Drawing and Construction Analysis: from Piranesi to Choisy

Javier Girón

INTRODUCTION

Nobel Laureate Richard Feyn remembered in his book, "*The pleasures of finding things out*", that when he was a child, he made a fundamental discovery. He was discussing with a friend what thinking really meant. When he affirmed that thinking was essentially to have words in mind, his friend defied him to think of a crankshaft with words. At that moment, he learnt that thinking could be either verbal or visual.

In so doing he pointed out at a fact sometimes ignored in the history of technology. What is more, we all think not only by using images, but also in drawings. Let me invite you to examine together the way we think with a special kind of drawings, those devoted to analysing the construction of ancient buildings.

They have distinctive scientific features, rather than technical, and therefore they achieve a very difficult task: penetrating and showing the intimate or invisible parts of the construction of an existing building. Very often in the past, their creators did so without any physical operation over their object of study. Their main instruments have been their bare mind and their drawing skills.

Those drawings - think of those by Viollet or Choisy - can be considered "intelligence condensed", as they are not a mere reproductions, but create new realities where construction processes become clear and "transparent". Any robot or photographic camera could never generate them.

How did they come into life? This impressive achievement may be easily underestimated now that their circulation has made them common and therefore very familiar to us. In my view, this reiteration is the sign that they possess something precious and difficult to overcome. In fact, this sort of drawings has a fascinating history that I wish to share with you.

My point is that those drawings are the coalescence of two changing factors, mind and drawing, whose relationship should be studied. Their creators' minds see the construction process "through" a particular analytical filter - as we will see, it is probably connected with those existing in fields as anatomy, geology, etc.. Also, their drawings use graphical strategies, borrowed from other fields as well.

As these studies are at present rudimentary, I will not offer a comprehensive view. If History may be compared to a chessboard, where some can move as a bishop making deep, straight movements

on a line, I admit I will rather here move as a knight, sometimes going forward, sometimes back, trying to avoid some obstacles along the way.

VIOLLET-LE-DUC ANALYTICAL CONCEPT

This history, or at least one of its branches, could start in the middle of the XIX century. I invite you to observe the drawings by Viollet-le-Duc, a French architect very well known for his work as a theoretical propagandist of constructive rationalism, as well as for his studies and restorations of medieval architecture.

It is worth noticing how warm and amazed was the reception of his drawings among some his contemporaries. When we hear Charles Blanc saying in his *Grammaire des Arts du dessin* (1867, p.289):

> In Viollet-le-Duc's book we can see the figure of all the members of gothic architecture, that is to say, the detailed anatomy of this great body. In each of his pages, the text is clarified by a marvellous drawing full of relief, truth and colour, making sensible, as if one could touch them with one's fingers, the demonstrations of this master.

We can feel the surprise, even the admiration, of being confronted with something new. It is not difficult to find more effusive appreciations. Claude Sauvegeot celebrated this analysis of a prototypical Doric temple **(fig.1a)–**intended for the instruction of the students of the Ècole Spéciale d'Architecture founded by Viollet-le Duc: "This was the best way to show every particular, of being for everyone understood, especially by the youth, who could find this drawing useful as a graphical model and as explanation of the structure and decoration as well"(Sauvageot, p. 118).

But, was all that so really novel? If, only for a moment, we pick up this drawing from Piranesi **(fig.1b)**, published in 1761, we begin to wonder if the history of this kind of drawing, analytical explanations of the construction of an existing building, can be tracked back. But I will resume this argument a little later.

First, let's examine in more depth the way that Viollet-le-Duc's drawings "work". We can see them as a reaction against the "normal", "customary" drawings in plan, section and front, following the principles of Monge's Descriptive Geometry. This comprehensive depiction of a building could be regarded as an external approach (that ideally a machine could trace). Instead, Viollet-le-Duc proposed an idea of drawing akin to the Leonardo's anatomies. To draw is to know the internal mechanism of form, the reverse being true as well. In order to reach this goal, some new graphical strategies are needed, and above all, a dialogue between hypothesis and drawing.

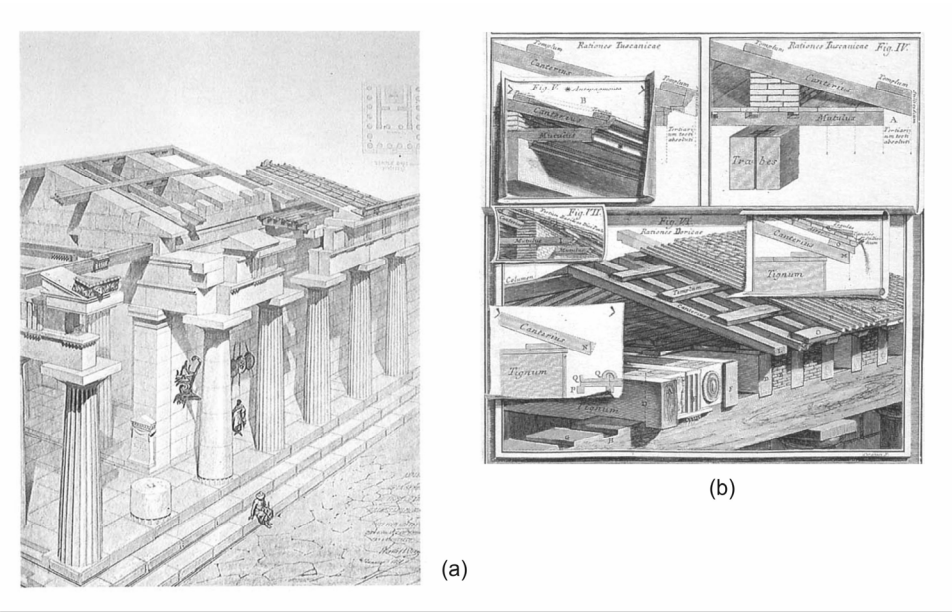


Figure 1a, 1b

What can be found when opening Violet's graphical toolbox? The most up-to-date studies on the matter, especially those by Bressani, (2000, 1996) have focused on the "exploded drawing" strategy. At a first glance, this approach was already used –probably for the first time– by Leonardo to illustrate a crane device (at the end of the XV century), a solution that will last occasionally in mechanical treatises that would appear from then on (or in woodwork and carpentry's manuals).

But, if we refer to a restricted analytical tool applied to existing buildings, it seems to appear later in a less known treatise written by Spini c.1658 (Borsi, 1980). But as long as those drawings remained unpublished in Viollet-le-Duc's time, his "architectural analytical exploded" drawings could be fairly judged new.

Then, why had Viollet-le-Duc to resort to this kind of drawings? As we have mentioned above, those analytical drawings are guided by hypothesis, presumptions that act as intellectual filters that make us see the reality in a new way. Therefore, they create, just by drawing it, a new reality open to our reason. Their aim is not representation but recreation.

One of those intellectual filters in the mind of Viollet-le-Duc is, surprisingly enough, Descartes. He urged explicitly reading his "Entretiens", so that the study of architecture reached the level of other disciplines (1863, p. 452).

He explicitly admits to follow the path of the "Regulae". He recommended first to separate a building in his minute simple components in order to examine them, and then to go backwards looking for a synthesis.

The "esprit du méthode" has not been yet applied to archaeological research pertaining to the arts… Applying a method is essential for the knowledge of the arts of the past, and I see nothing better than following the four Descartes precepts:

1) Never take something for granted without absolute certainty

2) To divide difficulties into simpler parts easy to manage

3) To go by grades from the simplest to the more complex elements

4) To do a thorough review in order to be sure that nothing is omitted.

Although, as we will see, these drawings are separated in time, the one shown on the left may illustrate the analytical phase and the one on the right could illustrate the synthesis.

VIOLLET-LE-DUC AND ANATOMICAL DRAWING

As we have suggested at the beginning, it is possible that another intellectual filter used previously in the graphical thought of other disciplines had migrated to the architectural analysis field. As Bressani has fairly remarked, anatomical drawing should be influential in Viollet-le-Duc's way of looking at reality.

Anatomy could be regarded as the science that applied "avant la lettre" a Cartesian program, as far as it dismounts a human body in the hope of a future problematic synthesis.

Bressani pointed out that Viollet-le-Duc benefited from some of the most recent advances gained by anatomical drawing in his time (focusing on J.B.M Bourgery's work). He had a good "historical" chance. New graphical strategies could be borrowed and incorporated into the tool box. If we return to the drawings in "Annales Archeologiques" **(fig. 2a)** we see that in 1847 he knew how to analyse in a way that seems to reflect anatomical treatises such as Süe's (1759). It is worth citing this one because it was used for the instruction of the École de Beaux Arts' students, and Charles Blanc recommended it. Both, Viollet-le-Duc and Süe present the bare components as if they were samples displayed in a drawer.

But by 1859 the strategy has dramatically changed (fig. 2b). We are submerged in a three-dimensional space where gravitational forces are in action. Now we can see at the same time the

analysis and the synthesis. Our mind "feels" the analytical action prompted by disaggregated parts, simultaneously experimenting that a natural force of attraction is pushing them together (the synthesis movement).

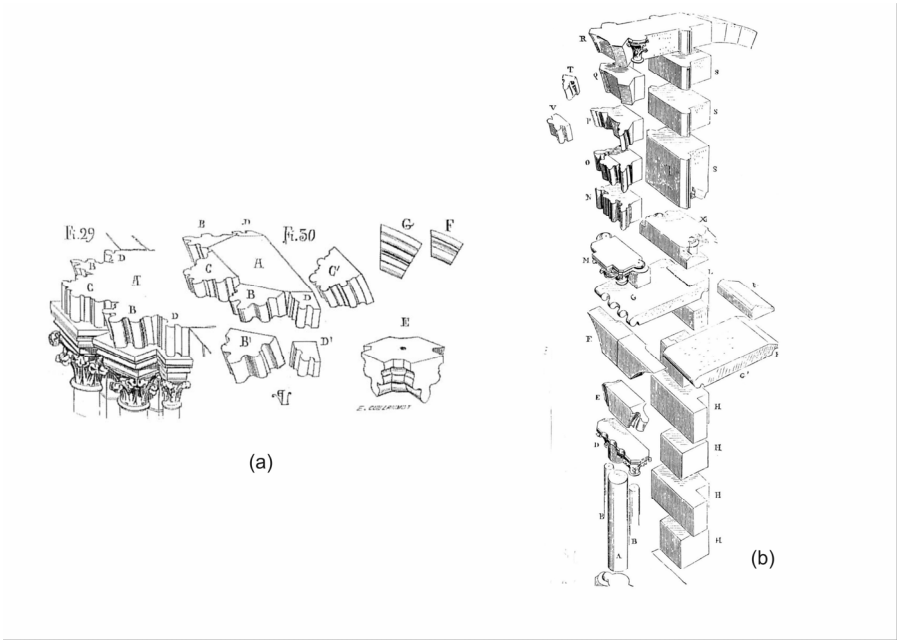


Figure 2a, 2b

RECONSTITUTION AFTER ANALYSIS: GEOMETRY AND THE INFLUX OF CUVIER'S PALAEONTOLOGY

As Bressani has suggested, other sciences are to be considered. It is also possible to trace some influx from the Cuvier's Palaeontology. For him the reconstruction of a body from sparse remains was possible, even from a single one. Trying the same thing in architecture was a fascinating challenge.

If for Cuvier (1825, p.3) "beginning by one any part (the claw, the shoulder-blade, the femur) and taken by itself, those who possess the rational laws of organic economy are able to rebuild the whole animal"; for Viollet-le-Duc (1872, p.34) "every fabric must be separated into its constituent parts, allowing each piece to exhibit clearly his function […] If when faced with one of the ruins of ancient buildings we follow this principle, we can be sure of its reconstruction".

A building according to that should be considered an organism in which the whole is implicit in every part. Viollet-le-Duc (1863, p. 418) assured that "if the Amiens cathedral was reduced to

debris, we should first examine each remain, and then, by using the graphical formula indicated in the figure, eventually assign its place".

What is noticeable here is his confidence in a new "graphical tool" to make that "cuverian" reconstruction in architecture: what later would be known as "tracé regulateur". In fact, he will urge and promote this kind of geometrical studies in his "Entretiens" (1872) (and celebrate the work already made by the engineers Aurès and Choisy (pp. 443-4). He believed that a new architectural history will emerge: a history not based in style and bare form, but a deeper form of knowledge, a history that will unveil the organic laws that rule buildings and their paths of transmission through different cultures. But this interesting trend, linked to the "cuverian" view, will be subject of a later study still in progress.

It is possible to explore further the connections between his analytical drawing and the ideas of Cuvier. For Cuvier, compared anatomy could never reach its end if it did not take into account the movements of the living body studied. Viollet-le-Duc tried to shift the comparative study onto the mechanical world. He invited in his charming last book, "Histoire d'un dessinateur" (1879, pp. 132-3) engineers to imitate the way nature produces movement when creating a mechanism (an engine in each kneecap).

Summarizing, Viollet-le-Duc's analytical drawing is born out of a fresh and sophisticated conception. His analytical view aims at eventually reconstructing a living building, with the guidance of Descartes in one hand, and the inspiration of anatomy and Cuvier's palaeontology in the other. His strategies (especially the "exploded" view) could remind us of others already used, but they are renewed and modified.

CHOISY'S ANALYTICAL DRAWING OF ROMAN CONSTRUCTION

But good as Viollet-le-Duc's drawing is, it fails when confronted to Roman construction, it shows its impotence to penetrate and explain it. Although Sauvageot (1880, p. 118) celebrated warmly this drawing **(fig.3)** of a Roman "Terma" that paired the reconstruction of the Doric temple we have already mentioned, what can be seen in the dissected zones is no more than a jumble. The expected "parts" are not shown. Drawing does not achieve its purpose, the analysis of the amalgam of Roman concrete. We must admit that we will never learn how the Roman constructed by looking at that illustration.

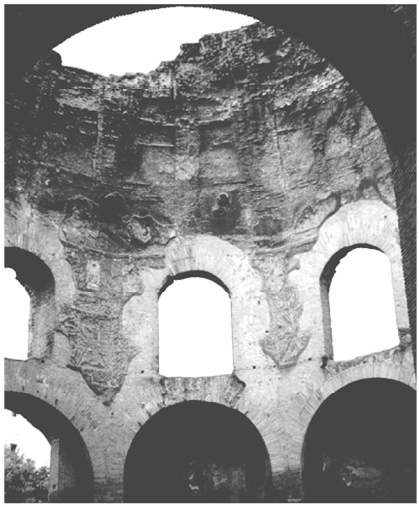
As is well known, the "discovery" of Roman construction is credited to Choisy, an engineer, who was supported in his youth by Viollet-le-Duc as a promising historian. How did he achieve to "see" and "show" in his drawings what was denied to the scalpel of his master?

Figure 3

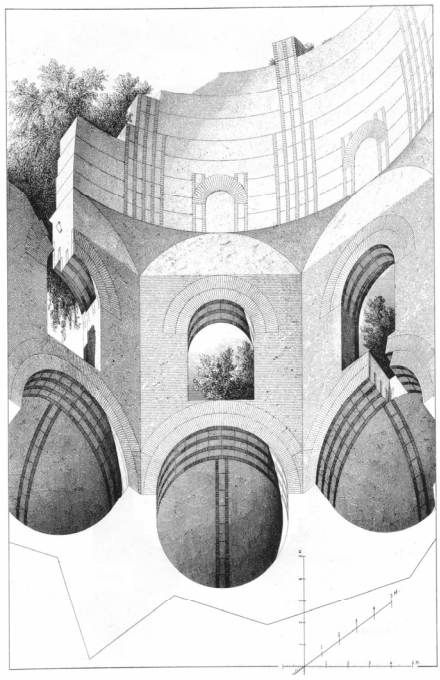
We are probably tempted to think that from Viollet-le-Duc on there is a simple, smooth propagation of his analytical strategies among his followers. Even Bressani (1996, pp. 28-30) leads us to see Choisy's drawings just as a kind of colder, mechanical adaptation. It is true that he acknowledged the influence of this master (1873, pp. 3-4) and that he diligently tried to answer the inquiries Viollet left unanswered, but his drawings use quite a different strategy, a strategy which empowered him to "see" what his master could not.

In fact, it is not only Choisy's graphical approach is different, but his intellectual filter as well.

Choisy (1873, p. 4) wanted to present himself as a "scientist": "I imposed myself as an obligation to mention anything but what I have tested personally". Nevertheless, "objectivity" was not aimed at any price. In other words, photography is not the ideal of scientific approach: "In order to make intelligible the thinking of the constructors, I have been forced to draw the "framework" with a regularity that an exam of the ruins will contradict in more than one instance" (p. 42).



(a)



(b)

Figure 4a, 4b

Photography and drawing of Minerva Medica speak out for what Choisy meant **(fig. 4a, 4b)**. There is a kind of "transparency", a creation of a new crystallized reality never reached by Viollet-le-Duc. It was a conscious intellectual and graphical operation, and a difficult one, as he admitted many times: "The constructive disposition shown by the drawing is not easy to be observed *in situ*, as the concrete is made of ceramics debris with the same colour than the bricks of the frame, and so clumsily made that one must be previously aware of its existence" (pp 50-51).

What led him to those graphical solutions that allow understanding Roman construction, so telling as to be replicated endlessly until nowadays? They show a different strategy, but a different intellectual filter too. He saw the building not as an organism to be dissected, but as the result of a

process. A building is something that has come to reality “through time” in a way that has to be tracked back in order to “cope” with what is in front of us (as in Geology). Choisy imagined the “building site”, the skill and organization of the workers, the different stages of the construction progress, the temporary means used and the various tasks.

His favourite graphical strategy is what can be described as “cutting layers”, a strategy more adapted to exhibiting the successive stages than the “exploded vision”. Very often, the beautiful illustrations at the end of the “L’art de bâtir chez les Romains” sum up in a single drawing what had been explained before in scattered drawings along the text, and draw attention to the different stages that can be seen at a glance.

What we have seen drives us to appreciate the originality of Choisy’s drawing and thinking. He used a different graphical strategy and a different approach, in the context of a scientific investigation. His drawings are not passive reproductions, but depicted hypothesis. Gazing at his drawings Roman construction is thinkable.

Bearing all that in mind, the history of drawing seems more complex than thought. Next, we will try to review and trace back theses strategies and filters used before and inherited by those founders of the modern analysis of construction.

THE BACKGROUND OF CHOISY’S GRAPHICAL STRATEGIES AND TIME’S CONTROL.

By “cutting layers”, Choisy condensed time, presented many successive actions and, as these actions were “frozen”, they could be examined calmly.

But the control of “time” is an old problem. From the Renaissance on, painters have faced it with fascinating naivety. If we take into account only construction-related time problems, we may point at some modalities: there are paintings that can be seen as the capture of an instant. Others are like “forged snapshots”, where what is represented as occurring simultaneously before our eyes is a sum of successive activities –even sometimes, as in the second drawing (fig.), there is a formal section disguised as a factual construction in progress! –. And we can also find the depiction of successive “instants” as occurring in the same place.

A scientific mind can take advantage of the fact that those depictions “create” a new reality that is not observable in a straightforward way. They “build” an idea of “time” and offer a way to control it, to take possession of it. Those formulas could be transferred from painting to scientific illustration.

“CUTTING LAYERS” STRATEGY. FROM PAINTING TO SCIENTIFIC RECONSTRUCTIONS OF VITRUVIUS.

To set one pioneering example of this strategy in painting we could stare at this “miniature” **(fig.5)**. This is a fragment inserted in the Roman de Gerart de Rousillon by master Jean Dreux (c. 1450).

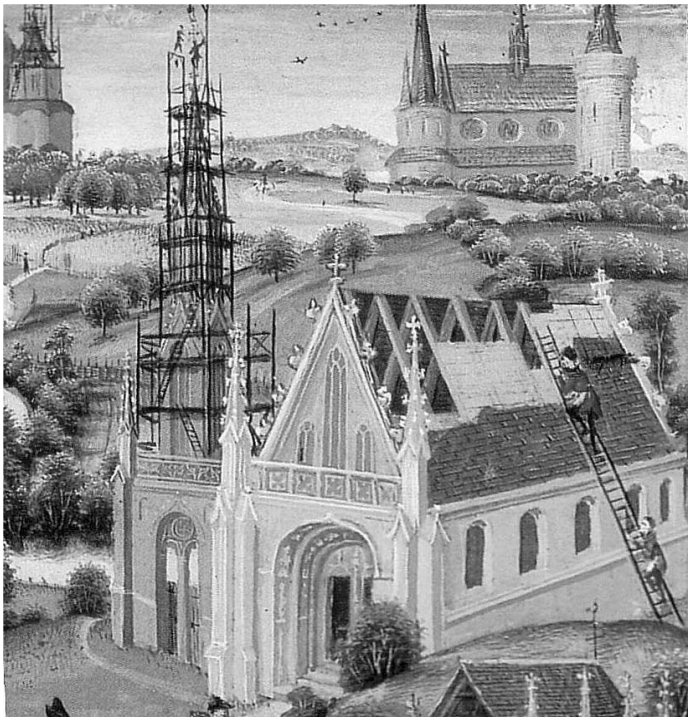


Figure 5

Its translation as a “scientific” demonstration, intensively used (and as far as I know, for the first time) appears in the Vitruvius of Rusconi, a Venetian architect and engineer that occasionally collaborated with Palladio **(fig.6)**. Having the misfortune of being Palladio’s contemporary, Rusconi’s work, written already by 1553, will have to wait until 1590 to be edited posthumously.

Although, as Choisy, Rusconi studies the construction of the Romans and the drawings echo in some way those in “L’art de bâtir chez les Romains” there is an important difference between them. Rusconi illustrates a treatise, his aim is to give visual form to a text, and there is hardly a representation of a probable existing building.

We take for granted that a scientific approach implies going directly to examine things themselves (as Choisy boasted about). But if we had in our hands a text that could account for the construction

of the Romans, and at the same time we realize how difficult is to "see" in the mingled ruins, probably we were forced to assume the same point of view as Rusconi's: the first task is just to produce a visual translation. Only then, and having those drawings as "filters" and likely "hypothesis", is possible to examine real buildings with some success. In other words, more than Anathomy, Rusconi makes Philology.

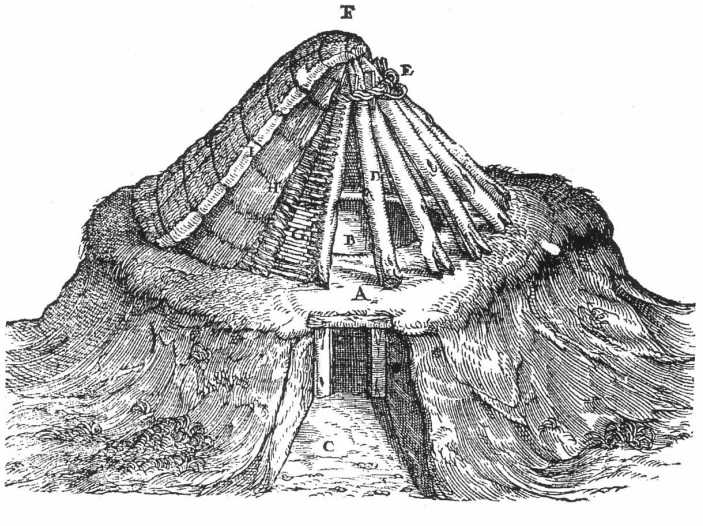


Figure 6

The excellence of the Rusconi graphical solutions is confirmed by the multiplication of their versions. Perrault (1673), Galliani (1758) or Soane (lectures of 1810-20) (Middleton, p. 13) among others would appropriate and transmit solutions as the "conical hut". The almost unchanged versions along two centuries are the proof of the excellence –and the difficulty of conceiving an alternative to them.

On the other hand, the merit of Choisy is enhanced when we remember that what was missing in Vitruvio is just vaulting technology.

FROM VITRUVIUS TO NEW ENGINEERING

The propagation of the "cutting layers" method will reach in the XVIII century new fields as engineering. To review them we must for a moment leave aside our focus in his analytical power and consider it as a descriptive tool ready to explain new technical solutions. This is a history that could eventually explain why Choisy, an engineer, found at hand this graphical procedure.

In "L'architecture hydraulique" (1753), Bélidor used intensively this strategy. This work, a compilation of projects for water mills, sluices, waterways, and one of the first reflecting the

"scientific revolution" (integral calculus is in it), will have great influence in the next century. Its drawings –this time in plan, section and elevation- have a pedagogical purpose and are doubtlessly fascinating. However, they have a limitation (present also in Rusconi): they explain the sequence of works, but not their duration. This drawback will be overcome by another engineer: Perronet.

PERRONET'S DRAWINGS AND THE SEQUENCE OF WORKS AND TIME

When we turn the pages of his "Description..." (1782), we find something new and surprising. There is a continuous narrative, from the very beginning (foundations) to the completion of the bridges projected by him **(fig.7)**. The drawings in plan and section are carefully dated, and the text is a very detailed memory of the work progress.

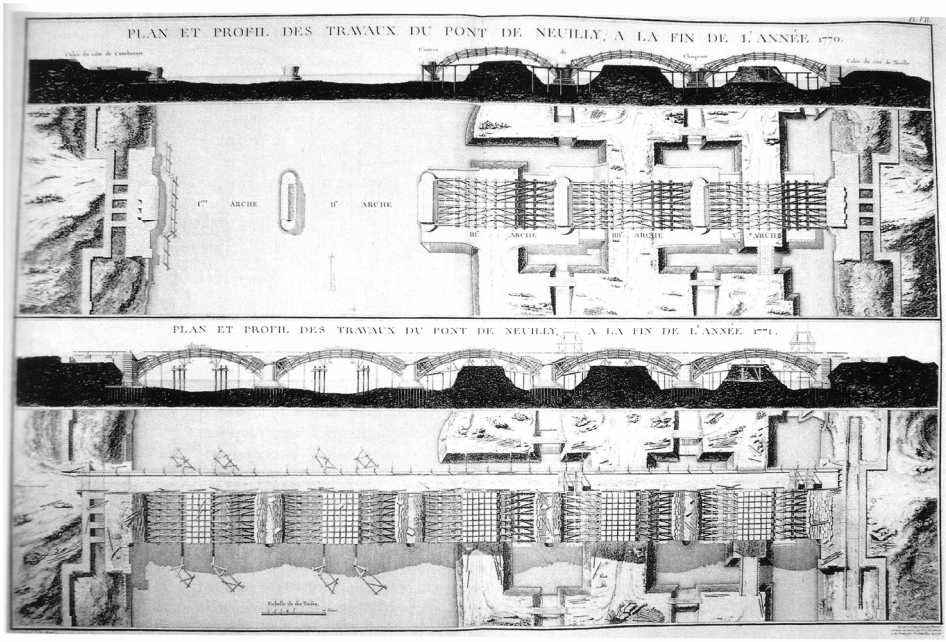


Figure 7

It is tempting to see the drawings as a kind of film. But it is even better than that. If we see an almost "true instant" of the building process of one of his bridges, we cannot see but a mess. In a film, we would have plenty of scenes as confused as this one. On the contrary, each of the stages is portrayed by "Rusconi like" drawings, where time and order are disciplined, and the sequence is clearly visible.

If his procedure could be termed an inverse anatomy, which builds instead of dismounting, it is one of a new kind: anatomy with a clock.

REVIEW OF STRATEGIES IN USE AND QUESTIONS ABOUT THE INTELLECTUAL "FILTER"

Let us summarize what we have seen. The graphical strategy of uncovering layers appeared as an instrument to portrait written descriptions of Roman construction in Rusconi's Vitruvius (XVI). The French engineers (XVIII) benefited from it to explain new technical solutions. At the end of this phase, not only the order of task, but the time consumed in each stage could be shown. A sense of efficiency and rational economy was penetrating the way buildings were drawn.

A philological reconstruction of Vitruvius (that could eventually conduct an examination of real buildings), and a pedagogical illustration were already at disposal. But a thorough analysis of existing buildings of the past was not yet achieved.

To go a step forward, something in the "intellectual atmosphere" that transmitted confidence in what Choisy was going to do was needed. Anatomy has been postulated as the inspiration of Viollet-le-Duc's method (to separate, examine, and then mount again). The efficiency in other fields (Philosophy and Palaeontology) had stimulated in Viollet-le-Duc the confidence in his translation.

But Choisy's achievement could be described differently: he was able to trace back the forces that end in the present form, to understand form as the end of a process which implied a sequence of tasks, more or less skilled operations, and temporary means.

There is no doubt that Choisy's education as an engineer and his probable knowing of engineering books had its influence in him. However, those books illustrated new technical processes, while Choisy did analytical science.

In order to find more stimulus for Choisy's mind, perhaps we should seek other sciences, search through other fields where this model of thinking, this "filter" had proved his value.

ENGINEERING AND GEOLOGY AS "FILTERS"

Geology is a science which exerted a significant influence among some French critics, historians and architects in the middle of XIX century. To select only some examples, we may see how Aucisse de Caumont in 1830 represented the history of religious architecture (Talenti, p. 203), or how in 1855 Viollet-le-Duc –I think for the first time– used a thematic map to establish a stylistic classification (Girón-Sierra, 2003). In this case, he correlated a geological map of France with that of different decorations of Gothic architecture. He showed how the various qualities of the quarries determined the carving subtleties. It is worth remembering also how in some instances Viollet-le-Duc set out the periods of Gothic architecture using geological language.

Also, Geology is a science whose procedures have something in common with Choisy's analysis of architectonic ruins. They both consider the object of study as the end of a process (that includes degradation), and so to understand the object presented to us we need to retrace its history back to an original moment. Then we can "set in motion" a hypothetical reconstruction. The agents that are involved in the changes that determined each phase should be identified. In sum, to understand the particular object I need to trace a hypothetical history.

Both Choisy's method and Geology also share some limits that Anatomy doesn't. They cannot destroy physically the object studied, whereas Anatomy can renew his object incessantly. The object has a singular individuality, which can be understood usually by inference. What is more important for us, these inferences have very often recourse to drawings that model each hypothetical phase. Those act as "new realities" not observable in fact. It must be said that the role of drawing in the history of Geology has been studied in Rudwick's (1976) pioneering and still stimulating article.

PIRANESI AND GEOLOLGY AS INTELLECTUAL "FILTER"

Before checking more precisely this similarity in Choisy's work, we can wonder about his originality. Is it possible to point at a precedent? Can we find someone who had paved the way for him? In order to answer this question we are forced to go back again in history, moving as the knight in the chessboard I mentioned above.

Piranesi could be regarded as the first who analysed singular buildings in that "geological" way, a fact I intend to show here.

There is an intriguing feature in his drawings that make them stand out from their precedents and even the future ones. Many of his surveys incorporated the foundations, giving a whole description of the building in plan, elevation and section **(fig.8)**. This suggests a more scientific approach than other views. But obviously, for most of them, there was no way to have a direct inspection of their subterranean constructions.

Taking into account what scientific work means for us nowadays, we are naturally tempted to consider those drawings by Piranesi as simply fantastical plays, exercises of imagination. However, astonishingly, there is no evidence that they were not taken seriously. I will show that they could be accepted by his contemporaries as coherent, credible hypothetical reconstructions. Even more, I will explore if they could be regarded as "scientific" in their own way.

Piranesi seems to have used previous graphical visualizations of the Roman foundations –in Vitruvius as Rusconi's, or illustrated editions of Alberti's treatise – as a starting point for his

hypothesis **(fig. 9a, 9b)**. He tried to accommodate them into each building (as we see in the Marcelus Theatre). What we see is not total fantasy… but a "probable state" of the construction. Could that operation be designated as science?

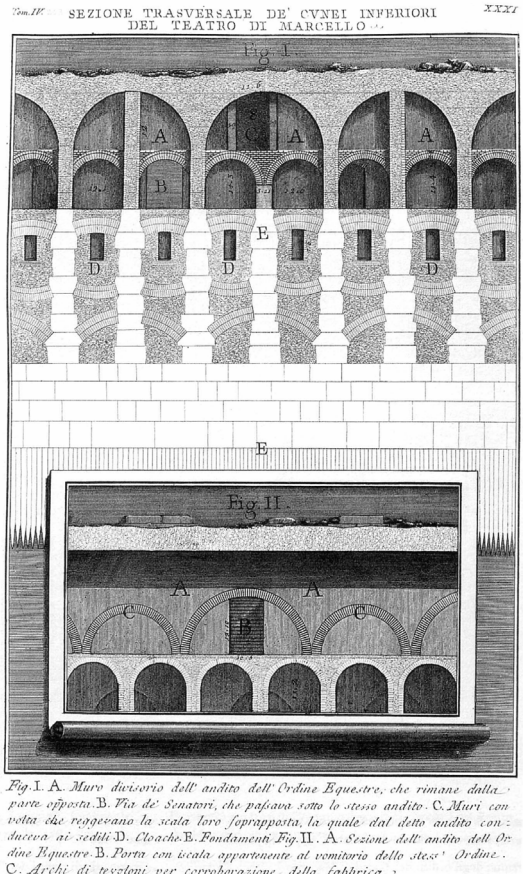


Figure 8

There are proofs of a scientific ambition in his drawings. For instance, when representing bridges he carefully made notes of the level of different river floods. When he proposed the graphical reconstruction of the "emissario del lago Albano" (1762), he debated other theories as Kircher's, supporting his claims in scientific data as the barometer measurements taken by the astronomer and antiquary Bianchini. Incidentally those registers are represented in the way "pregeological treatises", as Descartes or Weheler illustrated their visions of the earth history.

Apart from that, in his work on "Cammini"(1769) Piranesi recommended the designers to find inspiration in shells, arguing that the ancients had already showed the way. The fact that he believed

a shell inspired the form of an Ionic capital, and even probably some kind of roofing, can seem anecdotal. On the contrary, it is worth noticing in his text that he appeared to be familiar with the scientific collections preserved in museums, as the Collegio Romano, where he might find not only antiques, but natural curiosities as fossils. He also affirmed to be in possession of remarkable scientist's books as Gualtieri's on shells –whose illustrations he copied–, a science that was intimately related to the new Geology and which included references to fossils as well.

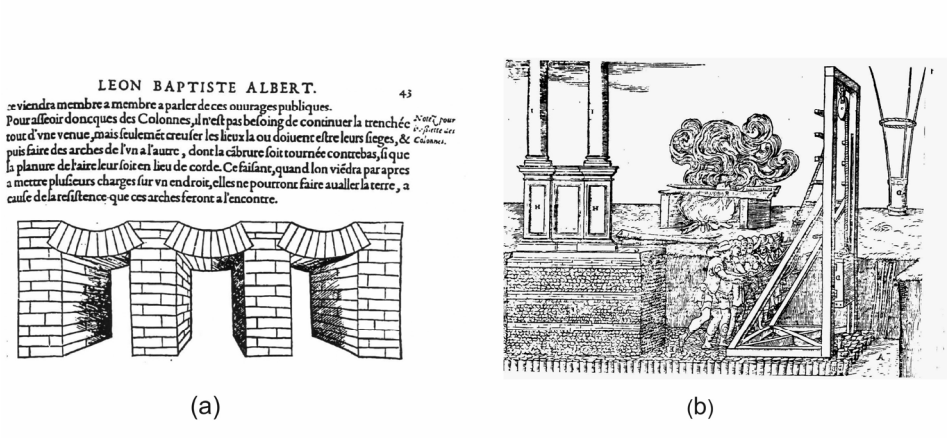


Figure 9

Presumably Piranesi had some contact and some knowledge of the scientific work in fields close to Geology. The similarities between the geological sections (as for example those in Moro (1740) and Piranesi's probably are more than superficial **(fig. 10)**. He could feel –so could his contemporaries– that his descriptions of whole constructions were not far from what Geology was doing at that moment: drawing credible hypothesis (usually in section).

He treated buildings as objects whose "invisible" construction could be inferred by using "credible drawn hypothesis", which eventually could prove true or false, as much as the construction of the earth can be drawn and inferred, and with as much the same grade of certainty (or uncertainty at that moment). He left a way of seeing into the invisible construction; and a way to represent it. Those questions are more extensively studied in Girón (2005).

CHOISY RECONSIDERED

As an engineer, Choisy must have been used to the graphical strategies that Belidor and Perronet had explored to explain a "project". These were technical and pedagogical tools to explain something the author knows well.

However, applying these graphical strategies to an existing building, with many hidden parts and

many others difficult to interpret is a very different affair. It means undertaking difficult "scientific" work that needs to make hypothesis. Here Geology could have had a role to be explored again.

Geology in Choisy's time was a mature science. Its status was solid and, therefore, more likely to inspire new ways of thought in other scientific disciplines. For an engineer, this was more obvious, as Geology was part of the curriculum and learning of this discipline.

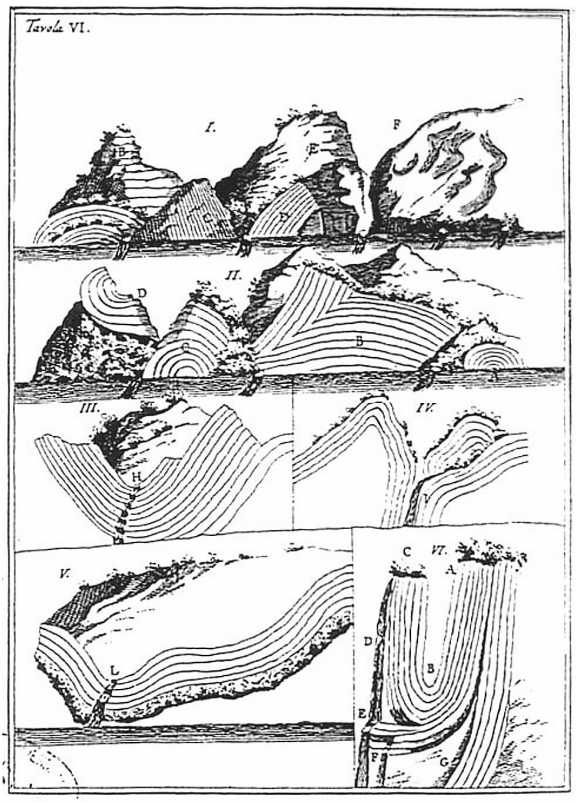


Figure 10

Geology corroborates that it is possible to analyse a scientific "object" (a field or a mountain) that we cannot physically cut or dismount. Their "object" has also usually an individual and historical quality (we cannot repeat an experiment).

To do so we need to collect data and theorize about the changes and forces that had modelled (through time or in sequences) the reality we have now. Drawings (sections) are an essential part (equipment) of the reasoning: they visualize and codify a "theoretical reality" hidden to our inspection.

So, Choisy made not the anatomy, but the "geology" of a building. The "forces" were the temporary means, the skill and organization of the workers. The changes were the different stages and their equilibrium.

A single example can show how having this "filter" in mind produces different scientific consequences, even if the "same tool or strategy" is in use. Viollet-le-Duc and Choisy made very similar drawings of a Roman wall, almost interchangeable. But they did not see the same thing. For Viollet-le-Duc, the hole in the whole corresponds to a scaffold (correctly), but he did not notice something essential to understand the Roman construction: this was movable scaffolding. Romans had to economize in means.

AFTERVIOLLET-LE-DUC AND CHOISY: THE RAMIFICATION OF ANALYTICAL DRAWINGS

During a fruitful period, those 25 years between 1850 and 1875, the methods and the "filters" used by Viollet-le-Duc and Choisy rapidly percolate among architects, historians and critics.

In France there were students of the "École des Beaux Arts" who, when carrying out a "reconstitution", if only for a moment, leave the usual path of the mere formal descriptive method and venture to the new analytical and constructive drawing.

This is the case of E. Poulin's drawings (1880-1) of the Dioclecian Baths, (Cassanelli, pp. 174-5). To put it frankly, more than a Choisy follower could be designated as a plagiarist: he simply replicated and coloured Choisy's drawings. Probably that reveals both the attraction for the new analytical method and the difficulties to "speak it". Although he himself was not able to "read" the construction in the ruins, he could substitute crude reality for those "clear crystal new realities" that constitute Choisy's drawings.

From this moment on, this will be a frequent phenomenon: Choisy's drawings are as good as reality substitutes, and so difficult to improve too, that they are more or less copied –and preferred over other documents as photographs.

In other "écolier", M. Lambert (Hellman, p. 254), the influence of Viollet-le-Duc seems obvious, if we confront his fragment of the Parthenon (drawing of 1877) with the drawing published in "Les Entretiens". Both used the same graphical strategy Choisy was so fond of. But we do not feel the existence of the same "mental point of view" (or "filter", here there is no need to reconstruct a sequence of operations) neither the same analytical efficiency than in Choisy's drawings

All during the 1882-1914 period, the monumental "Histoire de l'art de l'antiquité" will exhibit often

impressive analytical illustrations as this one (fig.). Their authors, Perrot (an archaeologist) and Chipiez (an architect) confidently created a new independent line, extending the graphical strategy to the architecture of the Persians, among others.

From the 70's on, applying the analytical drawing not only to fragments but also to the whole building will become a trend. Choisy did so in his next book, "L'art de bâtir chez les Bizantins" (1883), and again, in an original and distinctive manner that will not be usual in the future: Byzantine buildings are presented in axonometric view –and what has not yet been noticed, at the same scale–, forming an implicit parallel and a comparative study of the construction, something that Viollet-le-Duc never attempted to publish. Another feature not present in Viollet-le-Duc's perspectives is the interplay between construction and plan of the building, shown in these views below (fig.).

This new "line" is followed in France by an engineer-archaeologist, his close friend Dieulafoy, and many architects involved in restoring buildings in the orbit of Viollet-le-Duc, as his collaborator Duthoit or his "elève" Sauvageot. Their drawings will be published in first rank journals as "Révue Général d'Architecture" or "Encyclopédie d'Architecture" (here, in 1878, pl. 52 we see an impressive Sauvageot drawing, or in 1872 a compilation of examples by Viollet-le-Duc, Boileau and others).

Fascinated by the possibilities of analytical drawing, some of them will take part in what –seen from the distance– seems some sort of a competition more or less openly admitted: who will be the first to show the intimate construction of the great buildings of the past, such as the Colisseum, the Pantheon or Haghia Sophia.

In that contest we feel the tension of rivalries, the admired reception and the reward of prices out of use nowadays.

They were closing a cycle where descriptive drawing had prevailed as a self-sufficient method, and eventually showed its limits. In some way, they restored the link with the "old fashion" and "overcome" baroque drawings were –with a formal purpose– those great buildings were showed dissected in three-dimensions. The challenge was to orient them to constructive purposes.

In fact, a thin connecting line had survived during the "mongian period". In England, the Piranesian way survived in Soane illustrations of the "Doric entablature" (Middleton pl.19) In the more "rarefied" and hospitable French atmosphere we can remark on a not well known episode that concerns the Colisseum, one of the most challenging and intricate buildings –it has resisted even Palladio's scalpel. In 1827 Henri Labrouste (Gaiani, 2002, pp. 63-65) presented a pioneering

drawing **(fig. 11)** to the Academy which reacted with an interesting comment that confirms our point:

> Adhering to the method followed by most of the Renaissance architects, monsieur Labrouste has found in this procedure, more alert to reach understanding than accuracy, the simpler way to make sense of the general construction of this Amphitheatre and explain his distinctive nature in a single drawing.

The comment balanced praise and reserve; things were not mature enough, as only three years later the L-J- Duc proves, with impressive beautiful drawings, where plans and sections were intensively used (Conforto, 1985, pp. 258-291).

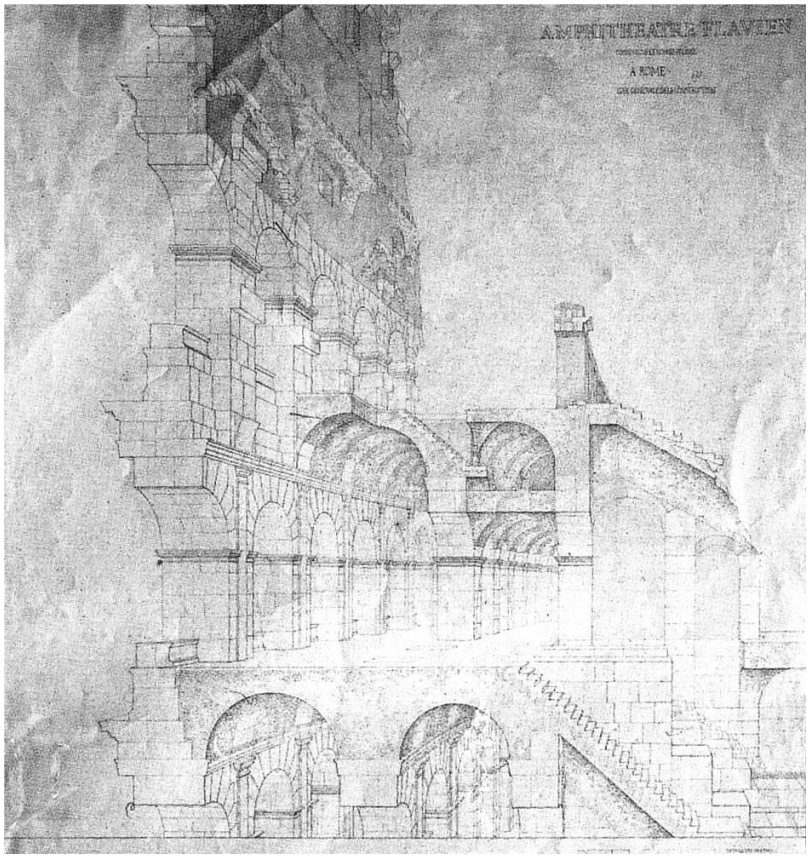


Figure 11

The next attempt is a very odd affair. The young Guadet, who had led the revolt in 1863 against Viollet-le-Duc teaching, comes back from Rome and shows in the Salon of 1870 a sequence of

analytical constructive drawings **(fig.12)**. An act of intriguing revenge, as the critic of the "Revue Générale" (Davioud, 1870, p. 134) let us guess:

> Guadet's aim has been surely to make us understand that even in the first century the great republican traditions have been not lost. This colossal Amphitheatre, by their excellent bonding, by the wise and economic use of the materials, that the analysis stone by stone reveals, can prevail in the comparison over the monuments that are now a day presented as the only models for construction art.

It appears that he tried, using the same graphical weapons, to show that the architectural position of Viollet-le-Duc was untenable, totally wrong. In fact, what was wrong was his fascinating unreliable version of the Colisseum as stonework comparable to medieval cathedrals. Strangely enough, he published it without much remorse eight years later (1878), even after Choisy had already asserted in the "Art de bâtir chez les Romains": "the Colisseum is like a huge synopsis of the Roman building art, in which we find applied all the constructive procedures".

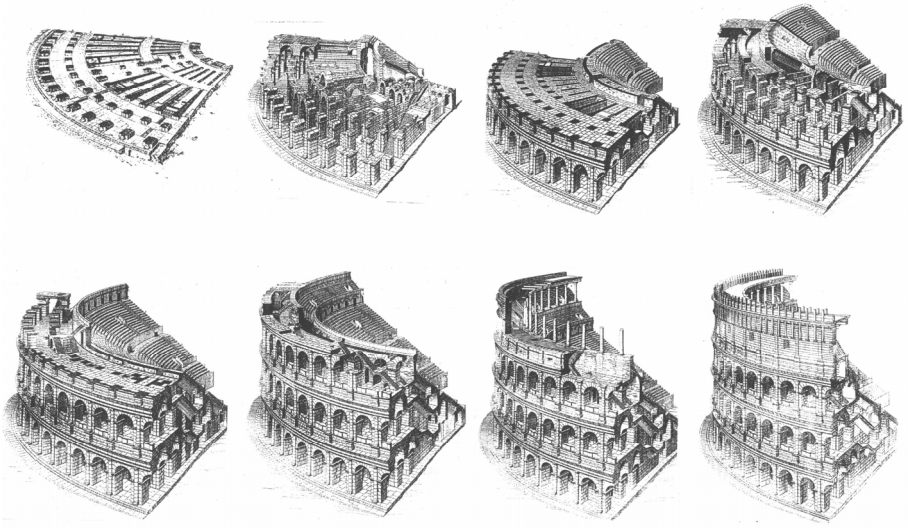


Figure 12

On the other hand, his drawings form a refined sequence of "rusconian" steps, which pursue, as he affirmed, to innovate by imitating the photographical records of buildings in construction. Guadet exemplifies well that if the "filter" is wrong -no matter how sophisticated is the graphical tool- the analysis fails. Instead of having a "better than reality", we have a "deceptive reality".

By the 80's some architects from outside France begin to participate in the "contest". In Germany, J. Durm, an architect very influenced by Choisy's drawings, published in 1887 some analytical

drawings of the dome of Saint Peter's in Rome **(fig 13 b)**. He illustrated the dome of Santa Maria dei Fiore in Florence as well **(fig.13 a)**, in a manner that can be described as a three-dimensional development of Sgrilli's (1733) "rusconian" plan and section drawings.

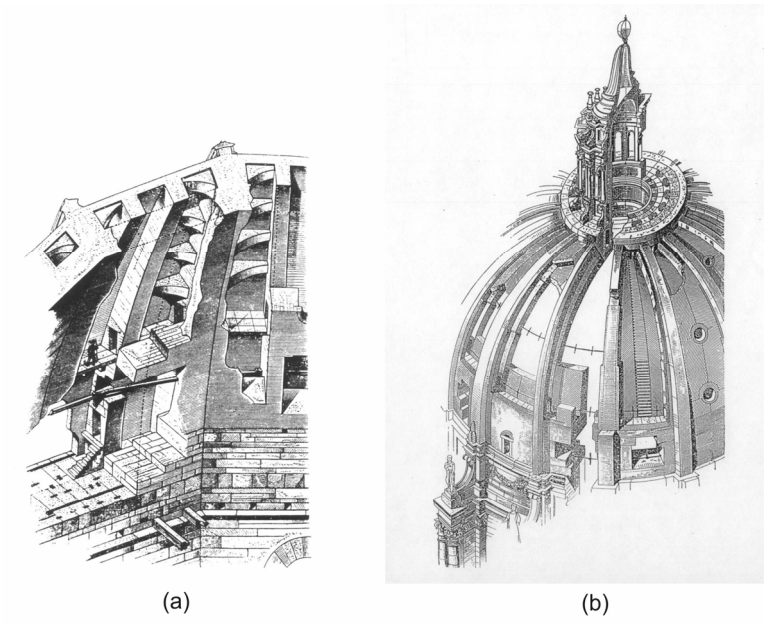


Figure 13 a, 13 b

Figure 14

Approaching the end of the century, another great building, the Rotonda, reveals his secret anatomy. Chedanne, Guadet's pupil, wins in 1887 the "Prix de Rome" and comes back from there with an impressive analysis of this building **(fig. 14)**. The "Révue Générale" comments them in 1891, and in 1894, "La Sémaine des constructeurs" enthusiastically celebrated them as a "triumph" of the ability in construction analysis gained by the architects formed by the École des Beaux Arts.

We could leave here our study, stop before entering the XX century, leaving for another opportunity the study of fascinating cases as H. Prost's drawings of Sta. Sophia. However, St. Paul's drawings of the first decades are a beautiful case in the same spirit. They represent the incorporation of England to the "great building analysis" competition and, in his way, they crown this period.

W. Dunn, who was working in the restoration of St. Paul's cathedral proposed in the Journal of the Royal Institute of British Architects (1907 p. 72) to elaborate –from the survey he was doing with his assistant Halley, and the drawings offered by McCartney– an isometric drawing that explicitly emulate those of Durm: " I thought that the relations of the whole would be better displayed in an isometric view such as foreign students have made of St. Peter's, of the Duomo at Florence, and other domes, but which no one has undertaken, so far as a I know, for St. Paul's".

The first view then published was a very modest one, almost limited to the lantern. The completion of the ambitious project was Geofrey Allen's work, among other architects, and it took many years (from 1923 to 928) giving birth to a spectacular drawing **(fig.15)**. No doubt they would agree with Viollet-le-Duc (1863, pp. 463-4) in that "the analysis of a Greek temple can be made in a few days, but this is not the case of a Roman bath, and for a better reason of one of our French cathedrals".

This drawing was published in 1929 in the RIBA journal, and hung in the Common Room of this institution as to serve for meditation and learning. This was a sign of respect and admiration, and the last homage to this kind of drawing.

CONCLUSION

We will conclude our review with this last drawing (fig.) As it was said at the beginning, this is not proper "History". It is the exploration of some of the interplays between the analysis of construction and drawing along History.

In fact, two related histories have been put forward.

On one hand, the history of historians of construction's mind: how they approached the constructive reality of the past, how their "prejudices" (mental filters) conditioned their findings (or their mistakes). How their particular position in history, the traditions they took for granted as methods of the past, their education have influenced them.

We have focused on some of them –Piranesi, Viollet-le-Duc, Choisy– and explored how their different "filters" conditioned them. However, there is further research to be undertaken in that field (Choisy's mentality and prejudices in his "Histoire de l'Architecture", Girón, 2003)

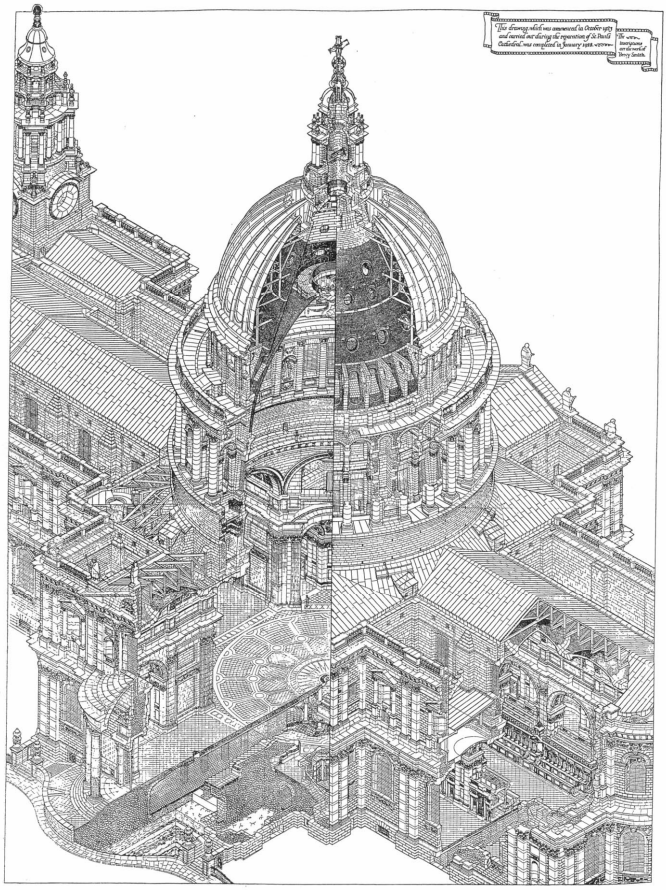


Figure 15

On the other hand, we have seen some trends in the history of analytical drawings. The construction analysts have benefited from graphical strategies that go across many fields (from painting to engineering, from anatomy to geology). These strategies can be differentiated by how they controlled a sequence of operations, time, etc. Again, there is much field open to future investigations (for a short review, Talenti, 2000).

Altogether it should be emphasized that drawings by those great analysts are not passive recollections, nor a simple articulation of those strategies, but new realities. Therefore, they constitute the fruit of creative minds and a motive of admiration.

REFERENCES

Belidor, B F de, 1782-1790, *Architecture hydraulique, ou L'art de conduire, élever et de ménager les eaux pour les différens besoins de la vie*, Paris: L Cellot, F Didot.

Blanc, Ch, 1881, *Grammaire des Arts du dessin*, Paris: H Loones

Borsi, F, Acidini, Cr, Lambertini, D, Morolli, G, Zanmgheri, L (eds.), 1980, *Il disegno interrotto, trattati medicei d'architettura,* Firenze: Gonelli

Bressani, M, 2000, "Viollet-le-Duc optic", *Architecture and the Sciences, Exchanging metaphors*, Picon, A, Ponte, A (eds.), Princeton: Princeton Architectural Press.

Bressani, M, 1996, "Opposition et équilibre: le rationalisme organique de Viollet-le-Duc", *Revue de l'Art*, n. 112, pp. 28-37

Cassanelli, R, David, M, De Albentis, E., Jacques, A, 2002, *Ruins of Ancient Rome. The Drawings of French Architects Who Won the Prix the Rome, 1786-1924*, Los Angeles: Getty Publications

Choisy, A., 1873*, l'art de bâtir chez les Romains*, Paris: Libraire générale de l'architecture et des travaux publics, Ducher et Cie.

Choisy, A, 1883, *l'art de bâtir chez les byzantins*, Paris: Libraire de la Societé Anonyme de Publications Periodiques,

Conforto, M L, Panella, S., 1985, "Le Colisée"in *Roma antiqua: Forum, Colisée, Palatin: envois des architectes français : 1788-1924*, Paris: École Nationale Supérieure des Beaux-Arts, 1985

Cuvier, G, 1825, *Discours sur les révolutions de la surface du globe, et sur les changements qu'elles ont produits dans le règne animal,* Paris

Davioud, G, 1870, "Le salon de 1870", *Revue Générale de l'Architecture et des Travaux Publics, vol XXVII*, p.134

Dunn, W, "The Dome of St. Pauls, by W. Dunn", 1908, *RIBA Journal*, vol. XV, 1908 (nov 1907-oct 1908), pp. 72-74

Durm, J, 1887, "Zwei Grosskonstruktionen der italienischen Renaissance", in *Der Zeitschrift für Bauwesen* , Berlin

Gaiani, M, 2002,"Il viaggio in Italia 1824-1830", in Henri. Labrouste (1801-1875), Dubini, R. (ed.) Milano: Electa

Girón, F J, 2003, "Drawing, reasoning and prejudice in Choisy's Histoire de l'Architecture*", Proceedings of the First International Congress on Construction History*, Madrid: Instituto Juan de Herrera, vol. I, pp.1007-22

Girón, F J, 2005, "El análisis de la construcción romana según Piranesi: ¿Fantasía o ciencia?", *Actas del Cuarto Congreso Nacional de Historia de la construcción*, Cadiz: Instituto Juan de Herrera, vol. 1, pp. 479-87

Guadet, J, 1878, *Etude sur la construction et la disposition du Colisée Amphithéatre Flavien*, Paris: Librairie Centrale des Beaux-Arts.

Gualtieri, N, 1742, *Index Testarum Conchyliorum quae adservantur in museo*, Florencia

Hellmann, M-Ch, Fraisse Ph, Jacques, A, 1982, *Paris-Rome-Athènes: le voyage en Grèce des architectes français aux XIXe et XXe siècles ,* Paris: EBA École Nationale Supérieure des Beaux-Arts.

Middleton, R, Rykwert, J, Watkin D, (eds.), 1996, *Sir John Soane, Enleightenment Thought and the Royal Academy Lectures*, Cambridge: Cambridge University Press

Moro, A-L, 1740, *De Crostacei e degli altri marini corpi che si truovano su' monti*, Venezia: S. Monti.

Monroe, A., Sue JJ, 1759, *Traité d'Osteologie traduit de M. Monroe...avec leurs explications par M. Sue,* Paris: G. Cavelier

Perronet, J-R, 1782-3**,** *Description des projets et de la construction des ponts de Neuilly, de Mantes, d'Orléans et autres ; du projet du canal de Bourgogne... et de celui de la conduite des eaux de l'Yvette et de Bièvre à Paris... par M. Perronet*,...Paris: Imp. Royale

Perrot G, Chipiez, Ch 1882-1914, *Histoire de l'art dans l'Antiquité*, Paris, Paris: Hachette

Piranesi, G B,1762, *Descrizione e Disegno dell'emissario del lago Albano..."*, Roma

Piranesi, G B,1769*, Diverse Maniere d'adornare i cammini ed ogni altra parte degli edifizi desunte all'architettura Egizia, Etrusca,e Greca con un Ragionamento Apologetico in difesa delll'Architettura Egizia, e Toscana, opera del Cavaliere Giambattista Piranesi architetto*, Roma

Rudwick, M J S, 1976, "The emergence of a visual language for geological science, 1760-1840", *History of Science*, xiv, pp. 149-195

Rusconi, G-A, 1590, *Della Architettura*, Venice: Gioliti, I.

Bedon, A, C.I.S.A. Palladio, Vicenza, 1996

Sauvageot , C, 1880, *Viollet-le-Duc et son oeuvre dessinée*, Paris, (from *Encyclopédie d'Architecture*, IX vol, Paris: Morel A. et Cia.

Sgrilli, B S, 1733, *Descrizione e studi dell'insigne fabbrica di S. Maria del Fiore*, Firenze.

Talenti, S, 2000, *L'Histoire de l'Architecture en France. Émergence d'une discipline* (1863-1914), Paris: Picard

Viollet-le-Duc, E-M, 1847 "De la construction des monumens religieux en France", *Annales archéologiques*, n.6, pp. 248-9

Viollet-le-Duc, E-M, 1863-1872, *Entretiens sur l'architecture*, Paris: Morel, A. et Cie.

Viollet-le-Duc, E-M, 1859, "construction", *Dictionnaire raisoné de l'architecture francaise du xi au xvi siècle*, vol IV. Paris: B Bance

Viollet-le-Duc, E-M, 1879, *Histoire d'un dessinateur*, Paris: J Hetzel