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ISSUE CONTENT

Presenting a “*varia*” issue is always a challenge because, by definition, it contains diverse contributions. However, in this one can be found three key points of view that shape the history of construction: one that associates tools and materials, starting from the materiality of objects, another that places at its centre human beings and their work, and yet another that envisages a political, social, economic and legal consideration of the phenomenon of construction, a kind of thought on a completely different scale. These three views are of course not mutually exclusive and often interpenetrate, especially since the effect of common sources and the disciplinary orientations of the authors contribute to blurring the lines of inquiry. Nevertheless, this distinction appears useful here for presenting the contributions.

A MATERIAL HISTORY OF CONSTRUCTION

In the course of a detective-like investigation, Nicolas Gasseau dismantles the popular beliefs, and even those of certain specialists, concerning the authenticity of two mythical instruments of medieval construction: the 13-knot rope and the builders’ *quine*. In the course of a rigorous scholarly demonstration, the author establishes that these tools are in fact only 20th-century inventions. His finely conducted critical analysis, endowed with common sense, reviews all the irrational clichés of the imaginary of medieval construction: the secret of the trades, the golden number, the esotericism of the journeymen, Masonic symbolism, the use of geometric formulas unknown at the time. To understand how these false attributions were propagated in the minds of medieval amateurs and even certain medievalists, the author takes

us on a journey from ancient Egypt to the Indian writings of the 1st century, *via* the work of the Pisan mathematician Leonardo Fibonacci and the Gaul of the Druids.

Models have always fascinated the minds of children and adults alike, as they let make them grasp monumental architectural works at a glance. The reduction in scale gives access to the building and puts it within reach to appreciate the volumes, the space, and the clutter in the space. What Bill Addis, Dirk Bühler and Christiane Weber propose here is a little-studied use of models as an aid to design in civil engineering. After a historical overview of this tool since antiquity, the text draws an astonishing parallel showing the equal importance of the theoretical and practical use of this type of model in construction design. This argument alone would contribute to the inclusion of a course on the history of these models and their use in engineering education, alongside indispensable theory. For its part, historical research should focus on the analysis of these tools, which need to be uncovered, documented and, of course, preserved in the best possible conditions. The authors strongly advocate recognition of this practice, which is so useful for design, by developing historical research to find models lost in various archives, forgotten places of experimentation and dedicated museums.

Bill Addis provides a history of metal framing for windows and glazing in Britain between the 18th and 20th centuries from both a technical and practical perspective. The development of two specific sectors contributed to the evolution of these structures allowing glass to enclose rooms on the outside as well as facades later on: the use of domestic, industrial and commercial buildings; and, the fashion from the 1820s onwards for greenhouses, railway stations, museums, covered passages and inner courtyards that called for the use of large surfaces of glass in metal structures. The author takes the opportunity to recall the technical context of the manufacture of these pieces: iron ore, wrought iron, cast iron and steel, highlighting their manufacturing characteristics (forged, hot rolled, etc.), assembly (lead soldering, copper and tin soldering, by hand or with a hydraulic hammer, riveting), solidity and corrosion (painting or zinc galvanisation). In a non-linear sequencing Bill Addis explores the different techniques that have overlapped over time.

Wrought iron with copper alloys lasted from the 13th century until 1820 thanks to its great stability; the processes were developed mainly

in France by Sieur Chopitel, a blacksmith at the Royal Manufactory near Paris, and patented by James Keir in 1779 with an alloy used successfully in the shipping industry, then by William Playfaire in 1783 in what was called Eldorado metal, which was used by the most renowned Britons in the 19th century. Cast iron was developed in the late 18th century as part of the quest for materials capable of reducing the vulnerability of buildings to fire, and was used with alloys in prestige constructions for wealthy clients. A major breakthrough came with the production of greenhouses and buildings with large glazed surfaces built in metal structures, such as the emblematic Crystal Palace in London in 1850-1851. The publication of the first manual dedicated to greenhouses in 1817 by John Claudius Loudon addressed many of the problems of water condensation drainage, glass breakage, electrical conductivity of metal, its corrosion and its propensity to attract lightning. He preferred wrought iron to cast iron, which was too brittle. Three transformations followed: mills to produce large sections of metal, larger than usual and even curved glass panels, and above all the industrialisation and standardisation of metal production. At the beginning of the 20th century, more than a hundred factories shared the market, which quickly became concentrated in two major companies that eventually merged in 1965: Henry Hope & Sons and Critall Windows, the former focusing on thermal and sound insulation, the latter internationally renowned for improving the assembly of corners with dovetail brazing, facilitating the cleaning of windows and proposing effective anti-corrosion solutions. These methods encouraged the use of curtain walls in contemporary architecture.

Although this history had little influence on construction theory, it was of great use to the development of metallurgical techniques. Many questions can still be addressed historically, such as the reception of such structures by users, the influence of the properties of metal on the design of structures, the evolution of building regulations for windows and glazing, the commercial aspect of these products and the conservation of these metal structures.

A HUMAN HISTORY OF CONSTRUCTION

By analysing the wages paid to ironworkers on the major construction sites of the late Middle Ages, Maxime L'Héritier examines the economic status of these craftsmen in their relationship with their clients. Using the serial accounting archives of these major works in Troyes, Rouen and Metz, the author examines whether the salaries received by these blacksmiths, farriers and locksmiths – to name only the most frequently cited – were dictated and imposed by the owners (did they constitute an economic pressure on the craftsmen?) or whether the workers could influence their remuneration and their regularity of employment to form a quasi-monopoly and thus constitute a privilege for them. The author first sets the question in the geographical context of the work, distinguishing between urban smiths and large rural forges and their blacksmiths, and the type of work envisaged, between large-scale work requiring the collaboration of several blacksmiths and more modest work carried out by a farrier or a locksmith in a workshop, and underlining the fundamental characteristics of ironwork as a “transformation craft”. He then describes his findings: first, the affirmation of a great stability over long periods of ironworkers on the building sites through the same families or the same workshops, sometimes even after the death of the head of the family, over several generations. Also, with regard to labour prices, Maxime L'Héritier uses numerous examples to show the oscillation between discounts chosen by the craftsmen and imposed wage reductions, in order to uncover the causes of these situations and their purposes: to compensate for the rising cost of raw materials, to guarantee the permanence of the work, to encourage associations between craftsmen, to monopolise a market in the long term, to put companies in competition with one another. The author is cautious in his approach as well as in his conclusions, and emphasises the value of pursuing his study from fiscal or notarial sources, putting his results into their context: the challenge of estimating the real incomes of blacksmiths, the economic impact of recycling, the evaluation of the price of labour compared to that of the material, and the relative position of work with metal, which represented only a few per cent of the

general expenses of a large building site, compared to other trades such as those working with stone.

Valérie Nègre proposes the publication of an exceptional archive, which is rare, precious and touching. It is the diary of the construction of the wooden dome of the Halle au blé in Paris, kept in the city's historical library, in which the architect Jacques Molinos relates the six months of construction in its smallest details (between mid-July 1782 and January 1783). He mainly describes the complex assembly of scaffolding necessary for the construction of the singularly large roof of the building's circular courtyard. This reveals how important it is to emphasise once again, and in an exemplary manner here, the need to understand both that the building site involves perpetual inventive questioning in the face of blockages and technical incidents – the building site is not only a place of execution, but also often a place of permanent creative emulation (the outlines have to be corrected as the work progresses); and that it is also truly a collective and not an individual work, highlighting the ingenuity of the craftsmen and the daring of the workers who labour together (carpenters and locksmiths) and whose zeal is rewarded (for example, in this case, the man who invented a simple process for making the mortices)

This project of political and technical importance for the royal authorities and the public good is reported in a handwritten document, probably prior to publication. It relates numerous actions, techniques and operations carried out by the many and varied actors involved, belonging to the many building trades. However, Molinos's text is written in an impersonal manner. Valérie Nègre puts this living testimony into context and is careful to point out that it does not say everything.

This text is fascinating in more than one way because it is close to a certain brutality of human reality (descriptions of carelessness and accidents). It deserves an in-depth analysis of the language used and the sustained discourse, so rich is it in technical vocabulary in terms of materials (even in the exact species of wood used: poplar for the rods, oak for the platforms, oak corners and pine masts, or their reuse: demolition stone, ship's wood), tools (for design: model; for hanging and carrying: trolley, ropes, spindles, baskets, clamps, pulley, or for working with wood or metal: chisel, axe, *bisaiguë* [noted *bieguë*], planer, saw...), actions (of measuring, handling, making, adjusting, checking...) and

figures of speech (analogy: metaphor of the sheepfold; personification in expression: hungry piece of wood; substitution: periphrasis in the use of “Newton’s pulley”¹) and rituals (topping out with a *bouquet* to mark the end of an important stage of construction).

The architect clearly specifies the various locations on the site: the building (courtyard) and its scaffolding (in the air), and also the covered and closed workshops or barracks. He organises the circulation of materials, tools and craftsmen. A visual reconstruction of the building site might even be attempted, as the actions are described with such accuracy.

The document highlights three recurring themes:

- Promptness *versus* slowness of work, the notion of time being related to the financial economy of the cost of labour, but also to that of techniques (throwing stones; use of the block instead of the hoist; the winch instead of the basket). Regularity is preferred to incident. The supply of tar by the bargemen is obtained at a lower cost. The ropes are borrowed from the *Menus Plaisirs* ceremonial office. The production of the planks takes “a considerable amount of time”. Adjustments can be difficult and time consuming. The reaction to uncertainty is immediate: a new scaffold is demolished and rebuilt as it goes along. The structure is fixed by a series of progressive adjustments. The forces are distributed evenly and the final balance is thus obtained.
- Solidity (the root of the word is mentioned ten times), safety, stability and lightness (relief of the structures) *versus* the fragility of the work, which triggers accidents along the way and which can even appear “to the eye”; hence the care and precautions (the word is mentioned eight times) taken to avoid them: use of plaster mixed with soot to consolidate the masonry (hardness and resistance to water); installation of tar to prevent moisture from penetrating the scaffolding either during its construction or during bad weather, help

1 Although optics records the reflecting telescope invented by Isaac Newton (1643-1727), father of modern mechanics, the pulley involved never bears his name except when it is used in the establishment of the three universal laws of motion (inertia, motion and action/reaction). This early attribution used by the architect Molinos remains exceptional.

with water drainage, etc. Preventive assessment is required against defects noted during the construction work (cracks, disjunctions, breaks, etc.). Respect for “customs” during the construction of two chimney pipes. All measures were taken to protect the workers, “so that the carpenters could walk and work on this ledge with greater confidence”. The fall of a careless worker is reported as a news story. The overturning of a truss is handled without damage with great mastery of material reuse. Overweight and bad weather are dealt with (ropes can break due to frost). The bending of the truss legs is monitored.

- Measurements are constantly taken and adjusted (with rulers, weights, and ropes) and the precise calibration is repeatedly checked, or even “re-checked” and corrected as calculation errors are discovered and according to the difficulties encountered in setting up the scaffolding parts. It is fascinating to read the proposals made to deal with the levelling defects of the platforms: “either by wedging [...], or by planing [...]”. The pieces of wood must keep their “direction” despite the sun and rain. There is constant supervision to reassure the workers.

A POLITICAL HISTORY OF CONSTRUCTION

Alejandro González Milea focuses on the short period between 1763 and 1803 during which Spain ran the government of Louisiana, which at the same time became one of the south eastern states of the United States on the Gulf of Mexico. This territory, with its multiple cultural influences (French, African, American and Franco-Canadian) reflected in the Creole and Cajun cultures, was – as is often forgotten – under Spanish occupation. On the occasion of the maintenance, repair and enlargement of the military works in New Orleans, a rich correspondence between the commander of the engineers, Joaquín de la Torre, and the intendant of Louisiana, Ramón López y Angulo, at the turn of the century provides information in a polemical tone

on the best legal, technical and economic ways of carrying out the works. The author notes the arguments (advantages and disadvantages) discussed by the protagonists, referring both to literature and past experiences, as well as details of constructions, amid power struggles between the institutions in place (the intendant and the governor, the engineers and the king, etc.). The main point of contention is the nature of the construction contracts used. These *asientos* were agreements that gave private actors a monopoly on exercising a state competence, whether it was fiscal, concerning public services, including the construction of military works, or of public interest working for the defence of the territory. These are, in a way, what we now call public service concessions. First, the author presents the context of the various military works carried out in colonial Louisiana and in its relations with its neighbours in order to illustrate the challenges of centralised control and the mechanisms for awarding contracts for these public works (subcontracting, choice of units of measurement, specifications, auctioning, guarantees, technical terms and conditions, plans). The author then focuses on the controversy surrounding the *asientos* in the recovered archives. The intendant, basing himself on local customs, considered that the concession contract was rather pernicious with regard to the king, that the works – although common – only presented an appearance of quality but that in reality they threatened ruin, that they were of excessive cost, despite the writing of precise specifications. The contractors were found to be speculative, discouraging innovation and above all poor performers in the exercise of their profession. The engineer retorted that it was better to make lasting repairs than to save money by paying less for them, that the contractors were constantly supervised for these complex repairs, and that the management of the *asientos* was as beneficial as if the work had been done by the administration. According to the author, it is important for our field to monopolise all the considerations at stake on a construction site without focusing only on the nature of the contract followed by the partners.

Nathan Brenu shows how politics was involved in the planning of Italian port construction at the dawn of Italian unity. In the 19th century, despite the financial burden of the civil war economy and because of the length of its coastline on the sea, Italy embarked on

an unprecedented campaign of public port works. The author begins by explaining how this infrastructure ambition fitted as a political symbol within the framework of an economic ambition inspired by 'free trade'. He emphasises the role of the centralised administrative organisation of this new state based on the Piedmont-Sardinian model. The laws of 1852 and 1859 originating in Piedmont-Sardinia classified ports according to their degree of commercial utility and divided the administrative, technical and accounting powers over public works between the various ministries (Navy, Finance and Public Works). The financing of the works was divided between the state, the province and the municipality concerned, with attempts at negotiations between peripheral bureaucratic bodies. Technical supervision was inspired by the French model with the predominance of engineers. However, the port construction programme was conceived in haste and difficulties in implementation were met with (administrative tinkering, lack of preliminary studies, successive modifications of the deliberations, increase in expenditure, delay in execution, etc.). In addition, the administration had to adapt to the new centralised regime. Finally, some of the works put out to tender did not find successful bidders and for others, the contractors chosen renegotiated the conditions. In a second part, the author focuses on the project of the port of Naples, which appeared to be disproportionate, especially as it promised a future of economic prosperity to a former capital city. The South had to be rebalanced in relation to the North. The management of the affair was not without its conflicts between local notables and the central government. A local commission was concerned that it was being ignored by the *arcana imperii* and that the project was not transparent. The public call for tender interested many contractors. The one who won the contract, Signor Gabrielli, blamed the authorities for the lack of access to the building site and their incompetence in the field of stone exploitation in order to justify his delay. The local commission appointed to monitor the work criticised its corruption and the use of convicts as labour, encouraging robbery. The state did not repeat the experience with this unscrupulous contractor, even though he managed to profit from the situation. To explain the contradiction between the unfulfilled port promises and the first results achieved with haste and incoherence, the author invokes on the one hand the French-style centralisation

versus an under-exploited localism, but also entrepreneurial thinking that contradicted the free-trade economic policy chosen by the new Italian state.

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