From Gothic to Bauhaus: A Lineage for Modern Curtain Wall Façade Construction

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Abstract: From the craft production of the Gothic to the standardised industrial production of the Bauhaus, this research follows the development of modern architecture and the evolution of façade construction. This paper examines how, as technology has continued to advance and modes of production have evolved, complete dematerialisation – defined in this paper as a non-structural glass exterior walls – of the façade was achieved with the curtain wall. This research aimed to establish a link between Gothic and Bauhaus architecture to propose a lineage for modern curtain wall façade production and construction. The paper argues that changing modes of production is in response to construction issues, technological innovation and are dependent on the socio-cultural context of a specific time. Presenting a lineage that places this evolution into three stages – pre-industrial, industrial, and post-industrial – the relationship of architecture, technology and how construction methods respond to new technology will be illustrated. This paper will examine the curtain wall’s arrival in New Zealand as a case study for the international dissemination of this system, to conclude with a discussion that outlines how the architecture of a post-industrial age both favours and can produce customised and complex façades.

Keywords: Architectural History; Façade Construction; Dematerialisation; Industrialisation.

1. Introduction

Historically, artistic hierarchies and changing socio-cultural contexts determined who designed buildings. This role shifted between the artist, craftsman, and architect (Rannells, 1949; Harvey, 1950). Although each art form is reliant on formal qualities, such as line, colour and composition, architecture must also express space (Rannells, 1949). Architecture accounts for gravitational forces and loads that act upon the building, but for it to become art, “spatial construction should be apparent to all who can see through façades” (Rannells, 1949, pp. 207). The Modernist architect and member of the Bauhaus, Mies van der Rohe, attempted to realise this with his early unbuilt proposals for glass skyscrapers. These structures with transparent, completely dematerialised, curtain wall façades revealed the structure within (Blaser, 1997). This paper places Gothic architecture at the beginning of this lineage for modern façade construction. Not only did Gothic architecture emerge without reference to historical precedent,
but a structural skeleton was developed by Gothic architects – a principle that has allowed curtain wall construction to develop into what it is today.

From here, the question is posed: how have modes of production evolved to produce curtain wall façades as they are today, and what are the causes for development? This research aims to establish a lineage for the modern curtain wall, to argue that changing modes of production are in response to the sociocultural context and technological advancement of a particular time. This paper will begin with a discussion of the Gothic architecture’s complex design and assembly, followed by how these principles were interpreted by the industrial age. Then, the architecture of the Bauhaus will be analysed, to understand its influence and circulation abroad. The paper will discuss architecture in New Zealand, to examine the influence of the Bauhaus internationally. Finally, the role of technology in architecture today will be discussed to reflect upon the influence of the lineage presented by this paper on contemporary modes of production and construction of façades.

2. The Gothic

Before the establishment of the Gothic period, at the beginning of the twelfth century, Romanesque architecture was the dominant style. It featured a system of circular vaults that were used to span spaces, but required thick walls to support the vault’s structural load (Fitchen, 1961). Experimentation and technological innovation converted dark and heavy Romanesque architecture into the “elegant cage of the Gothic cathedral” (Acland, 1972, pp. 39), and the architect emerged as the master mason, who coordinated the layout and fabric of the Gothic cathedral (Acland, 1972). Consequently, cathedrals became the exemplary form of art – the engagement of craftsmen with architecture and construction represented the harmony between art and architecture (Harvey, 1950).

To improve upon the Romanesque circular vaulting system, Gothic architecture introduced the pointed arch (figure 1). Arches, vaults and buttresses were derived from the pointed arch and were combined to create a structural skeleton. Each is essential within Gothic Architecture; together they form the skeleton and separate this structure from the walls and façade (Wolfe and Mark, 1974). Windows became larger to allow more light into the building and begin dematerialising the façade. Furthermore, the structure was expressed by the building’s form, to generate an “expressive interpenetration of inner and outer space,” and reveal structure in the interior and on the exterior (Rannells, 1949). The influential 19th-century art critic and advocate for the Gothic, John Ruskin, explains in The Stones of Venice:

We shall find that Gothic architecture has external forms and internal elements [emphasis added] ... Its external forms are pointed arches, vaulted roofs, etc. And unless both elements and the forms are there, we have no right to call the style Gothic. (Ruskin, 1874b, pp. 153)

Structure, therefore, determined the building’s formal expression, on both the inside and outside. As a result, the Gothic cathedral expressed a modern idea: the separation of the structure and façade. The combination of buttresses, arches and vaults meant that the walls only needed to protect from weather and provide privacy. Ruskin describes the walls of a Gothic Building:

In perfect architecture, however, walls are generally kept of moderate thickness, and strengthened by piers or buttresses; and the part of the wall between these, being only generally intended to secure privacy, or keep out the slighter forces of the weather, may be properly called a Wall Veil. (Ruskin, 1874a, pp. 52)
Unless a wall was required for a specific function related to the use of the building, the structural skeleton opened the space and reduced the form of the building to the essential structural elements. Arches and vaults, buttresses, or the later flying buttress, expressed the shape of the Gothic arch – a fundamental to the structural form of Gothic architecture – on the façade while supporting the exterior walls of the Cathedral. All of these components made the non-structural dematerialised façade a possibility.

The skeleton, an organic form, connected Gothic architecture to nature and made complexity possible (Harris, 2012). Ornamentation thus became secondary to structure (Wolfe and Mark, 1974; Harris, 2012); beauty was found in the structural skeleton – a form derived from nature – was celebrated as a piece of art itself (Harris, 2012). With so much complexity, the construction of cathedrals took centuries, required a large workforce of skilled and unskilled labour, and large quantities of materials. Additionally, without an understanding of structural engineering, 17% of cathedrals suffered structural failure; walls fell over and buttressing systems gave way (Scott, 2011). The structural achievements exhibited by Gothic architecture could not have been accomplished without the observation of earlier performance (Mark and Billington, 1989). These developments produced “engineering means [that] were entirely integrated and subordinated to the aesthetic aim, and the ensemble effect remains one of man’s greatest achievements, an overwhelming expressiveness” is hence achieved with structural form (Fitchen, 1961, pp. 2).

Great effort was required to locate, transport, and prepare the stone for the construction of Gothic cathedrals, which were then finished by skilled craftsmen (Scott, 2011). An overall plan was formulated before work could begin and the vast scale required the work to be carried out across generations. It made planning essential to identify, produce the component parts, and specify a method of assembly (Scott, 2011). Architects encoded the design so the building could be understood by successive builders (Scott, 2011). Modular construction became the solution to the assembly of a gothic building – a puzzle generations of craftsmen were required to solve (Scott, 2011). Without modularity, the structural complexity created by the Gothic’s organic origins would have made the building impossible to finish (Simon, 1962). Although subtle progressions of ornament indicate how construction evolved over centuries, the essential form of the skeleton remained (Mark and Clark, 1984). Modes of production developed by medieval craftsmen and architects can be summed up by Ruskin, reflecting on the difficulty in defining Gothic architecture:

Figure 1: Diagram illustrating pointed arches and the creation of vaults in the Gothic cathedral (source: author); interior of Gothic cathedral (source: Sullivan, 2006); exterior of Gothic cathedral (source: Benoist, 1861); section illustrating relationship between arches and flying buttresses that support and allow for the dematerialisation of the wall (source: author).
The principal difficulty in doing this arises from the fact that every building of the Gothic period differs in some important respect from every other ... Pointed arches do not constitute Gothic, nor vaulted roofs, not flying buttresses, not grotesque sculptures; but all or some of these things, and many other things with them, when they come together so as to have life. (Ruskin, 1874b, pp. 152)

The structural expression achieved by Gothic architects and artisans is, therefore, the result of advancing construction methods and modes of production (Simon, 1962). Architects and craftsmen overcame many problems posed by the conditions of the medieval age with the development of innovative structural solutions that presented opportunities for customisation and improvement, whilst still conforming to the Gothic style to produce a complete work of art.

3. The Gothic Revival

In the 19th century, the Industrial Revolution introduced mechanical production and separated manufacture from the assembly. During the same period, a renewed interest in the Gothic influenced commentary on these industrial modes of production.

Ruskin asked for a return to the Gothic craftsman’s modes of production, as he disapproved of the standardised, mass production that was altering the landscape. Ruskin believed the geometric repetition of the modern landscape represented the economic exploitation of architecture, which become embodied by the curtain wall’s modernity (Fry, 1969). Although Ruskin looked back, the architect and conservator of Gothic buildings, Eugène Emmanuel Viollet-le-Duc, looked forward (Pevsner, 1980). A rationalist, Viollet-le-Duc celebrated the Gothic for its modernity and break with antiquity (Lucan, 2012). In 1859, Viollet-le-Duc states:

> Gothic construction, despite its defects, its mistakes, its explorations... is an eminently worthwhile study: it is the surest initiation to this modern art that does not yet exist and is still seeking its path, because it sets down the genuine principles to which we should still adhere today. (cited in Lucan, 2012, pp. 259)

He imagined how Gothic architects could have designed buildings with modern materials: “We could not, it was true, go any further without substituting metal for stone” (cited in Lucan, 2012, pp. 261). With access to industrially produced cast iron and glass, Gothic architects “would have eagerly put it to work as a sure means of obtaining supports as spindly as possible and rigid” (Viollet-le-Duc, 1859, cited in Lucan, 2012, pp. 261).

Constructed in London in 1851, Joseph Paxton’s Crystal Palace was considered an elegant architectural solution that utilised the industrial materials of iron and glass. The Crystal Palace was a symbol of modernity and one of the earliest examples of prefabricated construction; standardised components of iron and glass were efficiently assembled to form a dematerialised structural skeleton (Bock and Langenberg, 2014). In the era of the Gothic Revival, the Crystal Palace illustrates a shift back to the appreciation of structure – beauty is once again the result of the structural expression (Smith, 2010). However, in the age of industrialisation, the structure does not only signify beauty, but modern economies of production (Gartman, 2009). It was as standardised objects were mass-produced and then assembled on-site, enormously decreasing production rates and cost (Smith, 2010). Mass production did not only express the technological innovations of the industrial revolution, but the economic motivation for architecture (Sands, 1986). Furthermore, manufacturing developments in 1905 resulted in the mass production of standardised, high-quality glass (Herzog et al., 2004). As a result, dematerialised façades,
like those exhibited in the Crystal Palace, became more prominent as they were now easily produced and assembled. The result was the curtain wall, which was believed to be conceived of by the Bauhaus’ founder, Walter Gropius (Mijovik et al., 2018).

4. The Bauhaus

Completed in Germany in 1913, the Fagus Factory is placed further along this paper’s lineage as an example of a building that utilises curtain wall façade construction. Like Gothic architects, the architects Gropius and Adolf Meyer separated the exterior walls from the building’s concrete structural skeleton (Lupfer and Sigel, 2004). As the walls are no longer load-bearing, they become a “non-structural curtain” (Murray, 2009, pp. 19). This curtain wall is formed with horizontal steel transoms intersecting with vertical mullions. These create a grid of glass panels, the repetition of which is ensured through standardisation and mass production (Murray, 2009). Although opaque spandrel panels conceal the structural frame behind the glass façade, the lines of the mullions follow the orthogonal form of the rigid concrete skeleton (figure 2).

In 1919, Gropius established the Bauhaus school. In his 1919 Bauhaus Manifesto, Gropius proclaimed that the function of fine arts was indispensable to architecture: “The ultimate aim of all visual arts is the complete building!” (cited in Wingler, 1969, pp. 31). Gropius believed that the arts no longer existed unity, he continues:

Let us then create a new guild of craftsmen without the class distinctions that raise an arrogant barrier between craftsman and artist! Together let us desire, conceive, and create the new structure of the future, which will embrace architecture and sculpture and painting in one [emphasis added]. (cited in Wingler, 1969, pp. 31)

A radical concept, the Bauhaus’ Modern ideology aimed to reunite the visual arts like the Gothic (Whitford, 1984). As a result, the school began teaching manual production methods oriented towards the crafts. Following these initial years, the school evolved to align with the industrial production of the age (Wingler, 1969). In 1922, Gropius explained:

Just as the Gothic Cathedral was the expression of its age, so the modern factory or modern dwelling must be the expression of our time: precise, practical, free of superfluous ornament, effective only through the cubic compositions of the masses. (cited in Wingler, 1969, pp. 66)

Despite these changes, Gropius’ words retain the Bauhaus’ lineage with Gothic. As Gropius said in 1923 “the teaching of craft is meant to prepare for designing for mass production” (as cited in Loureiro, 2014, pp. 182).

These ideas were not fully realised until 1927 when the Bauhaus moved from Weimar to Dessau. Here the school inhabited a building designed by Gropius and Meyer. Now teaching architecture, the aim of the Bauhaus was finally fulfilled, as the visual arts were unified (Weingarden, 1985). Gropius outlines these changes in his 1926 paper, Bauhaus Dessau – Principles of Bauhaus Production. New motivations for the Bauhaus were realised that aimed to “serve in the development of present-day housing, from the simplest household appliances to the finished dwelling.” (Gropius, 1926, pp. 109) Designed to fulfil their function, each machine-made object that served its function can be considered “beautiful” (Gropius, 1926, cited in Wingler, 1969, pp. 109). Gropius goes on, to acknowledge:
The crafts of the past have changed, and the future crafts will be merged into a new productive unity in which they will carry out the experimental work for industrial production. (1926, cited in Wingler, 1969 pp. 110)

These ideas amounted to the functionalist ideology that became essential for the design and subsequent construction of Bauhaus architecture, where each object is brought together as part of the modern building. A design that exemplifies the functionalism is the Bauhaus Dessau building. Enclosing machine-made objects within architecture, the building becomes a complete work of art. Described by some as a factory (Wilhelm, 1998), as the façade and the modes of artistic production within the building relate to the factory. The Bauhaus Dessau building is lined by curtain walls that form the building’s façade. The building is composed of individually designed blocks which express the function of each section; these intersecting geometric forms create an aesthetic unity representative of the machine age (Weingarden, 1984; Baumann, 2007). In light of this functionality, the building has no exterior focal point. With no official entry points, access is determined by the visitor’s needs – the communication of this is reliant on the façade’s expressive qualities (figure 2). Industrial modes of mass production allowed the Bauhaus building to be constructed in just one year (Baumann, 2007). Reinforced concrete formed the structural skeleton, to be largely enveloped in curtain walls (Murray, 2009). Informed by decades of development, from the Crystal Palace to the Fagus Factory, the curtain walls of the Bauhaus building were on a more ambitious scale than buildings before it – it was one of the most modern buildings of this period (Baumann, 2007; Murray, 2009). Consequently, the Bauhaus embodies the aim of this new architecture; it produces a new spatial experience characterised by dematerialised walls produced with modern manufacturing.

![Figure 2: The Fagus Factory (source: Lupfer and Sigel, 2004); The Bauhaus Dessau Building (source: Lewandovski, 2010).](image)

The strides made by this curtain wall, however, were not achieved without some failures. Although failure for Gothic buildings meant collapse, for the Bauhaus Building there were technical difficulties associated with the curtain wall. These issues included condensation and poor acoustic insulation caused by the single-pane glass (Murray, 2009).

5. The Bauhaus’ Legacy

Political tensions in Germany forced Gropius to leave the Bauhaus in 1928. Meyer replaced him as director until 1930, then Ludwig Mies van der Rohe in 1930 until Bauhaus Dessau closed in 1931. As Meyer and Mies were both architects, the Bauhaus became focused more on architecture, and responded to changing times (Wingler, 1969). Mies comments:
Economic, technical and cultural conditions have changed radically... It is very important for our culture and our society, as well as for technology and industry, to find good solutions. (Mies van der Rohe, 1928, cited in Banham, 1960, pp. 321)

Despite the closure of the Bauhaus, its ideology influenced architecture around the world. Prominent figures, including Mies and Gropius, spread Bauhaus design abroad. Their ideas become part of the international style (Banham, 1960), and Mies’ realised glass skyscrapers were a catalyst for this.

Mies designed buildings that utilised standardised and mass-produced components, and he recognised that structure was essential to the basic principles of construction. This thinking can be traced back to Viollet-le-Duc, and his belief that modern architecture was to find expression in structure (Blasser, 1997). Mies believed that skyscrapers with glass skins could raise architecture to the highest level of art (Blasser, 1997). In addition to this, the structural skeletons of buildings designed by Mies accommodated every type of function with flexible floor plans (Blasser, 1997). Furthermore, Mies believed that the assembly of machine-produced parts led to precise and quality construction, although he favoured assembly that allowed customisation – to increase the building’s structural expression. He stated: “The path must lead from quantity towards quality” (Mies van der Rohe, 1928, cited in Banham, 1960, pp. 321). An example of progress was glass production in 1959, which introduced a method for manufacturing high-quality glass with the opportunity for many variations (Herzog et al., 2004). It was during a time of wide dissemination of Miesian architecture that made transparency mainstream (Smith, 2010, pp. 28-29). Therefore, the curtain wall came to dominate architecture – including in New Zealand.

6. The Curtain Wall in New Zealand

After the closure of Bauhaus Dessau, many key figures within Modern architecture left Europe. Some immigrated to New Zealand, where the architectural legacy of Bauhaus resulted in the construction of International Style buildings with curtain walls.

6.1. The Arrival of Modern Architecture

Like other immigrants in New Zealand at this time, the Austrian architect, Ernst Plishke, was an inheritor of the Bauhaus’ ideology (Salinger, 1996). Plishke arrived in Wellington in 1930 as a recognised Modernist. He trained under the German architect, Peter Behrens – as Gropius and Mies van der Rohe had done (Gartman, 2009; Gatley and Walker, 2014).

While in partnership with the New Zealand architect Cedric Firth, one of Wellington’s Modern icons, Massey House, was designed by Plishke (Figure 3). Bauhaus influences are clear in the formal characteristics of Massey House. Notably, the internal plan and walls are free from the structure. Like in Mies’ glass skyscrapers, this allows for an entirely flexible arrangement of the floor plan and, importantly, the façade to be non-structural. A curtain wall lines the street-facing façade, composed of window panes that form repeating horizontal bands (Kernohan, 1989). The result is a clear statement of modernity – a functionalist and international style (Kernohan, 1989).
Arrival and execution of International Modernism in New Zealand led to its adoption by New Zealand architects. An example of this is Shell House, which, like Massey House, was also in Wellington (Figure 3). The partnership, Stephenson and Turner, designed the building with curtain walls that fully enclosed the structure’s interior (Kernohan, 1989). The building directly conforms to the modern architectural aesthetic set by Mies decades before. However, in New Zealand’s cities, “the glass towers envisaged as revolutionary by the European avant-garde around 1920 would become symbols of corporate cool some 30 to 40 years later” (Gatley and Walker, 2014, pp. 5).

The dissemination of the International Style resulted in very similar buildings around the world and it is evident that Modern buildings in New Zealand did not attempt to reinvent Bauhaus aesthetic ideas for this new context. Many contemporary commentators criticised the international style as it did not address the fundamental problems of building technology (Blasser, 1997), as seen in the curtain wall of the Bauhaus Dessau. Finally, a further critique was that mass production created a lot of material waste (Smith, 2010). This wide dissemination and popularisation of the International style led to banal and uniform urban landscapes (Smith, 2010). To resolve these problems, Gropius again refers to the Gothic cathedral:

The constructive achievements of the Gothic period – its vaults, arches [and] buttresses... become a common international experience. Yet, what a great regional variety had resulted from it in the different countries! (Gropius, 1943, cited by Loureiro, 2014, pp. 190)

Thus, the principles of the Gothic remained relevant in the evolution of Modern architecture, which, when compared to the Gothic, failed to successfully disperse around the world. In addition to the banality of Modern architecture, society’s increasing environmental awareness in the second half of the 20th century led to a call to develop modes of production that created less waste.

6.2. Today and the Future

Today, the relationship between architecture and technology has once again been redefined by innovation (Loureiro, 2014). The development of digital technology has resulted in a post-industrial economy (Stearns, 1998). In other words, the production relies on digital, rather than mechanical tools (Smith, 2010). The digital age offers a solution to the uniformity of Modernism and waste produced by mass production – mass customisation (Liker, 2003). Now, a product can be efficiently produced when it is needed, to exact specifications (Piroozfar and Piller, 2013). And, in comparison to standardisation, contemporary modes of production create very little waste.

These new methods of production look towards computer automation and manufacturing (Smith, 2010). Like the Gothic, the façade can be produced with the same elements, but when produced in different ways and for different conditions, resulting in a façade that suits the environment it is intended for. Returning to Ruskin, it is “all or some of these things, and many other things with them” (Ruskin, 1874b, pp. 152), that allowed the Gothic architect to utilise the structural skeleton and its elements, but was still reflective of the craftsmen and architect that worked on it and of course the conditions and requirements of the time.

Consequently, modes of production today still meet the economic motivations of the industrial age, but utilise new technology that reintroduces complexity into modern construction systems (Piroozfar and Piller, 2013). In an
environmentally conscious society mass customisation only produces the required amount of material for a specific project and tailors the curtain wall façade to particular environmental conditions. As the technology of building materials has improved since the Bauhaus Dessau, the façade can be designed to heat, cool and ventilate the building more efficiently (Oesterle et al., 2001). Technology, in its ever-evolving nature, now looks towards sustainability. Responding to the needs of the present, the development of technology today becomes a “matter of survival” (Loureiro, 2014, pp. 191). In that, “we must change the way we produce and consume, or else we might simply disappear” (Loureiro, 2014, pp. 191).

7. Conclusion

Through following this lineage from craft to industrial and then post-industrial production, it is clear how the Gothic initiated a new movement in architecture. In the year of publication, the centennial anniversary of the Bauhaus, this paper brings the legacy of the Bauhaus back into the spotlight to highlight the lineage between the architecture of today and the architecture of the past. Technology has returned architecture to the complexity and the customisation that was present in the Gothic, as it responds to the problems presented by Modernism and the contemporary sociocultural conditions to produce something new. Looking forward, the relationship between architecture and technology must continue to be reconsidered and reflected upon – as architecture responds to new technology, and the context that it exists within also changes – to develop according to the needs of the human race during a particular time.

References