The Significance of the Former Bryant & May Match Factory, Garston, Liverpool

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INTRODUCTION

> The war, the enormous manufacturing output which resulted, has brought forth a more comprehensive vision of how a huge factory site should be dealt with. Post-war factory establishments will vary greatly in size and shape; conditions of factory life will be much more complex and the demand for efficiency much greater.
>
> Only the architect can cope successfully with all these problems. He alone can grasp the essentials of the scheme, the handling of bodies of men and women, and the organisation of entrances and exits, so that employees leave their work in a minimum of time and with the maximum of comfort.
>
> (Mewes & Davis architects, quoted in The Builder, 1919, vol 117, p36)

Developments in concrete technology during the first two decades of the twentieth century provided constructional systems capable of dealing with the new functional requirements of the 'production line'. The war economy of 1914-1918 had demanded efficiency, efficiency brought about through new technologies, increases in scale and a new rationality of organisation. This rational planning would become the built realisation of the principles of Taylorisation, (a scientific managerial system proposed by F.W.Taylor, which reduces production to the series of its constituent actions).

A number of these new industrial complexes would go on to become iconic structures within the cannon of modernist architecture, in Europe these would include: the Fiat (Lingotto) factory in Turin, the Boots factory in Nottingham, and the Van Nelle factory in Rotterdam.

The significance of these technological advances and their built manifestations has been one of the central themes in the study of the Modernist tradition, with the European context, (Frampton 1980), being expanded to include parallel developments in the USA, (Banham 1986).

A personal link with this lineage was established when in 1998, whilst working at ShedKM architects, I became project director for the redevelopment of the former Bryant & May match factory at Garston on the outskirts of Liverpool. This building, whilst lacking the striking functionalist imagery of its European counterparts is of considerable significance in terms of its structural/organisational/social originality, and represents one of the first complete adoptions of the principles of the American *daylight factory* within the UK.

The Match Factory, designed and built 1918-21 by Mewes and Davies with Sven Bylander as the structural engineer, was little mentioned in the trade press at the time of its completion, The Builder 1919, vol 117, being the exception, and has subsequently had only limited coverage in publications on industrial architecture, (Brockman 1976) and (Jones 1985). Within the British context, its original structural solution has been overlooked in favour of the similar system at the more overtly *modern* Boots factory at Nottingham by Owen Williams, 1932.

The redevelopment of the Match Factory complex affords an opportunity for the re-examination of the original structure and a re-appraisal of its role within the development of modernism within the UK. This paper will examine: the original 1918 structural system and its precedents, discuss the significance of the import of the American *daylight factory* model, and illustrate the methods used in adaptation of this grade two listed building.

THE EUROPEAN CONTEXT

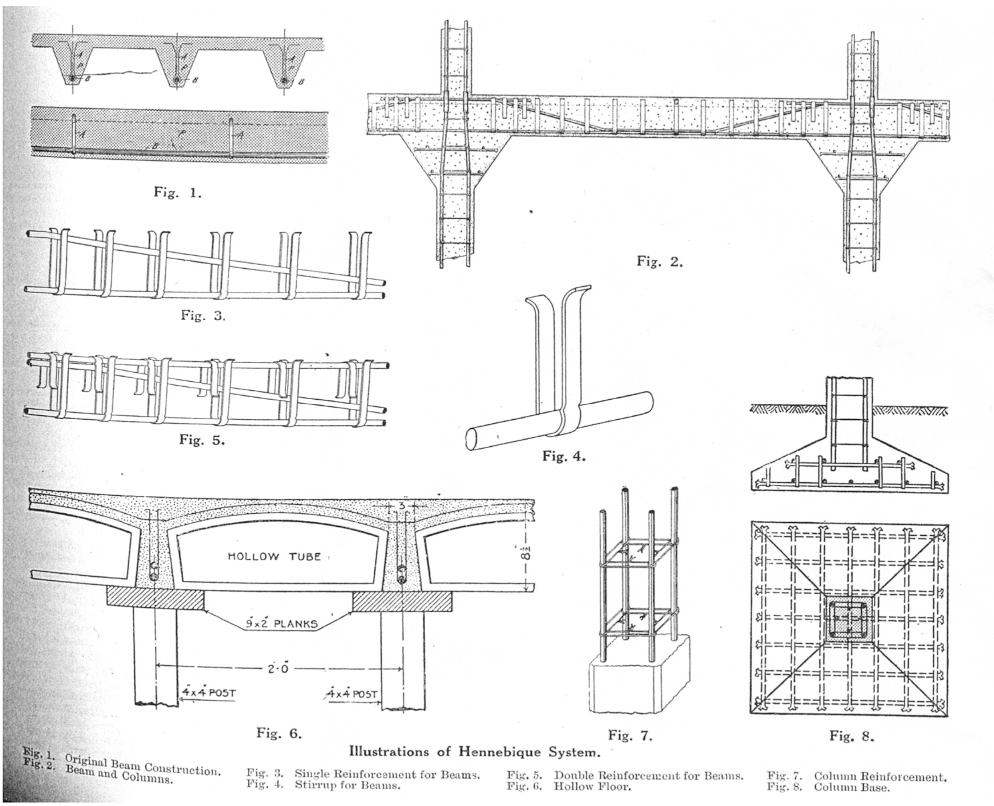

Figure 1. Details of Hennebique system illustrating nature and position of reinforcing (The Builder, 23 February 1912).

The earliest European developments in reinforced concrete construction began in the 1870's, one of the first being by the French contractor Francois Hennebique.

Hennebique first used concrete in construction in 1879, before refing and patenting his new reinforced concrete system in 1892. This comprehensive system of columns, beams, joists and slabs, was derived from steel and timber construction, loads being transferred from slab, to joist to beam to column in sequence, making on each occasion a right angle turn.

The originality in this design, other than the obvious change in material, was in the use of iron or steel reinforcing in conjunction with the concrete to enable the tensile forces, not readily accommodated by concrete, to be transferred with a degree of efficiency. Visually, the result was rather similar to the steel/timber equivalents, with downstand beams and joists sitting on columns, however unlike these predecessors the material was monolithic and formed in-situ.

Hennebique extended his patents as the system was refined, the British patent being lodged in 1892, the principle developments being improvements in the form of the stirrup hoops, which tied the horizontal reinforcing bars together to resist local sheer forces, **(fig 1)**. Britain's first reinforced concrete building was a flour mill in Swansea by Hennebique and Le Brun, 1897, (Jones 1985, p175).

An alternative technique was developed by Hennebique's colleague on the Paris exposition buildings of 1900, Edmond Coignet, who presented papers on his approach to the French Society of Civil Engineers in 1888 and 1894, (The Builder, 1912, p211).

The principal difference from Hennebique's approach being the use of specialised reinforcing steel, designed and fabricated in advance, often utilising helical coils of lightweight steel to act as ties in columns, wire ties were also used in place of the connecting stirrups.

By the 1910's the use of reinforced concrete had become well established in Europe, important buildings such as the apartment complex at 25 bis rue Franklin, Paris, by Auguste Perret, 1904, being commissioned and widely published.

The concrete work of Perret, is considered to have had a significant impact upon the early development of Le Corbusier, on his arrival in Paris in 1908 he sought employment in his office (Britton 2001). Between the Hennebique system as adapted by Perret from 1904 onwards, and the publication of Le Corbusier's Maison Domino in 1915, lay one of the most important developments in the technology and design of reinforced concrete, Maillart's *flat slab*.

Robert Maillart 1872-1940, the Swiss engineer, primarily known for his innovative concrete bridges, was also responsible for one of the first developments which recognised the true potential of reinforced concrete as a plastic material. In 1909, Maillart gave a lecture to the Zurich branch of the Swiss Society for Engineers and Architects on "The Safety of Reinforced Concrete" (Billington 1997, p48), in which he emphasised the nature of reinforced concrete as a new material, synthesized from two established materials, but having its own radically different properties, with its own efficiencies and aesthetic. He had already built a large factory at Wadenswil, near Zurich, 1905, in which he had eliminated the joists of the Hennebique system, and was engaged upon a series of experiments with an entirely revolutionary system which would replace all the downstand beams and joists with an enlarged column head running continuously into a totally flat slab, **(fig 2)**.

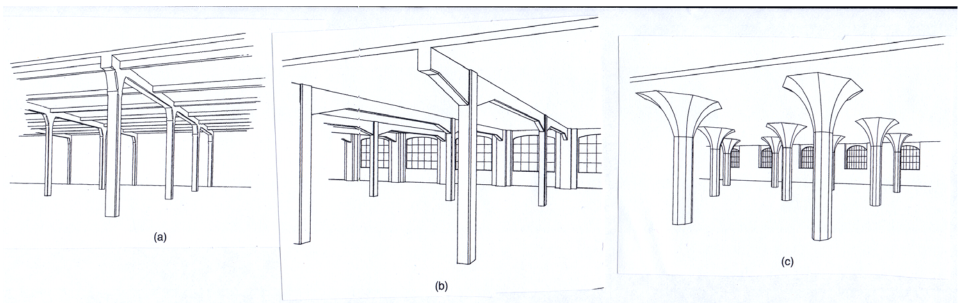

Figure 2. comparison of Hennebique and Maillart systems illustrating the transition from colomn and beam to flat slab (Billington 1997, figure 37).

The patent for this flat slab was taken out in 1909, the first application being a Warehouse in Giesshubel Street, Zurich, 1910. This pioneering building represents an entirely new approach to reinforced concrete construction based upon the properties of the material itself rather than developed from established forms.

Maillart after some success with the flat slab, completing similar structures in Switzerland, the Filter building at Rorschach, 1912, and in Russia, Spain and Italy returned to bridge design. It turned to Le Corbusier and publication of his Maison Domino of 1915 to interpret the architectural potential of this structural system to create an entirely new type of plan form, the *free plan*. These structural innovations in Europe during the first two decades of the twentieth century were being paralleled by advances in reinforced concrete design in America.

THE AMERICAN CONTEXT

> Thus we have the American grain elevators and factories the magnificent first fruits of the new age. the american engineers overwhelm with their calculations our expiring architecture.
>
> (Le Corbusier, 1927: Towards a New Architecture, p33)

The American daylight factory, which made such an impression upon Le Corbusier, had originated, in its concrete frame version, in 1903 (Banham p29), and had by the time the above quote was written in 1927 already become obsolete, replaced by large floor plate single storey steel framed sheds. The impact of this transitory development in industrial architecture, through its adoption by architects of the Modernist avant-garde, has been well documented (Banham), it was also to have a significant effect upon the design of the Liverpool Match Factory.

As in Europe the route to a mature appreciation of the structural potential of concrete involved a series of incremental improvements on traditional systems leading finally to a revolutionary step change. Initial developments in the use of concrete in the USA were lead by Ernest Ransome during the 1880's, although architecturally uninspiring his early work made the significant step of introducing reinforcing steel below the centre line of beams, in the area of maximum tension. Other forces such as twist and sheer were resolved by the mass of the surrounding concrete and the relatively short spans, (Condit, 1961, p154). Unlike Hennebique or Coignet, Ransome's reinforcing was formed from twisted square section bars.

The critical point in Ransome's career came with the construction in 1897 of the first phase of the Pacific Coast Borax company's plant in New Jersey.

> The Pacific Coast Borax Co.s building, at Bayonne, N.J., erected in 1897-1898, in a measure marks the closing of the old-time construction of concrete buildings, constructed more or less in imitation of brick or stone buildings, with comparatively small windows set in walls.
>
> (Ransome and Saurbrey, 1912: Reinforced Concrete Buildings, p12)

The second phase of this plant, completed in 1903 would expand upon these ideas, converting the solid walls of phase one into framed grid of columns and beams with extensive areas of glazing, the daylight factory had been born.

By 1900 this system of reinforced concrete construction was well established across the USA, with its application to the provision of warehouses and factories, being commonplace.

The major limitation of this new system was the cross-sectional size of beam required for large spans or heavy loads. Increases in beam dimension could only be accommodated by either reducing the head height between floors or by increasing the overall height of buildings, both solutions being far from ideal economically or functionally. The answer lay in eliminating the downstand beam, and resolving all forces within the slab itself.

In 1905 a comprehensive application of this flat slab system was put forward by the engineer C.A.P. Turner, patented in 1908 (Condit, p167). Turner's version of the flat slab was very similar to that being developed simultaneously by Maillart, involving flared column heads integrated with a flat slab and heavily reinforced around the junction between the two. There were however a number of apparently minor differences between these two approaches; in reality they represent the difference between purity and pragmatism. Both systems seek to resist the tendency for the column head to try to push through the slab by increasing the area of the junction, in the Turner system radial and concentric annular reinforcing is introduced around the capital, whilst Maillart relies upon a two-way reinforcing system with overlaid rods over the column head **(fig 3).** The first use of Turner's system was in the Johnson-Bovey building, Minneapolis, 1906 (Condit, p168).

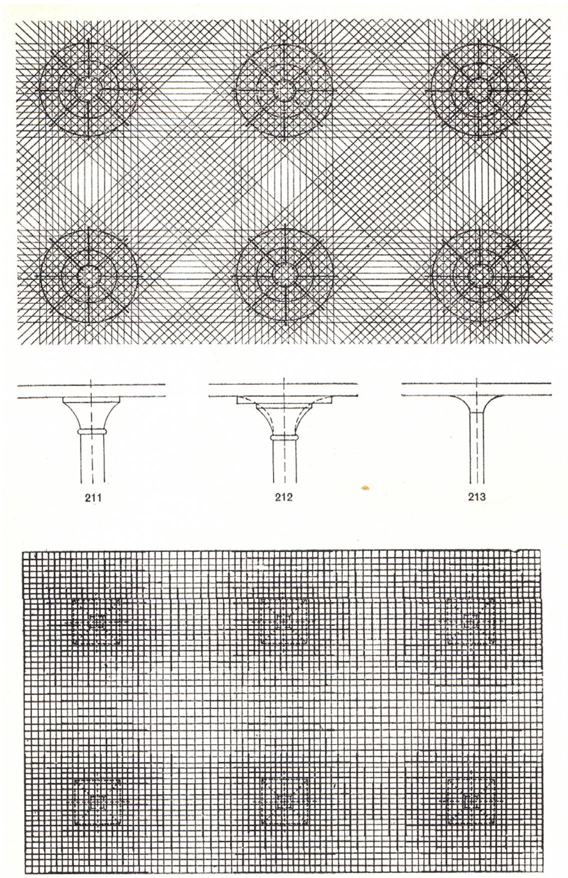

Figure 3. comparative reinforcing layouts of for flat slab systems, Turner (top), and Maillart (bottom), (Schweizerische Bauzeitung 22 May 1926).

Problems of high stress at the slab/column junction in the Turner system necessitated a complex reinforcing pattern, the resulting lack of space forcing some of the lower reinforcing away from the bottom half of the 'beam' reducing its effectiveness at the most critical point. To resolve this situation the Chicago engineers Condron and Sinks developed two modifications which would allow for more room at the mushroom head/slab junction: in 1909, by incorporating a broad shallow beam along the grid lines between the columns, creating what was known as a panelled slab, and in 1911, by introducing a lowered panel between the column head and slab, called a dropped slab.

The latter of these two developments would become the standard solution for American *mushroom slab* buildings, first applied in 1912 for the Sears, Roebuck and Company store in Chicago. In A Concrete Atlantis, Banham (1986, pp. 23-28) describes the impact of Bethune Hall, formerly the offices of the Buffalo Meter Company, 1915-17, by Lockwood Greene and Co., on himself and also upon Le Corbusier, who illustrates it in Vers Une Architecture. This building utilises the mushroom slab system allowing for all the recognisable features of a daylight factory, exposed concrete frame, large areas of glazing, unadorned use of materials, which would be so influential upon European Modernist architects.

At the beginning of the twentieth century advances in the use of reinforced concrete within the USA, echoed those of Europe, in one important respect however, the American's were well in advance; the functional organisation of their new daylight factories. The introduction by Henry Ford of the *production line,* with the Highland Park plant, Detroit, 1908, by Albert Kahn, revolutionised industrial production, and gave American factory design the edge over its competitors.

New organisational structures were now being generated, fuelled by the 1914-1918 war, which could take full advantage of the high loads, and open floor plates permitted by the reinforced concrete frame. By the end of the first world war, plants such as the Ilg Electric Ventilating Co. building in Chicago, 1919, by Alfred Alschuler, **(fig 4)**, were common on the new industrial estates located along the railway lines of the major US metropolitan centres.

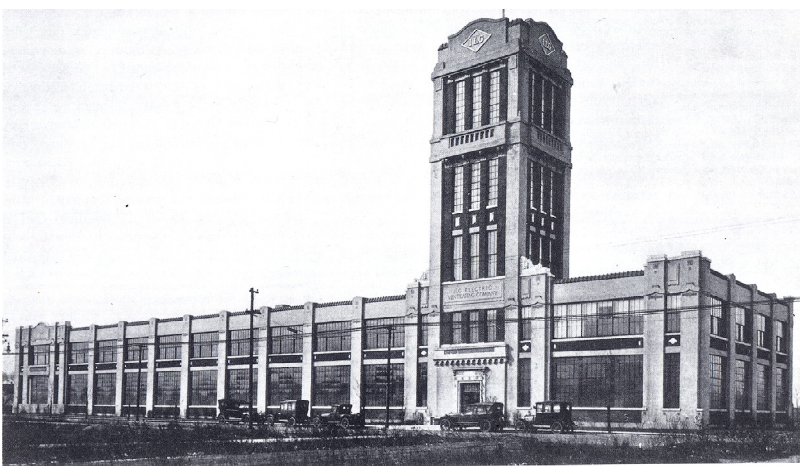

Figure 4. Ilg Electric Ventilating Co. Building, Chicago, 1919, by A. Alschuler (Westfall 1987, fig 13)

THE BRITISH CONTEXT

> Mr. E.P.Wells considered there was no reason why the usual architectural methods should not be adopted for the treatment of concrete. It was artificial stone in the same way that brick was an artificial material, and he could see no reason why it should not be moulded and treated in a proper manner so as to be pleasing to the eye.
>
> (proceedings from meeting of the Concrete Institute, 8 February, 1912)

It is clear from this quote, which reflects the overall tone of the discussion at the Concrete Institute, and from the contents of the architectural press at this time, most notably The Architectural Review, that the climate for innovation in form and structure in the UK at the beginning of the twentieth century was not good. A notable example of the restrictive environment which architects and engineers found themselves under was The Ritz Hotel, London, 1903-06, Mewes and Davis with Sven Bylander as engineer, this was the first major steel framed building in the country but it was required to have superfluous load bearing walls by the London Building Acts.

Early examples of reinforced concrete technology utilised the Hennebique system, with Hennebique's partner Mouchel establishing a practice in London in 1897. In addition to the multi-storey flour mill in Swansea, 1897, by Hennebique and Brun, the only other significant industrial building resorting to concrete in the first decade of the twentieth century, was the B bond tobacco warehouse in Bristol, 1908, by Cowlins, using the Coignet system, (Jones, p.176).

The next decade would see the wider acceptance of reinforced concrete as an architectural as well as engineering material, although still on a limited scale when compared with America.

In 1912, a depository for Harrods, at Barnes, London, by W.G.Hunt, introduced to Britain the mushroom headed column and flat slab, this building also incorporated cantilevered projections to upper floors, (Brockman, p.110). John Burnet and Sons, Wallace Scott Tailoring Institute, Glasgow, 1914, for the first time in the UK, expressed the true nature of the concrete frame, large steel framed windows, above small ceramic clad spandrel panels, were set within a striped giant order. This building adopted the American daylight factory aesthetic, but also included a number of social amenities for the workforce, canteens, recreation grounds, rest rooms etc., a none too common tendency which re-occurs with the Match Factory.

Following the enforced interlude of the first world war, the next major reinforced concrete building was the Maguire, Paterson and Palmer Ltd. (subsequently Bryant and May), match factory at Garston, Liverpool, 1918-21. I will return to this building in detail in the next chapter and so omit a description at this point.

Almost contemporary with the Match Factory, was the Witton Engineering Works, Birmingham, 1920, by Wallis, Gilbert and Partners, which despite its clear visual references to daylight factories and its vast size, 450 feet on the short side, makes no structural advances.

This pattern of a developing architectural style for large industrial complexes represents the only progression in the physical form of reinforced concrete during the remaining years of the 1920's. The tendency to dress up factories with respectable architecture at the front would permeate most of the new trading estates such as Slough and Team Valley and allow little room for innovation in articulation or structural solutions, indeed the structures themselves were often rather prosaic single storey steel framed sheds, as foretolled by post daylight factory developments in the USA.

Then in 1932 the Architects Journal reported:

> Sir Owen Williams has discovered a new species of factory design. More than this, he has produced, with his engineering knowledge and experience, a factory totally new, both in planning and construction….
>
> (The Architects Journal, 3 August 1932)

A dramatic addition to the cannon of modernist architecture, a powerful evocation of the organisational principles of the production line, a clear articulation of efficient structural solutions, this building was clearly important **(fig 5)**. To what extent was this complex any more original or innovative, as claimed in almost messianic tones by the Modernist avant-garde, (The Architects Journal, 1932, vol 76, p673), is open to question?

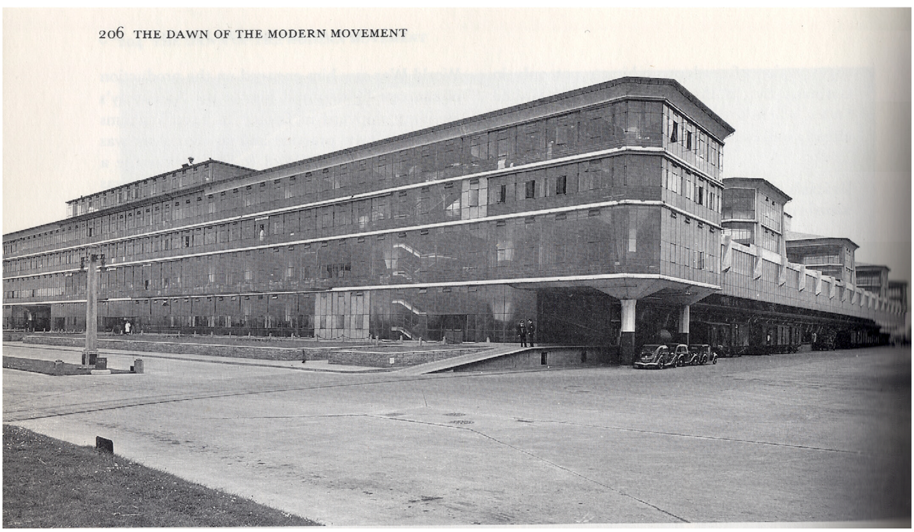

Figure 5. Boots factory, Nottingham, 1932, by Sir Owen Williams, illustrating the flat slab structure, edge cantilever and continuous curtain wall glazing (RIBA Library).

THE MATCH FACTORY, GARSTON, LIVERPOOL

Figure 6. Aerial view of Match Factory complex prior to redevelopment, looking south.

Site context

Located on the eastern edge of Garston, a southern suburb of Liverpool, the site for the Match Factory was carefully chosen. The particular risks inherent in any factory handling explosive substances required a position removed from residential areas, but with access to a large population to provide manpower for the estimated workforce of 2000. It was preferred that the location would offer ready road access, on major public transport routes (at that time primarily trams), and provide for a high profile street frontage onto an arterial road.

Maguire, Paterson and Palmer Ltd were not about to invest large sums of money only to be at the back of an industrial estate, and it was intended from the beginning that this complex be seen as an exemplar for the design of the new post war industrial premises. The delivery of raw materials and despatch of finished goods also needed ready access to the rail network, with space for private sidings.

In 1918, the chosen location was on the eastern edge of the city, adjacent to one of the main railway lines, close to Garston docks, and on the alignment of the proposed upgrade of Speke Road to Speke Boulevard. The City Engineer, J.A. Brodie was responsible for laying out a comprehensive network of tree-lined boulevards around the city from the 1910's onwards, including this south eastern extension of Speke Road. An important subsequent development, although not anticipated at the time of construction would be the location of Liverpool Airport first opened in 1933 with latter terminal and hanger buildings, 1937-39, by Edward Bloomfield (Sharples 2004 p296), immediately to the east on the opposite side of Banks Road, visible top left **(fig 6)**.

Site layout

The major route, Speke Road, on the north of the site provided an obvious principal frontage and public entrance, together with ready access to railway lines in the south west corner, these factors determined the orientation of the industrial buildings. A principal façade parallel with Speke Road could not be provided due to the acute angle of the junction with Banks Road creating a roughly triangular site.

The solution was to maintain the focus to the north, but to align the buildings at right angles to the long straight eastern side, Banks Road, this created an irregular triangle of land in front of the factory complex which would be used to accommodate the numerous ancillary, public and staff facilities. The factory itself could be arranged as a series of parallel halls with rail access at the western end and rear, undeveloped land was used for storage of materials, and future expansion.

The two principle frontages of the site were finished with cast iron railings and planted with a line of Black Poplars, these being the timber used in the manufacture of the match boxes.

Building brief and general arrangement

The main factory buildings had to accommodate: the reduction of timber to match size, the waxing of the matches, the mixing and application of the match heads, the production of match boxes the printing of the covers for the boxes, together with the usual pre and post-manufacture storage of materials. Ancillary activities included: management offices with public reception, staff toilets and lockers, staff canteen, medical rooms, pay office, power house, staff recreation rooms, bowling green, tennis court, and gardens.

The inclusion of such a wide range of recreation and support facilities for staff was similar to that at Burnet and Sons Tailoring Institute in Glasgow from 1914, but was not typical for the time and represents a considerable investment in the social provision of the works. A number of semidetached houses were also built along Speke Road to house the foreman and key staff.

The manufacturing component of the site was arranged to allow for the efficient flow of materials, utilizing American ideas of the production line, with deliveries of raw materials beginning at the log field and working their way clockwise through the buildings before finally being dispatched via direct access to private railway sidings from platforms to the rear **(fig 7)**. It is worth noting that the contemporary Lingotto factory in Turin, whilst exciting great interest amongst the Futurists and

Modernists was by comparison arranged in a rather illogical way, raw materials arriving at the bottom and progressing upwards to completion on the top floor, then having to be moved back down to the bottom for storage and dispatch. This system was at odds with the already established principles of a gravitational flow of materials, from delivery at the top to dispatch at the bottom, familiar from Henry Ford's New Shop at his Highland Park works (Banham, p 237).

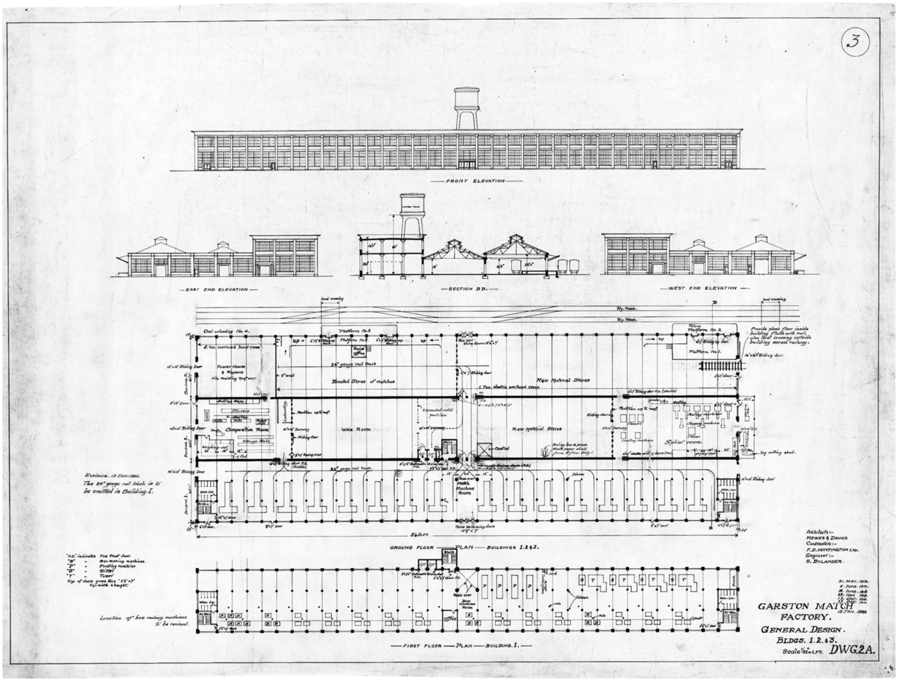

Figure 7. Plans Sections and Elevations of the main production buildings showing the location of heavy machinery, by Sven Bylander, reproduced with the permission of Bylander 2000 engineers

In detail, the first floor of the front building housed the production and printing of the match boxes, as these required lightest machinery, the ground floor saw the manufacture of the matches, preparation of the explosive heads (in a fire segregated section to the east), and final storage. It is not entirely clear why the match box preparation should be moved to the first floor, the site was not short of space, nor why the second and third bays should adopt an entirely different constructional system from the front (first bay) building, clearly visible on the sections **(fig 7).**

It can be seen from the consistent foundation details in **(fig 8),** that there were no ground bearing capacity issues across the site.

A possible reason for the shift from concrete to steel is the differing clear spans required for parts of the process, components in bay one being essentially small compared with those in delivery and dispatch. The arrangement of the process into the neat rectangular box creates a compact and efficient plan, with just enough flexibility to accommodate expansion south. The entire complex was crowned by a cylindrical water tower elevated on four splayed concrete legs over the centre bay of the front building, ensuring adequate water pressure for the sprinkler system and acting as a visual marker for the otherwise low physical composition.

Constructional systems

The separation into three distinct bays of the production facility is clear in **(fig 8)**, this tripartite division is curios for the differing structural solutions adopted between bay one (on the left of figure 8), and the remaining bays two and three (centre and right of figure 8).

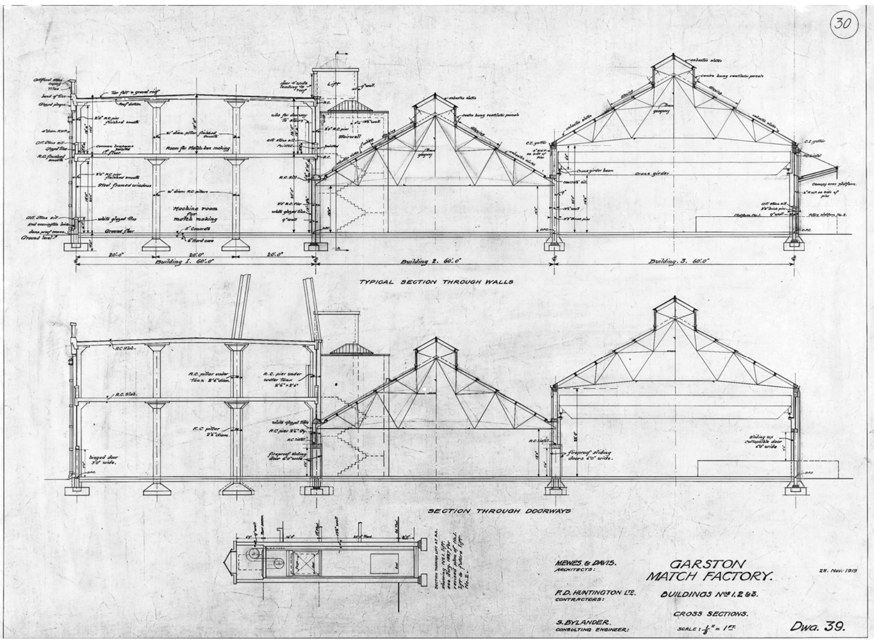

Figure 8. Typical cross-sections through the three production bays of the Match Factory, Sven Bylander, reproduced with the permission of Bylander 2000 engineers

Requirements for non-combustibility and restance to explosion, fire and the build up of explosive dust being a risk throughout the entire complex necessitated a robust structure and a concrete frame was adopted throughout. Bay two and three consisted of concrete columns with brick walls and steel trusses above, both single storey, the height difference being a product of the loading platforms for the trains whilst allowing cross ventilation via clerestory glazing.

The real interest, however, lies in bay one, the front section of the building, this utilises a *dropped slab* system as developed by Condron and Stinks by 1911, from C.A.P. Turners flat slab, and after the Harrods depository building in Barnes, 1912, is only the second example of such a structure in the UK. The characteristic splayed column heads, flat underside to the slab and area of dropped slab between the two clearly marks this out as the Condron and Stinks approach.

The characteristic reinforcing pattern confirms the lineage of this structure **(fig 9),** compare with **(fig 3).** This variant of the flat slab would come to be the most commonly utilised in Europe as well as America, in preference to that developed simultaneously by Maillart, (Banham, 1986).

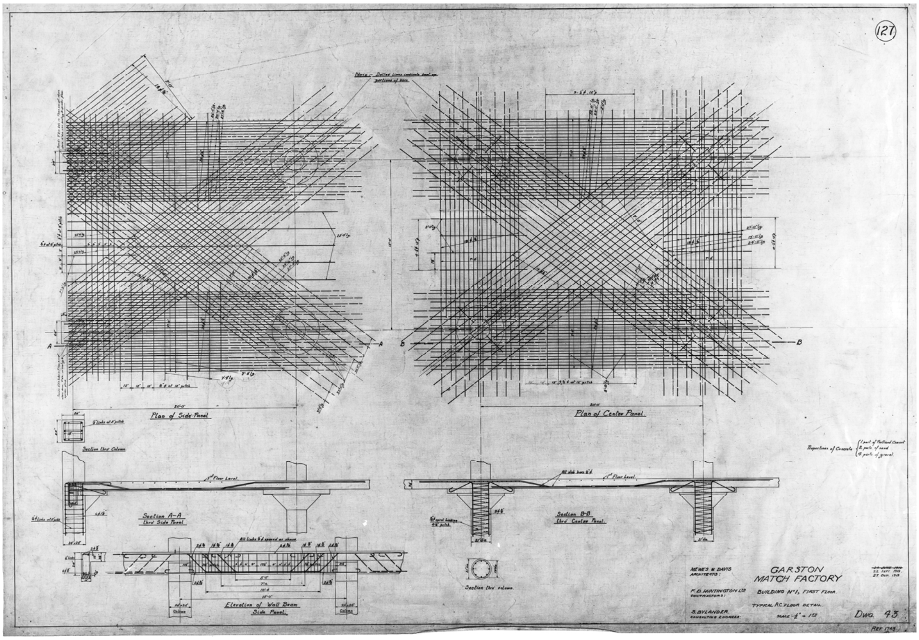

Figure 9. Reinforcing layouts for the Match Factory, front building, Sven Bylander, 1918, showing Condron and Stinks dropped slab system, reproduced with the permission of Bylander 2000 engineers.

The external treatment of the front building was just as revolutionary in the context of the UK, with its adoption of the architectural language of the American daylight factory. The daylight factory aesthetic, as illustrated in the contemporaneous Ilg Building of 1919, by Alschuler, **(fig 4),** allowed the clear articulation of the concrete structural frame in the elevations, maximising daylight by extensive glazed panels in-between, often with a small brick infill section built off the slab edges up to about three feet.

It is this external expression of the *truth* of the structure and materials which so impressed Le Corbusier at Bethune Hall (Banham, 1986). At the Match Factory, the frame and slab edges are exposed, with ceramic tile clad brick infill panels and steel framed windows above. The area of glazing within the wall is proportionally very high, and it would only be with developments in curtain walling, as at the Van Nelle factory, 1927-29, by Brinkman and Van der Vlught, that this would be surpassed.

Despite the overall impression of a rigorous expression of the structural functionality of the building, there is a level of detailing which betrays the inherent conservatism of the British architectural scene, Sven Bylander's powerful structure could not be left unadorned, and the front is made architecturally respectable by Mewes and Davis's application of a number of features. The top of the building has a strong cornice line, although elaborate parapet panels from an earlier version were not built, and the heads of each column incorporate a red rose motif, this is supposed to make the columns resemble the matches made within, but is more likely a reference to the Lancastrian context.

The use of Mewes and Davis is important as they represented an established practice with contemporary, innovative, but essentially establishment credentials. Mewes and Davis had not only been the architects for the Ritz Hotel, but locally, were the retained architects for the Cunard shipping line, and had been consulting architects for their new office building at the Pier Head, Cunard Building, 1914-16, Willink and Thicknesse (Sharples p 30).

The structural solution, the daylight factory articulation, the comprehensive social programme all made the Match Factory a significant development in industrial architecture at the time of its completion, and subject to the usual minor adaptations that are inherent in factories remained largely unaltered until its closure in 1987.

Adaptation and re-use

After closure in the late 1980's the Bryant and May match factory stood derelict for a number of years before being acquired as part of a wider regeneration programme by Speke Garston Development Company, in 1996. This public agency commissioned developers Urban Splash with their architects ShedKM, to undertake the re-development of the Match Factory in 1998.

The development strategy which won the commission involved refurbishment and adaptation of the front bay of the production complex and associated west wing, adaptation of the latter, 1948 building, to the south, and removal of ancillary structures to allow for car parking and associated landscaping **(fig 10)**. The principal functions Urban Splash proposed were small office units; however these should be capable of amalgamation into larger units up to a maximum size of a single tenant for the entire building. The loss of the Welfare building to the Speke road frontage was unfortunate, but unavoidable given the extent of car parking required for such an office development.

Within the front building ShedKM were very anxious not to loose the clear expression of structure and to create a simple plan organisation which would accommodate the inevitable accretions of tenants without compromising the integrity of the original building. The main block was divided into a series of pavilions, by means of block work crosswalls, which run on the original column grid but stop short of abutting the columns **(fig 11).** Toilets, stairs, kitchens, meter cupboards, and new incoming services would be housed in a series of new steel drums, to the rear, removing potential clutter from the original building whilst visually echoing the form of the retained water tower.

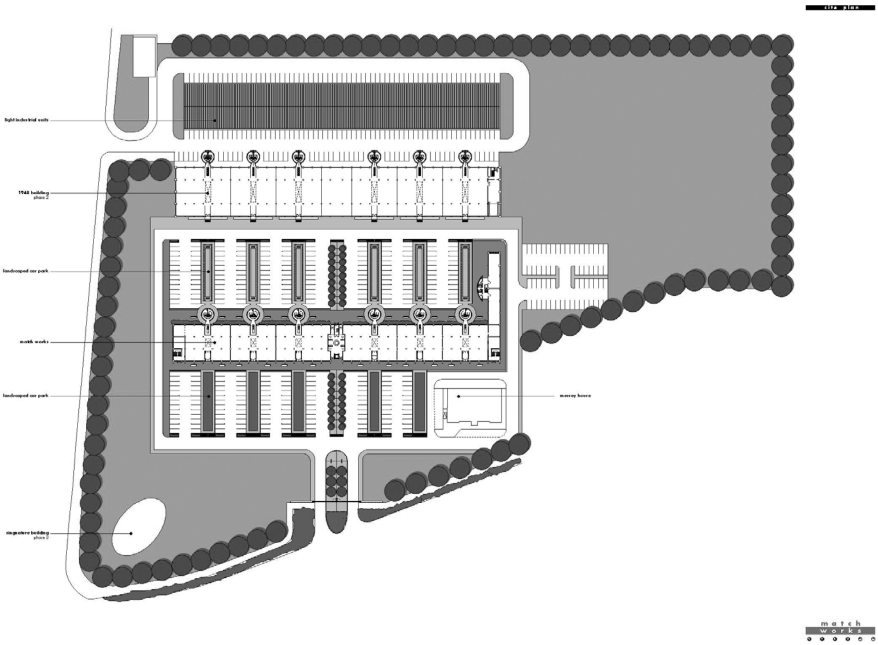

Figure 10. Match Factory site plan as re-developed, ShedKM architects, 1998-2006.
North is at the bottom of the plan.

In order to increase the lettable floor area in the pavilions the client required the insertion of a new mezzanine floor in the double height volume of the ground floor production space. ShedKM were concerned that any new insertion be clearly differentiated from the original, and that the visual strength of the columns and their splayed capitols be retained. After considerable examination of potential structural solutions for supporting a new mezzanine, including; an entirely separate grid of steel columns, or a steel suspension structure from the first floor soffit, the decision was taken to use the original structure.

A core was drilled through the concrete columns at the proposed mezzanine height and a solid steel rod inserted through them, onto the ends of this rod were placed a pair of flat steel plates (a gap being maintained between the steel and the concrete column), which acted as the new beams and carried the mezzanine floor **(fig 11)**. In order to maintain a visual connection between the ground level and the splayed column heads a void was cut through the new floor centred on a structural bay within each pavilion.

Figure 11. Ground floor office space during redevelopment, showing new block crosswalls, mezzanines and holes drilled to take steel supporting pins, 1999

Externally the main alterations to the front elevation were the insertion of six new front doors, and adaptation of the steel framed windows. The original windows were pre W20 section highly corroded and could not accommodate double glazed units. To replace the windows to the same pattern but with modern sections capable of taking double glazed units would significantly increase the sight lines of the glazing bars, and given the large number of small panes involved resulting in a change to the proportion of bar to glass.

In order to preserve the proportion of bar to glass, the decision was taken to reduce the number of panes by one vertically and two horizontally in each window, this maintained not only the bar/glass relationship but also the dimensional proportions of each pane.

A greater degree of alteration was required to the rear, due to the removal of the pitched roof sheds. Entirely new windows were inserted into the ground floor apertures between the columns, these had previously been filled with brick walls, the afore mentioned six service drums were also added **(fig 13)**. The area created by the clearance of the sheds was laid out as car parking in the same format as the front.

The inclusion of large areas of car parking was subject to a degree of detailed design as ShedKM wished to avoid the typical business park appearance, the built scheme being a regular orthogonal arrangement derived from the column spacing of the elevations, with raised boardwalks between bays centred upon the front doors.

Figure 12. Front view of completed refurbishment showing new car parking and landscape, 2002.

Figure 13. Rear view of completed redevelopment showing new service drums, link corridors and glazing, 2002.

Redevelopment entailed demolition of a number of the original surviving structures, but in doing so ensured the long term protection of the most significant, both structurally and aesthetically, section of the complex.

CONCLUSION

Technological advances in the use of reinforced concrete, begun by Hennebique and Ransome would fundamentally change the nature of architectural form, not just through their material innovations, but ultimately and more effectively through the adoption of an architectural language based upon industrial engineering by a new generation of the Avant-garde. Study of this process of appropriation of ideas and imagery from American daylight factories has been comprehensively covered by Banham in A Concrete Atlantis.

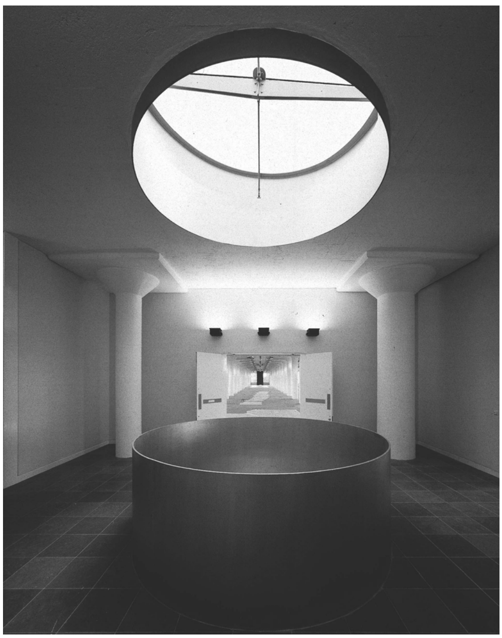

Figure 14. First floor interior after refurbishment, illustrating the characteristic splayed column heads, 2000.

That the process of recognition of architectural advances involves more than just innovation in form, technology, and programme is evidenced, in the British context, by the relative coverage afforded the Boots, Van Nelle, and Lingotto factories relative to the Garston Match Factory.

Here is a building complex which was in terms of its structure was ten years ahead of the Boots factory, and more advanced than the contemporary Lingotto works, but which hardly any architects outside Liverpool were aware of. In terms of the efficiency of its plan organisation it was comparable although more rational than Lingotto. As a comprehensive work environment it exhibited a level of concern for its workforce, which with the exception of the Tailoring Institute in Glasgow, was considerably in advance of either Boots factory or the post 1945 Brynmawr Rubber factory (Perry 1994). Visually, however, it is rather respectable, although much clearer in its articulation of structure than the Art Deco edifices of West London, such as the Hoover factory, 1931, Wallis Gilbert and Partners, it lacks the dramatic glazed facades of the Van Nelle or Boots factories.

It is perhaps for this final reason and because Mewes and Davis were not considered to be anything but establishment architects that the principle authors of the emerging Modern Movement, Pevsner, Giedion, Richards, missed its importance.

That the rather reactionary mainstream British architectural press ignored it at the time of its construction is not surprising, but that such an important and early use of flat slab technology, did not come to the attention of subsequent authors is perhaps due to the "Metropolitan Viewpoint" (Banham, 1986, p106), of the academic protagonists of the Modern Movement.

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