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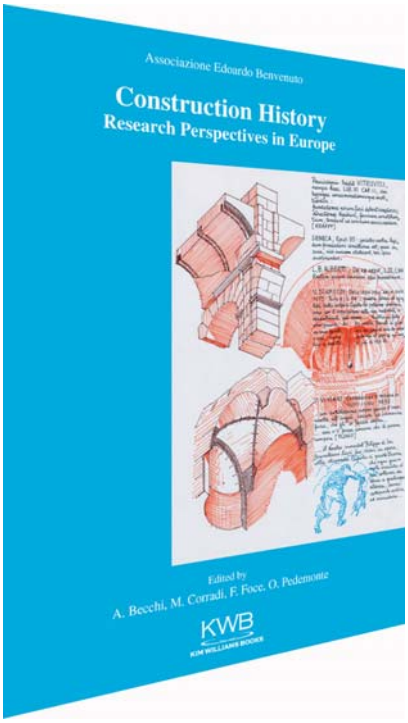

Construction History
Research Perspectives in Europe

A. BECCHI, M. CORRADI, F. FOCE AND O. PEDEMONTE, EDS.

This is vol. IV in the book series "Between Architecture and Mathematics". The Associazione Benvenuto for research in the Science and Art of Building in their historical development assigned to a few international "observers" the task of styling a map of Construction History in their various countries. Obviously, we are not dealing here with an exhaustive map, but rather with a first attempt to identify some of the significant lines of research and to put into contact the individual scholars. A small step towards the constitution of an international scientific community that is interested in architecture as well as mechanics; in construction as well as its history. A community which, up to the present, has not known how to find the essential points of contact and dialogue, and which has avoided the onus of long-term initiatives. The present volume is an aid for establishing solid collaborative research projects, knowing that this can happen only if the studies are so rigorous and detailed that those emphatic recall to arms of interdisciplinarity, sure signs of problems set forth badly, are rendered superfluous.

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CONSTRUCTION HISTORY IN FRANCE

Anne Coste and Joël Sakarovitch

Introduction

In the eighteenth century, every learned European was fascinated by classic antiquity and the technical qualities of buildings. In spite of this interest, Construction History started in France only in the nineteenth century. The *Traité théorique et pratique de l'art de bâtir*, published between 1802 and 1817 by JEAN-BAPTISTE RONDELET, is actually an encyclopaedia dedicated to construction and its history. The *Dictionnaire raisonné de l'architecture française du XI^e^ au XVI^e^ siècle* by VIOLLET-LE-DUC (1854-1868) had a long-lasting influence on research in Gothic architecture and its constructive creativity. *L'art de bâtir chez les Romains* (1873) and *L'art de bâtir chez les Byzantins* (1875) by the French engineer AUGUSTE CHOISY still are—130 years after their publication—fundamental references for all construction historians. In addition to these basic works, some important journals were produced during the nineteenth century, such as the *Bulletin monumental* and the *Annales archéologiques* and, later on, *Construction moderne*, as well as the *Génie civil*. Nevertheless, in spite of this rich past and the quality of the works aforementioned, Construction History is not at present a major discipline in France, nor even a standard topic regularly taught in the universities.

If we intended to speak only of the French papers presented at the large international meetings—four among twenty papers in Saragossa[1] in 1993, at the first symposium "Between Mechanics and Architecture,"[2] and, ten years later in Madrid,[3] only six among the almost 300 participants at the first international conference on Construction History[4]—the present article could be written in just a few words. This weak French participation is also evident at other meetings

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[1] P. RADELET-DE GRAVE and E. BENVENUTO, eds. *Between Mechanics and Architecture*, Basel, Birkhaüser, 1995.

[2] Symposium: *Between Mechanics and Architecture*, *XIX^th^ International Congress on History of Sciences*, Saragossa (Spain), August 1993: the French participants were JEAN DHOMBRES, ANTOINE PICON, JOËL SAKAROVITCH and ANNE COSTE.

[3] *First International Congress on Construction History*, Madrid (Spain), January 20-24 2003: French papers were presented by ANNE COSTE (GSA), JOËL SAKAROVITCH (GSA), LUC TAMBORERO (GSA), HUBERT GUILLAUD (CRATerre-EAG), ERIC MONIN (CERMA) and JEAN-LOUIS TAUPIN (ACMH).

[4] S. HUERTA, ed. *Proceedings of the First International Congress on Construction History*, Madrid, Instituto Juan de Herrera, 2003.

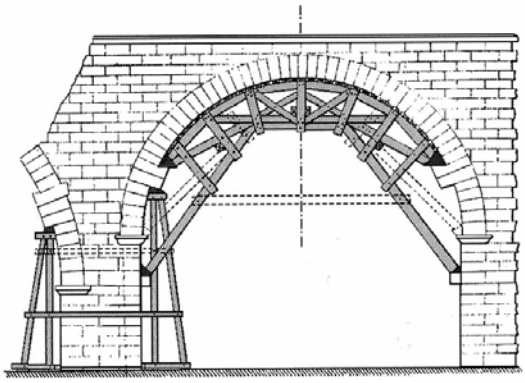

Fig. 1. The formwork of the Pont du Gard, from Auguste Choisy*, L'art de bâtir chez les Romains, 1873*

Fig. 2. The pont du Gard today. Photograph by Anne Coste

that provide opportunities to gather in much wider assemblies for architecture historians whose research is oriented towards construction. No more than three French scholars out of 220 total participants were present[5] at "*L'Arrigo Croce Memorial Symposium*" in Naples in 1996,[6] when JEAN KÉRISEL was awarded the Laurea *Honoris Causa* of the University of Naples "Federico II". Again, at the Second Arch Bridges Conference in Venice, Italy, in 1998,[7] France, the country of PERRONET and of the *École Nationale des Ponts et Chaussées*, was represented by only two speakers out of 100 participants.[8] These conferences certainly do not give a correct depiction of the French contribution to Construction History, but they do allow us to identify the French scholars working in the field. In fact, although French production is weaker than those of our English, Spanish, Italian, and even Belgian neighbours, it is stronger than it appears to be from the participation described above.

French studies are actually quite diverse—history and archaeology of materials, history of trainings and professions, history of building firms, history of construction sciences, history of techniques, history of ideas—and they are carried out within numerous institutions and laboratories that are linked to different networks. Still, scholars belonging to laboratories related to the *Monuments Historiques* or the archaeologists of the CNRS (*Centre National de la Recherche Scientifique*) such as JEAN-PIERRE ADAM, author of the French basic work on Roman construction[9] or JEAN-MARIE PÉROUSE DE MONCLOS, an expert of stereotomy—are part of a scientific community that has almost no relation with architecture and engineering schools.

Therefore, in France scholars of Construction History work within a rather scattered and fragmented framework, probably due to the very centralised and specialised structure of our higher education and research system. The teaching institutions that deal with Construction History concern four different branches of administration (Ministry of Equipment; Ministry of Culture; Ministry of Higher Education and Research; and the Ministry of Industry) and within the same ministry, even inside a same department—for instance, the *Direction de l'Architecture et du Patrimoine* of the Ministry of Culture—the various offices are exceedingly separated.

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[5] C. VIGGIANI, ed. *Geotechnical Engineering for the Preservation of Monuments and Historic Sites* -, Balkema, 1997.
[6] *Geotechnical Engineering for the Preservation of Monuments and Historic Sites - Arrigo Croce Memorial Symposium*, Naples, Italy, 1996.
[7] *Second International Arch Bridges Conference*, Venice, Italy, October 6-9, 1998.
[8] A. SINOPOLI, ed. *Arch Bridges: History, Analysis, Assessment, Maintenance and Repair*, Balkema, 1998.
[9] J.-P. ADAM. *La construction romaine. Matériaux et techniques*, Paris, Picard, 1984. Rpt. 1995.

Even though a French Society of History of Sciences exists, there is no similar specific association for Construction History that could draw together the scientists from various institutions. However, a dozen years ago a project started by the *Bureau de la Recherche Architecturale* (in the former Direction of Architecture from the Ministry of Equipment) made possible the constitution of a network called "*Cultures constructives*," which gathers together a fair number of scholars in Construction History. An extract of the report of the meeting of 20 May 1992, during which the network was founded stated that,

> To increase expertise, or more exactly the expertises that determine the constructive procedures, is the first purpose of the network. One of its long-term goals is the will to make students, and professionals, aware of the total amount of "know how", cultures, models of reflection which belongs to the chain of operations that are part of the building process and that make this constructive procedure expertise possible.

But the concept of *Constructive Cultures* goes beyond the strict historical approach.[10]

1 The state of research and didactics in the field of Construction History

Let us first specify the meaning of the French term "Construction History." Although architecture is considered to be one of the fine arts, and is therefore included in general studies of art history, when the ambiguous status between *science* and *art* is noted, we sometimes have to define the word *art* as "expertise in technique," as it is the case in the French expression "*les règles de l'art*", implying the art of building (*aedificatio*).[11] Furthermore, we may also notice that the relationships between art and science have inspired recent works, as ANTOINE PICON mentioned in an article entitled "Architecture, sciences et technique. Problématiques et méthodes."[12] Art history itself, in its most recent developments, borrows heavily from scientific culture.

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[10] Some researchers specialized in tensile structures (NICOLAS PAULI, RENÉ MOTRO from the laboratory GrrSLA in Montpellier), some others in spatial structures (JEAN-MARIE DELARUE from the laboratory GSA in Paris-Malaquais), in skin and structures (DANIEL BERNSTEIN), in morphology (MICHEL PAULIN, RÉMY MOUTERDE, FRANÇOIS FLEURY from the laboratory LAF in Lyon).

[11] In the *Dictionnaire historique d'architecture* by QUATREMÈRE DE QUINCY, architecture is described as the "*art de bâtir*".

[12] A. PICON, "Architecture, sciences et techniques. Problématiques et méthodes", in *Les cahiers de la recherche architecturale et urbaine*, n°9-10 "Méthodes en histoire de l'architecture", 2002, 151-160. PICON also quotes *Dictionnaire des cultures scientifiques*, N. WITTKOWSKI, ed., Paris, Editions du Regard, 2001.

Fig. 3. Meeting Albert Einstein – Le Corbusier in Princeton (USA), 1945.
Picture from vol.4 of *Œuvres Complètes de Le Corbusier, 1938-1946*

Construction, as a discipline related to architectural and urban design and production, refers to its own sciences and techniques. Geometry, stereotomy, statics, and strength of materials[13] are usually intended as "building sciences" while "building techniques" refer to the overall methods and systems, empirically or scientifically established, that belong to programming and constructing. Construction is not limited to the action of erecting a structure (*struere*), but includes all the choices related to materials that occur during the design and building phases: their dimensioning, their shaping, and their assembling in the whole structure. In French, the *techniques* (plural) are considered to be a subset of construction, which, in turn, is a part of the *technique* (singular),[14] which includes comfort and environmental aspects (thermal, acoustic, lighting), equipment and modern communication systems (network, home automation).

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[13] In his book *Principes d'analyse scientifique. Architecture : méthode et vocabulaire*, vol. 1, Paris, Imprimerie Nationale, 1972, 18, J.-M. PÉROUSE DE MONCLOS defines the word *architectonique*: as "related to the science of construction." For the same *architectonique*, J.-C. VIGATO quotes a definition from the *Grande Encyclopédie* (H.Lamirault et Cie, 1885-1892): " this word of a Greek origin, like all the words that come from the word *architect*, designates all what is related to architecture studies, and applies especially to the results of the architects' labour; while the word *architectural* has a broader meaning including all what is related to architecture in general." VIGATO also quotes the *Lexis* (Larousse) : "The whole of architecture rules". Agreeing with PÉROUSE DE MONCLOS, he also explains that the adjective is commonly used "in a restricted sense, only related to the technical and constructive aspects" (because of its similarity to the word *tectonique*).

[14] In English, it appears to be the oppisite: *building technologies* include construction.

We could also define *construction* by its limits, of which there are two kinds:

- the maximum dimension that determines the limit of a constructive system, which HUBERT DAMISH names "*les points de catastrophe*", i.e., the scale beyond which a system is no longer valid (a concept that may be applied to Gothic architecture);
- the realisation, intended as feasibility, i.e., the limit beyond which the construction is no longer technically or economically possible (the history of the conception of the dome of Santa Maria Del Fiore in Florence clearly illustrates this point).

All this introduces the notion of design validation through the construction, which PAUL CHEMETOV calls *effectuation*.[15]

The characteristic of the building process is its division among different professions: construction firms, engineering offices, economists, architects, promoters, etc. All these professions contribute, in complementary ways, to the production of buildings in general. But the loose definitions of some roles, economical and political evolutions, and a natural tendency for market ambitions all lead to conflicts between roles: all these considerations are part of the Construction History.

It is the task of *Construction History* to replace *Construction* within a wider cultural context. Architecture is connected to the scientific world by some subtle links that cannot be considered from a mere technical standpoint. From Galilean astronomy to the current techniques of virtual images and networks, exchanges between architecture and scientific world were alternatively productive and paradoxical. Therefore a cultural approach of construction is necessary in every historical study that intends to consider architecture from this angle.[16]

The teaching problem of Construction History in France can be discussed in short order. Construction History is almost completely absent from the tuition programs of the famous engineering schools—apart from the *École Nationale des Ponts et Chaussées*, which is a noteworthy exception—and is not taught at the University either. It appears in less than a third of the teaching curricula of the

[15] V. PICON-LEFEBVRE and C. SIMONNET, *Les architectes et la construction*, Paris, Techniques & Architecture, 1994.
[16] On this subject, one may read: "*Architecture, sciences et techniques*", by A. PICON in *Encyclopaedia Universalis* (1995 edition).

twenty French architecture schools, where it is given but slight importance in any case.[17]

The only school in France where Construction History is really taught is the *Centre des Hautes Etudes de Chaillot*. It is deeply developed and taught mostly from a technical point of view to architects who in the future will be in charge of the Built Heritage and Ancient Monuments (the program is available at http://www.archi.fr/CEDHEC).

As to university research, Construction History does not appear independently in the list of scientific sections of the *Conseil National des Universités (CNU)* and is therefore included under the heading of "Epistemology, History of sciences and techniques" (no.72). Nevertheless, as we said previously, we can identify very different approaches to the study of Construction History. We will quickly mention some of the works which, in our opinion, illustrate clearly the French approach, before giving further non-exhaustive details later on.

We can roughly divide the French works into two categories: those whose scientific argument is architecture in its constructive dimension, both as a corpus (buildings, civil engineering works,…) and a process (conception-realisation,…), and those which approach engineering in its historical dimension—the history of materials, history of building firms, history of ideas and innovation, together with the human and social contexts in which evolution occurs, this being the cultural history that PICON claimed for in a article published two years ago.[18] But the opening of the discipline towards a social history of construction—which HENRI RAYMOND named "architectural history of society" consisting in, he used to say, "going on with P. FRANCASTEL's project, which is to take information from art about the society from which it comes and that it explains at least as much as it is explained by it"[19]—remains rather unusual in France. Nevertheless, historians willing to inscribe their works within a societal debate are in opposition to scholars who study Construction history "for the construction." This reminds us of the familiar dispute between art historians, as well as between architecture historians. PICON points out the lack of interest of the French architects for the social dimension of their discipline, and the resulting contamination of the research circles in architecture history and even techniques history. He also observes that studies on the evolution of the structures and the

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[17] GWÉNAËL DELHUMEAU gives a course at the architecture school of Lille, BERTRAND LEMOINE at Marne-la-Vallée, NICOLAS NOGUE at Rouen, PHILLIPE POTIÉ at Grenoble, ANNE COSTE at Saint-Etienne and JOËL SAKAROVITCH at Paris-Malaquais

[18] A. PICON, "Building Technologies, Imagination and Utopia", in *News Sheet*, n°64, October, 27-34, 2002.

[19] H. RAYMOND, *L'architecture, les aventures spatiales de la raison*, Paris, Centre G. Pompidou, 1984.

development of the building techniques rarely consider the social and cultural contexts. He suggests setting up a relationship between the history of constructive thinking and the architectural theory, and proposes to consider the Construction History as a branch of social and cultural history. Let us note that, on the contrary, the social dimension is essential for archaeologists. For example, in the history of metallurgy, the technical data are tightly linked to the organisational and social data. As M. GUICHARD, head of the research in Mont Beuvray, explains, "The solutions are technical, not the choices. Choices are social."[20]

Actually the two approaches correspond to the divergent evolutions of the historians of sciences in the last thirty years, the big steps of which are related by DOMINIQUE PESTRE in a paper dedicated to the Social Sciences History.[21] He points out how the Anglo-Saxon school in *Social Studies of Knowledge*, resulting from a conflict that arose at the beginning of the 1970s between British sociologists, anthropologists, philosophers, and historians, joined by some US sympathisers, has profoundly renewed the subjects and methods of this discipline:

> In some way, relative to a subject of minor importance, the history of science is today in the same position as was general history in the early 1930s. Marc Bloch, Lucien Febvre and others redefined the legitimate borders of the discipline, proposing to bring into its reach a range of activities that had been kept separate until then, borrowing methodologies from other disciplines; as they enlarged the area of studies, they offered to the historian the skills and the opportunity to historicise some fields that had not yet been approached. Furthermore—and analogy with sciences history is mostly applicable here—they invalidated the sameness between a specific historical area and history in general, and abolished the supremacy of a unique and ruling style (the "big style", as we say for painting); they promoted and legitimated some approaches that had been considered minor and marginal until then.[22]

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[20] V. GUICHARD, *Rencontres transdisciplinaires*, 1997.

[21] D. PESTRE. "*Pour une histoire sociale et culturelle des sciences. Nouvelles définitions, nouveaux objets, nouvelles pratiques*", in *Annales Histoires, Sciences Sociales*, 50e année, n°3, 1995 May-June, 487-522.

[22] *En un sens, et toute proportion gardée pour une discipline de moindre ampleur, l'histoire des sciences se trouve aujourd'hui dans une position homologue à celle qui a prévalu dans les années 1930 pour la discipline historique dans son ensemble. Car Marc Bloch, Lucien Febvre et d'autres redéfinissaient ce qu'étaient les objets légitimes de la discipline, puisqu'ils proposaient de soumettre à son règne une gamme d'activités jusque-là tenues hors de sa juridiction, ils annexaient d'autres pratiques disciplinaires, ils ouvraient un espace nouveau à conquérir, ils offraient à la sagacité de l'historien la possibilité d'historiciser des pratiques jusque-là non considérées par lui. Plus spécifiquement – et l'analogie avec ce qui se passe en histoire des sciences est ici tout à fait*

In addition to the broadening of the subject, the *Science Studies* provided themselves with some principles, contrary to the former ones, among which we must remember the principles of "symmetry" and "impartiality," which forbid any judgement and consider success and failure equally, rejecting the *sin of anachronism*. Those principles were introduced by one of the founders of this movement, DAVID BLOOR, who was somewhat inspired by the theory set forth by THOMAS KHUN in the early 1960s in the United States.

This profound renewal of the discipline led the Anglo-Saxons to surpass its limits and go towards history in general and some of its branches in particular. In the works achieved in those days, we note two of the tendencies described by PESTRE, closely related to the current Construction History. With regards to the first tendency and the works of BARRY BARNES, STEVE SHAPIN, and DONALD MACKENZIE, of the second half of the 1970s, PESTRE says:

> The historian's task is to decode and describe these cosmologies (it concerns a group of scientific works "built by men to report about the world which is theirs"), and then to point out the cultural, political and social context that has determined the result. The heart of the demonstration is formed by a series of analysis embedded one in another, which starts from the local (such theory defended by such scientist in such time) and goes to the general (what the sociability is like in such town or in such country at such time). The historical explanation has to harmonise the cosmological and the social, the scientific and the contextual, to explain the "content of sciences" through their "milieu"—approaching the scientific production like any other cultural production generated by men.[23]

The second tendency is illustrated mainly by the works of MICHEL CALLON and BRUNO LATOUR:

> not satisfied by the sociologic pretension to explain a knowledge (scientific) through a context (social), (…) "goes out" of the laboratory and tries to

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pertinente – ils rendaient caduque l'assimilation d'une forme historiographique particulière à la discipline dans son ensemble, ils abolissaient la suprématie d'un genre unique et dominant (le grand genre comme on dit en peinture), ils promouvaient et rendaient légitimes des approches jusque-là tenues pour marginales ou mineures. DOMINIQUE PESTRE, op. cit.

[23] *Le rôle de l'historien consiste alors à décoder et décrire ces cosmologies [il s'agit d'ensembles de productions scientifiques "constituées par les humains afin de rendre compte du monde qui est le leur"], puis à mettre en évidence les conditions culturelles, politiques et sociales qui en ont gouverné la constitution. Le cœur de la démonstration est constitué d'une série d'analyses emboîtées les unes dans les autres et qui se déploient du local (telle théorie défendue par tel savant à tel moment) au général (ce qu'est la sociabilité de telle ville ou de tel pays à telle époque). L'explication historique a comme fonction d'harmoniser le cosmologique et le social, le scientifique et le contextuel, de rendre compte du "contenu des sciences" par leur "contenant" – l'approche traitant des productions scientifiques comme de toutes les autres productions culturelles générées par les humains.* D. PESTRE, op.cit.

> understand how the (techno-)scientific complex and the social body (re)define and (re)build themselves simultaneously. The secret of knowledge and its validation are no longer searched for at the local level of the laboratory only, but among the refits and translations in the whole of the social body.[24]

Apparently these evolutions, from which, according to PESTRE, the French historians of Sciences kept apart, have contaminated the history of techniques, which is traditionally more closely related to the socio-economic context, as PICON notes in his commentary to PESTRE's paper in the same journal. We may notice a similar tendency in the Construction History.

However, we have to keep in mind that this cultural evolution is part of a much wider mutation that has occurred in the last thirty years in the technological and communicational, political (the switch from dictatorship to democracy) and economical (neo-liberalism) aspects of the globalisation or worldliness, which influences the approach to the actual subject. We could mention some recent papers by FRANÇOISE CHOAY who takes part in this reflection in some of her studies on heritage.

Exemplary studies

Obviously, in Construction History there is a part of History of Science and a part of History of Techniques. Studies on the development of geometry and stereotomy, statics and strength of materials, including the various approaches to the dimensioning of the structures (geometry and analysis), are related to the History of Science. Scholars are interested in laws, methods and tools. Studies on building techniques, history of innovation of structural systems, development of materials and their manufacturing, etc. are related to the History of Technique. These studies belong to a wider socio-economical history. Some other studies focus on the history of trainings and crafts associated to the construction professions. Among these works, we will point out those that contribute to the major subjects: first history of techniques, materials and structures, then history of professions and trainings.[25]

As regards the history of techniques, of which the works of BERTRAND GILLE are exemplary, let us mention the research of JEAN-PIERRE ADAM, an expert in

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[24] *non satisfait par la prétention sociologique à expliquer un savoir (scientifique) par un contexte (social), (…) "sort" du laboratoire et cherche à comprendre comment le complexe (techno-)scientifique et le corps social se (re)définissent et se (re)construisent simultanément. Ce n'est plus localement, dans le seul cadre des laboratoires, qu'est cherché le secret des savoirs et de leur validation, mais dans les reprises et traductions qui opèrent dans l'ensemble du corps social*. D. PESTRE, op. cit.

[25] For a more detailed presentation, see A. COSTE, *Pour une histoire de la construction*, HDR thesis, Université Jean Monnet, Saint-Etienne, 2004.

Roman construction; those by JEAN-FRANÇOIS BELHOSTE or ANDRÉ GUILLERME, of an other kind; and those by the great specialists of the primitive materials history, such as the archaeo-metallurgists MICHEL PERNOT and OLIVIER BUCHSENSCHUTZ.

Contributions to the history of techniques are not always made by historians. Therefore some works by other experts who are interested in trans-disciplinarity or in the historical aspect of their discipline, belong to our subject as well. Mechanics of solids and geotechniques are generally fields that are very sensitive towards historical approaches, because specialists in such domains are often asked to give an expert's estimation of ancient monuments; they are aware that this complex challenge, whose risks and stakes are known, transcends their own opinion. Thus, in France, JEAN KÉRISEL, mentioned above, indirectly contributed to the history of construction. Nevertheless historians' contributions are rare in the disciplines oriented towards technical innovations and fundamental and applied research in the physics of materials. They are close to the Italian approaches such as the *integrated approach* or the *global approach*, in which history, as much as other factors, makes possible the move towards truth by the means of a process that R. JAPPELI compares to the *avalanche*, in which an increasing amount of information is considered in order to understand the consequences *inscribed* in the building. Construction History is thus exploited by Soil Mechanics: "throughout his adventure (CROCE) realized the predominant role of history in Geotechnical Engineering and man's skill to model the future somehow by deriving it from the past, where a sort of *frozen* accumulation of knowledge exists; and if you go into it enough, you will discover unknown facts and the ideas."[26] The scientific goal in this kind of approach is not in an increase of knowledge in Construction History but the conservation of the monument as a testimony of past phenomena, and the consolidation of its structure.

Among the studies that are mainly focused on materials, let us mention those by the laboratory CRATerre[27] of the Architecture School in Grenoble, which has carried out for the past twenty years various studies on clay construction, some of which are from an historical standpoint. As regards to the use of metal in construction, mainly in the nineteenth century, we should mention the works by BERTRAND LEMOINE,[28] and those by ANDRÉ GUILLERME[29] concerning the evolution of building materials during the industrial revolution.

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[26] C. VIGGIANI, ed. *Geotechnical Engineering for the Preservation of Monuments and Historic Sites*, Balkema, 1997.

[27] We can quote for example the names of PATRICE DOAT and HUBERT GUILLAUD.

[28] BERTRAND LEMOINE is a *directeur de recherche* at the French CNRS and a teacher at the architecture school of Marnes-la- Vallée, Paris.

Some studies are a cross between a character and a constructive technique. Among these, we will mention PHILLIPE POITIÉ's works concerning DE L'ORME and stereotomy, or those of CYRILLE SIMMONET and GWÉNAËL DELHUMEAU[30] concerning reinforced concrete. SIMMONET and DELHUMEAU are coauthors of a most complete monograph about HENNEBIQUE and exemplify an approach which is typically French.[31] Dedicated to the man and the building firm, DELHUMEAU retraces both the human destiny and the story of an extraordinary material. NICOLAS NOGUE focuses on the construction of thin shells with a double curvature, and particularly on the constructive innovations brought by the French engineer BERNARD LAFAILLE in the mid-twentieth century. ANNE COSTE is currently working on the constructive ideas of ROBERT MAILLART, especially for bridge designs, after having studied Gothic cathedrals at length, and having developed, in the 1990s, a new methodology of modelling and numerical calculations.

In between Sciences History and Construction History, JOËL SAKAROVITCH's works attempt to point out the nexus between stereotomy, geometry and mechanics.[32]

Finally the "Constructive Cultures" team—with, to a lesser degree, the MHA laboratory of the Architecture School in Grenoble—dedicates much effort on the study of the history of techniques and the constructive thinking history.

Among the earliest French historians to be interested in construction, JEAN-PIERRE EPRON has a singular approach. He is almost the only one to consider all the professional criteria: the statuses, the contractual relationships, the individual competences on which the control of the project and the power stakes are based. His works thus represent valuable references: his *L'architecture et la règle* and his *Anthologie* in three volumes form a scientific support on which young historians in Construction can rely. EPRON's basic hypothesis is that it is necessary to keep architecture and construction together and to consider "the action of building in a global way, and to investigate the scission between architecture and construction," trying to understand to what social necessity it answers. In *L'architecture et la règle*, he develops the idea that Construction History—he is

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[29] ANDRÉ GUILLERME teaches history of techniques at the French *Conservatoire National des Arts et Métiers*.

[30] GWÉNAËL DELHUMEAU, PHILIPPE POTIÉ and CYRILLE SIMONNET are researchers in the laboratory *Cultures constructives*, architecture school of Grenoble.

[31] JEAN PROUVÉ and the firms of Lorraines are, for example, the subject of VINCENT BRADEL's and CATHERINE COLEY's works (*Laboratoire d'histoire de l'architecture contemporaine*, architecture school of Nancy).

[32] ANNE COSTE, NICOLAS NOGUE and JOËL SAKAROVITCH are members of the laboratory *Géométrie-Structure-Architecture*, the architecture school of Paris-Malaquais.

among the very few to name his studies with these words—comes from "circumstantial" rather than "systematic" encounters between five sectors: the architectural doctrine, the architectural institution, the economical and political context of the architectural production, the technical aspects of construction (procedures, components…), and education, which follows competences and behaviours. EPRON takes into consideration both the functional aspect of the technical forms of construction and its symbol value in the system of social values:

> Those five points are tied together by some particular links, specific to the various historical periods of Construction History. The actual research achievements do not provide us with a broad explanation that could be applied to construction in its whole, a kind of general theory that would establish, by difference, its specificity to any field. More likely, among the network of relationships linking the five points described above, particular answers brought by every social form to any emergent situation might exist.[33]

We will find the five points identified again in his 1981 *Anthologie*.[34]

The French works that are most well-known internationally are certainly those by PICON, currently professor at Harvard Design School (Boston, USA). He has studied numerous subjects, but we may point out his fundamental works on engineering training and on the History of Technique thinking and constructive imaginary. His *Invention de l'ingénieur moderne*,[35] which analyses in detail the period between the eighteenth and nineteenth centuries, during which a new professional environment and a powerful corporation appeared and grew, marking a turning point in French production. Equally interested in the objective data—quantity and origin of the students, content of the educational programs, quality of the teachers—and in the social and ideological factors—speeches, projects—PICON has opened a new methodological way, and simultaneously enlightened modern technology, which still is his major scientific interest.[36] In addition to the undeniable quality of his work, they have succeeded

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[33] *Ces cinq domaines sont en relation d'une manière particulière à chaque moment de l'histoire de la construction. Il n'y a pas pour nous dans l'état actuel de cette recherche, de système explicatif qui puisse s'appliquer à toute la construction, une théorie générale qui établirait par différence à toute autre activité sa spécificité. Il y aurait, plutôt au contraire, dans l'agencement de cet ensemble de relations qui traverse les cinq domaines que nous distinguons, la réponse chaque fois particulière qu'une formation sociale apporte à une situation chaque fois nouvelle*. J.-P. EPRON, *L'architecture et la règle*, Bruxelles, Liège, Mardaga, 1981, 10-11.

[34] J.-P. EPRON. *Architecture une anthologie*. 3 tomes, Bruxelles, Liège, Mardaga, 1992-1993.

[35] A. PICON. *L'invention de l'ingénieur moderne. L'Ecole des Ponts et Chaussées 1747-1851*, Paris, Presses de l'Ecole nationale des Ponts et Chaussées, 1992.

[36] A. PICON. *La ville territoire des Cyborgs*, Besançon, Ed. de l'Imprimeur, 1998.

in stimulating some emulation in the fields of the History of Architecture and Engineering Education in France.[37]

3 Programs and institutions

The recent and simultaneous publication of two volumes published by the *Bureau de la recherche architecturale et urbaine*, the 2002-2005 annual of the research teams in the architecture schools and an index of the publications about architectural research of the last thirty years, gives some visibility to the range of publications related to Construction History within architecture schools.

The indexing by theme—especially the themes of "Construction History", "Geometry History", "Technique thinking History", "Science History", "Heritage" and "Professions"— and by author makes it possible to extract the publications concerning the subject of interest and, through comparison with the partners list of the Constructive Culture network, the principal related research laboratories as well.

We will introduce first the three research centres for which the Construction History is a major subject and then those for which it is only a rather marginal topic.[38]

CRATerre-EAG: This laboratory, directed by HUBERT GUILLAUD and attached to the architecture school of Grenoble, has for the past 25 years specialised studies of technique and culture related to clay construction. A part of its activity is dedicated to the "patrimonial value" and to the "economy and social development", through local actions and educational programs, as well as material studies from a mechanical and physical standpoint. Nevertheless, its major goal is to study local constructive cultures and to make an inventory of clay architecture. In 1998 this laboratory gave birth to the UNESCO chair "Clay Architecture, Constructive Cultures and sustainable development", under the authority of PATRICE DOAT, and enjoys wide international fame. Its fairly rich program is available on the website http://www.craterre.archi.fr.

Géométrie Structure Architecture: GSA is a research laboratory of the Paris-Malaquais architecture school. It gathers specialists in structural morphology whose works mix theoretical and experimental approaches (JEAN-MARIE DELARUE, ROBERT MARCH, PATRICE CECCARINI, and others) and construction historians. Among them, JOËL SAKAROVITCH, co-director of the laboratory with JEAN-MARIE DELARUE, a specialist in stereotomy and geometry history, studies

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[37] We can mention, for instance, F. SEITZ, *L'école spéciale d'architecture 1865-1930*, Paris, Picard, 1995.

[38] For a more detailed presentation, see http//:www.culture.fr/mrt/cnrs/cnrs_min.htm.

the emergence of construction science in the seventeenth and eighteenth centuries, as well as education at the turn of the nineteenth century and, more precisely, MONGE's course at the *Ecole Polytechnique*. NICOLAS NOGUE studies constructive innovation in contemporary history and ANNE COSTE focuses on the inclusion of constructive wills in the design process, especially in the design of metallic and reinforced concrete artworks. For further information, the website of Paris-Malaquais architecture school may be checked: http://www.paris-malaquais.archi.fr.

Cultures constructives: Recently created and governed by the promoters of the network which bears the same name, and put under the scientific responsibility of PHILIPPE POTIÉ, this research team is attached to the architecture school of Grenoble. It includes several architects whose activity is oriented towards material questions (GILLES PERRAUDIN, PASCAL ROLLET, and others) and architectural historians whose studies focus on construction (GWÉNAËL DELHUMEAU, CYRILLE SIMONNET, and others). Its scientific program covers both branches of materials and techniques, and its essential themes are the inheritance of the twentieth century and the emergency buildings. The program is available on the website of the architecture school of Grenoble: http://www.grenoble.archi.fr.

What follows is a list of the research centres for which the History of Construction only comes up incidentally, as part of a program focused on other topics.

Laboratoire d'Analyse des Formes **(LAF):** Researches from this laboratory, attached to the architecture school of Lyon, are based on an approach to architecture that is mostly morphological, but they sometimes fall in the field of history of construction when objects (patrimonial) or tools (analysis of the morpho-mechanic systems) are considered (Michel PAULIN, FRANÇOIS FLEURY, RÉMY MOUTERDE, DENIS GREZES, and others).

Laboratoire d'Histoire de l'Architecture Contemporaine **(LHAC) :** Related to the architecture school of Nancy, the LHAC deals mainly with "rationalist" traditions in France. It carries on a specific research on JEAN and HENRI PROUVE which can be included in the cultural and technical History of Construction.

Laboratoire des Métiers de l'Histoire de l'Architecture **(MHA):** In Grenoble, the MHA dedicates one of its six research themes to "the history of the project's rationalities". *Les ingénieurs des Etats et l'aménagement de la Bourgogne au XVIIIe siècle* and *histoire comparative des méthodes en perspective, de Vitruve à Newell* are two among the works that are being carried out.

To conclude the discussion about French architecture schools, we will mention two further laboratories that allow us to make reference to the *Programme Urbain Construction et Architecture* (PUCA), a specific program set off by the Ministère de l'Equipement, des Transports et du Logement, which is available at: http://www.equipement.gouv.fr/recherche/incitatif/puca/.

Independent from the authority of the architecture schools, this programme generated an important workshop for construction research which mainly focuses on the history of the protagonists of construction and the relationships existing between them, in which history plays a part, albeit a minor one.

Laboratoire Espace Travail **(LET) and** ***Profession, Architecture, Ville, Environnement*** **(PAVE):** The activities of the LET, at the architecture school of Paris-la-Villette, and of the PAVE, at the architecture schools of Bordeaux and Toulouse, are related to this program. The former develops researches on "actors and procedures of urban and architectural design" (http://www.let.archi.fr). The latter focuses on the "analysis of architectural professions, decisional and manufacturing procedures of which they are part." The website of the urban and architectural activities and professions network, whose administration is run by these two laboratories is http://www.ramau.archi.fr.

The *Centre d'Histoire des Techniques*, directed by ANDRE GUILLERME, is governed by both the *Conservatoire National des Arts et Métiers* and from the *Ecole des Hautes Etudes en Sciences Sociales.* Its research covers a fairly wide field, but few studies are related to the history of construction.

This overview ought to be completed by an analysis of the programs of the various universities, of the engineer schools and of the CNRS (*Centre National de la Recherche Scientifique*). We also should point out the particular role of the *Association Ouvrière des Compagnons du Devoir du Tour de France*. The *Encyclopédie des Métiers*, in publication, dedicates several volumes to historical aspects and the articles, mostly written by professionals, renew the general opinion upon building techniques used throughout history.[39]

4 A pertinent bibliography

As to a bibliography, in addition to the sources mentioned above, and references mentioned in the notes, we want to cite, from the most ancient to the most recent, the fundamental French works on the history of sciences and building techniques: the works that constitute the core of discipline.[40] Let us

[39] *Encyclopédie des métiers, La Charpente ; La maçonnerie et la taille des pierres*, edited by l'*Association Ouvrière des Compagnons du Devoir du Tour de France.*

[40] We will only mention books. Quoting all the articles and papers about Construction History involves a detailed investigation and a very long bibliography.

mention first the *Histoire générale des techniques*,[41] to which BERTRAND GILLE largely contributed, with *Ingénieurs de la Renaissance* (1964) and *Mécaniciens grecs, la naissance de la technologie* (1980). Among the most recent works, we have to mention the ones that best illustrate the different tendencies of the French production, that sometimes are at the limit of discipline, but which consider it from a different standpoint.

Core works:

ACHE, J.-B. 1970. *Eléments d'une histoire de l'art de bâtir*. Editions du Moniteur.
ADAM, J.-P. 1982. *L'architecture militaire grecque*. Picard.
CHOISY, A. 1899. *Histoire de l'architecture*. Paris. Rpt. 1996, Bibliothèque de l'Image.
———. 1873. *L'art de bâtir chez les Romains*. Paris. Rpt. 1999, J. Laget.
———. 1883. *L'art de bâtir chez les Byzantins*. Paris.
DELBECQ, J.-M. 1983. "Analyse de la stabilité des ponts en maçonnerie par la théorie du calcul à la rupture", Ph.D. thesis, engineering. Paris: ENPC ed.
MARTIN, R. 1965. *Manuel d'architecture grecque. Matériaux et techniques*. Picard.
ORLANDOS, A. K. 1966. *Les matériaux de construction et la technique architecturale des anciens Grecs*. Paris. (1st. ed. 1955).
PEROUSE DE MONCLOS, J.-M. 1982. *L'architecture à la Française, XVI^e, XVII^e, XVIII^e siècle*. Picard.
PICON, A. (dir.) 1997. *L'art de l'ingénieur constructeur, entrepreneur, inventeur*. Paris: CNAC Georges Pompidou.
RONDELET, J.-B. 1802-1817. *Traité théorique et pratique de l'art de bâtir*. Paris.
SAINT-AUBIN, J.-P. 1992. *Le relevé et la représentation de l'architecture*. l'Inventaire.
SAKAROVITCH, J. 1998. *Epures d'architecture : de la coupe des pierres à la géométrie descriptive, XVIe-XIXe siècle*. Basel: Birkhäuser.
VIOLLET-LE-DUC, E. 1854-1868. *Dictionnaire raisonné de l'architecture française du XI^e au XVI^e siècles*. Paris.

Monographs of architects, engineers or building contractors:

BONILLO, J.-L. 2001. *Fernand Pouillon*. Marseille: Imbernon.
BRADEL, V., et al. 1998. *L'entreprise France-Lanord et Bichaton, un siècle de constructeurs*. Nancy: Archives modernes de l'architecture lorraine.
Buildings monographs :
COLEY, C. 1993. *Jean Prouvé*. Paris: CNAC centre Georges Pompidou.
COSTE, A., A. PICON, and F. SIDOT (dir.) 1993. *Un ingénieur des Lumières : Emiland-Marie Gauthey*, actes du colloque du Creusot. Paris: Presses ENPC.
DELHUMEAU, G. 1999. *L'invention du béton armé : Hennebique, 1890-1914*. Paris: Norma-IFA.
DUMONT, M.-J. (dir.) 1997. *Anatole de Baudot, 1834-1915*. Bologne: Rassegna, n°68.

[41] A.Dumas, ed. *L'Histoire générale des techniques*, Paris, P.U.F., 1962.

POTIE, P. 1996. *Philibert de l'Orme. Figures de la pensée constructive*. Marseille: Parenthèses.
SADDY, P. 1977. *Henri Labrouste, architecte, 1801-1871*. Exhibit catalogue. Paris: CNMHS.

About tools and building sites:

ABRAM, J. 2001. *A. et G. Perret, le Théâtre des Champs-Elysées, 1913*. Paris: J.-M. Place.
FERRO, S. et al. 1988. *Le Corbusier, le couvent de la Tourette*. Marseille: Parenthèses.
SIMONNET, C. 1987. *Le musée-bibliothèque de Grenoble, histoire d'un projet, chronique d'un chantier*. Grenoble: PUG.

About materials:

BARDAGOT, A.-M., et al. 1995. *Architecture et cultures constructives. Programme de développement pour la Guyane*. Grenoble: Craterre.
DELHUMEAU, G., et al. 1993. *Le béton en représentation : la mémoire photographique de l'entreprise Hennebique, 1890-1930*. Paris: Hazan-IFA.
DUMONT, M.-J. and B. MARREY. 1991. *La brique à Paris*, catalogue d'exposition. Paris: Picard, Pavillon de l'Arsenal.
HOUBEN, H.and H. GUILLAUD. 1989.*L'encyclopédie de la construction en terre. Traité de construction en terre*. Marseille: Parenthèse.
LEMOINE, B. 1986. *L'architecture du fer. France XIX^e siècle*. Seyssel: Champvallon.
MARREY, B. 1994. *Des histoires de bois*. Picard.
SEITZ, F. 1995. *L'architecture métallique au XX^e siècle*. Paris: Belin.

About constructive theory and techniques:

———. 2001. *L'architecture ou la fiction constructive*. Paris: éditions de la Passion.
BECHMANN, R. 1991. *Villard de Honnecourt. La pensée technique au XIII^e siècle et sa communication*. Picard.
BESSAC, J.-C. 1993. *L'outillage traditionnel du tailleur de pierre de l'Antiquité à nos jours*. Editions du CNRS.
COLOMBIER, P. du. 1953. *Les chantiers des cathédrales - Ouvriers - Architectes – Sculpteurs*. Picard. (Rpt. 1973)
COSTE, A. 1997. *L'architecture gothique : lectures et interprétations d'un modèle*. Saint-Etienne: PUSE.
CROZAT, P. 2002. *Le Génie des pyramides*. Dervy.
FERRO, S., et al. (dir.). 1986. *L'idée constructive en architecture*, acte du colloque de Grenoble. Paris: Picard.
GIMPEL, J. 1958. *Les bâtisseurs de cathédrales*. Paris: Seuil. (Rpt. 1980).
GUILLAUME, J., ed. 1991. *Les chantiers de la Renaissance*. Picard.
GUILLERME, A. 1995. *Bâtir la ville. Révolution industrielle dans les matériaux de construction*. France-Grande-Bretagne: Champ Vallon.
HOUDIN, J.-P. and H. 2003. *La pyramide de Kheops*. Editions du Linteau.

PICON-LEFEBVRE, V. and C. SIMONNET. 1994. *L'architecture en construction*. Paris: Techniques et Architecture.
POTIE, P. and C. SIMONNET, (dir.) 1992. *Les cahiers de la recherche architecturale*, "Culture constructive", n° 29. Marseille: Parenthèses.
RECHT, R., ed. 1989. *Les bâtisseurs des cathédrales gothiques*. Exhibit catalogue. Strasbourg.
SIMONNET, C. (dir). 1997. *Cahiers de la recherche architecturale*, no. 40, "Imaginaire technique". Marseille: Parenthèses.

We should add to these references some papers from international conferences proceedings, some publications by engineer schools (like the *Ecole Nationale des Ponts et Chaussées*) and the issues of the circle of the *Monuments Historiques*. Finally, in order to complete the overview of French production in this matter, we should make the inventory of the histories of architecture in which construction, in its socio-economic as much as technical dimension, holds a significant place, like for instance in the recent works published under the direction of GÉRARD MONNIER: *L'architecture moderne en France*. Speaking of publishing, we may point out the fact that the Parisian *Editions du Linteau*, directed by BERNARD MARREY, specialised in the history of construction: "Founded in 1993, their goal is to publish texts by constructors, architects, contracting authorities, engineers or building contractors, and whoever works in these ventures." The École Nationale des Ponts et Chaussées press devotes a collection (*Tradition*) both to the great constructors and their works, and to the history of their training. Numerous publications by the *Éditions du Moniteur* also deal with the history of construction.

Translated from the French by Sylvie Duvernoy