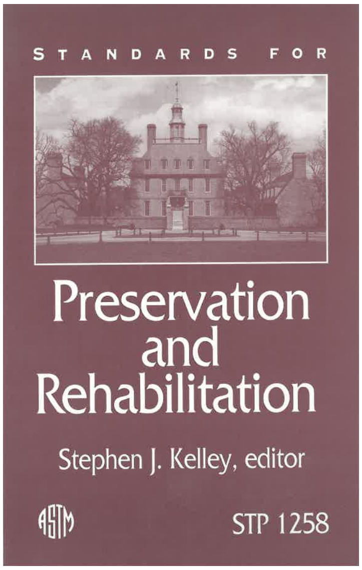

. HERITAGE CONSERVATION: FROM TRADITIONAL TO CONTEMPORARY HERITAGE USINE ONE ANALYTICAL METHOD

Standards for Preservation and Rehabilitation
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Heritage Conservation: From Traditional to Contemporary Heritage Using One Analytical Method

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ABSTRACT: The Hôtel du Breuil St. Germain in Langres is a town house constructed in the sixteenth and eighteenth centuries, now used as a museum. The architectural study for restoration of the house began with archival research and archaeological investigation. It was essential to understand the chronology of construction of the house, including both sixteenth and eighteenth century construction and alterations made during the nineteenth and twentieth centuries, before a program for the restoration could be designed. It was decided to retain the eighteenth century work as well as the original sixteenth century house in the restoration. The restoration of the garden was included in the program after sketches of the original planting scheme were discovered during the archival research.

The Marché à Reims (Reims Market) is a thin-shell, catenary barrel vaulted structure composed of reinforced concrete. It was constructed in 1927 and designed by engineer Eugene Freyssinet, a pioneer in the use of reinforced concrete, with architect Emile Maigrot. Mr. Gatier's investigative methodology for this structure included archaeological as well as architectural and structural study. Archival research included the study of old photographs showing the construction process. These photos permitted the investigators to understand the original form marks found in the concrete. The selected restoration technique will retain these original marks of construction.

Through these case studies, Mr. Gatier will address the theme that whether restoration deals with old or modern structures the same methodology is required. There is no gap between preservation of the old and the new. And only with appropriate archival research and archaeological investigation can the restoration be properly designed.

KEYWORDS: preservation, rehabilitation, standards, building technology, buildings, evaluation

Restoration of historic resources has been practiced in France since the nineteenth century, with specific attention placed on the study of pre-modern era buildings. Archaeological taste and opinion typically considered the end of the eighteenth century as the modern limit for a structure to be recognized for its historical significance.

Today, conservation architects confront the challenge of treating modern buildings. These structures differ completely in their design, function, materials, and construction methods from their pre-industrial counterparts. Experience shows that conservation methodology should remain the same in all heritage work. This methodology consists of deciding the conservation measures as a function of the research findings: (1) construct a research design to determine how to document the building; (2) define the study parameters; (3) complete measured drawings

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and historical document research; (4) determine the building chronology; and (5) devise conservation intervention by the synthesis of all gathered information. The following two case studies juxtapose the analysis performed on two historic buildings. The historical significance of the first (sixteenth to eighteenth century) has been traditionally recognized. It is only recently, however, that the historical significance of the second (twentieth century) has come to be appreciated.

Breuil de St. Germain Mansion (Sixteenth to Eighteenth Century) Langres

The Breuil mansion is an urban residence that consists of two main wings, one dating from the sixteenth century (Figs. 1 and 3) and the other from the eighteenth century (Fig. 2). The building forms an "L" along a courtyard that extends into the garden. The garden extends away from the courtyard and a stone privacy wall separates the property from the street. The study undertaken reconstructs the mansion's complex evolution, recognizing all successive modifications since the sixteenth century [1]. A thorough knowledge of this evolution, combined with an existing condition assessment analysis, permitted the intervention strategy to be determined.

Archival Research—Property Development

The municipal archives that were destroyed in the nineteenth century were studied by way of copies and interpretations made by nonprofessionals in the nineteenth century. This docu-

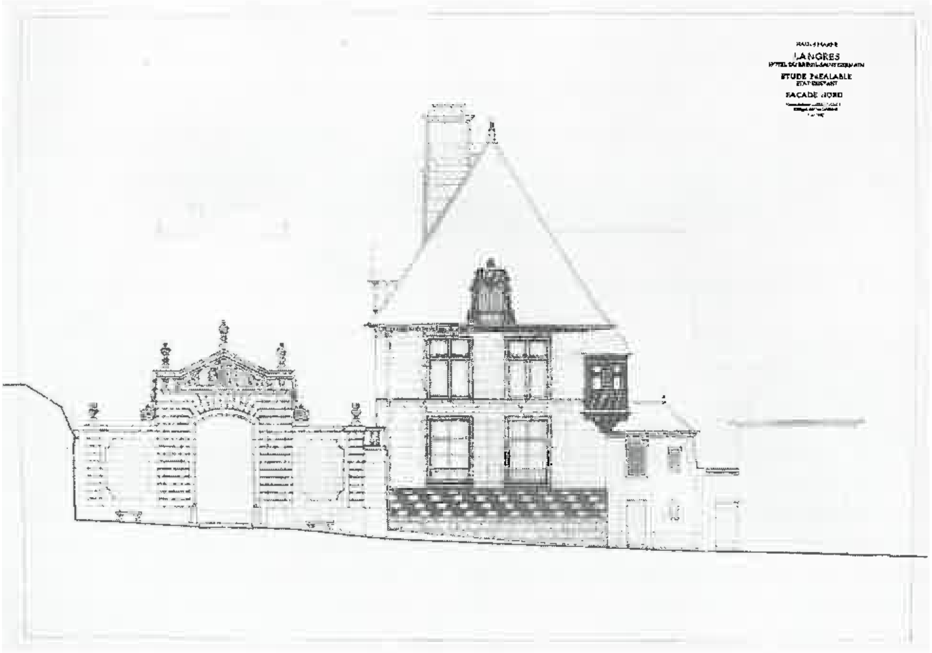

FIG. 1—*Breuil Mansion—North elevation from street, showing sixteenth century wing and eighteenth century gateway* [1].

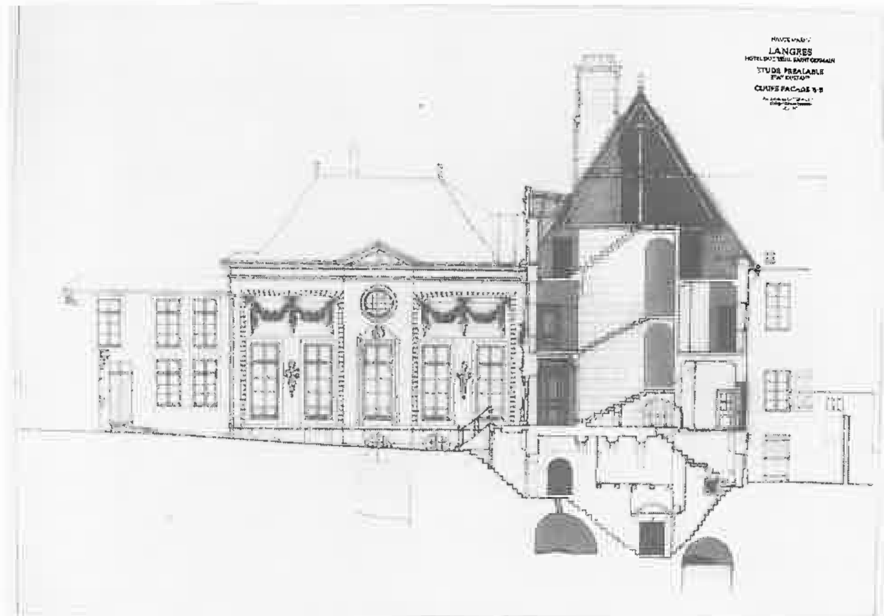

FIG. 2—*Breuil Mansion—Cross section through sixteenth century residential wing showing north elevation of eighteenth century service wing rehabilitation* [1].

mentation made it possible to identify the residence's site development. This type of information is rarely found for the era, and thus helped the research effort greatly. The process testifies to the urban politics at the end of the sixteenth century, which was motivated by an urban beautification mentality different from that of the modern age. As a result of this exchange, the owner received one contiguous parcel of land in exchange for the demolition of several of his other properties that were projecting into the proposed street alignment. The description, without mentioning the exact interior arrangement, stresses a hierarchy between the residential and service wing portions distinguishing them by their roof materials. At that time in France, slate was reserved for the use of the nobility (partially in view of quarrying and transportation costs). Tile, on the other hand, was a material made of ordinary clay, that was available to the common man. Thus, the residence is called the "slate-roofed" building, and the service wing is called the "tile-roofed" building.

Building Survey—Comparison with Contemporary Examples of the Sixteenth Century

The building survey was completed in the next phase. In situ observation using nondestructive methods made the collection of information possible. Existing conditions were recorded on the plans and elevations. The annotated plans were compared with the pattern book written by J. Androuet du Cerceau (1589) that noted the Breuil Mansion among those adopting a grand Renaissance-based classical style to a smaller structure [2]. This compendium of sixteenth and seventeenth century architecture follows the Italian architect Serlio's example that was written in France (Book VI, 1540 [3]). In a practical manner, the treatise identifies residential examples organized in hierarchical order, which could be adapted to any client's needs, according to his

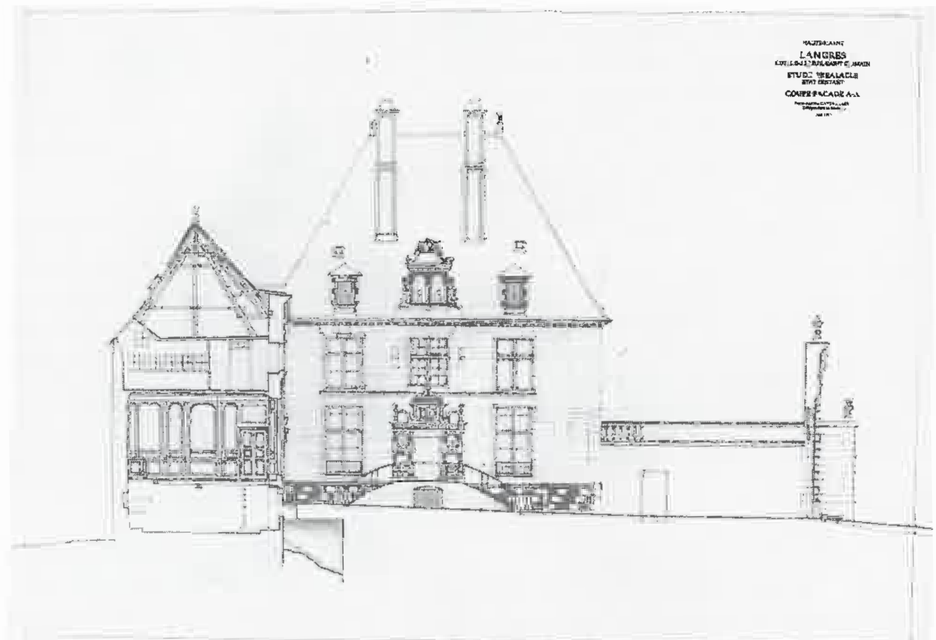

FIG. 3—*Breuil Mansion—Cross section through the eighteenth century rehabilitation with the west elevation of the sixteenth century residential wing* [1].

social status. One can compare the Breuil Mansion with J. Androuet du Cerceau's ideal *premier baftimen* (Book of Architecture, Paris, 1559 [*4*]) with its arrangement of two rooms flanking a central, axially oriented staircase, with another smaller room behind. Comparing the two confirms the residence's innovative characteristics. The notable difference relative to the ideal is the change in position of the corner pavilions to suit the site geometry and urban setting.

The interior floor plan is organized around a central stairway core (Fig. 4). Analysis led to the discovery of "ghosts" of nonload-bearing timber frame partitions, making an approximation of the original plan possible. One ceiling beam retains mortise scars of studs from a wall below. This partition is situated in the middle of a window, in line with the existing mullion. This rarely preserved arrangement of a partition dividing a window opening in two seems to be of J. A. du Cerceau's own invention, being found among several other of his plans [2].

Analysis of Measured Drawings

Measured drawings should show the building complete with evidence describing all modifications and restoration campaigns. An analysis of these documents showed the magnitude of modifications made on the two wings during the eighteenth century. The so-called eighteenth century wing is, in fact, a rehabilitation of the former sixteenth century service wing refaced with a new facade. The sixteenth century exterior stair consisting of only one wing parallel to

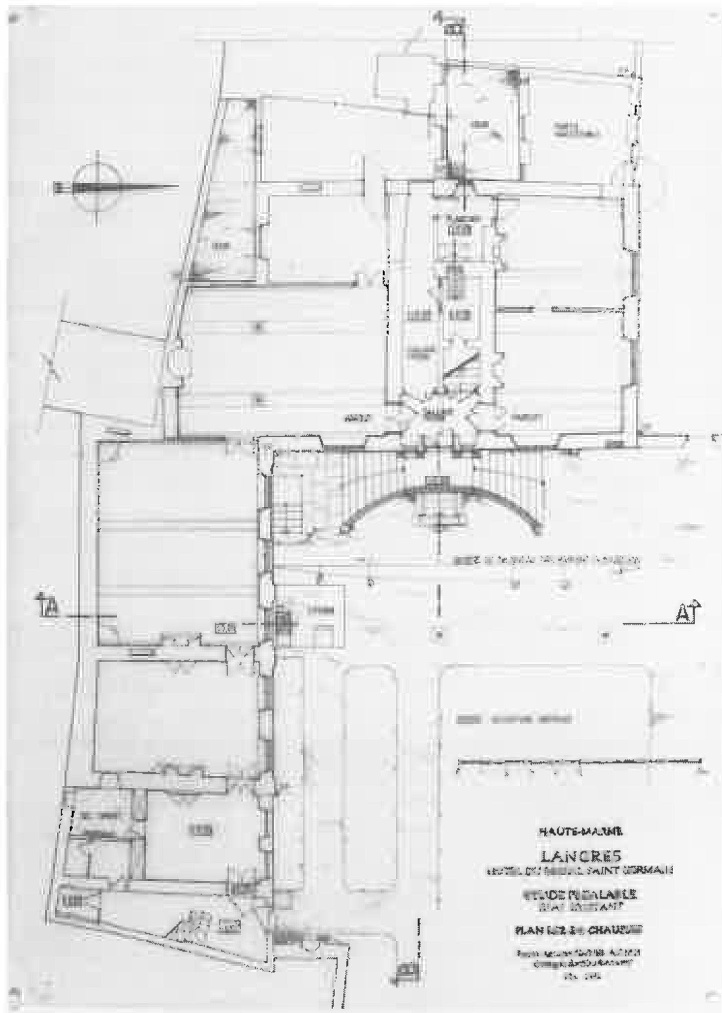

FIG. 4—*Breuil Mansion—First floor plan, existing condition* [1].

the facade, could be reconstructed graphically since the ghosts on the stone cladding still showed the tread profile (Fig. 5). The proposed disposition was consistent with preserved contemporary examples as well as with architectural pattern books. Evidence of wrought iron balustrade anchoring was also found.

All of the sixteenth century window openings were enlarged, testifying to the eighteenth century taste for light. The window enlargements were realized by altering the lintel and sill levels (Fig. 6). The mullion and muntins, which were traditional window elements into the seventeenth century, were removed. The removal of the central load-bearing mullion required that a keystone be added. The only window that was not modified was on the second floor where the porch sculpture is attached.

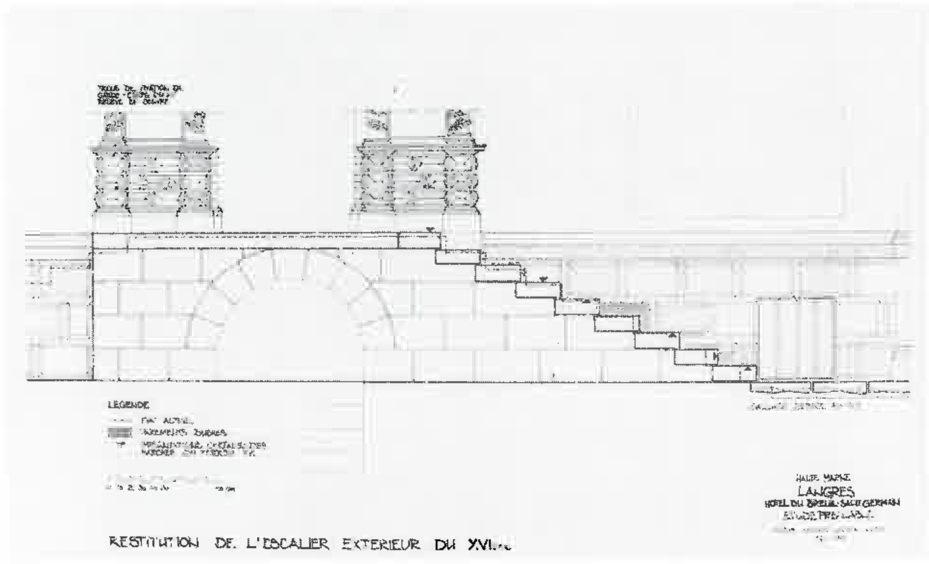

FIG. 5—*Breuil Mansion—Graphic reconstruction of sixteenth century residential wing stair* [1].

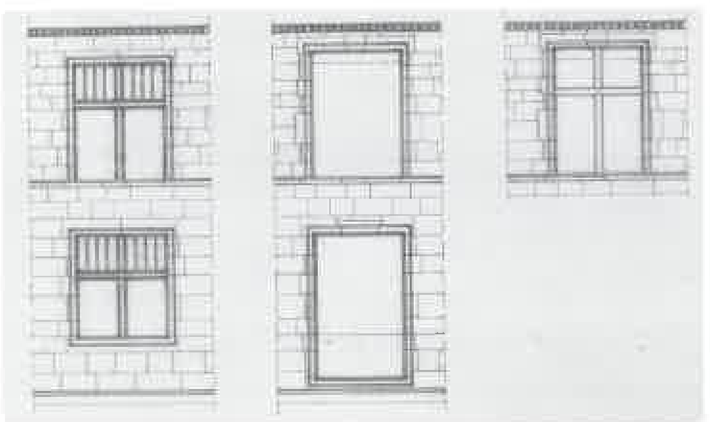

FIG. 6—*Breuil Mansion—Study of window modifications: (1) beginning of sixteenth century, (2) eighteenth century, and (3) existing condition after early twentieth century restoration* [1].

Presentation of Successive Phases—Choice of a Restoration Strategy

Historical records have made it possible to show all of the successive stages in the mansion wings from the sixteenth century until the "amateur" restorations at the beginning of the twentieth century. The choice of a restoration strategy resulted from critically analyzing the buildings' evolution. The eighteenth century was chosen as the historically and architecturally significant period to avoid any de-restoration.

The entire building history was considered in determining the significant period. The choice of the eighteenth century is practically a choice for the existing condition, minus certain maintenance campaigns undertaken in the nineteenth century. Because the recognized significant period was originally the sixteenth century, the architect's choice represents a respect for the significant addition that occurred later. As such, this position signals a departure from the long-held assumption that this building's significance should remain as it was when landmark status was conferred.

Modifications made during the nineteenth century consist of work required because of the lack of previous maintenance, including the abandonment of the garden. The most significant nineteenth century change is the replacement of the original, locally quarried slate roof by the industrially produced, uniformly cut slate from Anger. Although keeping this roofing would represent a respect for the industrial advancements in building material production, returning to the original hand-cut slate represents a stronger respect for the original regional character, which has in part been lost due to this same use of later materials.

A plan for a garden at the back of the mansion courtyard was also found during the archival research. This project also included the eighteenth century garden restoration, whose completion would render the composition homogenous, showing the spatial organization of the courtyard, garden, and residential wing as a whole.

The Central Marketplace in Reims—1927

The Reims Central Marketplace was built in 1927 of reinforced concrete using a process developed by the engineer Eugene Freyssinet (Fig. 7). The original architectural design was completely transformed by applying Freyssinet's engineered solution of thin-shell concrete (Fig. 8). The building is really at a crossroads between engineered practicality and architectural expression (Fig. 9). These shell vaults with a parabolic profile now show signs of serious deterioration, making it necessary to close the building and discontinue its use (Figs. 10 and 11).

This study was able to concentrate on archival research, with information at least being available, although sometimes being as difficult to find as for the Breuil Mansion project.

Comparing available historic documentation with the building's existing condition led to the discovery of a variety of on-site construction techniques employed. Close in situ examination of the concrete shows that this material still bears evidence of all of the means of construction used (imprint of formwork, construction joints). The restoration strategy, which was determined following the historic fabric analysis, defined the acceptable limits of work to be done. This included maintaining the integrity of the historically and technically significant character-defining elements. The previously considered solutions of partial restoration and surface application of sprayed concrete (gunning) were eliminated.

The Historic Setting—Reconstruction 1918 to 1929

The Reims Central Marketplace was built from 1926 to 1929 as a part of the reconstruction effort in Reims, partially in ruins since the end of World War I. The reconstruction of the city continued from the Armistice in 1918 until the crash of 1929. This enormous "construction site" provided a testing ground for new urban thought (zoning) and experimental materials (cement and reinforced concrete). Even though there was the concept of a new urban order, this concept was not imposed in the overall development of architectural character on a large

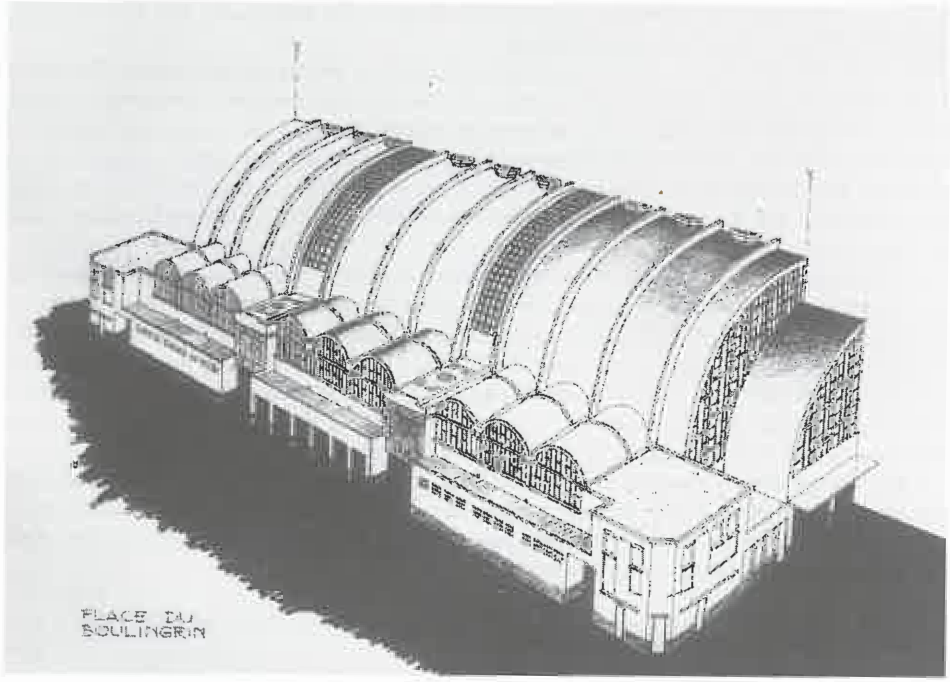

FIG. 7—*Reims Marketplace—Perspective sketch, 1992* [9].

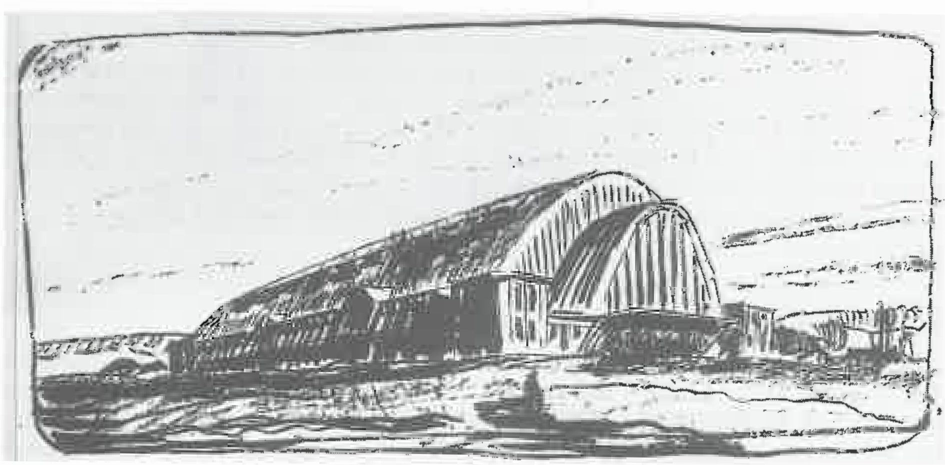

FIG. 8—*Reims Marketplace—Design of the marketplace following the Limousin Company's response, incorporating slip formwork, parabolic shell vaults, and other technical advancements* [17].

FIG. 9—*Reims Marketplace—Exterior of north elevation, 1928* [17].

FIG. 10—*Reims Marketplace—Exterior existing condition, 1992* [9].

scale. Perhaps this was because of the weight of historicism relative to the newness of modern expression. The marketplace was changed from the central crossroads in the Roman city to outside the historic city, close to main transportation and rail access. However, along with the will to reestablish the historic character of the city of Reims came the imposition of the regional style. The Reims Marketplace stands as the city's sole representative of the Modern Movement among all of the newly developed facilities.

FIG. 11—*Reims Marketplace—Interior existing condition, 1992* [9].

The Building Program and the Competition of 1923

The reconstruction of the marketplace may be attributed to the initiative the city took in defining the building program and in selecting the architect by competition. The program required the assembly of different commercial trading methods under one roof including wholesale, resale, and sale by auction, all of which were surrounded by small stalls. The program also required that vehicular access and delivery be taken into account.

Invitation to Bid—1926

The architect Maigrot won first place and thus issued a call for contractors' bids. The structural portion of the job was assigned to Limousin and Company, whose technical branch was directed by the company's cofounder, Eugene Freyssinet (1879–1962). Freyssinet is famous for his use of concrete on numerous bridges, dirigible hangars, and factories. He developed parabolic vault forms, decentering techniques, and, perhaps most importantly, prestressed concrete. Despite the existence of the architect's original design, the influence of the contractor completely changed the aesthetic view of the structure because of the contractor's successful use of Freyssinet's patented concrete construction techniques including thin-shell concrete, parabolic arches, slip forms, etc.

Appearance of the Marketplace Structure

In order to cover the market's uninterrupted space, Limousin and Company proposed the use of an immense parabolically shaped vault (Fig. 12). Its structure consisted of a double row

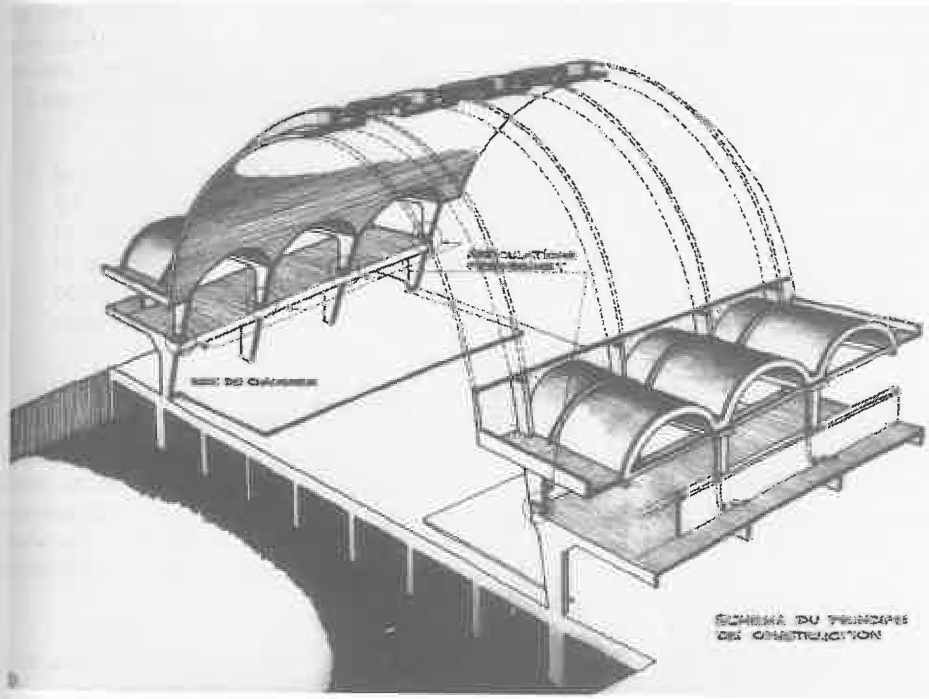

FIG. 12—*Reims Marketplace—Model of bay structure* [9].

of vertical supports on pile foundations. Parabolic arches extend between the columns, with thin-shell concrete vaults (5 cm) poured between them. Tie rods embedded in the floor slab provide structural stability in cross section. A level of galleries with perpendicularly oriented barrel vaults diminish the horizontal thrust of the upper vaults by adding a downward vertical force component, and thus verticalizing the resultant (Fig. 13).

Lateral and Longitudinal Expansion

The designers incorporated bidirectional expansion into the structural concept. Lateral movement was made possible by ''Freyssinet hinges'' (reinforced concrete hinges, the equivalent of a pinned joint) at the base of the arch by a reduction of the reinforced concrete section that is governed by the reinforcing bar coverage. The structure was divided into three longitudinal bays, with an expansion joint at each juncture.

Form, Function, and Structure

The marketplace fulfills certain tenets of the Modern Movement in the sense that the building's form and structure developed in direct response to its function. The three bays of the building correspond to a function (retail, wholesale, or sale by auction). The expansion joints between the bays are reinforced architecturally with the placement of continuous skylights, at the bottom of which are situated the side entries to the hall.

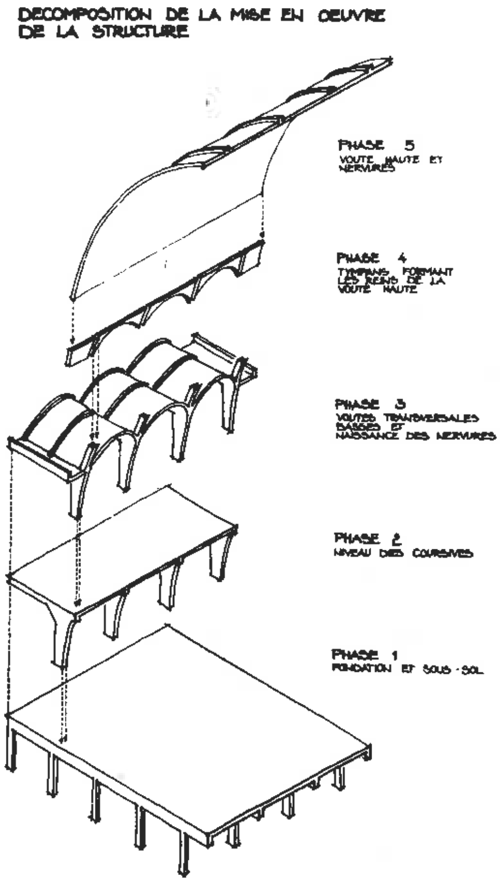

FIG. 13—*Reims Marketplace—Structural element construction phasing for a single bay* [9].

Preliminary Analysis

Archival Research and Laboratory Analysis

Archival research led to the discovery of documents that Maigrot (architect) and the Limousin and Company (contractor) exchanged at the time of the call for bids. These included specifications as well as structural calculations. Newspaper articles from when the building was under construction and a collection of historic photographs were added to the documentation. This collection groups all the images of the major construction phases together with views of the building at the time of its opening. These photos were intended to documents the construction process, but were also destined to illustrate various printed articles. In order to understand the structure and its construction detailing, Freyssinet's patents were recovered, analyzed, and then compared with current day treatises on reinforced concrete.

Material Analysis

Reinforced Concrete—Use of Two Types of Concrete Having Different Characteristics

At the same time, a series of laboratory tests were conducted on a collection of 40 core samples, each measuring 50 mm in diameter. The samples were taken from the concrete and the steel reinforcement. Results of these analyses include a description of physical characteristics (porosity, density), mechanical resistance (under tension and compression), and chemical composition (detected by X-ray diffraction and electron microscope).

Concrete sampling revealed that two types of concrete had been used:

1. for all of the thin-shell structures (shells and arches): a homogenous mixture indicating the great care taken during the pouring process; and
2. for the other structural elements (posts, slabs etc.), the concrete appeared heterogeneous in addition to having a low density, being minimally vibrated if at all, leading to the high porosity (originally on the order of 15%) before carbonation (conversion of lime to calcium carbonate in the presence of carbon dioxide and water).

The analysis of the quantities take-off and estimate (dated 1 Dec. 1926 and written by Limousin and Company) does not reveal the use of two different concretes in the following excerpt, "Reinforced concrete (300 kg of Portland cement to the m^3 of sand)." On the other hand, articles written during the construction period stress the importance of vibrating the concrete for the vaults, "Because of the slope, the concrete must be poured between two forms. To avoid voids, the concrete must be agitated by using pneumatic hammers applied to the formwork, causing the concrete to go into place" [*11*].

Variation in the Aggregates—Reinforcing

The aggregate found was mainly siliceous (chemical analysis), in all sizes and shapes, mixed with calcareous elements. The aggregate particle size did not seem to be consistent.

The steel reinforcement (Fig. 14) is of two types: small diameter (10 and 6 mm) bars of cold-worked steel and larger diameter bars of ductile steel.

Cement Stucco

The concrete surfaces were plastered to form either a plain surface coating or a waterproof coating. Concrete construction in the 1920s in France was rarely left bare. It usually received a protective layer.

Waterproof Coating on Vault Exteriors

The waterproofing layer (2 cm thick) that was added to the outside of the vaults ensured that the exterior surfaces, including the protruding ribs, were protected. "A cement stucco is anticipated for the entire roof covering. All of the numerous projects which we have completed up until the present day have included, for roof systems analogous to this one, an ordinary cement rendering which has proven totally satisfactory from the waterproofing point of view" [*12*]. This simple method permitted a lightweight waterproofing to be used (50 kg/m^2) that was compatible with the thin-shell vaults (5 cm thick for the upper vaults, 7 cm for the lower vaults). This resolved the problem of adhering the waterproof layer to a nearly vertical surface by forming a support following the profile of the vault base.

The waterproofing layer ensured a complete coverage of a variety of different projecting elements. The work was completed in sections. The joints between pours are the only joints in the waterproofing. No provision for expansion or contraction of the waterproofing or base support was made.

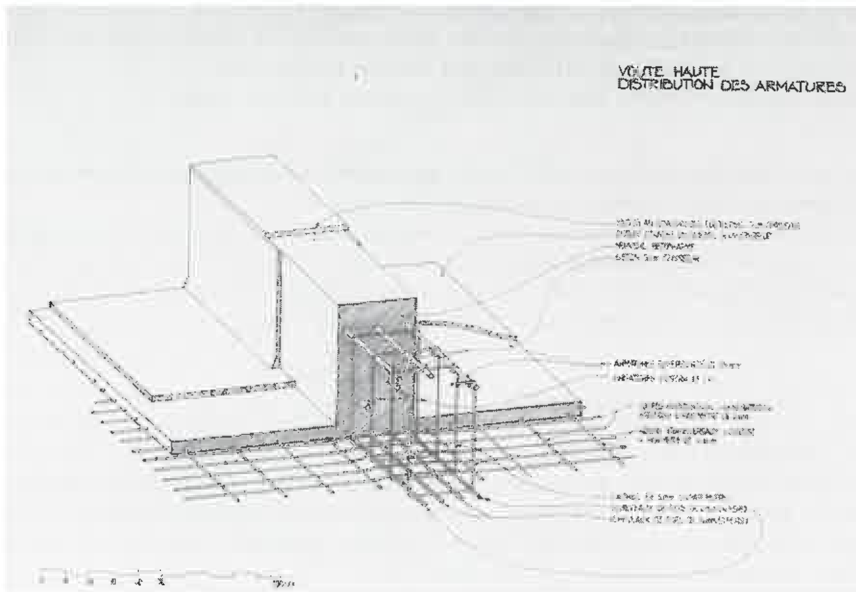

FIG. 14—*Reims Marketplace—Main vault rib reinforcement after test boring and analysis of specifications* [9].

Reconstructing the Construction Process from Job Site Photographs of Prefabricated and Poured-in-Place Concrete

Among buildings constructed in concrete, the methods used at the marketplace seemed like reasonable choices (prefabricated and poured-in-place concrete). Each method was employed in an effort to find a standardized process.

Standardization of poured-in-place complex geometrical forms was made possible by Freyssinet's technical innovations (smooth vaults poured with slip form work). All structural elements were placed on the exterior so that the forms could be moved easily and re-used for the entire length of the building. The thin-shell vaults with projecting ribs were poured-in-place. Secondary structural elements connecting to the main structure were either site- or shop-prefabricated (for example, window structures) and were probably due to the involvement of another contractor, thus not demonstrating any particular technical advancements.

The base surrounding the entire building was treated with light aqua blue plates made of a material identified only as "lap." They were prefabricated, modular, thin, reinforced slabs poured over a piece of glass to give them a marble-smooth finish. They were surface tinted to a depth of approximately 1 cm. "The 'lap' is a new product for Cie. Generale de Construction de Fours, destined for use in coatings and multiple applications. The coating may be produced in any color" [*21*]. Archival research has not turned up any more technical information on this topic. This difficulty illustrates one of the issues of twentieth century materials because most of the materials and the fabrication processes that were used are already lost.

Construction Phasing

Project phasing was reconstructed from photographs, some of which were dated (Fig. 15). Construction phasing seemed to have been determined by two parameters: structural necessity and constructability.

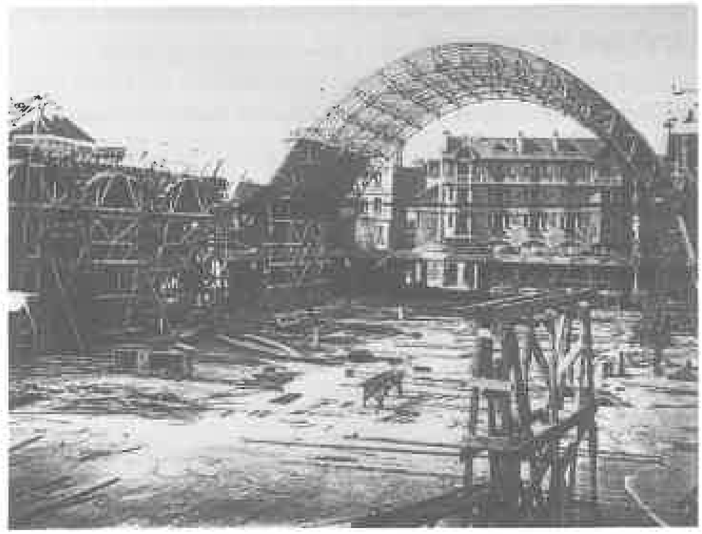

FIG. 15—*Reims Marketplace—Pre-formed centering lifted into position, 25 Sept. 1927* [26].

After the foundations and basement were poured, a structural hierarchy was established between the buttressing-portions and thrust-producing portions of the upper vaults. The buttressing elements were done before the upper vaults (Fig. 16). "The project was executed in two distinct phases: 1) construction of the side aisles and the galleries, and 2) construction of the main vault proper" [*17*]. Henri Deneux, who was working on the restoration of the Reims cathedral, saw the resemblance between the historic cathedral building techniques and phasing, and the continued modern development and application of "new" methods. He evoked his

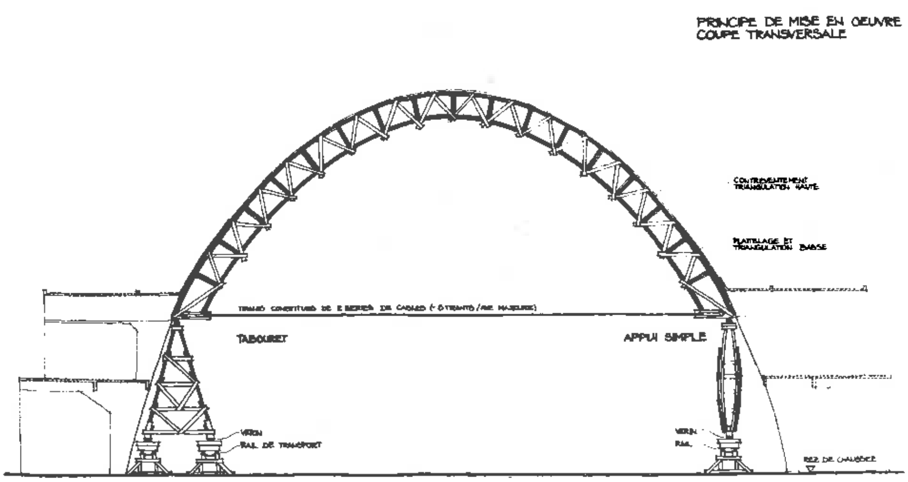

FIG. 16—*Reims Marketplace—Graphic reconstruction of vault formwork after construction photographs* [9].

concept of an architectural continuum instead of a break by continuing to reference the marketplace using traditional building terms.

The Connection Between the Upper and Lower Vaults—Point of Penetration

The link between the upper and lower vaults was treated as an integral connection. The impost of the upper vault is situated above the keystone centerline of the lower vaults. This structural organization is typical of construction methods used in French historic architecture; illustrating again that despite an outward appearance and completely different materials, architecture and structural systems develop in a continuum. Perhaps the evolution is not always obvious, but it is there.

The lower vaults and the imposts of the upper vault stiffening arches were poured first. The second phase consisted of pouring the upper spandrels separating the lower vaults (Fig. 17). Third and finally, the upper vaults were completed.

Condition Assessment

Despite using a single material for the building construction, a lack of uniformity in the material's proportions and placement caused differential deterioration. Deterioration is concentrated among the structural elements in contact with the exterior. Since these elements extend through to the interior, the deterioration follows them. The interior faces exhibit, in fact, the most serious deterioration. Intersections between dissimilar elements tend to accumulate water because they are usually valleys, which incidentally have a maximum concentration of reinforcement. The concrete, and then the steel reinforcing, deteriorates just where the greatest strength and material integrity is required for the safety of the building.

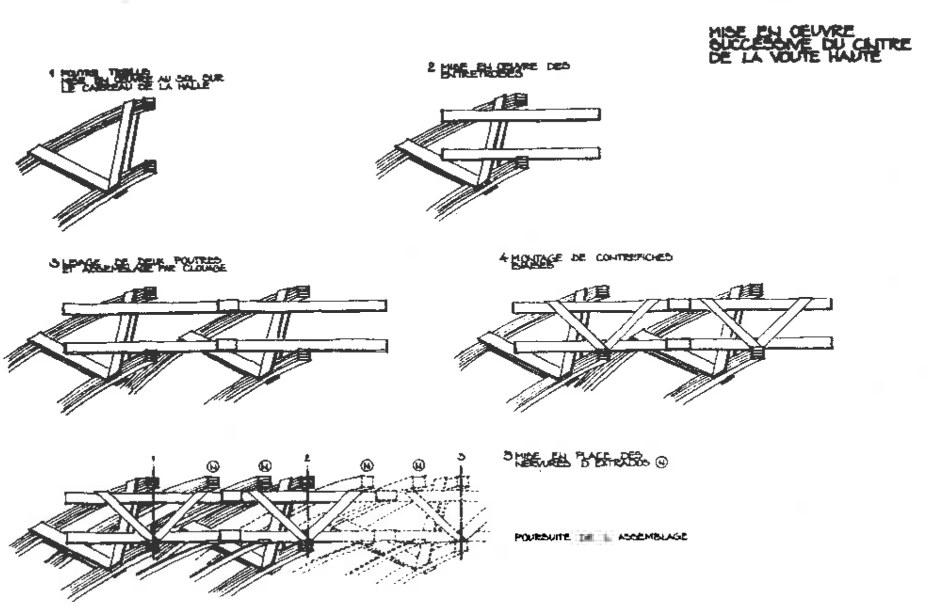

FIG. 17—*Reims Marketplace—Construction phasing for vault centering after construction photos* [9].

Deterioration of the Waterproofing

The waterproofing layer on the upper vault is deteriorated, being cracked but partially adhered. Differential shrinkage between the concrete vault and its exterior layer resulted in longitudinal cracks on axis with each bay. The location of water infiltration and deterioration on the underside of the vaults corresponds with the position of these full-depth cracks.

The Natural Damaging Effect of Water on Concrete

All damage to the reinforced concrete at the Reims Marketplace is due to the action of water, as is typical for all concrete deterioration (the combined effects of rainwater, surface runoff, condensation, frost, and capillary rise). Infiltrations caused breaks in the waterproofing membrane. The carbonation of concrete and the depassivation of the steel reinforcing (corrosion) also resulted from these infiltrations.

Restoration Strategy

Defining the Interventions

The interventions that were necessary for the conservation of the marketplace may be broken down into two types of actions: (1) those whose aim is to eliminate the cause of the problem by reestablishing the mechanism that protects against water's aggressive effects and (2) those repairs whose aim is to address deterioration caused by water left unchecked in areas stripped of their protective layer, including small, localized damages and overall deterioration.

Patch Repairs and Surface Rendering

Research led the architect to determine that formwork imprints, other construction marks, and the rendering are character-defining elements, and as such, should be conserved (interpreting concrete as a historic material and not just as an industrial fabrication that could be redone without consequence to the fabric). Restoring the rendering, which was consistent with the historic appearance, seemed to be the best technique for hiding the internal repairs. First, the structure had to be stabilized. Then, it had to be restored. Archival research brought to light the way the rendering had been originally executed. In the same way, the restoration of the interior with a white lime wash, which appeared in the construction specifications and whose use was confirmed by its appearance in construction photographs, was the most sensitive technique available.

Patching poses several problems. The patch must be mechanically secure, homogeneous, and visually integrated. Laboratory analyses set the ingredients and binder/aggregate proportions to be the same composition as originally, which would allow the homogeneity of the base material to be restored.

Conclusion

These two studies were undertaken on two buildings that seemed to be completely opposite from their construction dates down to their construction materials. The first belongs to the traditional cultural heritage category, while the second belongs to the world of engineering, patented building processes, and technical history. They do, however, have one thing in common: a new look at their significance based on an evolution of the perception of their value. For the Hotel de Breuil, the study effectively reclassifies the period of significance based on further research, while conflicting with standing opinion. The Reims Marketplace becomes significant as an example of an industrial process, often previously repeated, but whose extant applications are now rate. This, too, challenges current opinion.

Criteria of significance for a structure vary depending on a building's type, function, and history. When a building is not universally recognized, one may assume it is because either the criteria defining its significance are not clearly defined or they are not systematically applied, allowing for multiple interpretations. It is also possible that criteria evolve with how a culture perceives its patrimonial value. It is important to be aware that these changes occur and to be ready to regularly reassess our heritage with an informed, critical eye. If the criteria for evaluation are valid, structures previously not considered to be significant will be recognized methodically, despite tradition, taste, or opinion to the contrary. The application of this process becomes the link between these two seemingly disparate case studies.

These two examples underline the role that critical analysis of a building's authenticity plays in determining the building's character-defining elements and construction techniques that one wants to preserve. The technical solution can not and must not precede historical research and interpretation.

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