The Origins of the Modern Curtain Wall

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The practical realization of the glass wall depended upon developments in window technology.

If we want to preserve our history, we first have to understand and recognize it. Of course, if we have the history wrong, then we might end up preserving nothing more than a myth. On this basis, I am disinclined to believe the received wisdom on the history of the curtain wall, that is, the normally accepted view that the Crystal Palace led in some way to the development of the glass curtain wall in this century.1 I do not see an obvious trail leading from the one to the other, and this is not just an issue of historical pedantry. As a conservator, to ensure that we are preserving significant buildings, I want to know that we have the history correct. One of the reasons for listing buildings under British legislation is for architectural interest that may include “important examples of particular building types and techniques (e.g. buildings displaying technological interest or virtuosity).” Among such I would include a small department store in Princess Street, Edinburgh built for St. Cuthbert’s Co-operative Association in Edinburgh (1937) (Fig. 1).2 This had a complete glass window-wall, an obvious early example of curtain walling but one that has not been widely recognized. Although this was built nearly twenty years after the Hallidie Building in San Francisco, it perhaps deserves a similar place in the British history of this form of construction — a unique example that was ahead of its time. For that reason it might have been worth listing, but the building no longer exists in this form.

When we look at the early examples of twentieth-century curtain walls, they seem to have little in common with the Crystal Palace. As a large shed clad and roofed in glass, its wall was certainly non-load-bearing; it was the frame that carried the load. Mass-production techniques were also used for its construction, at least the kind of mass production as applied to buildings with standardized workshop-made components assembled on site in an organized way. While I can understand that the Crystal Palace might be a powerful image, influencing architects down the generations, and that modern curtain walls also display a similar degree of organization in their erection, there seems little evidence of the transmission of this idea from the nineteenth-century pioneer to the modern glass-walled buildings of the mid-twentieth century. Neither do I see an obvious trail of influence even of the idea of the glass wall. While there certainly were examples of buildings with non-loadbearing walls during the intervening years, there is no evidence of a developing technology during that time.

What intermediate buildings might suggest such a transmission process? They are mainly a few department stores in Europe and some offices in the United States. By the end of the nineteenth century there was a number of large department stores, such as the Bon Marché in Paris, built with glass walls, although Nikolaus Pevsner chose to illustrate Sehring’s Tietz Department Store, Berlin (1898).3 Of the buildings of this type, the one that survives is the Samaritaine in Paris (Frantz Jourdain, 1905). The reason for adopting this form seems to be that either their architects or their owners saw the buildings as showcases. “En effet la façade devait être un grande vitrine” was the way that one such building was described at the time.4 For department stores, however, this generally was only a passing phase. It certainly did not become the common method of handling such buildings that were eventually to confine display windows to the ground floor and rely on artificial light to illuminate their deep plans. Only on narrow sites was there an advantage in several floors of display.

Fig. 1. Cuthbert’s Co-operative Association in Edinburgh. From Architectural Review 81 (1937): 65.
windows, which accounts for the form of the Edinburgh example.3

I have no functional explanation for the Boley Building in Kansas City, Missouri (Louis Curtis, 1909), an early twentieth-century American example of the use of a glass curtain wall, but the Hallidie Building in San Francisco (Willis Jefferson Polk, 1918) reportedly used the glass wall to maximize light.4 If light was the reason for glass curtain walls, this suggests a more-obvious origin for the modern curtain wall in technical terms, although one rather more prosaic than the Crystal Palace: the modern factory. Perhaps it is because they are so prosaic that we fail to recognize them. Using the Pevsnerian definition of architecture (in which Lincoln Cathedral is a work of architecture, while a bicycle shed is merely a building), factories are perhaps not worthy enough to be considered as the progenitors of an architectural movement even though there are some famous factories that might be so considered.

It is not so much the large shed-like factories to which we should primarily look but to the multistory factories. Of the former type, Behrens's AEG turbine factory in Berlin may well have influenced Walter Gropius (who was working for Behrens at the time of its construction) in his own designs for the Fagus factory of 1911 and his subsequent workshop building for the Bauhaus at Dessau (1925-26). In both Gropius used the idea of carrying the glazing over three floors; in the later building this was uninterrupted by either columns or by opaque spandrel panels. With no backup wall, the edges of the floor slabs and the radiators standing on the floors behind were clearly visible. While this was not a factory, as the workshop block of the school, it had a very similar function.

These buildings were not widely publicized outside Germany at the time (and particularly not in America), but a building that did receive coverage in America was the Van Nelle Factory in Rotterdam (Brinkman and van der Vlug, 1924). It was described in detail by Robert Davison, although a few years after it was built.5 In Britain the outstanding interwar factory design was Owen Williams's pharmaceutical factory for Boots at Beeston near Nottingham (1930-32); this shortly followed his more public collaboration with Ellis and Clarke in the design of the Daily Express building in London (1929-31). Neither had glazed curtain walls set on frames that were carried forward of the structure as in the Bauhaus and Van Nelle buildings, but they were substantial essays in the use of glass walls. The construction of the Boots factory was extensively covered both in British and American journals. It was originally to have glazing that was continuous past the intermediate floor slab, but plans were changed and each floor was glazed separately. The Daily Express building in Fleet Street was followed by other buildings in Manchester and Glasgow, all adopting the same glass-wall treatment that relied on sheets of black Vitrolite fixed against a concrete wall with aluminum strips.

The Daily Express building was later to be illustrated in Talbot Hamlin's Forms and Functions of Twentieth-Century Architecture as an example of a Modern-Movement framed building. The other British building he illustrated was the Peter Jones department store in London (W. Crabtree, 1936).6 With its vertical mullions, this came much closer to achieving the form of the 1950s curtain wall. However, between its continuous mullions it had simple sash windows used both as windows and as a cladding for the painted concrete backup walls.

The purest interwar expression of the idea of the glazed wall can be seen best in the drawings of Mies van der Rohe. These include his Alexanderplatz and department store projects of 1928 in Berlin. The latter could have been derived from the late nineteenth-century department stores of Berlin and Paris, but Mies had already proposed quite different glass-walled buildings in his office building project of 1921 and in his glass skyscraper project the following year. These ideas are closest to the buildings that were eventually built after the war, but at that time they were not

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Fig. 2. Part of an advertisement for Hellwell Patent Glazing, showing different arrangements of bar shapes and sealing methods. From John E. Sears (ed.), The Builder Compendium and Catalogue (London, 1928).
related to any technology that might have facilitated their realization: they were simply ideas. What made such ideas possible were the developments in window technology that were only just about to occur.

**Panel Curtain Walls**

So far, only one kind of curtain wall, the type called the window wall during its early development, has been considered. However, at much the same time as he was describing the Van Nelle factory, Davison was also advocating a quite different form of construction — a thin, insulated metal panel wall. His reasoning was not so much an architectural idea as an economic one. His observation was that a thin, insulated wall panel would take up less floor space than a heavy masonry wall, thus increasing the rental area of a building. In 1930 he reported on what appears to be a practical realization of this idea in Chicago, although, as this article was only illustrated with drawings, it is not clear whether the building described was actually built. The building was an apartment house that purported to achieve even greater usable floor area by having ducted hot air rather than radiators. Its metal-faced panels had 3-inch (75-mm) rockwool insulation with a 0.5-inch (12-mm) plaster backing. The architects of this innovative design were the Bowman brothers, who also produced a project for the Museum of Modern Art's exhibition of modern architecture a couple of years later.

How they developed this idea so far remains a mystery. It is too early to have been influenced by Prouvé's work in France, so we must assume it either to have been their own invention or to have been derived from the idea put forward by Davison in the previous year. But, as there is no evidence for the actual construction of the 1930 apartment block, it is not clear how practical it was at the time.

The metal panel necessary for such a project depended upon the availability of a suitable insulation material and the means for forming a sufficiently stiff panel. It would also have required a means of controlling the passage of water vapor to the cold side of the panels and provision of an adequate weather seal between them. The first of these technical issues was the kind of problem that Davison went on to tackle in experiments with prefabricated housing for the John B. Pierce Foundation, and it was also a technology stimulated by the growing aircraft industry.

Shortly after the war, Davison worked with Lescaze on the development of experimental panels for Republic Steel, by which time the idea of the panel was clearly a practical reality because Republic Steel made some prototypes. Nevertheless, the company had no immediate plans to put these panels into production. The architectural breakthrough came some five years later in both aluminum and steel, with the construction of the Alcoa and Equitable Life buildings in Pittsburgh, both completed in 1952.

Reports suggest that the former had taken some years of development to realize. Less was said of the development process of the latter at the time, although its construction was more complex. Perhaps there was insufficient time to refine it and simplify it. However, the reason for both the choice of construction method and the extensive
An Idea Whose Time Had Come

Both these technologies (i.e. the glass wall and the panel wall) were ideas whose time had come, as suggested in the almost-simultaneous appearance of very similar forms. Simultaneous invention is, after all, a common if not widely recognized phenomenon, one commented on by Gilfillan in his *Sociology of Invention*. One does not suppose, for example, that Newton and Leibnitz both derived their ideas of calculus from some common source. One can find similar examples of simultaneity in technological inventions. My inclination is therefore to look at the immediate conditions and ideas that might have given rise to these ideas and, as important, the state of technology that made the ideas realizable. It is the variety of buildings and projects appearing in the interwar years that are for me the immediate precursors of the curtain wall that became familiar during the 1930s.

It also seems clear that we cannot view the curtain wall as a single technological idea. While Davison was drawing the attention of American architects to an example of the glazed curtain wall, the Van Nelle factory in Rotterdam, he was putting forward his own ideal for the metal-panel curtain wall. There were thus two ideas current at that time, and the effective development of both depended upon technological developments. The historical question is whether these technological developments took place to enable the realization of the architectural ideas or for other reasons, with architects then taking advantage of what these technological developments made possible. The common experience of architectural technology is surely that there have been relatively few cases in which a technology has been developed specifically to meet an architectural requirement. Manufacturers develop and improve products for which there is an established need, and architects may then adapt them to suit their purposes.

Window Technology

A major technology of the Crystal Palace was that of the glazed roof, a technology that was to be developed for railway stations and factory sheds. The glazing of the Crystal Palace relied upon the use of putty, but this was hardly satisfactory for large areas of roof glazing in permanent buildings. Instead, by the interwar period, the widely used technology that had developed was (and still is) referred to in Britain as patent glazing — a term that covered any method of glazing roofs without the use of putty. The basic form was a T-shaped glazing bar of galvanized steel or timber (eventually precast concrete was used), with the glazing both held in place and sealed against the rain by a cap of soft metal (lead or copper), together with a soft bedding of asbestos rope, either above or below the glass. A wide variety of forms was patented with some glazing bars also incorporating channels to carry off condensation (Fig. 2).

However, the curtain wall was an extension of the window rather than of roof glazing, and the earliest buildings with glass curtain walls drew heavily on existing and developing window technology. Window-frame technology from the late 1920s can be seen from contemporary advertisements. In the early 1920s advertisements of the McCoy Bronze Company showed how their bronze casements were built out of many sections (Fig. 3). In 1935 the Bohn Aluminum and Brass Corporation was showing its “integrale extruded hollow shapes” (Fig. 4). The advantage
of these was that it was “no longer necessary to accept the substitutes of lock seams, dovetail pieces or welded seams.” Perhaps so, but cold-formed steel sections welded together were already being marketed by Henry Hope, and this technology was also used in some of the earliest glass curtain walls, as were hollow extrusions.

The Peter Jones store in London simply used Hope’s windows, with their cold-formed steel frames fixed in front of a concrete spandrel wall to provide the glass surface that the architects wanted. Moreover, this was not the continuous plane of glass seen in the postwar examples. Instead it stepped back and forth at the window head and sill with only the nonstructural Mullions as continuous verticals (Fig. 5). The same window technology provided by Henry Hope was used for two postwar university laboratory buildings: by Saarinen, Swanson, and Saarinen for Drake University (1948) and by Anderson and Beckwith for the Dorance Laboratory at Massachusetts Institute of Technology (1950). Here, however the glazing was in a continuous vertical plane, with the Mullions formed of pressed steel. At Drake University the glazing at the intermediate floor was carried on shelf angles, the technology of the brick curtain wall. The visual form may have been a continuous sheet of glass, but the technology was still one of story-height panels.

The early exception to this adoption of existing window technology was Belluschi’s Equitable Savings and Loan Building in Portland, Oregon, conceived at the beginning of the war and eventually built in 1948. Belluschi had foreseen the possibility of supplies of aluminum for building purposes becoming available after the war, and he designed his cladding on this basis. This cladding used T-section Mullions and transoms, angles, and other extruded components to frame both glazing, as well as aluminum spandrels and column covers. It was a system totally designed for this particular building, although it drew on readily available manufacturing technology.

Thus when we examine the technologies used for glazed curtain walls, we see them drawing upon recent technologies, the cold-formed and welded steel or the extruded aluminum Mullions that were a far cry from the patent glazing bars that developed from the technology of the Crystal Palace. What seems curious in retrospect was that it did not seem to occur to the early designers of curtain walls that existing window technology might need to be modified for this new situation; the adoption of existing technology to this new form was not an immediate unqualified success. The United Nations Headquarters Building of 1952 had problems when rain was driven upward over the face of the building, a direction from which windows are not normally expected to be able to exclude water. In 1955 Architectural Forum also reported problems with Lever House because of the drying out of putty: “Glass walled buildings such as Lever House and the UN Secretariat have developed loose, leaking windows within a year of their installation because the putty has dried out, cracked and fallen away.” This is an aspect of existing window technology that was not going to stretch to this new use. The new form called for new methods of sealing that were then developed, although, curiously, new mastics were already in existence and being marketed for roof glazing (Fig. 6).

**Conclusions**

The development of the glass curtain wall (the window wall as it was commonly called at the time) has been described as much in terms of the facilitating technologies as the architectural idea. By considering this window wall as it appeared in the immediate postwar period and asking upon which technological developments it depended, we see that there were a variety of streams coming together that facilitated its eventual large-scale adoption. It is quite clear from the interwar projects and buildings that this was an idea for which architects were striving. That some of these architects had the Crystal Palace in mind may be a tenable hypothesis, but it is one for which we are unlikely to find any clear proof, and there seems to have been no imperative to undertake any positive development work that would have brought the idea into being any earlier.

The development of any innovation requires investment; the difficulty for architects is that clients are unwilling to invest in an idea for their building, and manufacturing businesses are unwilling to put funds into something that may not receive architectural approval. Nevertheless construction is a huge market, so that once an idea has been adopted, companies rush in to try to obtain their share. Seen in this way, the early pioneers of the window wall were obliged to use little more than window technology. One exception is the Miners Hospitals built in West Virginia and designed by Sherlock, Smith and Adams in the early 1950s. Ten hospitals were to be built, and this was sufficient to encourage Truscon to set up a team of designers to collaborate in designing a curtain-wall system for them that eventually became a standard system of the company.

What has not been considered are other factors that were at play, particularly the economic advantages of increased floor space adumbrated by Davison or the straightforward building advantages of the thin glass curtain wall. Its simplicity of construction compared with, for example, the brick curtain wall. The same advantages were also provided by the metal panel wall, but the same level of opportunism (i.e. drawing on existing technologies) cannot be argued. The realization of the metal panel curtain wall required a much more deliberate development of new technology. At least Alcoa was prepared to invest in this way for advertising advantage. Neither have the external pressures upon architecture that encouraged, or perhaps one should say facilitated its adoption, been considered. Which word one chooses to use depends upon whether one regards the curtain wall as an idea waiting in the wings to be called upon the architectural stage or an architectural response to prompting by the circumstances of the time, a “necessity is the mother of invention” argument. My own view of history inclines me toward the view that a full explanation involves both.

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Notes

5. The near-contemporary Simpson’s store in Piccadilly, London, used a similar solution but without a curtain wall.
14. Their simultaneous inventions were to solve quite different kinds of problems. Newton was concerned with describing movement while Leibnitz was looking at areas under curves.
15. Illustrated by Talbot Hamlin, Forms and Functions 1: 280.