation. Specifically, the notion of high resolution – in other words our ability to control an increased density of morphological information – appears to be leading architecture into a new direction and to a – seemingly previously unexplored – aesthetic that reflects exactly this abundance of data that defines our era.
With the ability to handle an unprecedented amount of detail along with the use of ever-evolving digital methods and technologies of design and fabrication, structures that previously seemed inconceivable are now designed and manufactured. Structures with levels of detail and information that often go beyond what the human mind can capture and manage.
However, as is always the case with every new breakthrough in architectural design, we initially lack the necessary tools that will aid us to form the criteria with which to evaluate the produced results. In order to do so, the proposed paper starts from the

hypothesis that high-resolution is not necessarily a completely new condition for architecture. On the contrary, the paper argues that many of the properties of what we are currently calling 'high resolution design' can be found in several instances of architecture's history, and therefore by studying those instances we can better understand and evaluate our current situation. In other words, the paper proposes that there have been conditions in the history of architecture that resemble the characteristics brought forward by high resolution.
Ornament is such a condition: it has always been a feature of high spatial density of information, which, before the advent of digital design and fabrication methods, was exclusively managed by humans. We can, for instance, think of the wealth of information that incorporates a sculptural facade of a Gothic-era cathedral. The ability of human to manually manage this plethora of details related to ornament made

the latter an important design feature, which ultimately led to an increase in the resolution of each architectural project in general.
The paper, therefore, turns to the past and identifies architectural examples from different historical periods that negotiate the issue of ornament, seeking in them traces of increased resolution and its management. Through the examination of those historical case studies, we can inform our current practices and set them into perspective. Ultimately, understanding high resolution through a historical lens will help us define new architectural practices that are not mere formal pyrotechnics but are instead forming a new generative architecture within the current social, political and cultural framework.

A new condition: Resolution

The rapid progress and development of information technologies that took place during the last twenty years, led to the condition that we are facing today, where it is ultimately possible to collect, store and process previously inconceivable amounts of data. The new scientific framework that is inevitably formed – described by the somewhat ambiguous term 'Big Data' – has radically transformed every field of the current societies, including of course architecture [1]. Indeed, the new condition that is codified under the term Big Data – which in short "*refers to data sets whose size is beyond the ability of typical database software tools to capture, store, manage and analyze*" [2] – has created a large array of reactions, most of them negative. However, while social scientist and political activists raise worried voices in relation to personal freedoms, private data and a more and more dystopic picture of the world where everything is recorded and stored, architects seem to look at those developments in a more optimistic way.
In architecture therefore, the above framework in combination with the ever-increasing computational power and the emergence of fabrication technologies such as 3d printing, leads to a new understanding of architecture and its formation where large amounts of detail – which we are now able to control – appear as an opportunity for investigations towards new forms of expression and are defined by new architectural vocabularies. In this context, a new concept emerges as a notion able to aid us to understand and describe the current phenomena: the concept of *resolution* as a factor that can affect and alter our understanding of the architectural creation. Resolution of course is a concept of a much larger scope; however when we focus on an

architectural context we notice that there are already in place several attempts to appropriate the concept and define the framework that describes it. For example, in the work of Michael Hansmeyer and Benjamin Dillenburger the term resolution refers to "*the spatial density of information inherent in a building"* [3]. In a direct relationship to its two dimensional counterpart that can be found in the term image resolution, in three dimensions resolution refers also to the amount of information that is or that can be embedded in a particular region (in a volume, a structure, etc.). Pixels are replaced by voxels and spatial information is stored in a continuously increasing three- dimensional grid. Specifically, the notion of 'high resolution' – in other words our ability to control an increased density of morphological information – appears to be leading architecture into a new direction and to a – seemingly previously unexplored – aesthetic that reflects exactly this abundance of data that defines our era. With the ability to handle an unprecedented amount of detail along with the use of ever- evolving digital methods and technologies of design and fabrication, structures that previously seemed inconceivable are now designed and manufactured. Structures with high resolution as an inherent characteristic, with levels of detail and information that often go beyond what the human mind alone can capture and manage.

The above described approach is based on two fundamental assumptions: The first is that the concept of high resolution is a 'digital concept'; as something facilitated by digital tools it has to abide to a digital way of thinking. The second is that the introduction of high resolution is bringing forward a novice and previously unseen process that can be understood as a 'paradigm shift' [3]. It would appear however, that both assumptions could be misleading.

Digital vs Analog

It is understandable that since digital computers are facilitating high resolution one could think of the later as a digital concept. After all, it is only through digital means that we became able to harness such amounts of data and consequently design in high resolution. Even more importantly, it is through digital fabrication, and more specifically through 3d printing, that we are able to fabricate objects of high density of detail. Therefore 'digital' is always part of the description when it comes to the relationship of architecture and design to high resolution. However, using digital tools does not require necessary a digital way of thinking. On the contrary, a closer look would reveal that resolution is never a question of size, therefore it cannot be numerical or digital. In fact resolution is always and by definition a relationship between two sizes: it can be for example pixels per inch as it is in the case of digital images. It never refers to just one size: it represents the relationship between two sizes and more specifically the density of one into another expressed as a fraction. Therefore resolution is always a *logos*. Within a digital computer, resolution relates a digital, discreet unit with a physical size. It is the logos of information units per size, therefore it is a pure analog concept, despite being implemented through digital means. The analog nature of resolution – and therefore of 'high resolution' too – has several implications. Continuity is one of them (as opposed to the concept of discreetness that is employed recently by several architects). On a second level it implies a relational concept that can therefore never take an absolute value.

Shift vs Re-iteration

The speed that defines the ways in which digital tools are developed and upgraded often impose the idea that they bring with them a fundamentally new way of understanding or doing something. Similarly being able to manipulate extremes levels of geometrical detail in design and architecture could impose a sense of a paradigm shift. A change brought forward by the new concept and the tools and technologies that support it, which would alter architecture itself and will create a new condition. However, a more historical approach could be enlightening by revealing previous approaches to architecture and design that incorporate some of the principles that appear fundamentally novice when examined without a greater historical context. In other words, we could perhaps identify historical architectural examples where properties similar to that of high resolution emerge, and therefore build a case that supports an understanding of continuity and re-iteration of concepts and ideas rather that one of rapture and 'shifts'.

In order to formulate our research and identify the examples that would be the most useful, we have to turn our attention to another concept that was always related to the codification of information in architecture: *ornament*. Indeed, ornament could potentially be identified as a condition that resembles the characteristics brought forward by high resolution: it has always been a feature of high spatial density of information, which, before the advent of digital design and fabrication methods, was exclusively managed by humans. The ability and effort to manually manage this plethora of details related to ornament, made the latter a generative element in architectural creation and an important design feature, which ultimately led to an increase in the resolution of each architectural project in general. Thus, the paper turns to the past and identifies architectural examples from different historical periods that negotiate the issue of ornament, seeking in them traces of the concept of increased resolution, its creation and management.

Gothic architecture

One of the most impressive features of the Gothic style is the combination of architecture and sculpture. The significant and intense presence of ornament is immediately apparent by observing the characteristic cathedrals of High Gothic architecture of the 13th century, such as the Cathédrale Notre-Dame de Reims, in northern France.

Both in exterior and interior, the various parts of the building are highlighted with a particularly intense emphasis on sculptural ornament [4]. And it is precisely this feature where the concept of increased resolution is found: in the multiple facets and innumerable formations created by the sculptural management of stone. At every part and element, the material, a kind of local limestone, has been skillfully carved and shaped, incorporating, more or less, an increased amount of information and enhancing the overall density of morphological details. Indeed, in many cases the scale and the plethora of details of the ornament are on such a high level that it seems impossible to immediately perceive all of its features. An increased number of elements with intense three dimensionality, such as carved figures – full or bas-relief –, foliage and naturalistic ornament, etc. Even the sculptural treatment of the multitude of components in the interior, such as the ribs, form a unified and complex condition of high resolution.

According to the principles of the

architectural style of this period, ornament is not an independent element, but rather serves to complement and complete the architectural expression [5,6]. Under this light, the increased resolution, achieved with the use of ornamental features, appears mainly as an inherent feature of the structure, reminiscent of the condition of the current digital age, where the vast amount of morphological information is an innate element. Thus, even elements that can be considered as additional information - for example, the carved figures that are created in a single volume of stone that accommodates also the building parts - could be perceived more as integral parts of a single whole, rather than as superficial add-ons. Throughout the history of architecture, while this increased morphological detail was associated exclusively with manual labor, the creators had been led to seek and develop suitable modes of management, creation and construction, as well as the use of materials with appropriate properties. Using metal tools, mainly various types of chisels, they were able to form the limestone, a sedimentary type of stone, with medium hardness and easy to be carved, producing this way highly detailed reliefs. Stone-carvers and sculptors of this era had developed and mastered modes of stone carving, as well as a high level of skill, both in the conception of composition and form, and in the manual skills to create them, that in Reims achieved some of "*the most thrilling extremes of which stone was capable*"[7].

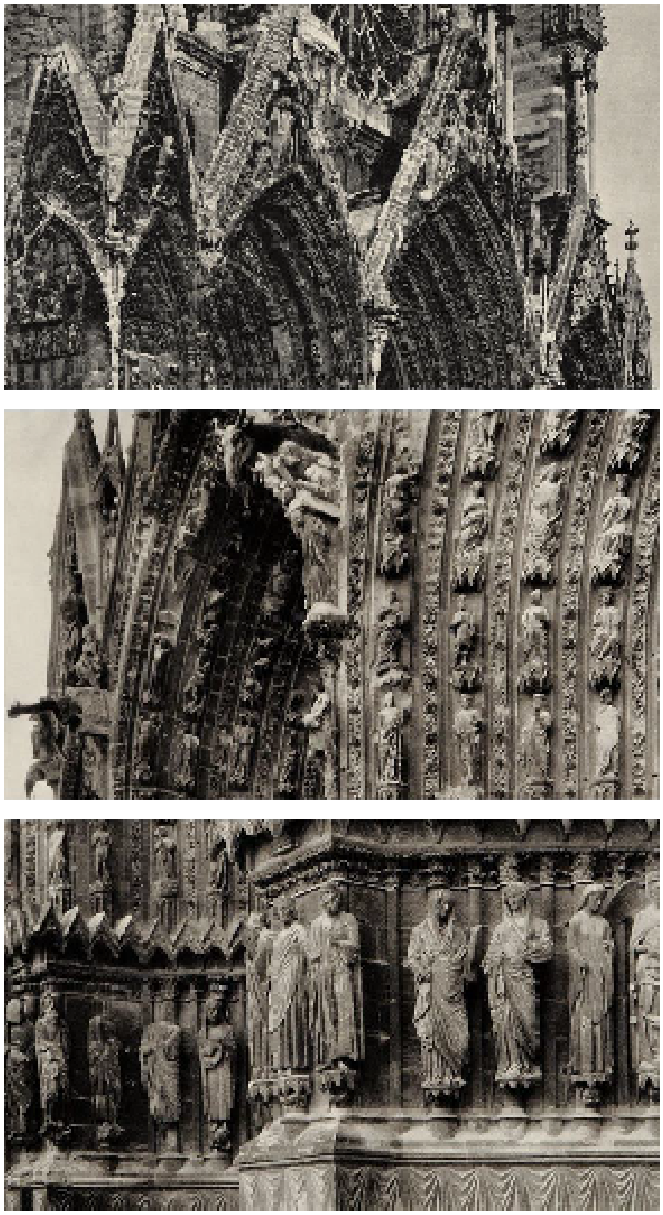


Figure 1: M. Hürlimann, Reims Cathedral,

1937 (source: [12])

Louis Sullivan

One of Sullivan's major contributions to architecture is the unique ornamental system he had developed. One of his most important high-rise office buildings, the Guaranty Building, designed and built in the late 19th century in downtown Buffalo, New York, expresses precisely the essential role that ornament played in his work. The building is a metal structure, the facades of which are covered by

surfaces with intricate and rich geometric and foliage patterns and shapes. These ornamental facades then, with the multiple relief elements that increase the density of morphological information through their innumerable formations , is the point that the paper focuses on in the search for the concept of increased resolution. In his book *A System of Architectural Ornament: According with a Philosophy of Man's Powers*, Sullivan described the design methodology for creating the intricat e ornamental features of his buildings. The process began with a simple geometric shape, which through a series of design actions resulted in a highly detailed foliage form. In short: some axes of the initial form were the

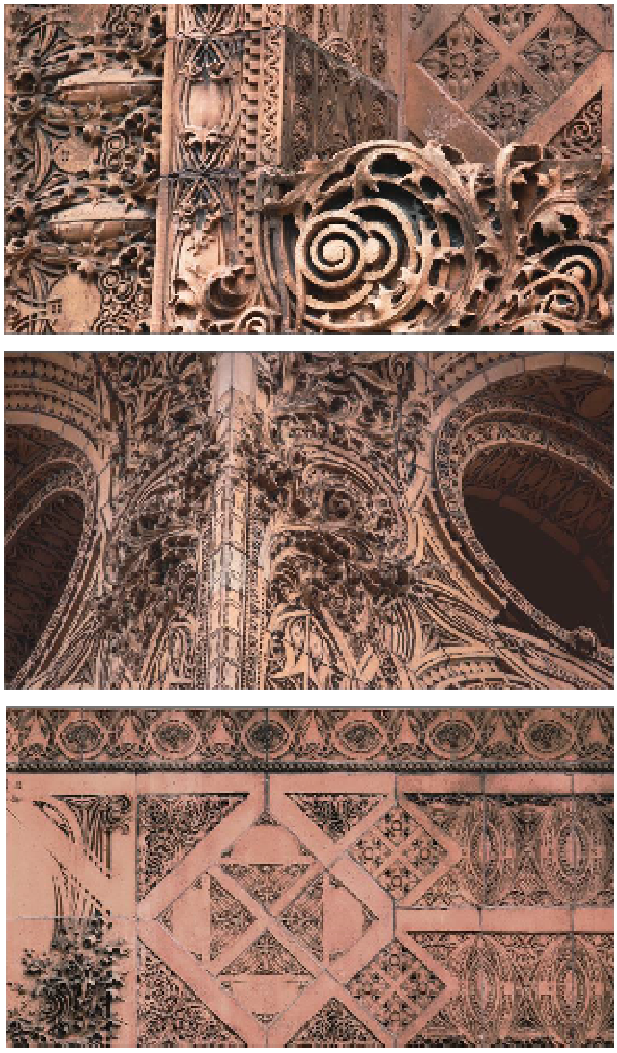
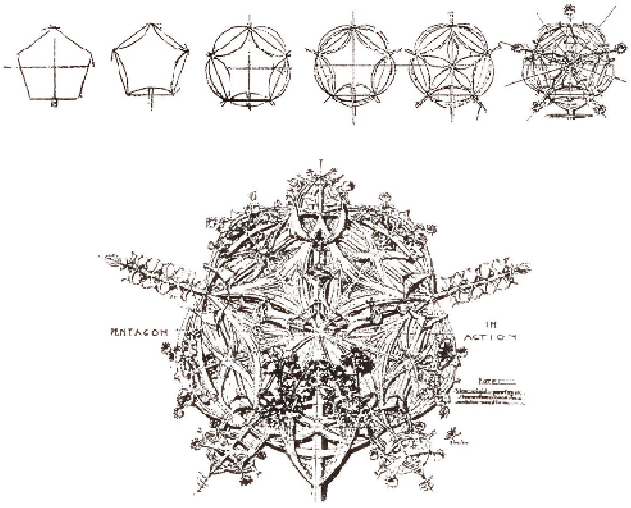


Figure 2: E. J. Nordstrom, Louis Sullivan's Guaranty Building: A photographic study of its terra cotta ornament, 2019 (source: www.urbanremainschicago.com)

guides for developing a series of manipulations based on the innate geometry of the shape. The resulting grid was the basis along which a system of abstract plant forms was developed. This growth or 'efflorescence', as Sullivan called it, of these forms, according to the rules of nature, led to a very intricate foliage outcome [8,9]. Today, the use of computational methods has as a result the emergence of a variety of techniques that can lead from a geometric shape to high resolution outcomes. A typical example is the logic of subdivisions: through innumerable subdivisions of an original shape, it is possible for a structure with infinite individual formations to be formed. It could be said that Sullivan had devised and developed, using paper and graphite, such a technic of his own.

Figure 3: Figure-: L. H. Sullivan, The Awakening of the Pentagon, 1924 (source: [9])



These intricate designs were firstly translated into clay molds, which were then used to form the elaborate individual relief ornamental pieces that constitute the facade of the building. All parts are made

of terra-cotta, a ductile type of clay, which can be formed into a variety of complex shapes and designs. Of course, the repeated use of molds made possible to produce the countless ornamental pieces of the building, which is the reason why many elements appear identical. Undoubtedly - not only in this example, but in architectural practice in general - the creation of multiple morphological features through manual processing was a time consuming but also a costly process. The application of molds for multiple repetitions of patterns and elements had greatly contributed to limiting the above. However, repletion through molding could have an additional interpretation. Using molds is a method that helps reduce and limit the amount of information, making it more accessible and manageable by the human factor. This technique, which results in repeated information, had often seemed necessary in the past to achieve a wealth of morphological detail. In the current condition, the use of the machine in the design and construction process makes such methods superfluous, as it can handle any amount of data without the need for simplifications or reductions.

Carlo Scarpa

As a last case, the paper focuses on Carlo Scarpa's work, which is generally characterized by an elaborate design of all the components and an insistence on the details - mostly ornamental. In these details is where the concept of high resolution lies. The ability to design and manage the multiple ornamental elements found throughout his works, enhance the information embedded in them, ultimately serving as a process for enhancing their resolution in general.

Figure 5: Details of molding in the Brion cemetery (sources: above [13] – below [11])

Figure 4: Detail of the façade of the Banca Popolare, Verona (source: www.archipicture.eu)

The forms and shapes of these ornamental elements that contribute to the increase in morphological information of the structures in Scarpa's works vary and occur at various and multiple scales. They have mostly to do with the creation of the various elements and materials, with their formulation, combination and composition. The peculiar formation of each material is, for instance, one of these elements. In Tomba Brion, in particular, the ornamental

management of building material is the most characteristic feature of the project. Using molds, the concrete is shaped into many parts in a 'ziggurat' motif. This geometry is a characteristic pattern of Scarpa's work, which is found, always enhancing the amount of morphological detail, on various scales, but also on additional works, such as the facade of the Banca Popolare in the city of Verona, this time elaborately carved in marble.

Figure 6: Detail of the paving in the entrance hall of the Querini Stampalia Foundation, Venice (source: [11])

Figure 7: Detail of the external revetment of the sacellum in the Castelvecchio Museum, Verona (source: [11])

Figure 8: *Detail of the wall cladding in the Querini Stampalia Foundation, Venice(source: www.archipicture.eu)*

Today, the emergence of the concept of resolution is directly linked to the perception of the architectural form as a synthesis of multiple individual elements, fragments or particles [3]. In a sense, a similar logic applied to Scarpa's design concept: "*an architectural whole is seen as a phenomenon composed by details*" [10]. Each of these details – shaped as a unique element [11] - is not just a secondary processing, but one of the multiple elements that 'articulate' each structure, ultimately producing forms with increased morphological information. This concept is strongly reflected in the creation of surfaces, such as walls, floors, etc. The use and skillful synthesis of various materials is another element that contributes to the process of increasing morphological information. Such surfaces, which consist of a combination of multiple elements like stone, marble, wood, metal, glass, and could therefore be characterized as high resolution, are innumerable in his works. Representative examples are the exterior lining of the 'sacellum' at the *Museo di Castelvecchio* with its intricate stone and marble pattern, the mosaic on the floor at the entrance of the *Fondazione Querini Stampalia*, with its various marble tiles, the formation of walls at the same project with the combination

of pieces of travertine, brass and glass, etc.
Finally, it is worth pointing out that this plethora of details, developed through a sequence of actions - from Scarpa's inspiration, invention and design to, ultimately, the construction by experienced craftsmen - were not merely an ornamental condition, but they had strongly component role. This fact makes increased resolution an inherent feature of the whole synthesis and, somehow, an integral feature of the structure and of the design process.

Conclusion

As is always the case with every new breakthrough in architectural design, especially since the beginnings of the digital age, the initial stages of the process most often than not lack the necessary tools that will aid us to form the criteria with which to evaluate the produced results. Thus, we are often led to view them as completely new and revolutionary conditions, as 'shifts' in the way we think about and practice architecture.
Here we propose a different way to 'read' such conditions. One that is not based on 'shifts' and therefore is not based on negations – in effect one that is not dialectical in nature. Instead we propose an understanding based on continuity, affirmation and constant modulation of concepts, ideas and processes. Continuity because older things don't break in order to be replaced by new ones but they rather the former ones are transcribed into the later ones. Affirmation because such a process has to be based on the acceptance of one condition in order to transform it into something new. And modulation because precisely there are always transformations that take place: it is not about repeating the past but instead about constantly altering into something else. In essence, it is about an analog way of thinking as opposed to a digital one: Despite the digital nature of our tools – in fact in some cases it is exactly because of that – we can support an analog, continuous way of thinking and acting that keeps transcending the past into new directions.
To conclude, through our reference to the past and the examination of historical case studies, we can inform our current practices and set them into perspective. Ultimately, understanding current, emerging conditions and concepts, such as 'high resolution', through a historical lens, will help us define new architectural practices that are not mere formal pyrotechnics, but are instead forming a new generative architecture within the current social, political and cultural framework. High resolution architecture, when understood as an analog concept that re-iterates the concept of ornament can become generative and lead towards new design directions.

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