CAD and the Past: Learning from Historical Representations and 'Virtual Heritage'

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TRADITIONAL ARCHITECTURAL REPRESENTATION TECHNIQUES

THE FLATTENED SPACE – J. N. L. DURAND

Technical architectural representation methods, such as plans, sections and elevations are orthogonal projections of a building; two dimensional abstractions of a three dimensional object. Such depictions not only serve as plans for a future building and therefore provide guidelines for its construction; in the practice of architectural history and archeology the orthogonal rendering methods are the essential and fundamental tools for documenting, measuring and representing a building. Here the descriptive drawings may come long after the building has been built, or in many cases after it has been compromised or destroyed. This two-dimensional documentation is the first step in understanding, analyzing and, if necessary, reconstructing the missing parts and details of the historical building.

The French architect, engineer and scholar, Jean-Nicolas-Louis Durand (1760-1834), was one of the most influential architectural theorists of the early 19th century.[1] In one of his major works, *A Parallel of Architecture* (1800), he illustrates public buildings of different periods and countries arranged by type, according to his theory of modular proportions. As a catalog of building types, there are more than one hundred plates carefully drawn in strict technical delineation.[2] The black and white line drawings each explore one building type, drawn to the same scale on each plate, and arranged in a symmetrical order when possible. Durand sometimes drew in different scales for sections, plans and elevations. There are no perspective views or axonometric projections; the same orthogonal vocabulary guides the viewer throughout the entire series of drawings.

Although this method too is abstract for a general audience, its significance lies in its simplicity. Architects, architectural historians and archaeologists share Durand's objectivist language and intent. The drawings, by their directness, let their reader quickly understand the building's organization and composition, and its comparative morphological relationship to other buildings. The creation of a three dimensional model from such sources is therefore very simple. In Durand's clear-cut, linear drawings the same technique is applied to every part of the building and the uncertain details that Durand may have hypothetically added to the reconstructed ruins are not revealed.

THE DISASSEMBLED AXONOMETRIC – AUGUSTE CHOISY

The axonometric view is used infrequently today in everyday architectural and archeological practice. Like orthographic renderings (plans, sections and elevations), this representational technique is also a parallel projection created with the aid of descriptive geometry. Therefore they also do not correspond the way we humans perceive the world, because, unlike perspectives, dimensions do not shorten with distance. Although this technique has the illusion of three-dimensionality, it still retains its technical characteristics, such consistent scale.

An engineer by training, Auguste Choisy (1841-1909) in his book, *Histoire de l'architecture* (1899), explored important periods in the history of architecture, which he interpreted from prehistoric times to the present in terms of continuous technical development.[3] Like Durand's work, his study is intended for educational purposes particularly for architects. It includes descriptions of buildings in textual and graphical form, and maps, diagrams and short summaries of historical events that had an impact on architecture. The main source of information is the text; the drawings serve mainly as illustrations. The book is divided geographically and chronologically into locations from ancient Greece to the architecture of the Far East.

Choisy extends the "conventional" methods of architectural representation (plans, sections and elevations) by introducing axonometric views. His illustrations integrate the individual orthographic projections in one single image, attaining the illusion of a three dimensional appearance without losing the drawing's technical capacity. This method of superimposing discrete views draws attention to spatial relations within the building and through its interpretation of all three dimensions eliminates the possibility that discrete plan, section or elevation drawings would not match. For instance, in drawings of Greek temples, Choisy demonstrates their structure by combining plans with axonometric worm's-eye-views. He slices the building at varying heights at different rows of columns, creating a three dimensional section and showing different constructive layers of the edifice in a single drawing. By combining plan, elevations and several different sections, the interior and hidden components of the building, such as roof trusses, are revealed, as well as the construction of the building. All of this synthesized dimensional information leads to a higher understanding of the building's form, mass, space and structure.

Choisy also applies this method of cutaway axonometric views to the visualization ancient building systems and components. For example, when discussing the Doric order, he depicts only a fragment of a typical colonnade, and removes certain pieces to show the general layout: for example, cutting away one part of the architrave or one of the columns in order to see the capital above it. Such drawings are accompanied by smaller explanatory illustrations of details: molding profiles and cross-sections that are not readable from the axonometric view. This "analytic ruin" technique demonstrates the relations of discrete pieces of the edifice to each other in three dimensions, and *explains* how the buildings are built in reality.

Even though these illustrations provide a sense of three-dimensionality, they are still too abstract and complex to be useful for a wide audience. Like axonometric views, these abstractions of form and space are far away from recognizable. Choisy uses this projection method to maintain a distance between the viewer and the building, since it is not portrayed primarily as a piece of architecture in reality, but rather through the lens of a uniform representational technique. This analytical "distance" or removing the building from its multiple "contexts" allows him to examine the historical buildings with a more objective, or scientific approach, considering only morphology, and not the way, for example, people might have used, inhabited or interacted with them.

Choisy's work proposes an important question: can the same representational technique be applied to all pieces of architecture, whether a Greek stoa or a Japanese temple? Viewers, who can gain only a "second-hand" experience through his analytical drawings, can see only the morphological and structural differences, but not the different "contexts": such as the building's cultural, social, physical, topographical, etc. In some cases Choisy saw the limitations of his method: he rendered the previously mentioned Acropolis "walkthrough" in perspective.

The "Analytic Ruin" – Eugène-Emmanuel Viollet-le-Duc

Eugène Emmanuel Viollet-le-Duc (1814-1879) was a French architect and theorist, best known for his reconstructions and graphical analyses of medieval buildings. His view of architectural history was a fusion of romantic enthusiasm for and a rational architectural analysis of the middle ages. He considered the mid-thirteen-century Gothic style as the summit of architectural and artistic achievement, and the Renaissance as an age of decline.[4] He was a central a figure in the

Gothic Revival in France and helped to create a public discourse on "honesty" in architecture, which eventually transcended all revival styles to inform the emerging spirit of Modernism.

Viollet-le-Duc saw beyond the romantic, atmospheric fascination that drew his British contemporaries to Gothic architecture, to what he conceived of as its rational structural systems and their implications for modern building materials such as cast iron. He practiced as archaeologically precise a style of restoration as he could manage, but his own designs were also remarkably innovative. His approach to both medieval and modern architecture was severely rational, in keeping with his own unsentimental appreciation of the Gothic achievement.

One of the most influential parts of Viollet-le-Duc's architectural theory was applied to building restoration and hypothetical reconstruction. He deliberately aimed to put the building into an imaginary "ideal stage" where, in reality, it may never have existed. He stated: "To restore a building is not to repair or to rebuild it but to reestablish it in a state of entirety which might never have existed at any given moment."[5] These reconstructions, however, were highly investigative and analytic, excluding the notion of uncertainty from the perspective of his audience.

Compared to other professors at the *Ècole des Beaux-Arts*, Viollet's drawings retain the technical approach, but place the buildings in perspective and with certain contextual or atmospheric qualities, such as light, shadow, and human occupation. Such representational characteristics are more appealing to human perception that the drier axonometric or orthogonal projections. Viollet-le-Duc also used the "analytic ruin" concept, where, similarly to Choisy, he disassembled building structures. But Viollet, unlike Choisy, rendered them in perspective: for example, when depicting an interior of a Roman building covered by a series of cross-vaults, he portrayed the first bay in high detail, as it might have looked, but the second bay is depicted in a structural from in a more technical fashion.

Viollet-le-Duc thus fused the analytic and "atmospheric" approaches in architectural representation. His main goal was to teach, and to illustrate his distinctive and innovative concepts of architectural history. Still, compared to those of Choisy, his works can also be considered artistic and yet purely analytic. Unlike the similar, dry style of technical delineation, he used shading, showed textures of different materials and sometimes added colors. In contrast to axonometric rendering, where the scale of the drawing is easily readable, perspective rendering requires a different set of tools for explaining the size of the portrayed building, and for this purpose he included people and other contextual elements in his illustrations. Ironically, the principles of perspective rendering were invented in the Renaissance, a period that Viollet-le-Duc considered the beginning of the decline of architecture, and yet the Renaissance emphasis on a human-centered world and a human point of view informed his representational techniques.

Analytic Romanticism – Giovanni Battista Piranesi

Giovanni Battista Piranesi (1720-1778) was an Italian architectural theorist and artist trained as an engineer and architect, he was best known for his numerous engravings of Roman antiquities. His dramatic views of Roman ruins and his imaginative reconstructions of ancient Rome inspired a new recognition of antiquity. As art historian Luigi Ficacci notes, it was in Piranesi's art "where the landscape composition coincides with archeological interest and the style of rendering becomes perfectly expressive of his intention and archeological demonstration."[6]

Piranesi's productive life-work includes etchings of ruins, depictions of structural details and analyses of historical styles in architecture. His four volume treatise, *Le Antichità Romane* (1756), contained an unprecedented wealth of technical and visual drawings about the architecture, engineering and ornament of ancient Rome. This work included 250 plates of etchings and revolutionized the range of technical and archaeological illustrations.[7] The absence of color, which would be the most essential tool for an artist of his time, is compensated for by Piranesi's accuracy and completeness in the way he depicts the context of the ruins: he illustrates the sky and the clouds, light and

shadow, and exhibits the ruins overgrown by vegetation.[8]

Piranesi's art and explorations in architectural history not only consisted of "atmospheric" depictions of ancient ruins; he made several other contributions to the graphical representation of architecture. Although he preceded the analytically-minded professors at the *École Des Beaux-Arts* discussed earlier, he created the concept of the "analytic ruin" by disassembling the structural components of the building at a very high level of detail and accuracy. Like Viollet-le-Duc, he rendered buildings and their parts in perspective and also portrayed their environment. His "assembly drawings" show how different structural and mechanical components or ornamental details were integrated or assembled into whole buildings. He also created an almost encyclopedic catalogue of details, again arranged in compositions, studying them separately but re-integrating them with the totality of the building. These drawings and all this complex information were consistently synthesized in beautiful evocative compositions, similar to the "analytiques" of a century later at the *École Des Beaux-Arts* in Paris.

Depictions of Ancient Egypt – David Roberts and Others

The British painter and traveler, David Roberts (1796-1864), during the early 19th century made long journeys in the Middle East and Egypt, which seemed to Europeans at that time a mysterious, strange and sensuous land. Being the first British artist to explore the Middle East and Egypt, Roberts presented his works in a series of views published between 1842-1849, entitled *The Holy Land, Syria, Idumea, Egypt and Nubia.* [9] The Romantic attitude towards the unexplored Orient can also be traced in paintings portraying Biblical scenes.[10] These works, like those of German artist Caspar David Friedrich, used buildings as one of the many elements, along with light, clouds, etc., that could help achieve a Romantic or "atmospheric" effect. On the other hand, Roberts treats a reconstructed ancient Egyptian city with greater detail and brings the reconstructed architectural forms into more focus. Similar to other Romantic artists, he concentrates more upon the context of the building rather than the buildings themselves, although the reconstruction of the historical forms is inevitable in order to portray them.

In most cases, the portrayal of the ruins plays an important part in the composition of the paintings. They are not merely one component among many, nor do they act as stage sets for the events occurring in front of them. If they are in the background, they provide context for the foreground, dwarfing the human scale, and they act as a metaphor for the past. Roberts may have added colors to them where the original paint had already weathered away, or he may have reconstructed them partially, but he played an important role in introducing the ancient architecture of Egypt to the Western world.

Evanescence of Existence – Caspar David Friedrich

According to art historian Wieland Schmied, the works of 19th century German Romantic painter, Caspar David Friedrich (1774-1840) are characterized by "exactitude and spirit, portraying fixed objects, giving them a special luminosity within the context of a composition."[11] His Romanticism manifested itself in depicting nature as an important component in his paintings, for example, sunsets, winter scenes or vast landscapes with misty mountains. In many cases he included architectural ruins in his paintings, portrayed through the same lens as his vision of the seasons, colors and sometimes dying nature. The ruinous buildings served as huge set-pieces in his art, underlying the idea of passing time, the evanescence of existence and human life.

In his painting, *Monastery Graveyard in the Snow* (1817-19), the ruin of a monastery is framed by two oak trees that echo dying nature during winter in their truncated, branchless forms. Only the entrance and the choir remain of the ruined church, which is represented as having greater height than it would have had in reality. The vertical linearity of the two oak trees reappears in the tracery of the Gothic windows, and also as a counterpoint to the background of the surrounding forest. Similar to the *ruins*, the cemetery in the foreground symbolizes the temporality of human life. The significance of the painting, besides its artistic value, is that the ruin of the monastery is based upon the still-intact Marienkirche in Stralsund,

Germany.[12] The artist thus imagined how it would look in the future in a ruinous form, even as he was in fact, in 1817 making designs for the altar of this church in detailed orthogonal drawings.

The significance of his paintings lies in their treatment of the ruins. Friedrich used the general concept of a ruin as a vehicle for portraying the Romantic melancholy about time passing. Among the many tools he employed, such as color, atmosphere and nature, the built forms are treated as metaphors, and not merely as architectural objects. The portrayal of the buildings does not have to be as accurate as the drawings for the more analytical approach; they are represented in perspective, and are sometimes altered to give them a more melancholy look.

Summary

The list of historical representation techniques described in this section differs significantly in their treatment of the portrayed buildings and ruins. From the analytic approach to the more atmospheric treatments, the focus shifts from the building itself towards its context. The works of Durand and Choisy rarely portray the surroundings, but Friedrich's ruins become almost unified with it. The audience is also different: the drawings of Durand and Choisy were dedicated to academics and researchers, whereas the artistic paintings of Roberts were intended for a wide popular appeal.

The historical representation techniques discussed in this section are also applicable on computer models in the digital medium. In fact, similar to the process of architectural design, the various examples in this section showed how, from orthogonal drawings to perspective renderings, these representational techniques reflect the steps taken in the practice of computer reconstructions, namely; thinking and drawing in two dimensions (in plans, sections and elevations); then synthesizing these distinct renderings with the aid of the computer into a virtual object; then constructing it further in axonometric views; and then finally creating perspective renderings, sometimes with atmospheric qualities added.

Unlike today's digital world, these historical techniques had only one possible output medium, what we call today "still images:" pictures on a flat surface that do not move or interact with their viewer. What may be a simple and modest method of architectural representation today, when real-time interactive virtual realities provide almost first hand experience with the buildings, these historical precedents are yet potentially valuable as examples of how to convey more types of architectural information besides simply a final rendering of the reconstruction. In this section emphasis was laid not on the various medium types, such as still images, animations or interactive virtual realities, but on the treatment of the model itself, with special attention to the somewhat neglected analytic qualities of Piranesi, Viollet-le-Duc or Choisy.

From the works of the artists, architects and scholars mentioned in this section, the most successful and applicable methods to computer reconstructions are potentially the ones that can synthesize both the analytic and "atmospheric" approaches. For example Piranesi and Viollet-le-Duc created works that explained structure, construction and morphology, and yet simultaneously appealed to the human perception of the world. They sought historical accuracy and yet were also very successful in making their works easily interpretable and understandable. In computer reconstructions it should be our goal to follow the path of such historical representation methods.

Reviving the Long Existing

In this section it will be demonstrated, with accompanying images, how techniques in the first section can be applied on a virtual reconstruction. As a case study, the cloister and the fountain of the Cistercian Abbey of Pilis will be displayed in a range of representational techniques. In reality, a building in its physical form may turn into a ruin or be completely destroyed. During a reconstruction, the opposite happens: once existing architecture is revived and, in the virtual world, is remodeled. As it will be shown in this section, some analytic concepts will turn the models again into ruins in order to reveal their structure and massing arrangement. Following the "analytic ruin" idea, not only are the once existing architectural forms remodeled, but is created the effect of time as well. For instance, the

virtual fragments of the fountain were dissembled from a finished model, which first had to be completed and created according to the remaining physical evidence.

In architectural practice, buildings are portrayed by abstracting space, in orthogonal projections: plans, sections and elevations. The understating of an object begins with a reading of these drawings. Here, the Pilis fountain is portrayed in these projections, like to Durand's works, not as plans for a building being built in the future, but as portrayals of already existing architectural forms. These renderings bear explicit information about dimensions and shapes, but they are too abstract to appeal to a wide audience.

Following the general architectural representation method of plans, sections and elevations, a more complex understanding of the layered structure can be achieved with Durand's methods. The projections are still orthogonal, but discrete levels of the edifice are combined in a single drawing. This treatment of the fountain takes advantage of its symmetry, similar to the example of different amphitheatres from the *Parallel of Architecture* discussed in the first section.

Like the corresponding examples in the first section, axonometric worm's eye views of the cloister and the fountain synthesize plan,

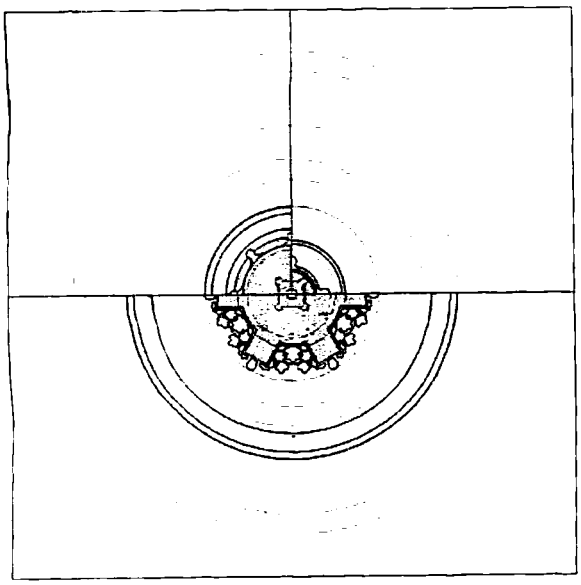

Figure 1. Bottom view showing discrete layers of the edifice, exploring the fountain with Durand's method

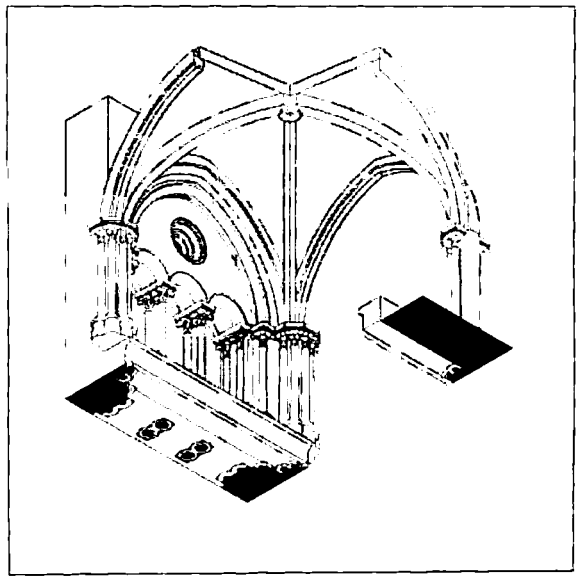

Figure 2. Axonometric rendering of the bay, synthesizing plan and section

section and elevation. Compared to orthogonal drawings, these methods of depicting buildings emphasize spatiality without losing any of the dimensional relations. The shaded section and the axonometric view of the cloister both express three dimensions; yet only the latter retains the technical information of discrete plans, sections and elevations.

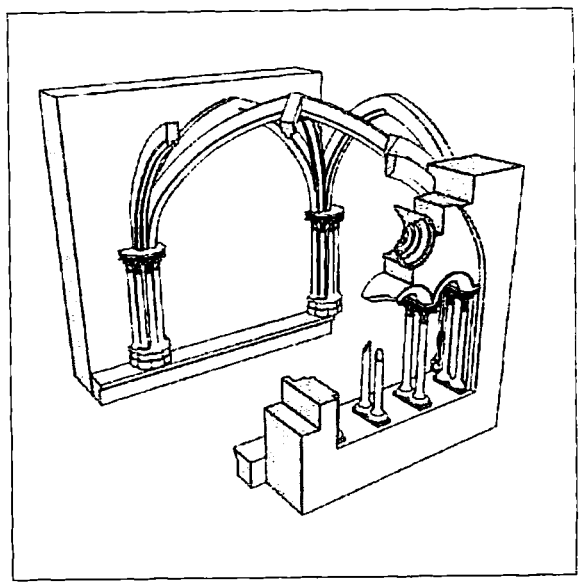

Figure 3. One bay of the cloister turned into an "analytic ruin"

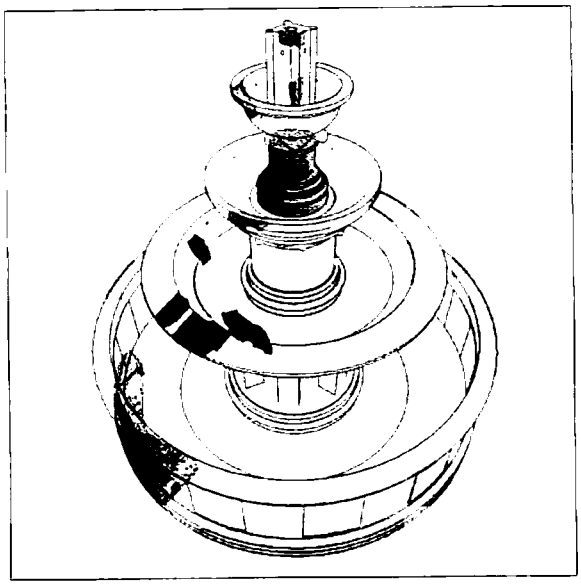

Figure 4. Superimposing fragments of the fountain with complete model

Figure 5. Interior view of the cloister

Viollet-le-Duc used the "analytic ruin" idea to disassemble a reconstructed building and therefore to demonstrate the structural systems and relationships between interior and exterior. One bay of the cloister was turned into a ruin, alluding to the deteriorating effect of time. Even though put into perspective, these renderings take the architectural form out of its context. Though these renderings are excellent technical tools for creating formal studies, they are still too abstract for a general audience.

In archaeological practice and architectural history, piecing together the remaining physical evidence of the once existing building is crucial during the reconstruction process, but can be difficult to visualize. It can be verified later by placing the still existing pieces into the completed digital model. Fragments of the fountain of Pilis Abbey made from a complete, rendered computer can be highlighted like "digital ruins," and positioned within the complete reconstruction depicted only in hidden wireframe.

Colors, shading and contextual elements, such as water in the fountain, bring the model to life. Excluding the context, the accompanying images represent a compromise between the analytic and atmospheric approaches. The colors correspond with the archaeological findings. Such renderings make the edifice historians and the general public alike. The model aims at accuracy, but photo-realism may obscure the possible questions of uncertainty about the reconstructed forms.

Conclusion

The first section demonstrated that even though many techniques are known and are used in computer representations in architecture today, most of them were invented and exploited for centuries by skilled architects, artist and art historians. These still works represent a great diverse selection of ideas in architectural representation: analytical technical drawings of plan, section and elevation; investigative perspective renderings of structures; and landscapes with distant and imagined buildings filled with emotional and atmospheric appeal. However far they may be from each other in their approaches to the problems of visualization, these techniques share one thing in common: all depict the non-existing and seek to rebuild the lost architecture of the long-ago past.

The goals of today's computer reconstructions have not changed. It is therefore important to take into account these historical methods that have already been improving over centuries, and have a well-established role in architectural education, art and even entertainment. The analytic approaches mentioned in the first section can serve the

need of emphasizing the technical aspects of the building, while also highlighting the interpretive nature of digital reconstructions. For example, the explanatory illustrations of Choisy shed light on spatial and planar correlations; the disassembled buildings in the drawings and etchings of Piranesi and Viollet-le-Duc portray structural systems that would otherwise be hidden. The "atmospheric" treatment, on the other hand, of Roberts and others draws attention to the architectural context and appeals more to human perception, but can exaggerate the emotional aspects. From analytic to atmospheric, the sequence of exploration of these techniques reflects the process of reconstruction itself: from plans and sections to three-dimensional models placed within contextual environments.

With the synthesis of traditional representational techniques, the analysis of contemporary digital reconstruction projects, and with the historical overview of the site, this paper attempted to shed light on emerging questions in computer reconstructions. It utilized ideas of scholars in architectural education to reflect more upon the educational, analytical and interpretive capacities of digital models. These concepts were transformed into the virtual world to create images of the Cistercian Abbey of Pilis that show more than a finalized, mostly photo-realistic rendering. The images of Pilis demonstrate that the infinite possibilities in the digital world may be utilized to create three-dimensional visualizations of abstract analytic thinking, exploratory perspective drawings and atmospheric renderings all at the same time. All these techniques in combination provide a rich, multi-dimensional visual and intellectual experience that goes beyond the merely resemblance of the long existing.

Notes

[1] Fleming, John. *The Penguin Dictionary of Architecture*. Harmondsworth: Penguin, 1972. p 81.

[2] Durand, Jean-Nicolas-Louis. *A Parallel of Architecture*. New York: W. Helburn, 1905 (1800).

[3] Choisy, Auguste. *Histoire de l'architecture*. Ivry: Serg, 1976 (1899).

[4] Kruft, Hanno-Walter. *A History of Architectural Theory: from Vitruvius to the Present*. New York: Princeton Architectural Press, 1994. p 282.

[5] Viollet-Le-Duc, Eugène-Emmanuel. *Dictionnaire raisonné de l'architecture française du XIe au XVe siècle*. Paris 1854-68. Vol VIII (1866) p 14.

[6] Piranesi, Giovanni Battista. *Giovanni Battista Piranesi: The Complete Etchings*. Köln; New York: Taschen, 2000, p 19.

[7] Ibid. p 9.

[8] *Piranesi*. Smith College. Museum of Art: Northampton, Mass. 1961. p 11.

[9] Mancoff, Debra N. *David Roberts: Travels in Egypt and the Holy Land*. San Francisco: Pomegranate Communications, 1999. p 10.

[10] Ibid. p 36.

[11] Schmied, Wieland. *Caspar David Friedrich*. New York: H. N. Abrams, 1995. p 7.

[12] Hofmann, Werner. *Caspar David Friedrich*. London; New York: Thames & Hudson, 2000. p 66.