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Material Transformations in Architecture

Tracing the Design Process of the Iron Column in Wagner's Postsparkasse

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Abstracts

EN

In architecture, thinking and making are in a continuous dialogue, particularly in situations where designers are confronted with material innovations. Whereas historical research of iconic buildings typically documents the work of the architect, this chapter proposes an alternative reading by emphasizing the role of the material. Otto Wagner's Postal Savings Bank in Vienna (1906) offers an insight into how material innovations in iron are entangled with the genesis of the project. A detailed archival study on the iron column in the central banking hall traces its conversion from material to architectural element. Ideas on 'Construction' and 'Composition', which Wagner had developed as separate chapters in his book *Moderne Architektur*, are merged into the design. The properties of iron, its production process and assembly, enabled Wagner to reconsider the relations between object, ornament and space, resulting in an innovative, abstract and modern style.

FR

En architecture, penser et faire sont en dialogue permanent, en particulier dans les situations où les concepteurs sont confrontés à des innovations concernant un matériau. Alors que les travaux d'histoire portant sur des bâtiments iconiques rapportent généralement la démarche de l'architecte, ce chapitre propose une lecture alternative en montrant le rôle actif joué par le matériau de construction. Le cas de la *Postsparkasse* d'Otto Wagner (Vienne, 1906) permet de montrer comment la genèse du projet est étroitement liée à des innovations matérielles autour du fer. Un minutieux travail d'archives concernant les colonnes en fer du hall central permet de suivre leur transformation : de matériau, elles deviennent élément architectural. Les idées sur la construction et la composition que Wagner avait développées sous forme de chapitres séparés dans son livre *Moderne Architektur* ont fusionné dans ce projet. Les propriétés du fer, son processus de production et son assemblage ont permis à Wagner de reconsidérer les relations entre l'objet, l'ornement et l'espace, donnant naissance à un style novateur, abstrait et moderne.

5 Material Transformations in Architecture. Tracing the Design Process of the Iron Column in Wagner's Postsparkasse

Eireen Schreurs

In architecture, thinking and making are in a continuous dialogue, especially in situations where designers are confronted with material innovations [Ingold, 2013]. New materials and production processes challenge the architect to interact with the material in the process of design. Historical research of iconic works of architecture usually documents the 'voice' of the architect, with a focus on the finished project, whereas the material side and the development of the project receive much less attention. Recently, the interdisciplinary field of Material Culture Studies has started to address the agency of materials and acknowledge the reciprocal relation between idea and materialization in the processes of making. Their promotion of the material from an 'intermediary' to a full blown 'mediator' can offer a refreshing perspective.⁴¹ This chapter does not explicitly question the nature of the material's agency but rather aims to translate these insights into the field of architecture.

The project concerned is by the architect Otto Wagner, whose Postal Savings Bank (Vienna, 1902–1906) is generally understood as one of the first true modern buildings. In terms of its materialization, the most extensively studied feature is the marble façade held by exposed iron bolts [Fig. 5.01], representing the fixture of the marble plates.⁴² But in historiography, not the material itself,

⁴¹ On intermediary and mediator see: LEHMANN A. (2015) 'The Matter of the Medium. Some Tools for an Art Theoretical Interpretation of Materials', in ANDERSON C., DUNLOP A. & SMITH P. H. (eds.) *The Matter of Art: Materials, Technologies, Meanings 1200–1700*. Manchester: Manchester University Press, 28–30. Other literature includes BENNETT J. (2010) *Vibrant Matter. A political Ecology of Things*. Durham: Duke University Press.

⁴² Their function is largely decorative, since they have only carried the plates in the montage phase. TOMASELLI M. & HASLER T. (2018) 'Des Nagels Kern und seine Hülle, über die Konstruktive Wahrheit des legendären Scheinnagels', in NIERHAUS A. & OROSZ E. (eds.) *Otto Wagner*. Vienna: Residenz Verlag; FORD E. R. (1990) *The Details of Modern Architecture*. Cambridge MA: MIT Press.

but rather its symbolic meaning is used to point at the influence of Semper's theories of cladding on Wagner's thinking. While the historical and cultural interpretations offer interesting insights, Wagner's challenges in dealing with iron in his design process can invite alternative ways of looking at the project. We will therefore focus on an element for which the choice and production of iron were particularly essential in the design process: the central banking hall, which is covered with an exposed iron roof construction. At the time of the project, Wagner was facing an iron industry that was shifting towards standardization, radically changing the material's formal and ornamental potential. The research looks specifically at the column, allowing for a detailed analysis of iron's capability to challenge the conventions of architecture. In order to understand Wagner as a thinker, we use his influential publication *Moderne Architektur* from 1896 (reworked in 1898, 1902, and 1914), in which he formulated an architectural programme that preluded the ideas of early Modernism.⁴³



5.01 Front façade of the Postal Savings Bank, with a pattern of bolts.
Photograph by Thomas Ledl, CC BYSA.

Unlike an artist or a craftsman, an architect does not personally make or construct a building. But even though Wagner was an architect with a certain distance to the material, his involvement in the building process itself was

⁴³ All the quotations in this chapter refer to the third edition from 1902, which was out just before Wagner started the design of the Postal Savings Bank. MALLGRAVE H. F. (1988) 'Introduction', in WAGNER O. (translation: H. F. Mallgrave) *Modern Architecture: a Guidebook for his Students to this Field of Art*. Santa Monica CA: Getty Publications, 1–51.

intense. An explanatory leaflet lists fifty-seven separate firms intervening on the construction site, supplying everything from *Armierter Beton* (reinforced concrete) to *Teppichstangen* (carpet rods),⁴⁴ and no general contractor is mentioned. Wagner had full control over the construction process, so that he could report back to the client whether the project was kept within budget.⁴⁵ In this position he must have collaborated closely with the firms involved, all of which were Viennese, and he must have visited the workshops and the building site numerous times.⁴⁶ Moreover, Wagner made the calculations for the iron structure of the hall himself, demonstrating a technical insight in its dimensioning and assembly.⁴⁷ This equipped him with the knowledge, experience and many examples to pick from, in order to understand iron and what it had to offer.

We will now turn to the building, first sketching the debate over architectural iron that Wagner was following up on, and the state of the iron industry at the time of the project. The text, which is based on detailed archival research, will then follow the design and building process of the banking hall. Three acts reconstruct the different steps that led to the final form and detailing of the iron column: its introduction into the design of the hall; the choice of material and cladding; and finally, its tectonic expression, all the while tracing the transformation of Wagner's thoughts and ideas into form, questioning how iron assisted him in his search for an innovative, modern language. By studying the negotiation between the material and the architect – and thereby intertwining the architect's thinking and making – this chapter tests what a material- and process-oriented reading of the architectural project can offer.

The Context for the Postal Savings Bank

Iron had entered the architectural debate some sixty years before, in 1840. The possibilities of the material had created a dynamic context for the practice of architecture, coinciding with the architects' search for a new style, one that was able to represent the industrial age.⁴⁸ Iron's structural capacities and (supposed) incombustibility offered architects novel forms of construction, such as large spans, roof lights, and much thinner columns. It had forced them to contest established ideas on the relationship between mass and constructive performance, and on top of that, innovations in the production kept changing the

44 'Erläuterungen' (Explanations), December 1906. MAK Archive box 3, n° H3361/1906.

45 Wagner's official title was *Oberbaurat*, an honorary title, which also usually referred to the function of building officer or surveyor in service of the municipality. The minutes of the meeting with the client demonstrate that the meetings were largely about keeping the project within budget. MAK Archive box 2.

46 As an example: the workshop Wagner, Biro & Kurz AG where the columns were produced was only 8 km away from the construction site.

47 Otto Wagner calculated the iron dimensioning himself, but the final calculations were carried out by the firm Wagner, Biro-Kurz Waagner in 1906. MAK Archive box 2.

48 For an overview of the introduction of iron, see: RINKE M. & SCHWARTZ J. (eds.) (2010) *Before Steel, the introduction of structural iron and its consequences*. Sulgen/Zurich: Verlag Niggli AG.

terms of the discussion. As such, iron had caused confusion and controversy amongst architectural theorists [Dobraszczyk & Sealy, 2017]. Vienna's most influential thinker and designer Gottfried Semper (1803–1879), for example, argued that iron lacked monumental power,⁴⁹ yet at the end of his life, cast-iron columns appeared in his final masterpiece, ironically now a monument: the Viennese *Semperdepot* (1877). It was a German theoretician, Karl Bötticher, who influenced Wagner's ideas on construction the most, helping him to take position in the matter of iron.⁵⁰ According to Bötticher, architecture consisted of a *Kernform* and a *Kunstform*. The functional construction (the *Kern* or core-form) was dressed in an artistic cladding (the *Kunst* or art-form) that articulated and expressed the structure, in the details of the column's capital, for example, or the ornaments in the corniches. Wagner used the idea of structural expression for his *Moderne Architektur*, dedicating a whole chapter to the issue of construction and form.

At the time Wagner started his design of the Postal Savings Bank, the Austrian iron industry was flourishing. This had resulted in a network of Viennese construction firms with knowledge, experience, and a range of production techniques. Wagner was bound by contract to collaborate with these firms, since he was only allowed to use Austrian iron for the Postal Savings Bank.⁵¹ The companies produced both cast iron and rolled iron; the names derived from their different industrial processes. Cast iron was poured in a mould, and could take any form, including the ornament. It was high in compressive strength, but brittle, and for this reason its application had increasingly been confined to columns. Rolled iron was rolled into profiles and sheets and from around 1880, rolled iron profiles were prefabricated in standard quality, sizes and shapes, affording precise (and economical) calculation [Wehdorn, 1979]. Both rolled iron and its successor, steel, were tough and capable of handling tension and distortion, making it suitable for beams and all sorts of frame-works, slowly replacing cast iron for all construction work. Wagner had been given ample space to experiment with iron, often combining the two types, in the extensive project of the Viennese *Stadtbahn* (1892–1898) with its many small station entrances and platform coverings. But how would his ideas work out in a larger space, and in such an important institution that the client would call it both royal and imperial?

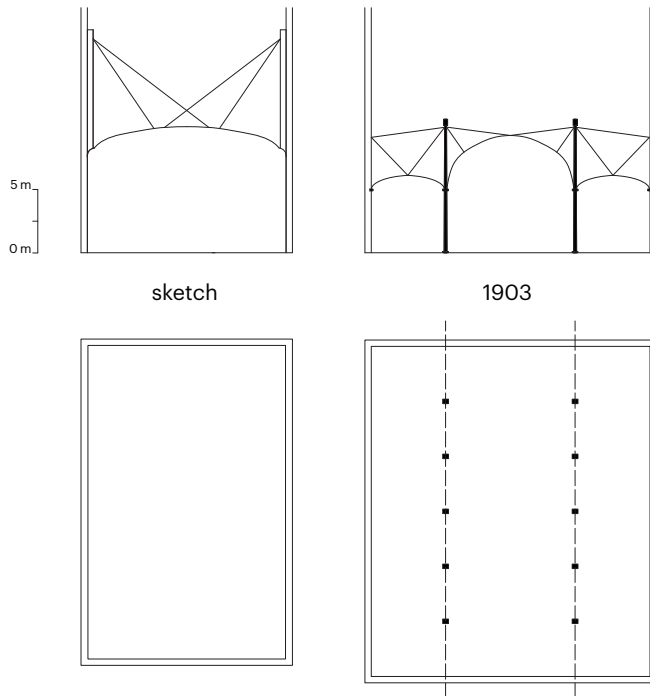
49 For Semper's relationship to iron, see also: WEIDMANN D. (2003) 'Sempers Verhältnis zum Eisen', in OECHSLIN W. & NERDINGEN W. (eds.) *Gottfried Semper 1803–1879. Architektur und Wissenschaft*. Zürich: Prestel Verlag, 321–329.

50 I rely here on the interpretation of H. F. Mallgrave in: WAGNER O. (translation: H. F. Mallgrave), 1988.

51 'Besondere Bedingungen, Eisenkonstruktionen' Gewichts und Aluminium Schlosserarbeiten' (Special Conditions, Iron Construction and Aluminum Work). MAK Archive box 1.

The Introduction of Iron

It took Wagner some sketching before iron even appeared in the design for the banking hall, which started out as a central courtyard simply covered with a curved glass ceiling [Fig. 5.02a]. The competition entry [Fig. 5.02b] shows a more differentiated setup of the interior. Two parallel rows of slender columns had appeared to carry the glass roof, dividing the hall in three barrel-vaulted parts, a gesture that was not a technical necessity, since iron could have spanned the width of the hall (24 metres) in one go. Instead of mentioning the material, Wagner stated there was ‘a lack of direction in the space’ that he ‘aesthetically corrected’ with a row of columns, giving the hall a longitudinal form.⁵² But the fact that the columns needed to be iron became clear when the architect later claimed, in a meeting with the building committee, that the columns had to be ‘light and elegant’, iron being the only material that could provide this quality.⁵³



5.02a–b Section of the banking hall in 1903 (first sketch) and 1903 (competition entry). Drawing by Eireen Schreurs.

⁵² Description in the explanatory report on the competition (*Erläuterungsbericht zur Wettbewerb*), in GRAF O. (1985) *Otto Wagner. Das Werk des Architekten 1903–1918*, Vol. 2, Vienna/Cologne/Graz: Hermann Böhlhaus Nachf., 425.

⁵³ Wagner complained bitterly when, at a later point (when the construction was already halfway completed), the upper roof had to be brought down and integrated into the glazed ceiling, resulting in bigger columns: ‘The necessary reinforcement of the ten iron stands will take away the light and gracefulness of the cash hall [...]’. ‘Bauprotokol VIII’, May 1905. MAK Archive box 2.

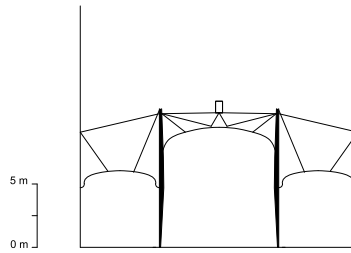
The iron columns were part of an ingenious suspended construction that supported the glazed ceiling and was clearly derived from techniques developed in suspension bridges.⁵⁴ The 11-metre-high columns stuck through the ceiling, at the point where the central high bay met the two side bays. From the top of the columns, slim iron rods extended to bear the glass ceiling, a structure reliant on the high tensile strength of iron. With the construction concealed, the ceiling turned into an abstract grid of iron and glass, hovering above the hall which was able to bathe in equalized light. In *Moderne Architektur*, Wagner had formulated his ambitions for clear, well-lit interiors in the chapter ‘Composition’, which was separate from the chapter ‘Construction’, but the iron enabled a merging of these two categories. The perspective from the material points us to the fact that the strength of iron not only ensured a brightly illuminated hall, but at the same time offered a correction of the hall’s spatial experience. With iron came also an atypical structure, which was kept concealed, allowing Wagner to move towards abstraction, an aim Wagner had not explicitly formulated. The second step would concern the form and finishing of the iron column, which, according to Wagner, had to bring forward ‘a new style, the modern, that will represent us and our time’ [Mallgrave, 1993: 79].

The Iron Rivet as a Game Changer

At the start of the building phase, a year later, a subsequent drawing reveals that the column had undergone a transformation [Fig. 5.03]. The competition drawings had suggested cast iron, a sensible choice for columns due to its high compressive strength, plus the casting also presented an endless array of formal possibilities.⁵⁵ But it was precisely the massive proliferation in the fabrication of all sorts of ornamented cast iron at the end of the nineteenth century that had ‘contaminated’ this type of iron with the idea of commodity, decreasing its cultural value. A few years later, in 1908, the architect Hermann Muthesius, a very influential figure for the modern movement, would confirm the low status of the ornament, stating: ‘The ornament has become common’ [Nierhaus & Orosz, 2018: 90]. It was a modern and clean style that Wagner was looking for, away from the romantic, distinct from the past. And the construction held the key. In his book, Wagner had laid out an interesting argument regarding the construction: he was convinced that new forms had to ‘develop out of the construction itself’ and it was necessary for the construction to express its speed of production [Wagner, 1902: 105].

⁵⁴ It is interesting to note that the company that produced the columns and the roof, Biro-Kurz Waagner, also built a number of bridges for Wagner in his *Stadtbahn* project.

⁵⁵ The slightly tapering form, slim dimensioning and ornaments on the drawing of the competition entry all point to cast iron.



1904

5.03 Section of the banking hall in 1904 (start of construction). Drawing by Eireen Schreurs.

It may have been for this reason that Wagner decided against cast iron, and instead chose to compose the columns of rolled iron: two standard C-beams, connected by two metal plates, that enhanced the rigidity of the columns.⁵⁶ The composed column allowed for a specific form that again affected the space: the slight tilting of one of the C-beams strengthened the dynamic experience of the hall. The column formed the core-form: the straightforward and still unmediated construction, according to Wagner's theory [Wagner, 1902: 93]. The riveting of the iron columns was visible, and clearly expressed the act of assemblage in prefabrication, symbolizing at the same time the pace of the new and the modern. But was this enough to make the architectural gesture of the art-form? Since profiles had a standard form, and since the art-form was – according to Wagner – intrinsic to the construction, the question became: what could the 'artistic expression' of iron look like? [Mallgrave, 1993: 93] What other means were at his disposal?

Wagner introduced an even newer material: he projected a casing of the columns with cast, slightly bulging rings of aluminium, similar to the columns that carried the canopy at the main entrance [Fig. 5.04]. The introduction of aluminium opened new perspectives: it could be considered the up-market alternative for iron, and yet at that point it had scarcely been applied in buildings [Ashby, 1999]. Being non-corrosive, furthermore, it offered the option of staying untreated: indeed, its soft polish produced a distinguished look. The bulging rings turned the lower parts of the columns into giant upside-down screws, a quite striking and literal representation of the act of assemblage. Above, the iron remained in plain sight, rivets and all [Fig. 5.05].⁵⁷ Apart from the question of how to slide the rings around the columns without damaging the much softer aluminium, Wagner's proposal had one indisputable drawback, which was discussed in the client meetings: the outrageous costs of the cast

⁵⁶ WAGNER O., 'Statische Berechnungen der Eisenkonstruktionen für den Bau des k.k.Postsparkassenamtsgebäudes', 4 May 1904. MAK Archive box 1.

⁵⁷ See also the drawing that Wagner produced for his book *Einige Skizzen*: HAIKO P. (ed.) (1987) *Einige Skizzen. Projekte und Ausgeführte Bauwerke*. Tübingen: Wasmuth Verlag, 318.

aluminium rings.⁵⁸ This forced Wagner to arrange a much cheaper alternative and have it priced by a construction company, which he managed over the Christmas holidays, again demonstrating their close collaboration.⁵⁹ He did away with aluminium in many places, but kept it for the columns, covering them with layers of small aluminium plates (plates being much cheaper than casts) which could easily be fastened on site, with bolts, after the columns had been put into position.⁶⁰ These bolts could then not be hidden from view.

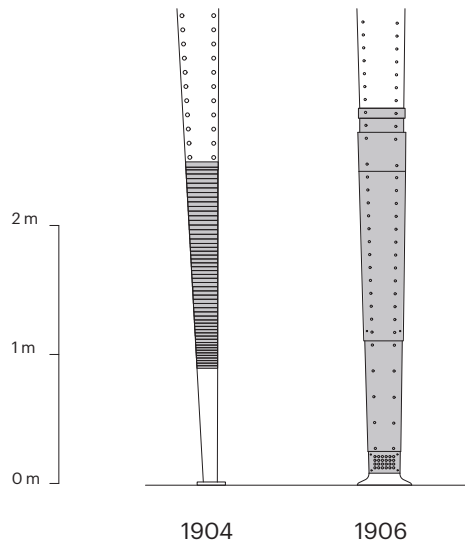


5.04 Aluminium clad columns to resemble screws at the entry canopy.
Photograph by Eireen Schreurs.

⁵⁸ The first offer for the aluminium works came to 500.000 kr, a sixth of the total of 3 million kr for the whole building. 'Protokol Baukomitee-Sitzung', 22 December 1905. MAK Archive box 2.

⁵⁹ At the meeting of 5 January, the alternative offer was accepted, and the aluminium work was given to Kammerer und Filz. 'Protokol Baukomitee-Sitzung', 5 January 1906. MAK Archive box 2.

⁶⁰ A picture of the building site shows the columns were placed without aluminium covering. MAK Archive box 3, PSA nr 80A Ka 23280-182.



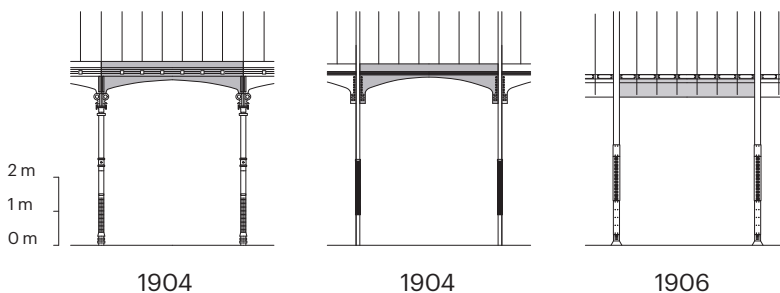
5.05 Column with aluminium rings in 1904 and the cladding with aluminium plates realized in 1906. Drawing by Eireen Schreurs.

It was the montage that provided Wagner with means for ‘artistic refinement’, by using these aluminium ‘rivets’, which in reality were bolts with aluminium heads. In mimicking the rivets of the iron columns, they allowed for the construction itself to be expressed: it was as if the columns shimmered through, like an X-ray picture. Wagner composed dynamic rhythms, sometimes densifying, then diluting again [Fig. 5.05]. The patterns invaded the room, fastening the marble panelling and glass tiles to the wall, securing the lighting to the columns, to the heating elements, and even to the tailor-made furniture.⁶¹ This unifying grid even involved the exterior, so that the famous iron façade bolts could now be considered to predict the interior, or the inverse: the interior could turn into a public façade. In his writing, Wagner strove for a rational architecture, but the building process proved to have its own rationale. The focus on the material allows a reading of the design process as an activity that reacts to industrialization, economy, and the realities of making. We can see how the industrial production of iron ‘solved’ Wagner’s aim to represent the construction process in the building. It presented Wagner with aluminium, whose material surface qualities apparently had ornamental value. New artistic motives surfaced, patterns that were again abstract, allowing him to equalize different material finishes and to strengthen the idea of the hall as a coherent space, connecting it to the street outside. But there was still one detail unsolved: the *zweckmässig* or ‘purposeful’ connection of the column to the rest of the structure.

61 For sketches around the composition of the grid, see also: GRAF O. (2000) *Baukunst des Eros 1900–1918*. Vienna: Böhlau Verlag.

The Invisible Capital

The last decision regarding the columns was also made at some point during the building phase, and concerned their capitals, or to be more precise, their lack of a capital. Each column had been prefabricated in the nearby workshop of the firm Wagner, Biro & Kurz AG, together with the other parts of the iron skeleton for the central banking hall.⁶² The columns were probably individually transported to the construction site and after being erected, secured with horizontal beams. In earlier design phases, these beams had been cast in a slight arch, transforming the spaces between two columns into little gates, stressing the connection by a capital [Fig. 5.06]. Eventually, the beams became straight and they simply ‘punched through’ the column, with no capital, thereby avoiding the suggestion that the iron was stapled, as would have been a logical way to express the construction in a conventional (stone) construction. This was in correspondence with the structural function of the beams: for it was the construction above that carried the main structure of the glazed ceiling – and remained hidden. The beams rather functioned as stabilizers, to avoid buckling while carrying a small walkway behind the glass. Since the beams were still cast iron, the moulding process allowed the inclusion of vertical ornamental strips on them that continued the pattern of the vertical glass rods, strengthening a reading of the beam as an integrated part of the glass ceiling. Through this small detail, the beam disappeared and the glass now seemed to be ‘draped’ over the courtyard, as a salute to Semper’s fascination with cloth and cladding. In the period photo of the interior taken from the lower bay [Fig. 5.07], we can see that the horizontal beams are indeed hardly visible.



5.06 Horizontal cast iron beams in 1904 (start of construction), further developed in 1904 and as realized in 1906. Drawing by Eireen Schreurs.

⁶² ‘Protokol Baukomitee-Sitzung’, 20 January and 17 March 1906. MAK Archive box 2.

5.07 The banking hall interior in 1910. Courtesy of Bildarchiv Foto Marburg.

Now that the columns had their final detail, they formed the connection points in a second grid of lines, linking the floor – consisting of concrete floor beams filled up with glass blocks – to the glass frames of the ceiling. The mirroring of ceiling and floor was strengthened by the lack of column base and capital. All walls were blank, clad and shiny, equally lit, in only subtle shades of grey and white, almost dissolving. Here we see that iron freed Wagner from the conventional language of base and capital to express its tectonic language of assembly, rather than stapling. Thus, the detailing of the structure could push the architectural theme of abstraction further forward, to be experienced by the visitors in one fluent movement through the hall, with the lines guiding them to their destination.

Conclusion

In the process, the columns had transformed from fluid, ornament-inclusive cast iron with a traditional shape, to a composition of standard C-beams, in a thoroughly innovative form and finish. The research perspective that has been developed here, reveals that Wagner's new aesthetic agenda very much depended on the interaction with the material, and that it was the iron's logic that provided the necessary tools to realize the architect's ambitions. The transformation of the column went beyond the object and the surface: it ultimately

also led to a new and more fluid experience of space, while the industrial production process was celebrated as a sign of the time. The acceptance and willingness to see the material's potential offered architecture a way forward towards a new language. What the study at the same time demonstrates is that the makers, the craftsmen, but also the actual processes of detailing and making form a black hole in the archives of the MAK, the Viennese museum for applied arts. In the three boxes that contain only the competition selection, the architect's plan sets, the building reports and lots of bills, the material side of the dialogue remains difficult to trace.

Wagner's theory and writings had set the dialogue with iron in motion: there he had laid out the strategies and rules to find a form that represented his time. While Wagner had devoted separate chapters in his *Moderne Architektur* to 'construction' and 'composition', in the material reality of the building the categories merged, presenting an outcome that the theory could not have answered for. What the material perspective also teaches us is that an understanding of the material's impact upon the architectural design is not as simple as tracing the material flows. The architect is not a sculptor, and even if he does not have a direct engagement with the material, he builds upon precedents, both in understanding and experience. The design process demonstrates that Wagner was not led by technical imperatives, but rather challenged by the material, which opened new doors, and closed off some others. An architect needs the material to provide him with a potential innovation, but the material needs the expertise of the architect to be appraised, and to be positioned within the material culture of architecture.

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Bibliography

- ASHBY J. (1999) 'The Aluminium Legacy: the History of the Metal and its Role in Architecture', *Construction history*, N° 15, 79–90.
- BENNETT J. (2010) *Vibrant Matter. A political Ecology of Things*. Durham: Duke University Press.
- DOBRAŚCZYK P. & SEALY P. (eds.) (2017) *Function and Fantasy. Iron Architecture in the long Nineteenth Century*. Abingdon: Routledge.
- FORD E. R. (1990) *The Details of Modern Architecture*. Cambridge MA: MIT Press.
- GRAF O. (1985) *Otto Wagner. Das Werk des Architekten 1903–1918*, Vol.2, Vienna/Cologne/Graz: Hermann Böhlau Nachf.
- GRAF O. (2000) *Baukunst des Eros 1900–1918*. Vienna: Böhlau Verlag.
- HAIKO P. (ed.) (1987) *Einige Skizzen. Projekte und Ausgeführte Bauwerke*. Tübingen: Wasmuth Verlag.
- INGOLD T. (2013) *Making. Anthropology, Archaeology, Art and Architecture*. Abingdon: Routledge.
- LEHMANN A. (2015) 'The Matter of the Medium. Some Tools for an Art Theoretical Interpretation of Materials', in ANDERSON C., DUNLOP A. & SMITH P. H. (eds.) (2015) *The Matter of Art: Materials, Technologies, Meanings 1200–1700*. Manchester: Manchester University Press, 28–30.
- MALLGRAVE H. F. (ed.) (1993) *Otto Wagner: Reflections on the Raiment of Modernity*. Chicago: University of Chicago Press.
- NIERHAUS A. & OROSZ E. (eds.) (2018) *Otto Wagner*. Vienna: Residenz Verlag.
- RINKE M. & SCHWARTZ J. (eds.) (2010) *Before Steel, the introduction of structural iron and its consequences*. Sulgen/Zürich: Verlag Niggli AG.
- TOMASELLI M. & HASLER T. (2018) 'Des Nagels Kern und seine Hülle, über die Konstruktive Wahrheit des legendären Scheinnagels', in NIERHAUS A. & OROSZ E. (eds.) *Otto Wagner*. Vienna: Residenz Verlag, 96–109.
- WAGNER O. (1902) *Moderne Architektur*. 3rd edition, Vienna: Anton Schroll & co.
- WAGNER O. (translation: H. F. Mallgrave) (1988) *Modern Architecture: a Guidebook for his Students to this Field of Art*. Santa Monica CA: Getty Publications.
- WEHDORN M. (1979) 'Die Bautechnik der Wiener Ringstrasse', in WAGNER-RIEGER R. (ed.) *Die Wiener Ringstrasse, Bild einer Epoche*, Vol. 11, Wiesbaden: Franz Steiner Verlag BMBH, 50–51.
- WEIDMANN D. (2003) 'Sempers Verhältnis zum Eisen', in OECHSLIN W. & NERDINGEN W. (eds.) *Gottfried Semper 1803–1879. Architektur und Wissenschaft*. Zürich: Prestel Verlag, 321–329.