The Conservatoire National des Arts et Métiers and The Preservation, Dissemination and Innovation of Construction Know-How (1794-1971)

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To understand the role the Conservatoire des arts et métiers played in the world of construction throughout almost two centuries – from its creation until the engineer-builder Jean Prouvé stopped teaching there in 1971 – may seem, at first sight, a complex task. For during that period, the Conservatoire, founded by Abbé Grégoire in 1794, undertook a variety of missions relating to all arts and trades. Yet the *Art of Building*, throughout the evolution of its various forms, has left its mark on a great many other disciplines: in the engineering sciences of course, but also in the burgeoning social sciences.

Designed to be "a depository for machines, models, tools, drawings, descriptions and books about all the arts and trades" (Fontanon and Grelon 1994b, p. 25), the main purpose of the Conservatoire is to provide a museum for collections of machines from institutions that were abolished during the French Revolution and, more generally, those relating to arts and trades. In 1798 a library was created and exhibition galleries to display machines and models. Later, the mission of disseminating knowledge was added to that of archival storage: the Conservatoire produced drawings of award-winning inventions and published them as well as old patents. At the beginning, three "demonstrators" were employed to show the public the machines in action. This type of instruction, based on "letting people see" (Fontanon 1994a, p. 62), which combined with and aimed to supplant the more theoretical teaching given by trade associations, was itself replaced in 1819 by evening classes in applied science: open to all, free of charge therefore accessible to the *labouring classes*. Neither the constant diversification and specialisation of teaching, or even the radical evolutions in higher education (the creation of specific diplomas in 1902; of institutes devoted to specialised instruction in 1923) deprived the institution of this characteristic that set it aside from other higher education establishments: the Conservatoire offered a high level of instruction to the working classes. At least one more mission was added to archival storage and teaching: the assessment of industrial production. This expertise was the fruit of the Mechanical Trials Laboratory (Laboratoire d'essais mécaniques), created in 1854 and transformed into the National Trials Laboratory (Laboratoire national d'essais, LNE) in 1900, but also the Conservatoire's active cooperation in establishing standards for the construction industry and its training of new experts.

How does *the Art of Building* fit into all this? Right from the start, it was apparent in the establishment's three principal missions: conservation, teaching and assessment. But it developed, more or less rapidly throughout the years, under the influence of men (teachers, directors), with the

backing and encouragement of public figures, and thanks to the initiatives of administrations and professionals in the building trades. Created to implement an industrial policy whose initial aim was to give France the technical and pedagogical means to compete with other European countries (especially England and the Netherlands), the Conservatoire was particularly reactive to political, economic, cultural and technical evolutions: this is another of its distinctive characteristics. Our intention is to treat only the original aspects and high points of the art of building experienced within the Conservatoire, and to present a vision of the subject seen from an internal perspective. So we will examine the three missions in turn; teaching, assessment, and the storage of archives and objects. Although no less important than the first two, the third would merit more complete and separate research.

TEACHING AND BUILDING

Before going any further, it would be useful to define what we mean by teaching building construction, for many courses dispensed by the Conservatoire have treated building construction while also touching on other domains. An example is the so-called "little school of technical drawing" (Petite école de dessin), and the first non-specialised courses such as "Mechanics applied to the arts", first taught in 1820 by Charles Dupin. This course, which was followed by architecture and engineering students as well as craftsmen in the building trades, included descriptive geometry (stone and wood cutting) (MNT Bibl. 10°45) and mechanics, but it was designed for participants from all branches of the industry. Likewise "Geometry applied to the arts" (1839) where notions of topography, drawing plans and surveying were taught. Later, other specialised courses were introduced to teach skills relating to the building trades: "Ceramics" (1848), "Applied Chemistry for the lime and cement industries, the manufacture of glass and ceramics" (1868), "Agricultural Works and Rural Engineering" (1864), "Metallurgy and Working with Metals" (1890), "Industrial Electricity" (1890), "Industrial Hygiene" (1905), "Industrial Heating and Glass-making" (1925). To give a full account of all these programmes would require much more space than the present paper affords.

That is why we have chosen to focus on teaching intended principally for professionals involved in the construction of buildings and civil engineering structures: i.e. five disciplines: "Géométrie descriptive" (Descriptive Geometry, 1839), "Constructions civiles" (Civil Constructions, 1854), "Histoire de la construction" (Construction History) (1950), "Techniques industrielles de l'architecture" (Industrial Techniques in Architecture, 1958, first called "Art applied to trades") and "Droit immobiler appliqué à la construction et à l'habitation" (Real Estate Law Applied to Construction and Housing, 1961). Two periods seem to emerge: the Second Empire, and later, after World War II, the so-called *Reconstruction* period. During these times, construction was a State priority. We shall look more closely at these courses, usually programmed over three years with roughly forty lessons a year: at their contents, their uniqueness and pedagogical methods, based mainly on the use of technical drawings and models.

Housing and Comfort – a priority

The Conservatoire's first discipline, intended particularly for builders, was Descriptive Geometry. Two years before it was abandoned in 1906, it was defined as covering "all the applications of geometry and drawing in the building industry" (CNAM 1 BB/3 1855). Almost all the students, around fifty between 1880 and 1903 and almost a hundred at the beginning of the twentieth century, were members of the building trades in 1905. The majority were draughtsmen, student architects, building clerks and surveyors. (CNAM 1 BB/3 1905). The Descriptive Geometry chair was created in 1839, along with five others, in response to a decision to further specialise the instruction. Descriptive geometry, formerly linked with mechanics, became a discipline in its own right.

Introduced by Gaspard Monge to the Ecole du Génie de Mézières around 1795, and considered from that time on to be an indispensable part of an engineers' and architects' training, descriptive geometry was taught at the Conservatoire according to a *practical* method. As the last holder of the chair pointed out in 1907, there were two conflicting schools in the nineteenth century: "one *theoretical,* which teaches formula and applies it to inexistent objects; the other *practical,* which never loses sight of the technical aim of the geometric drawing and confines it to those signs that serve a purpose" (Bkouche 1994, p. 242). On one side, there were those who believed teaching must begin with the abstract presentation of lines, their applications only to be considered at a later stage; on the other, those who believed descriptive geometry must remain attached to stereotomy. The teachers at the Conservatoire, especially Jules Maillard de la Gournerie (1854-1883) defended the *practical* method (Dhombres 1994). Finding Monge's methods too theoretical for stone-cutters, Jules de la Gournerie preferred "to put descriptive geometry aside", and explain the lines of stereotomy "only when the principal theorems of plane and solid geometry have been learned" (La Gournerie 1874, p. 297). In 1855, his policy was to devote one year to representation (perspective and the drawing of shadows), one year to those notions of descriptive geometry required to understand the cutting of stone, and the final year to cutting wood. Where perspective is concerned, La Gournerie also defended "the practical method, easier and less time-consuming", "la méthode des points de concours" (the converging points method) for conic perspective and cavalier perspective or axonometry (rejected - to his mind unjustly - by Monge at the Ecole polytechnique) because it offered the advantage of "being easy to determine and accompanied by a scale" (La Gournerie 1874, p. 294). La Gournerie organised a progression in his lessons. On Mondays he taught notions that could be grasped by "all the workers with even limited intelligence: simple carpentry lines for roof timbers, scaffolding and stairs". Thursday's lessons were more complex and touched on the principal intrados surfaces (CNAM 1 BB/3 1855). This practical orientation was to be maintained: in his opening lesson of 1906, Carlo Bourlet (1866-1913) declared that his lessons would be "resolutely situated in the practical camp" (Bkouche 1994, p. 242).

The main evolution in the curriculum took place in 1884: the introduction by Emile Rouché of graphic statics. The Conservatoire and the Collège de France were the first two establishments in

Paris to teach this discipline. One year before the chair was supplanted by that of Mechanics (1907), it filled a whole year's training and also figured in the Civil Constructions programme.

With the arrival of the Second Empire, a second course specifically designed for building and civil engineering professionals was dispensed by the Conservatoire. Between 1852 and 1854, a period of intense activity when Baron Haussmann's urban renovation works were in gestation, the project to create a "Civil Constructions" course got underway (Seitz 1994). It was to attract a big audience, 200 - 300 students between 1880 and 1893 and a hundred between 1893 and 1907. This course, part of whose contents is revealed to us by the notes of the engineer and architect Emile Trélat (1821-1907), focused on construction materials and methods, but above all on architecture. This choice was not a new one. Before architecture and building were separated, the Construction course, taught by Charles-François Mandar at the Ecole des Ponts et chaussée*s* (1799) also included architecture (Picon 1992, p. 279). In the Ecole Centrale des arts et manufacture programme, Emile Trélat's old school, there was also a course named "Architecture and civil constructions" (1829 - 1865).

Yet the Civil Constructions course as taught at the Conservatoire was original (certainly for Paris) and it reflected a deliberate policy. Emile Trélat, who some years later (1865) founded the Ecole Centrale d'architecture (which became the Ecole spéciale d'architecture), intended to "guide while uniting" the two professions: architects and engineers; on one hand to fill in what he considered to be gaps in his architectural students "knowledge of the varied and recent progress in means of construction"; and on the other, to show the engineers how wrong they were "to abandon the spiritual satisfaction of their mission by rejecting as futile and gratuitous […] decoration and ornamentation" (CNAM 1 BB/6). At a time when, as he says himself, people were deserting the countryside and crowding into the towns (Trélat 1895, p. 115), Trélat wanted to train accomplished builders in art skills as well as science.

Trélat wanted his lessons to be all-encompassing and down to earth. The course, dispensed over three years, was divided into two parts: "means of construction" (the study of materials, their use and the calculation of building costs), and "composition and execution of buildings" (Trélat 1895, p. 108; Seitz 1994). The habitat was given great importance: more than half a year (17 lessons). Six lessons were devoted to homes for the working classes, including three to housing in England. Trélat gives a detailed account of the actions of the Society for Improving the Condition of the Labouring Classes as well as several of Henry Roberts' projects: "Model Houses for 48 families" (1850) and "The Lodging-house for unmarried labourers" published in *The Dwellings of the Labouring Classes,* translated into French as soon as it came out in 1850.

In sympathy with Eugène Viollet-le-Duc, Trélat insists on the *needs,* or the *programme* to which the buildings must respond, architecture being, to his mind, "the total expression of a need satisfied" and not a search for "absolute beauty, or the sole defence of one architectural system, to the detriment of all others" (CNAM 1 BB/6). His method is based on criticism: it consists in presenting recent constructions, published in books like *Parallèle des maisons de Paris* by Victor Calliat

(1850), or architecture reviews such as *Le Moniteur des architectes,* and examining them in detail (CNAM 1 BB/6). In the lesson entitled "House Facades", all the parts that do not express the construction or the function of the building are severely criticised: the mouldings "stuck on with strong glue", the simultaneous and therefore pointless presence of pediments and cornices, the projection of string courses on the pilasters.

Trélat adds a section devoted to the hygiene and salubrity of houses (Trélat 1895, p. 116). The "Important factors of Salubrity", air, light, heat, water and flooring, become more and more important to the point of taking a whole year to cover. For Trélat, son and brother of doctors, experts in matters of hygiene, "the builder's principal problem is to re-establish hygiene in urban installations" (CNAM 1 BB/6). The contents of this course, which offered a global vision of building and favoured innovation in standard constructions, were more or less maintained by Jules Pillet (1842-1912), also an engineer and architect, who nevertheless developed the stability and strength of materials. In 1905 he taught "Materials and elements of construction"; "Construction parts and the compositions of buildings" and "The stability of buildings, the strength of materials, the salubrity of buildings and towns".

The importance given to housing and hygiene diminished in 1913 with the arrival of Augustin Mesnager (1862-1933), an engineer. Granting less attention to architecture and the global approach to building, his course is a juxtaposition of different elements: statics, strength of materials, and especially reinforced concrete. The third year is almost exclusively based on this material, on which Augustin Mesnager was working actively at the Ecole des Ponts et Chaussées' trial laboratory. Mesnager brought teaching at the Conservatoire' into line with the building practice of civil engineers. His son and successor, Jacques Mesnager (1894-1971) maintained this direction.

Post World War II: building for *Reconstruction*

At a time when housing was once again a State priority in France, three new disciplines devoted to construction were created at the Conservatoire: "Histoire de la construction" (Construction History, 1950), "Techniques industrielles de l'architecture" (Industrial Techniques in Architecture, 1958) and "Droit immobiler appliqué à la construction et à l'habitation" (Real Estate Law Applied to Construction and Housing, 1961). Widespread destruction after the war, the population explosion and the rural exodus to urban centres brought about a shortage of housing that the government tried to remedy with a series of measures in favour of the construction industry, piloted by the Minister of Reconstruction. As the Minister declared during his inaugural conference, the creation of the Construction History chair was plainly part of this policy (CNAM 1 BB/9, p. 3). It was the Paris Town Council, not the Conservatoire, who initiated and financed this course, specifically created for Jean Ache PhD (1905-1983), close to the Gaullist Resistance group, decorated for his actions during the Résistance (1945) (Pieuchot 1994, p. 74).

Ache maintained it is a question of "giving builders, who are constantly absorbed by immediate problems, the necessary foundation of general knowledge that only an understanding of history can

provide" (CNAM 1 BB/9, p. 3). His aim is to convince them that "it is our duty today to build the constructions that correspond to our techniques, to our social structure, to our sense of aesthetics and even to a certain philosophy of our times" (CNAM 1 BB/9, p. 11). A former student of the art historian Henri Focillon, Ache was a qualified historian specialising in the history of architecture. His ambition is to avoid "the double obstacle of art history: being punctilious and over-influenced by aestheticism; and the history of architecture, too often obsessed with form and exterior decoration". His teaching, however, remained largely a course on the history of architecture. His approach was chronological (CNAM 1 BB/9). For each period studied, Ache insisted on the social factors and the techniques that determine architecture, then presented the evolution of buildings according to their type, (private housing, palaces, churches, hospitals, schools, bridges, etc.). Each session concluded with a search for the reciprocal links and influences "between civilisation and building" (CNAM 1 BB/3). Antiquity and the Middle Ages were studied during the first year, "Construction in the modern world" (seventeenth century-1830) and "New Building (1830-1950)" during the second.

Ache treated contemporary problems by holding complementary conferences devoted to urban residences and urban planning in large towns (four conferences in 1951 and five in 1952). The practical exercises, completed by interviews with architects and engineers, also offered an opportunity to study recently-built constructions. Ache gradually gave more importance to the nineteenth and twentieth centuries and in 1954, he created a research and documentation centre for construction history in the nineteenth – twentieth centuries (Centre de Recherche et de Documentation d'Histoire Moderne de la Construction, closed in 1989), which provided him with a new rostrum and a new tool to advocate contemporary architecture. A library was set up, exhibitions organised and, with the encouragement of his archivist, Henri Poupée, the archives of construction firms and architects were assembled. A true pioneer, he collected hundreds of thousands of dossiers (working drawings, models, photographs, manuscripts, related documents) on modern building. Henri Poupée was careful to conserve not only the finely executed final drawings, but all the successive stages (projects, sketches, tracings, etc.) and written documents (Poupée, 1988, p. 59). The better known pieces include archives from Guadet, Magne, Perret, Lurçat, Le Cœur, Hennebique, as well as documents relative to the *Reconstruction* of France after the war in 1945. When he received the Perret collection, the Director of the Conservatoire exclaimed: "In this, the oldest of all technical schools, Construction history will be firmly founded, not on rich erudition, but on the very creation of a master" (CEA 1960).

The nomination of Jean Prouvé (1901-1984) to the "Art applied to trades" chair in 1958 was also a response to the French policy of *Reconstruction* expressed in the dynamic industrialisation of the building industry. Jean Prouvé profoundly transformed the contents of the discipline created in 1892 (although solicited since 1854) to catch up with "England's progress in the domain of industrial arts" (Laussedat 1892, p. 16). The Art applied to trades course, first dispensed by the architect Lucien Magne, was principally intended for the artisans of different artistic trades (pottery,

ceramics, jewellery-making, silversmiths, ironwork, carpentry, tapestry, etc.) but also architects. Jean Prouvé confined it to building and civil engineering and based it on "the study of today's constructions and trades" (CNAM 1 BB/8 1960). The audience was henceforth transformed, as Prouvé observed in 1963: it was mostly made up of "tradesmen and technicians" (CNAM 1 BB/8 1963), among whom a certain number of architecture students from the Ecole des Beaux-arts. The course, initially divided into three parts; "housing, the street and works of art", focussed especially on housing and public equipment, which covered one year out of two from 1963 onward. Prouvé decided to advocate new, more rational solutions in the industry, founded on the economy of materials, prefabrication and the simplification of assembly operations. Renamed "Industrial techniques in architecture" (1970), the course presented new elements for building: shells, curtain-walls, panel-facades, "blocs techniques" (prefabricated units) (Archieri, 1990) but also complete projects such as "Abbé Pierre's house". Sometimes called "the minimal house" or "the house of better days", this was an experimental residence in three parts, commissioned by Abbé Pierre from Jean Prouvé in 1956 to deal with the post-war housing crisis. At the beginning of the sixties, the three courses: Civil Constructions, Construction History, and Arts applied to trades, formed a fairly complementary ensemble, principally based on contemporary construction. The Construction Department had a Research Centre for the Modern History of Construction (1954) that included a specialised library.

In 1961, three years after Jean Prouvé's arrival at the Conservatoire, the discipline "Real Estate Law applied to the construction industry and housing" was added. In a conference given at the Conservatoire on 20 April 1951, Claudius-Petit, Minister of Reconstruction, spoke, at Jean Ache's request, about legislation relating to rents, housing allowances, urban and country planning and architecture as the basis of his policy:

> If you go to avenue Paul Doumer, you will see, in 1951, what the Parisian urban legislation, dating from 1902, permits and tolerates. And you will be convinced of the need to change things. But to change things, you need to have the means, and to have the means, you have to be able to say to owners of building land "you can't just build anything old thing on this land!" You have to be able to persuade the owners to agree to put together their illogically-divided, badly assembled bits of land, incongruous too, because they come from history and heritages. That is precisely the object of the town planning law now brought before Parliament, that will, I very much hope, be voted and will allow us to plan intelligently, consequently, and, even in large towns, to apply a policy of land consolidation...
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> (CNAM 7 AA/12)

French housing policy, which dated from the *Reconstruction*, was obliged to resort to legislation, or more usually to parliament, to impose its will and compel the banks, investors, architects and contractors to build. Laws were modified by increasing their number and revising them as

necessary. The law was even reorganised in certain fields (the construction lease, co-ownership, decentralisation, town and country planning, expropriation, social housing, development, rents, planning permission, allowances and loans, planning rules, etc.).

The creation of the Construction Law chair clearly served that policy. It must be noted that this constituted an innovation in teaching. Since the architect Desgodets who taught the *Loix des bâtiments* (Building Regulations) and the *toisé* (the quantitative survey) at the Académie d'architecture (1708 – 1719), many teaching establishments had covered the legislation of the construction industry in engineering or architecture schools, many compilations of legal sources had been published, but no teacher had attempted to make a synthesis of practice and theory, public and private law - and most importantly - no one had tried to invent new laws unifying the rules of urban planning, architecture and construction. Only when the publicist Georges Liet-Veaux (1949, 1954, 1961) arrived at the Conservatoire was an Institute of Economic and Legal Studies Applied to Construction and Housing created (Institut d'Etudes Economiques et Juridiques, called the ICH), of which he became director in 1960. In the same drive of energy he also created a chair of real estate law applied to construction and housing (1963). There had been a course of the same name two years earlier (1961).

The ICH was created on the initiative of the professions concerned by the Reconstruction policy. The same is true of the Real Estate Law course, subsidized at the beginning by the Union de la propriété bâtie de France, then by the Fédération Nationale du Bâtiment, finally taken over by the Conservatoire when the chair was created. The aim was to provide theoretical and practical instruction on legal, administrative, financial and accounting legislation applied to construction and housing. It addressed all those who wished to improve their technical, artistic or legal skills: architects, engineers and technicians in the construction industry, white-collar workers in building firms, real estate experts, the personnel of construction or property management firms, even those with the ambition to work in professions that use economy and construction law: promoters, property managers, estate agents, the personal of council housing departments, building societies, State and territorial administrators, insurance agents, investors, etc. The course met with considerable success, almost 700 participants enrolled each year in the sixties (Liet-Veaux 2005).

The creation of an Institute, supported by lectures on "Real Estate Law", undoubtedly gave rise to "a new branch of law", which automatically stimulated and directed new research. Under the generic title of "the law of construction", Georges Liet-Veaux wrote a book that was constantly updated throughout its many re-editions (1970). It is divided into two parts: the study of real estate law (including the private and public status of buildings according to property law) and the status of the builder in terms of liability laws. It was the double creation of the Institute and the course that led to the discipline being introduced to university syllabuses in the seventies, the opening of a real estate office at the Ministère de la Justice and a third specialised court at the Cour de Cassation. It is worth mentioning that the diploma and certificates issued by the ICH now have international

renown in the building industry and that the Institute has been a partner of the Royal Institution of Chartered Surveyors (RICS) since 1995, awarding a joint diploma of construction expertise.

Drawings and models: the core of the instruction

What was specific about those free courses, open to all, including in theory the "labouring classes"? (Day 1987). Nothing, if we look at the teachers' profiles. Those holding the Descriptive Geometry and Civil Constructions chairs were all graduates from the Ecole Polytechnique or Centrale, teaching in the same schools or at the Ecole des Beaux-Arts. It is surprising to see candidates for teaching posts from professional schools or the Ecole des Beaux-arts rejected by an institution whose vocation is to welcome technicians. This is because the Conservatoire, as the Conseil de perfectionnement put it in 1883, while addressing a popular public, aspired to a higher level of instruction, capable of teaching the latest innovations (CNAM 1 BB/3 1883). In concrete terms, graduates from the Ecole Polytechnique and, to a lesser degree, the Ecole Centrale, monopolised the chairs; the practice of plurality of functions, widespread in higher education and research in the nineteenth century, allowed them to teach in two, three or four establishments simultaneously. Apart from Augustin Mesnager's son, preferred in 1913 to the great French engineer Eugène Freyssinet, the descriptive geometry or construction teachers were all well-known engineers, the authors of many works of reference (courses, handbooks, dissertations, articles). This was true of all disciplines except those closer to the arts than science: the Construction History was taught by a historian of architecture; The Arts applied to Trades by architects or self-taught builders. Their audience, however, was not the same as in engineering or architecture schools. A petition to conserve the Civil Constructions course in 1933 mentions a "poor" (CNAM, unreferenced) public. In 1950, Jean Ache evoked "this enthusiastic audience who, after a day's work, take the time to come and listen to a lecture. […] Many are workers, architects' employees, 'practitioners', employees in technical departments, workers unable to attend a day school" (CNAM 1 BB/9). As Robert Fox stressed, the Conservatoire plays a marginal role in the training of the industrial and technical elite (Fox 1974).

It is more difficult to define the specific nature of the teaching methods. In 1798, Alquier, the MP, mentioned the importance of "letting people see". But were those descriptive geometry lessons, where people were encouraged to observe, really so different from those given by guilds or by master-carpenters like Nicolas Fourneau who, as early as 1773, created public lessons for Parisian carpenters "of all classes" (MNT H 96)? This pedagogical policy of "letting people see" was based on the use of models, in the Conservatoire at any rate. We know that in 1829, eighty-two models made of service wood were purchased for the Mechanics Applied to the Arts course. For the Descriptive Geometry department, Théodore Olivier designed about fifty articulated models, in order to clearly demonstrate the geometric properties of surfaces and to illustrate transformations allowing the passage from one to another (Sakarovitch 1994, p. 332). Augustin Mesnager used highly original models made of glass, the fruit of his own research. His method consisted of replacing calculation by direct observation of models under different stresses. The models allowed

students to visualise the results of theories whose demonstrations couldn't be followed by the audience, allowing him to demonstrate the principles and the practical consequences (Montel 1994, p. 240).

Drawings placed on easels or drawn on a blackboard occupied an even more important place. Arthur Morin, director of the Conservatoire from 1849 to 1880 who also taught Mechanics Applied to the Arts, stressed the advantages:

> [The drawing is] a very useful secondary means to demonstrate and expound principles. It allows us to make most propositions of elementary geometry, descriptive geometry, even mechanics, and their applications, visible and perceptible to intelligence… There isn't one industrialist, foreman, worker, who doesn't constantly need to represent his ideas in sketches… So one should always begin, almost always, with a free hand drawing, even for geometric figures, and only move on to a line drawing later. […]. This is also true and no less important for everything that concerns the arts of construction […]. Drawings of various types of constructions in masonry, carpentry, joinery, ironwork, stove-building, etc. showing the dimensions of the main pieces according to the size of the building and its parts, constitute for building workers what we call in the artillery *construction tables*, in which the workman, the foreman, the contractor, can find, if need be, the most useful information.
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> (Morin 1868, p. 451)

The working drawings in descriptive geometry, but also the plans, facades and sections of buildings are drawn directly in front of the students, by the teacher or the "demonstrator". In his introductory lesson, Jean Prouvé insisted on the importance of the drawing: "We will draw a lot, demonstrate a lot and speak as little as possible. In brief, I will do my best to reconstruct every work in front of you with the help of drawings and photos" (Archieri 1990, p. 16).

It is interesting to note that the teaching of Construction History and Construction Law were based on visits to building sites and conferences. Georges Liet-Veaux's teaching took place in strict liaison with the everyday tasks of workers in the construction industry. Lots of practical assessments, conferences, debates, visits to offices or real estate projects, were part of the course. An approach that would seem iconoclastic for a jurist!

ASSESSING CONSTRUCTION PROCESSES

Assessment is not one of the declared missions of the founders of the Conservatoire. Yet, it soon becomes manifest to anyone reading the archives conserved by the institution, especially in the construction domain. Construction is, in essence, a broad discipline combining many skills and constantly evolving. It has always summoned a host of experts, capable of assessing new techniques

and materials before putting them into practice and pleading causes in case of disputes between private individuals. We may recall the competitive relationship between masons and architects under Louis XIV, which gave birth to two bodies of experts: the sworn- building contractor and the bourgeois-architects. The French Revolution, with d'Allarde's decree and Le Chapelier's law abolishing guilds, disrupted the world of craftsmen by depriving them of a part of their competence. It was the Conservatoire's mission to assume that competence, especially since its action also aimed to restore some of the confidence the public had lost in regard to trades. In these circumstances, it is not surprising to see the Conservatoire take on the task of assessment by offering advice, then testing building materials and techniques in its trials laboratory, where their dependability and quality was analysed. In the increasingly technical twentieth century, the institution became involved in the standardisation of construction processes and the training of new experts for the building industry.

From consultancy to testing: the trials laboratory

When it was created, the Conservatoire provided advice and expertise to those institutions whose function was to award prizes for inventions. Its members (Claude-Pierre Molard and Joseph-Michel de Montgolfier) took part in the work of the Bureau de consultation des arts et manufactures, whose mission, as early as 1795, was to keep the Minister of the Interior informed about the situation of industry and subsidize inventors. When the Bureau was temporarily closed from the year XI to the year XIII (1802-1805), the Conservatoire took over these tasks. The "demonstrators", and later the professors, were also solicited to this end all during the nineteenth century by the Société d'encouragement pour l'industrie nationale, (1801) (Tresse 1952).

In the building domain, the institution also carried out experiments. At the Conservatoire, they tested heating equipment registered after a competition launched in 1807 (Place 1981, p. 121). But the practice continued to develop, especially after the creation in 1852 of the Salle des machines en mouvement (a gallery where machines were shown in action) and the mechanical experimentation laboratory. Undoubtedly, the most original initiative came in 1852 from Arthur Morin (1798-1880), graduate of the Ecole Polytechnique, who with the help of a former student of the Ecole Centrale, Henri Tresca (who became professor of Mechanics applied to the Arts), created this laboratory: a first in Europe that remained a model for all other European laboratories (Fontanon 1994b). Set up in the nave of the Saint-Martin des Champs church, transformed into the Salle des machines en mouvement, the function of the trials laboratory was to allow industrialists, constructors and inventors to test innovations and inventions, but also to present the tests instructively to all visitors, by showing the new machines in action before their eyes. In this new initiative, Morin institutionalised assessment, which he had previously practised on a private basis in the field of hydraulic construction. Very soon, and all during the Second Empire, the assessment activities (whose results are published in the *Annales du Conservatoire*) extended beyond this one sector to include the strength of materials and especially heating and ventilation techniques, which were still little-known and little-understood (Guillerme 1992; Gallo and Thomine 2004). The experiments

took place either in the amphitheatres of the Conservatoire, which Morin equipped with heating systems, or *in situ* in the public establishments of Haussmann's Paris. Morin closely studied British processes, which he had the opportunity to see at the Universal Exposition of 1862. In 1864, he had some models of English chimneys delivered and tested them (Morin 1862, 1864-1865, 1865-1866). The Conservatoire became a place where methods of observation and control, as well as procedures that would be recommended for use in public buildings, were perfected. Comfort, quality and air purification were among his principal preoccupations (Morin 1863; Blouin 1994). The convectors installed in the chimneys were judged to be more salubrious than stoves, because with the former the air is renewed more often. According to Morin, the sole action of heat correctly used was enough to produce dynamic ventilation; the use of ventilators was pointless. The work on ventilation and heating came to an end with the departure of Morin and Tresca.

Under the Third Republic, from 1880 to 1900, the trials carried out essentially involved the strength of common construction materials: stone and bricks mostly, also metal and cement. Construction structures (metal flooring, hollow blocks) were also tested. The demand came from industry, merchants, professionals in the building industry (architects, civil engineers). In 1886, the architect Julien Guadet tested the tensile strength of cast iron specimens taken from different pieces of metal to be used in the machinery of the new post office. In 1881, the architect Lacroix tested samples of *composite concrete*. As far as tests on stone are concerned, most demands came from quarry-masters, quarry-owners and contractors. For bricks, the number of tests increased between 1895 and 1900, requested by directors of brickyards and contractors, such as Etablissements Perrusson père et fils in 1885, La Grande Tuilerie de Bourgogne in 1886-1887, Les Frères Delécourt in 1898 (CNAM 1 EE/10-11 1889-1899).

If initially the Conservatoire acted as a model for Europe, it must be confessed that it lost that lead in the last thirty years of the nineteenth century, compared with foreign laboratories which were based on wider activity. Masson, former deputy director of the Conservatoire and director of the trials laboratory in 1900, attended an international congress on trial methods for construction material and was obliged to acknowledge the sad state of the laboratory (CNAM 1 EE/3 1901). Yet at the Conservatoire half of the trials done concerned building. But the German laboratories, unlike the French, offered experiments on the assemblage of several construction elements in their real conditions of use. Moreover, they were open to wider demand from industry and commerce, unlike other French laboratories, like the one at Ponts et Chaussées which accepted to do trials only if they presented an interest for civil engineering.

In order to overcome these drawbacks (Bourgeois and Hartmann 1901), a new Trial laboratory for mechanics, physics, chemistry and machines was created in 1900. Officially, its purpose was to serve small and medium-sized industrial firms which did not possess the necessary testing and trial equipment that the larger factories had, but also consumers, like the German laboratories. In 1910, it was established that the Ecole nationale des Ponts et Chaussées would not intrude in its area of

competence. A *provisional* trials service for woods was created in 1919 to test colonial tree species after the destruction of the forests during World War I (CNAM 1 EE/14). But for want of personnel, this branch had to be closed.

The annual report published by the laboratory shows that for the inter-war period, (1922-1934), the building industry requested most of the tests (CNAM 1 EE/1-4). The most common materials were the most frequently tested. Out of almost 600 trials per year, about 900 were on samples of natural or artificial stone, 150 on cement, 150 on bricks, tiles and slates and 135 on ceramic or heat-resistant substances. Sometimes there were special tests done on various water-repellent substances, for waterproofing mortar and cement; on the conservation of paint and stones to be used for national monuments as well as the phonic properties of construction material. Yet trials in the laboratory were no longer enough. The complexity and the multiplication of new techniques in construction justified an organisation that produced standards.

Standardisation of building techniques

Through its assessment activity, the Conservatoire participated in the general movement toward standardisation, i.e. to the more or less legal written definition of technical standards, considered as "information to be used as a reference, resulting from a rational choice made to form the basis of a solution to recurring problems" (Penneau 1989, p. 37).

Although the French National Association for Standardisation (Association française de normalisation -AFNOR) was created in 1926 with the initial aim of improving production in the secondary sector of economic activity, it was only in November 1938, with the coming of war, that the State invested in the mechanism, or that the Conservatoire revealed its active participation in the process as an indispensable partner of that "ardent crusade" (CNAM 6 AA/1 1951). Only then did the construction industry become representative of standardisation policy (more than 30 % of the approved standards between 7 March 1940 and 27 June 1941 concern the building industry and public works) (CNAM 6 AA/5). On 15 May 1945, the report presented to AFNOR's Ordinary General Assembly mentions fifty-three approved standards in the building trades out of a hundred and fifty-nine for all sectors in 1944, i.e. a third of the total. In 1948, standards in Building were still amongst the most requested (CNAM 6 AA/1 1948). The Conservatoire participated in establishing the standardisation of techniques firstly because it possessed expertise in industrial, commercial and traditional techniques and was often aware of the most recent inventions, but also because its teaching was emblematic of harmony and a social synthesis between the most distinguished engineers and the most modest artisans. In concrete terms, the Conservatoire's activity was apparent in the participation of its directors, especially Louis Ragey (1940-1965); and more intermittently of certain of its members, as well as the many working commissions constituted according to the needs of different sectors. The establishment of industrial standards requires practical confrontation and concord between different viewpoints in order to establish the best choice of models.

Issue n° 51 of AFNOR's Courrier de la Normalisation (June-October, 1940) is entirely devoted to

building. A general committee of the building industry assembled several subcommittees in relation with the trade associations (CNAM 6 AA/4-5). For firms standardisation means the economic rationalisation of production, which is consequently divided into a series of modules. This must be done with the users, but without diminishing the firm's creative capacity. In 1942, for the first time, one French standard: the "Code of minimum conditions for the execution of plumbing work and urban sanitary installations" became compulsory, at the request of the very firms upon whom it imposed the *rules of the art* (Peannau 1989; Violet 2003).

Standardisation, if it was to be useful and productive, needed to use "propaganda", because it was not an obligation in the legal sense of the word. On 16 December 1942, the Comité national de l'organisation française organised a one-day event to study and propagate standardisation, supervised by the Conservatoire in the person of its Director, Ragey, and some of its professors, like Louis Danty-Lafrance and Henri-Marcel Magne (CNAM 6 AA/3). Many different professions in the building industry were represented and several issues pertaining to construction were debated: "The social signification of standardisation in the building industry"; "The architect's mission and standardisation". In 1943 "a system of automatic diffusion of all published or forthcoming standards to firms and institutions in relation with the Building Industry" was studied. In 1952, it was still a recognised fact that the advantages of standardisation in the domain would become evident only if their diffusion were increased, and especially in the building and construction materials sector. Even the language used in construction had been standardised, e.g. the terminology used to describe the strength of materials. Considerable efforts were made to teach standardisation, especially in technical schools (CNAM 6 AA/1).

On 15 January 1943, the Conservatoire's intervention was more incisive when Ragey, who as well as being its director was an active member of the board of governors of the Association française de normalisation, demanded that standardisation be attributed to national brand of hydraulic binders only on condition that regular tests be done by the Conservatoire's trials laboratory (CNAM 6 AA/3 1943). In 1947, the standards for plaster in the Parisian region was approved (classification, specifications, setting times, conditions for use, etc.) (CNAM 6 AA/1). In 1948, although the quality control of lime was entrusted to the Paris Council laboratory, the Conservatoire was represented on the Special Committee for national brands of lime and cement (Comité particulier des chaux et ciments de la marque nationale) (CNAM 6 AA/4). Ragey frequently took the floor, sometimes to point out that the Conservatoire's competence was essentially technical and concerned with precision, as opposed to the weights and measures service which was more commercial; or to make the Conservatoire a partner in the special committee for gas appliances; or to coordinate the distribution of a series of standards to pupils when leaving the school. In December 1953, Ragey reminded the assembly that within the CNAM, there existed a Metrological section, particularly well-equipped to carry out tests on scientific apparatus.

As early as 1948 there was talk of unifying standards. "The standardised specifications of the general conditions and obligations applicable to building works which are the object of a private

contract" was published, and a "Code of instructions for roofing" (CNAM 6 AA/1). But, the creation that year of the Scientific and Technical Center for Building (Centre scientifique et technique du bâtiment - CSTB) made the problem more complex (CNAM 6 AA/1 1949). *De facto*, this institution collaborated with the AFNOR and the reconstruction studies department at the Ministry to encourage the development of standardisation. Firstly it established documents that constituted 'pre-standardisations'; secondly it diffused standards *via* its continued publication of the list of all manufactured goods necessary for architects involved in reconstruction (REEF). This publication mentioned most of the approved standards and contained extremely useful technical documents. The CNAM and the CSTB convened at AFNOR to simplify standards in the building industry.

The Courrier de la Normalisation of 1950, with its new lay-out, showed graphic representations of standardised techniques (sections, exploded views, plans, photographs) easily usable by professors at the Conservatoire. The same year, the Conservatoire was invited, once again *via* its trials laboratory, to join in the effort to unify standards by participating in the creation of a specific Building Committee, in the context of brand status, along with all the associations who represent this sector. Even a reminder of the classification of standards according to their degree of obligation was not enough to ensure that standards would be applied in a uniform manner, because they were not able to achieve this uniformity (CNAM 6 AA/1 1953).

In the fifties, the building industry took a decisive turn when quick methods of prefabrication appeared alongside the traditional processes. Although AFNOR incorporated that fact and adjusted its own standards while introducing notions of modulation, the object of considerable international research, on 22 June 1958, on the CSTB's initiative, the DTU (unified technical documents) (CNAM 6 AA/2) were drawn up. In the presentation of motives, a list of exclusive documents was established that from then on would form the reference for construction deals: the standards (Normes Françaises), quality brands or labels, specifications, recommendations made by the Bureaux de Contrôle and lastly the rules to be applied when calculating. All these documents, collectively drawn up on one single occasion, had to be coordinated according to precise rules, especially when being used to settle a disagreement between partners. By successfully establishing regulations for the construction industry, the CSTB naturally took the upper hand over the CNAM. When in 1959, a statement from AFNOR's board of directors described the realisation of the Tancarville Bridge according to the standardised processes, the Conservatoire had disappeared from the standardisation of the art of building. But it had invested in another quest just as important as standardisation over the previous thirty years: the training of new experts.

Training the guarantors of expertise: hygiene and surveying

At the turn of the century, the Conservatoire focused on some new domains of study as well as some older ones which had been renovated because of technical discoveries in the field of construction. It was then that the Conservatoire, in a bid to make its training more prestigious,

decided to launch its own diplomas (Fontanon and Grelon 1994b, p. 51-56). Only in 1920, when the Conservatoire no longer depended on the Ministry of Trade but on the National Educational Board did this desire to create specialised diplomas become a reality, often *via* the creation of specialised institutes. The Conservatoire's integration to the State Educational system did not enhance relations with private industry. Instruction dispensed for a century to *auditors*, workmen or company directors was now addressing *pupils* out to obtain a diploma. These were no longer people trying to improve their knowledge and climb the social ladder; the ambition of these students was to become experts, specialists in a clearly-defined field. The diplomas were sub-divided and became more specialised. In the construction field, two professions were reorganised: those of the hygiene technician, who ensures the salubrity of buildings and the surveyor who measures and situates buildings; an institute having been created for each of these two trades.

Hygiene Technicians

Hygiene, since the contribution of Pasteur and his proselyte Emile Trélat (Trélat 1896), had been greatly developed in many of the Conservatoire's different courses. It became a major discipline when the "Industrial Hygiene" chair was inaugurated in 1905 and attributed to Frédéric-Louis Heim de Balsac. The importance of this discipline, at a time when the Conservatoire was seeking to generate new diplomas, resulted in the creation in 1922 of an Institute of Sanitation Techniques (Institut de technique sanitaire), which organised examinations each year and awarded a certificate for hygiene technicians.

But this was not enough. Hygiene continued to gain momentum. It soon became necessary to create a higher level of diploma, with distinct specialities. The certificate-holders, who had acquired real recognition as specialists, wanted "to prove their effective specialisation by obtaining a State diploma." (CNAM 2 EE/4 1934). In 1935, a report made out by a professor of applied arts, Henri-Marcel Magne, recommended the creation of a higher-level certificate, because it was impossible, in the space of four months, to train a hygiene technician in the different branches of sanitation other than in very general terms; even if the theoretic instruction - still based on commenting visuals - were to be complemented by practical exercises (demonstrations of appliances, visits, practice, making reports). He wrote:

> There exist a considerable number of certificate holders from the Institute of Sanitation techniques, who now have jobs - positions of real responsibility - in public service sanitary departments and in private companies. They are highly specialised technicians, some of whom have realised works that are deservedly recognised.
>
> (CNAM 2 EE/4 1935)

The professional groups in the building trades believed it was in the public interest, and that the time was right, to create a higher professional diploma awarded by the Conservatoire, with the seven following special mentions: sanitary installations; drinking water; waste water; heating and

air conditioning; disinfection (destruction of insects and pests); scientific research; artistic or architectural research; urban and community planning (a specialisation added after the war). Candidates must already possess the certificate and have job experience in a public or private sanitation firm and present an original, personal project in front of a jury who would question the applicant to test his knowledge.

The matter was considered so urgent that the diploma was created in 1939 on the simple decision of the Conservatoire's Board of Directors, without referring to higher authorities. Exam sessions were organised. The first thesis was defended in 1942, the second in 1947. The war slowed things down. Only in 1948 when the director of the Conservatoire was searching for the official texts on the creation of this diploma was the legal void discovered. He then requested an official decree which he obtained in 1949. But things were also moving in the provinces following discussions between the Institute's supervisor of studies and the Directors of Rural Engineering and Reconstruction. In 1950, the possibility was created for certain employees to take two months leave a year in order to obtain partial certificates in Paris. The division of lessons was arranged so that the subject of sanitation for the construction industry would be taught during both years of the course. Of the Institute's forty-three conférenciers, 5 were also professors at the Conservatoire, twenty-three (more than half – they were 40% in 1936) came from the building industry (entrepreneurs, architects, engineers); thirteen from the health sector (almost a third, 37% in 1936), 5 from science and 2 from agriculture (CNAM 2 EE/4 1936-1938; 1949a).

In the fifties, the World Health Organisation appealed for more hygiene technicians throughout the world. In 1949, the monthly architecture review *La construction moderne* published a special issue on the 'improvement of sanitation techniques in construction', under the direction of Henri Heim de Balsac, deputy director of the Institute, and Gérard Richard, an engineer from the Conservatoire in the service of the Institute. In it were two articles: one on "sanitation techniques for the ventilation of large basement kitchens" and the other on "sanitary conditions for the reinstallation of hot air stoves after long periods of disuse". To give an idea of the number of students at the Institute, in 1949 there were fifty-eight pupils enrolled in the first year, sixty-two in the second and thirteen presented for the examination; eleven received the diploma (CNAM 2 EE/4 1949b). A cycle of conferences on new developments was organised by the Conservatoire in 1950, on the theme of "Sanitation techniques for reconstruction and re-equipment", with speakers such as Tanon, the doctor; Caquot, the engineer and Perret, the architect. They were completed by interventions on urban and country planning, reforestation and electricity (CNAM 2 EE/4 1950). The participants were motivated by optional questions to obtain a medal from the employers' federation. Those who succeeded came from diverse backgrounds, but all of them were already trained as chemists, geologists, lawyers, quantity surveyors, site clerks, draftsmen, engineers, surveyors, engineer officers, etc.

There remained one challenge, which, to our knowledge, was never taken up: how could they

compete, on the international scene, with the technical assistance offered by engineers from the United Kingdom and America? Docteur Francis Borrey raised this question in a letter he wrote on 10 February 1958, to the Minister of Health and Population. To meet this challenge, it would be necessary to create, in France and under the auspices of the State Education system, a diploma for sanitary engineers! The notion of "Engenering"(sic !) "so necessary in France, is the sole means of permitting our worthy hygiene technicians to become competitive". For him, the cause was already lost as far as public health was concerned: "There's nothing to be done in Public health. The *Big Wigs* don't understand a thing about it !" But, contrary to the creation of the School of Higher Studies for Surveyors and Topographers (Ecole supérieure de géomètres et topographes), which awarded a diploma in engineering, in this sector, State support (health and reconstruction) and certain building industries were totally absent (CNAM 2 EE/4 1958), probably because of the political aspect of hygiene.

Surveyors and Topographers

Unlike hygiene, surveying and topography are very old disciplines. Yet all three are rich, sub-divided into several other disciplines and extremely useful. Surveyor-topographers work in the geographical departments of armies, topographical and street lines services of communes, land registry, agricultural and civil engineering, real estate, farming, and were then present in Algeria, the colonies and protectorates, etc. (CNAM 2 EE/23b). Contrary to the profession of hygiene technician, which immediately mobilized the Conservatoire, the State lay at the origin of the administration and reorganisation of surveyor-topographers. The Conservatoire, which possessed the expertise, was *de facto* the seat of that creation, and conserved the privilege of awarding a higher engineering diploma in the discipline.

In 1929, a State diploma for expert surveyors was created for "technicians wishing to effect as their usual profession: defining, measuring, organising rural and urban real estate, carrying out expertises in all land disputes, topographical tasks and levelling for the study of civil engineering and cadastral operations" (It is interesting to note that in English, the word *surveyor* stands alone while in French, it always forms a compound with *expert*: *géomètre-expert*). Opposite this new State qualification was the private Union of Surveyors, with its eight hundred members. To obtain the diploma, the candidate, among other conditions, had to possess a vocational training certificate, have at least 5 years job experience and pass the final exam. The decree of 29 June 1929 defines the quality of jury members and the modalities of the examinations. The instruction must cover geometry (plane, solid, descriptive and analytical); property law (civil, rural and forestry, boundary marking, land registry, rights of way); topography (surveying, drawing a plan, instruments, levelling) and applied sciences (optical, geology, geography). But all these disciplines were taught at the Conservatoire. So it was natural that the final exam should take place in the Conservatoire which became, via its director and its committee for development, the guarantor of the examination, exemptions, and dispensations (CNAM 4 CC/3 1934-1936).

The war greatly upset the organisation of studies for the diploma in surveying. Firstly, the number of specialists was insufficient, secondly the teaching was disorganised, and thirdly the French diploma did not have the same value as foreign ones, which were spread over three years of higher education. Before the Institute was created, two establishments taught this discipline: one private, the Ecole Spéciale des Travaux Publics in Paris, and the other public, the Ecole Nationale Technique in Strasbourg, but neither provided, as yet, higher technical instruction. The services and associations concerned by the discipline demanded a reform from the Minister of Education. They approached the Conservatoire, which "had possessed, since 1937 a department of photogrammetry, one of the modern sciences related to topometry and topography" (CNAM 3 EE/23 1939a) and asked them to create a centre of instruction worthy of the profession, similar to those of hygiene and accountancy. "The overall programme should renovate, in a complete and unified form, that of the former chair of descriptive geometry applied to the arts, where the surveyor Dupin (Fox 1994) and the photo-topographer Laussedat showed such distinction" (Carbonnell and Fontanon 1994). This 'Centre of Instruction for Surveyors and Topographers' would receive pupils who had passed their first year exams in existing schools, as well as candidates for the State Diploma, and some others dispensed from these conditions. The teaching would consist of conferences and practical sessions focussing on general, technical, economic and legal knowledge on the curriculum. So in 1939, the Conservatoire's Institute of Topography (Institut de topographie) was created. Its principal aim was to provide the teaching of general technical and legal knowledge related to the State surveyor's diploma, in conditions adapted to the constraints of students who had jobs. The Institute also had to "prompt and direct" all the scientific research corresponding to methods and measuring instruments, but also skills in real estate law. A quarter of the members of its technical commission were from the Conservatoire. The contribution of these training centres to technical progress is well-known. But other reasons, of a more psychological nature, also argued for the creation of the Institute: national prestige and the predominant public interest (CNAM 3 EE/23 1939b; 3 EE/24 1966).

Yet, this institute did not provide higher education. In 1945, it was completed by the creation within the Conservatoire of the School for Higher Studies of Surveying and Topography (Ecole supérieure des géomètres et topographes, ESGT). Its courses lasted three years; the first simultaneous with job experience. The lessons took place in the morning, with projections of clichés and continuous assessment, practical work in the afternoon. The specialisations, surveyor and topographer, were treated in the third year. To be accepted, candidates had to pass the preliminary exam of the State diploma and an entrance examination based on the contents of the preliminary exam. Some courses dispensed by the different departments of the Conservatoire could be made compulsory. The title of engineer was obtained after another two years of job experience, the presentation of a significant personal and professional project at the Conservatoire, and a dissertation allowing the jury to appreciate the aptitude of the candidate to treat questions that demand a strong sense of judgement and investigation.

In spite of the competition that the Conservatoire has to face from other schools (CNAM 4 CC/3 1940-1942), it has succeeded in producing a complete range of professionals working as or for surveyors. They are the products of the topography institute, a supplement to the main body of teaching; the Centres of Professional Training, with one preparatory year at the School for Higher Studies of Surveying and Topography, providing general knowledge for white-collar workers (surveyors' technicians); and the so-called School of Higher Studies where future managers are trained in the two specialities that, *in fine,* allow students to acquire, around the age of twenty-four, the title of engineer and the quality of surveyor of constructions, indoor and outdoor. (CNAM 3 EE/24 1944).

CONCLUSION

Two decisive periods emerge for the construction industry. Firstly, the beginning of the Second Empire, which saw the creation of the Civil Constructions chair and the Mechanical Trials Laboratory. Secondly, the years after World War II, when a Research Centre and several courses on contemporary construction were created, and collaboration with the associations in charge of standardisation for the building trades was set in motion. They are also two periods when construction was a State priority. As we have seen, the Conservatoire des arts et métiers maintained, *via* its directors and professors, direct links with the industrial and economic world. Though never steered by a coherent policy, its mission to diffuse knowledge and expertise and to promote innovation in the construction domain was nevertheless constant. In the words of Henri Poupée, "To *conserve* means presenting innovations and serving industry by publicizing them". The museum's collections (drawings, objects, archives) first designed for pedagogical and practical use, illustrate his point to perfection.

The Portefeuille industriel, a collection of more than fifteen thousand drawings, is largely the work of draftsmen at the service of a Conservatoire whose mission was to create "the archives of arts and trades" (Mercier 1994, p. 161). With many drawings of elementary machines (capstans, hoists, lathes, winches) and machines or specific devices for the production of construction materials (woodworking and brickmaking machines; plaster, lime or brick kilns) - French or foreign in origin - its aim was to illustrate the progress of industry. We find examples of the engineer Arthur Morin's work: two-hundred and forty-one dossiers on heating and ventilation equipment for the hospitals and theatres of Hausmann's Paris. Even if construction techniques are less well represented than machines and instruments, it is worth mentioning a superb series of one hundred and sixty-eight dossiers showing all sorts of bridges (end of seventeenth – end of nineteenth century). We know that many drawings from this collection came from copies of invention patents that the Conservatoire, as from 1798, was responsible for conserving and publishing. The Conservatoire carried out that task until 1900, then even more completely between 1900 and 1939 with the creation of the National Registry Office of Invention Patents and Brand Names (Office national des brevets d'invention et des marques de fabriques, ONPI) (CNAM 1 EE/3 1901; 2 EE/1 1902). Apart

from the drawings, this activity led to the publication of patents in the collection “Description des machines et procédés” (Emptoz 2002).

The Museum’s collection of objects, also designed with teaching and practical use in mind, is particularly rich in the construction domain: three thousand, three hundred and thirty-four objects have been listed under this theme. They are tools relating to all the trades of the building industry, models and samples of construction materials. The gallery now devoted to construction is a testimony to the variety of these objects. The importance of this collection for the history of technical instruction is self-evident. There are small wire models made at the request of Théodore Olivier for the Descriptive Geometry department, and a collection of models for stone-cutting. The Museum also possesses many other models, for stereotomy and wood assemblage, as well as constructions or sections of constructions that have still to be identified.

The objects, like the drawings, reveal the Conservatoire’s constant interest for Universal Expositions. Many objects were acquired during Arthur Morin’s directorships (1855, 1867 and 1878): the model of a Polonceau farm in wood and iron (1855), a Coignet balaster in reinforced concrete (1878), etc. Many of them have been drawn: from woodworking machines in 1851 and 1855 to kilns and brickmaking machines in 1867; others photographed, like the site of the Universal Exposition in 1878. The Conservatoire owes part of its international renown to the fact that the collection featured in those exhibitions. Many of its professors are simultaneously organisers, jury members and reporters of these major manifestations, as the rich collection of catalogues and exposition reports conserved in the library archives clearly shows. These were recently digitalised in the context of the Digital Conservatoire (CNUM).

The written documents conserved in the Museum’s archives make particular mention of the active role played by the Conservatoire in ensuring recognition for inventions. Its active participation in different commissions allowed it to fall heir to one thousand, eight hundred and eleven dossiers from the first Office of Consultation of Arts and Trades (Bureau de consultation des arts et métiers, 1791-1798). The papers in this office, which recompense almost three hundred inventors, including almost a quarter in the construction domain, are especially interesting for the history of the art of building at the time of the Revolution (Place 1981, pp. 118-120). These collections of written documents, drawings and technical objects, once so useful to artisans and industries and now museum pieces are an essential tool for those who wish to understand the history of construction today. From “salutary conservation”, we have progressed to “the preservation of memory”. The objects, in particular, have much to teach historians about techniques.

At the end of our reflection, we may ask ourselves if the Conservatoire, in the domain of construction, followed innovations or heralded them? *A priori,* we could assume that it has always followed them since it was constantly updating its knowledge, then presenting it according to the needs and the preferences of the times. However, through certain powerful personalities, the

Conservatoire made a contribution to the art of building in two ways: in the cases of La Gournerie, Mesnager or Prouvé, it benefits indirectly from their reputation in construction science, conveying their innovations. But in the cases of Morin, Trélat or Liet-Veaux, who were closely identified with the institution, the Conservatoire's role was more pioneering.

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