Greeks, Romans & Goths in an Age of Iron

Hentie Louw

It is customary for architectural historians to regard the so-called "iron problem" in British architectural history as belonging to the mid-19P^{thP} century, focused on the building of the Crystal Palace. At most its duration is extended up to the 1870s. (Muthesius 1970) This paper argues that this was a much deeper cultural phenomenon that conditioned architectural thinking throughout the Victorian period and beyond.

CULTURAL CONTEXT

So when exactly did iron become a "problem" for the British architect and, why? The answer to these questions has two sides to it depending on the different application of the material in building: whether it was used for decorative and/or structural purposes. In both cases the reaction was precipitated by the abundant availability of iron at low cost due to industrialized mass production, which made it competitive with traditional building materials like wood and stone. It is the structural aspects that will be the main focus of the essay but - and therein lies the rub - for the architect these two entities can never be entirely separated out. Another difficulty with the so-called, "iron problem", is that it was actually several problems rolled into one, cultural as well as technical. This complexity added potency to the "presence of iron" as a catalyst on several levels regarding architectural development. The reason why iron assumed such an important dimension is its singular identification with the Industrial Revolution. (Thorne 1990) More so than any other material iron became associated with the dramatic socio-economic-technological changes that transformed the face of Britain during the 18P^{thP} and 19P^{thP} centuries. (For the purposes of this study the cast iron/ wrought iron/ steel axis is treated as a continuum – overlapping phases of the same base metal becoming increasingly more sophisticated through the application of industrial processes.) The tempo at which this talismanic substance developed and found application in practice was therefore seen as a general standard for progress and achievement; iron became a metaphor for an age, but it was a divisive one. To Ruskin, in 1880, it was the agent that "changed our merry England into the Man in the Iron mask". (Ruskin 1880, p.39).

A counter-revolutionary cultural movement had emerged in the course of the 19P^{thP} century which drew inspiration from an idealized medieval world: aesthetic medievalism was established as an alternative value system to the dominant industrial capitalism that was driving the productive economy of Victorian Britain (Wiener 1981) and, because of its absolute dependence on science and industrial production, iron was located firmly in the latter camp. For those who adopted medievalism as a creed the use of the material was no longer simply a matter of taste or practicality, it had political connotations. Under these conditions the Gothic revival assumed a new importance – a new urgency and rigour that would require facing the question of iron, and its role in architecture, front-on. It had to be, because Gothicists claimed to be *the* "progressive" party. (Hope 1863) This cultural movement also hastened the separation of the architecture and engineering professions that had originated in the need for specialization in a rapidly expanding and diversifying market for construction. Architects and engineers identified with different socio-cultural groupings and these leanings would determine their allegiance in the ensuing cultural debates. But it needed something specific to bring the difference in outlook of the two divergent professions into sharp relief, and that was provided by the use of iron in construction.

THE ENGINEER AND IRON

To the British engineer the new material offered new horizons, new challenges and new powers - their ambition, as defined by Thomas Telford (1757-1834) in his address to the Institution of Civil Engineers in1828, was to direct "the great sources of power in Nature for the use and convenience of man." (Sutherland 1997a, p. xiii) Iron made it possible for them to address the novel structural problems posed by the building of large-scale engineering projects in a rational and progressive manner. Unconstrained by any need for reference to stylistic precedent - as the architects of the day were - and stimulated by improvements in the production of iron products and the entrepreneurial spirit that prevailed in the industry during its early heroic phase, c.1820 – c.1860, men like Telford, Robert Stephenson (1803-1859) and Isambard Kingdom Brunel (1806-1859) revolutionized the field of long-span construction and placed Britain at the forefront of engineering design. People were amazed by the audacity of the engineering feats and the great elegance and simplicity of these novel iron roofs and bridges set standards of formal beauty that challenged traditional conceptions of architectural aesthetics.

There is, however, little evidence that the engineering profession placed emphasis on such matters, neither did ordinary architectural practice challenge them in this respect. In striving towards predominantly structural and practical goals in their use of iron the British engineers were breaking new ground and confirming public belief in an industrialized future for the country. They seldom participated in aesthetic debates on what an appropriate formal language for such a situation might be, and seemed content to follow, pragmatically, either their client's wishes and/or the architectural fashion of the day. It seems plausible to attribute this reticence on the part of one of the leading design professions to the cultural breach that, as was mentioned above, was beginning to open up in British society, and which caused clear distinctions to be drawn between the respective domains of architecture (art) and engineering (science). An interesting insight into the kind of issue that might have figured prominently in such a debate between architects and engineers (had the civil engineers been more proactive in arguing a case for a new industrial aesthetic in construction) comes from the field of machine design.

In 1842 a civil engineer, Samuel Clegg Jnr., published an essay entitled, *Architecture of Machinery; an Essay on propriety of form and proportion, with a view to assist and improve Design.* In this

Clegg attacked the custom of decorating steam engines with architectural orders, arguing that these were not appropriate for, nor proportionally suited to machines; that, if the various machine parts are scientifically designed to fit their purpose exactly, they would require no external ornament at all, but would be beautiful in their own right. His views received a rather hostile reception from the editor of *The Civil Engineer and Architect's Journal,* who, while agreeing that some of the machines illustrated were indeed "architectural monstrosities", disliked the "vapid and quakerlike arrangements" of Clegg's own proposals even less, claiming that "two-third of our engineers will be found to be of our way of thinking." Instead the editor argued that, "cast iron has its appropriate architecture as well as stone, engines as well as cathedrals, differing as much, too, from mere unembellished construction as a barn differs from an abbey." (*Civil Engineer* 1842, pp.235-6, 252-3) As it turned out, within a generation British machine manufacturers were producing entirely unornamented designs following Clegg's precepts – a transition from a traditional to a modern utilitarian conception of design that seems to have occurred without any fuss.

Civil engineering design was moving in the same direction, but more slowly as the large-scale introduction of improved iron products, wrought iron and steel, during the latter half of the 19P^{thP} century began to expose strategic weaknesses in the British industrial set-up, especially in so far as buildings were concerned. Restrictive and uncoordinated building legislation with regard to frame construction, the lack of coordination between the building professionals, the lack of standardisation and poor on-site quality control, insufficient economic incentives – all these were factors retarding development in the field. (Scott 1928; Bowley 1966, Chapters I, VI, XIII) An inadequate technical educational base, with poor scientific instruction, caused standard engineering practice to remain as wedded to traditional artisanal technology as the architects were, only, in their case it was constructional precedent, not stylistic precedent that prevailed and slowed down progress towards the "scientific engineering" approach required by the new materials. (Smith 1999) Their reliance on basic rules of thumb rather than structural design theory, the Continental practice, contributed towards British engineers losing their creative edge – triumphs like the Forth Bridge notwithstanding. Despite William Fairbairn's innovative work, structural design, the branch of engineering specifically concentrating on structure for buildings, remained a relatively neglected field that did not attract the best-qualified people. A backward looking engineering profession, resistant to new ideas and lacking ambition at this critical point in time regarding the application of iron and steel construction in architecture meant that there was no sense of urgency, no external pressure on the architects to take the new structural developments seriously. No wonder that the Victorian architects could be so complacent about the 'iron problem'! But, the architects had their own record to account for.

THE ARCHITECT AND IRON

Architectural interest in cast iron as a utility building material began as soon as industrial processes made sufficient quantities of the material available on the market during the latter half of the 18P^{thP} century. By the early 19P^{thP} century its decorative potential for architecture was fully appreciated as well. The versatility of the material: its great structural strength, its malleability, its resistance to fire, combined with its facility for mass-production made it a natural choice for application to the many novel design problems emerging from a rapidly expanding industrial economy. From the pool of architectural talent of the period (loosely defined to comprise all those with a technical background, design ability, entrepreneurial skills and an interest in technology) came the pioneers who first explored the various uses of iron in architecture and related fields.

The hidden figure behind all these early ventures, and the one whose understanding of the properties of the material was crucial to the success of the various pioneering projects, was the iron master. Usually iron masters operated in a supporting role, but in some instances they became the leading partner. A notable early instance of such a partnership came in 1813-1816 when the Liverpool iron master, John Gragg, collaborated with the architect, Thomas Rickman (1776-1841) to produce three fine Gothic churches made mostly of iron. Sir Robert Smirke worked with the London firm, Foster Rastrick and Co. on the King's Library at the British Museum, 1824-5, where a clear span of 12,5 metres was achieved by the floor structure designed by Rastrick. (Sutherland 1997b, p.67) The most celebrated example of an architect working closely with an iron master to produce a masterpiece came later, with the building of Palm House at Kew Gardens (1846-1847) where the designs of the innovative wrought iron structural system were provided by the Irish ironmaster, Richard Turner (c.1798-1881), and the architect, Decimus Burton (1800-1881), was responsible for the overall architectural form. (Diestelkamp 1997) During this pioneering phase those architects with a special interest in the use of iron, Nash, Smirke and Fowler, probably had as good a technical command of the material as any of the other parties involved in the design process and we have no reason to doubt Nash's claim in 1831 that, "No founder ever furnished me with a design for any casting I ever used." (Sutherland 1997b, p.72) They were, though, the exception amongst the ranks of those who styled themselves, "architect", in the new professional era and increasingly, as the use of iron in structure and decoration gained in popularity during following decades, the design initiative passed to the engineers and iron masters. As a consequence the architectural profession had no claim on the two really significant architectural statements in the use of iron, J.B. Bunning's, Coal Exchange, London, (1846-1849), and Joseph Paxton's, Crystal Palace of 1851.

With the use of iron becoming ubiquitous in building during the 1830s, touching every aspect of the architectural scene and not always with positive results, it began to attract the attention of architectural writers. Not surprising it is J. C. Loudon, the pioneer of iron greenhouses and enthusiastic advocate of the material's general use for decorative purposes who, in 1837, opened the debate in his journal, *The Architectural Magazine*. (Loudon 1837) Loudon's aim was to formulate a theoretical justification for iron in architectural design, so that the material would "receive a welcome at the hands of taste, corresponding with that which it has received at the hands of science." Since it was possible to conceive of a building as being constructed entirely of iron, he argued that the "nature" of the material had to be "consulted" in order to achieve the appropriate formal language: "[…] it is more desirable that architects should qualify themselves, not less to adapt their designs to the new material, than the new material to their designs", in which case, "all habituated notions of those proportions which appertain to masonry must, of course, be discarded." The guiding principle was, a "correct translation of the philosophy, not the poetry, of ancient architecture into the iron tongue"; by which he meant that the style followed the material as the material followed social purpose. He reassured his reader that the general introduction of iron into the construction of buildings should only affect design in those particular cases where it conspicuously entered into the ornamental parts of the composition. But, "in such cases it should become authoritative, and not subject […]." Finally, in order to illustrate his theory on the selective application of iron, on the basis of it being the most appropriate for the job at hand, Loudon gave worked examples of different types of building and their component parts. (**Figures 1 and 2)** As J. M. Crook has shown, with this essay and his subsequent publications Loudon provided a bridgehead with earlier picturesque theories, where proportion was regarded as a variable and not a constant, and which held that, "social and functional propriety finds its expression in a hierarchy of style." (Crook 1987, pp.28-30, 105)

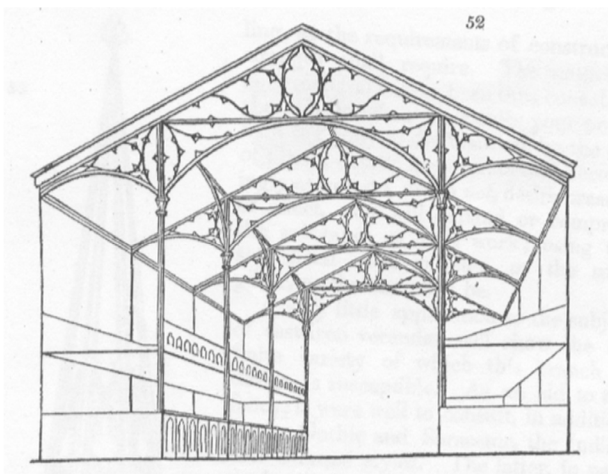


Figure 1. Interior of an iron church (Loudon 1837, fig.52)

Another notable attempt at finding an architectural language suited to iron came as a result of the Institute of British Architects setting this as a question for its annual essay competition to students in 1842. In the winning essay, which was subsequently published (*Civil Engineer* 1843), the author [Ambrose Poynter] took his cue from two ancient examples that demonstrated how the Romans and Greeks adapted their proportional systems according to the medium employed, in order to argue for a new iron style. In the first instance he suggested that the Romans themselves might have been adventurous in their use of iron, as was demonstrated by the imaginary architectural schemes in murals at Herculaneum and Pompeii. Second, he showed how the Greeks managed to maintain stylistic consistency between pieces of furniture fulfilling the same function, but executed in different materials, marble and bronze. **(Figure 3)** The ancients, he noted, were not so obsessed by reducing material to the absolute minimum, but sought proportional beauty as an objective in its own right according to the properties of the material. Taking the analogy further to the Gothic period he suggested that the medieval builders, judging by how they strived for slenderness and verticality in intractable materials, would have enjoyed exploiting the superior potential of iron construction in this respect much more effectively than his contemporaries, who were satisfied merely to copy slavishly authentic Greek, Roman and Gothic architectural details in iron, pretending that these were stone or marble. Again he demonstrated this point by comparing similar ornamental features from the period executed, respectively, in brass and stone. **(Figure 4)**

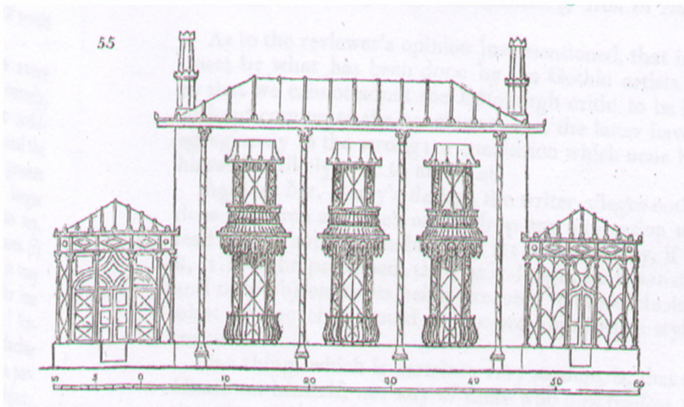


Figure 2. Exterior of a house with maximum use of iron (Loudon 1837, fig.55)

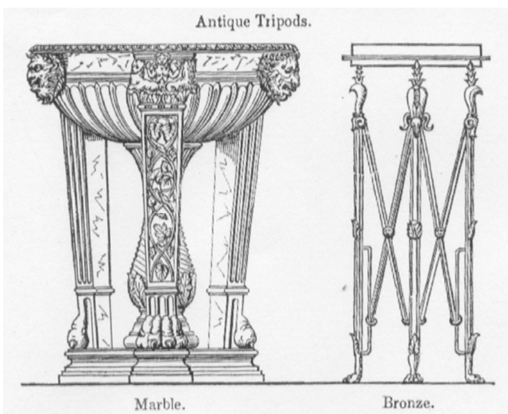


Figure 3. Comparing marble and bronze furniture from antiquity

(*The Civil Engineer and Architects Journal* 1843, p.293)

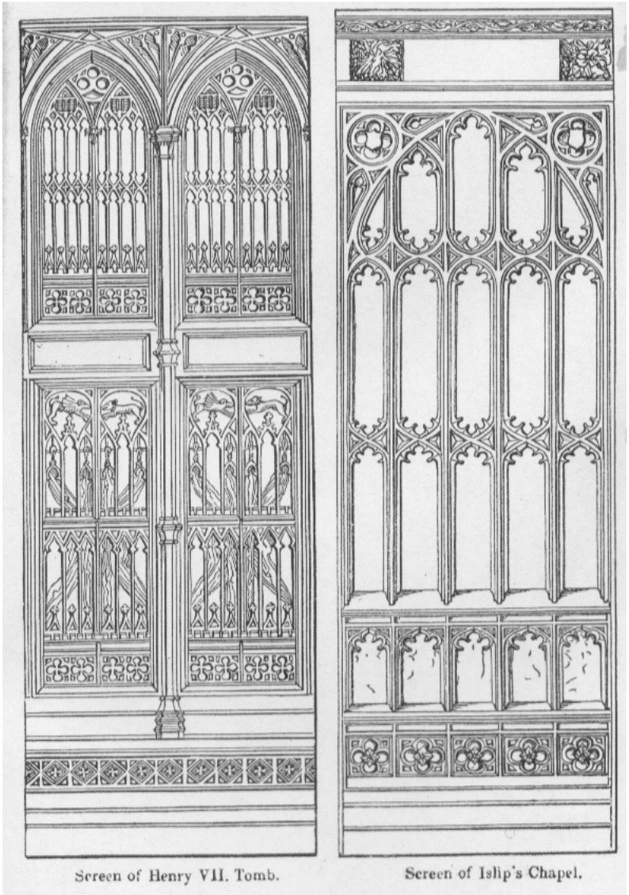


Figure 4. Comparing medieval church screens in brass and stone
(*The Civil Engineer and Architect's Journal* 1843, p. 295)

This progressive, albeit optimistic, attitude to the potential benefits of iron for architectural configuration found its most systematic exposition in the comprehensive "New System of ['metallurgic'] Architecture" invented and promoted by William Vose Pickett between 1844 and 1849. (*Westminster Review* 1849) Pickett approached this problem from an entirely different perspective. Stylistic issues did not concern him; he regarded reference to antique precedent as a cul-de-sac. After an analysis of the problems encountered with the use of iron in contemporary practice, technical as well as aesthetic, he concluded that the only route forward was to start afresh, to produce an architecture of invention, from first principles arising from the close study of the natural properties of the material. His sources of inspiration were Jeremy Bentham's utilitarian philosophy, natural form, as found in animal bone structure, and long-span engineering structures. The latter to him was evidence of the capacity of "the industry and energy of modern mechanical science" to deliver a new architecture that combined the "advantages of utility, cheapness and beauty." Pickett succeeded in developing a coherent and original set of principles for this new metallurgic architecture consisting of a metal skeleton with hollow non-load bearing walling containing all the utility services, in-built furniture etc, "interstitial ornamental form" [perforated and open cast grilled screening devices], low-relief decoration, suspended canopies and long-span roofs, curvilinear, 'anti-angular' forms with painted surfaces. But his ideas - which foreshadowed, as Peter Collins pointed out, later developments such as the Art Nouveau (Collins 1961) - was too far ahead of his time, and not supported by convincing worked examples. Consequently, Pickett was dismissed as eccentric and his proposals stone-walled by the Institute of British Architects. (Crook 1987, p.114)

The debate took a negative turn when two of the leading theorists of the day: A.W.N. Pugin (1812-1852) and John Ruskin (1819-1900) came out in opposition. Pugin acknowledged that "mechanical improvements" were useful, admired the way in which medieval architects had "made their mechanism a vehicle for their art", but warned about the danger of "mere mechanism" usurping the "place of art" in contemporary architecture. He could not be persuaded that engineering was of equal importance to architecture, and saw no benefits from their integration for developing the new Gothic future that he propagated. In his influential treatise, *The True Principles of Pointed or Christian Architecture* (1841) Pugin laid much of the blame for the denigration of architecture at the door of "modern metal-workers", who proceeded from the "false notion of disguising instead of beautifying articles of utility". Cast-iron, although in itself a useful utility material due to its superior strength, was in no way fit for replacing stone work, because, if worked true to its properties, as Pugin's doctrine demanded, it produced unsatisfactory proportions and inferior detailing. **(Figure 5)** An even more dangerous aspect of cast-iron according to Pugin was its manufacturing process which, for economic reasons depended on mass-production and was therefore, by definition, "subversive of the variety and imagination exhibited in pointed [Gothic] design", as well as leading to inappropriate application. (Pugin 1841)

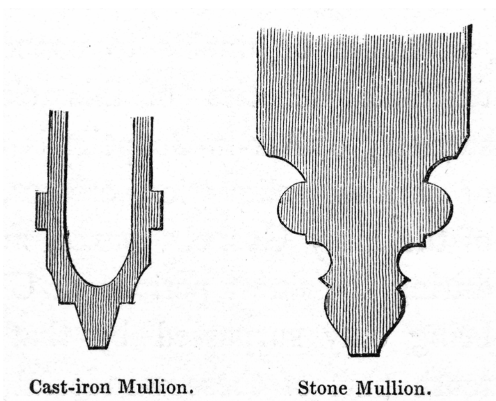


Figure 5. Comparing Gothic detailing in iron and stone (Pugin 1841, p.29)

Ruskin was as moralistic as Pugin and much of the same mind regarding the abuses in the general use of iron in contemporary architecture, but his earliest writings on the subject in *The Seven Lamps of Architecture* (1849) were not outright antagonistic. Since, in his view, structure was of historical rather than intrinsic importance to the concept of architecture, he could allow the material an equal place as timber; even admit that there was a real prospect of it becoming dominant, if a "new system of laws […] adapted entirely to metallic construction", was developed. However, because one of the "chief dignities of architecture is its historical use", and this being "dependent on consistency of style", he felt compelled to conclude that "true architecture does not admit iron as a constructive material". To his reasoning – which drew a clear distinction between architecture and mere building - this meant that even "periods of more advanced science" should restrict themselves voluntary to "the materials and principles of earlier ages", that is, in buildings of any public consequence. On this premiss he proposed a general rule: "that metals may be used as a cement [i.e. binding element], but not as a support." More objections to the use of iron emerged elsewhere in the work. He valued "the appearance of labour upon architecture", venerated "those grey heaps of deep-wrought stone". Cast-iron components, being mechanically produced in multiples could never have this human touch. Moreover, as the glory of a building lies in its age, iron being prone to rapid deterioration in the atmosphere rendered it intrinsically inferior to stone as a building material. Ruskin was clearly not persuaded that iron had much of a future in architecture. (Ruskin 1880)

A year after Ruskin's *Seven Lamps* an architect by the name of Edward Lucy Garbett published *Rudimentary Treatise on the Principles of Design in Architecture,* aimed at students of architecture. Garbett took issue with the Ruskinian notion that there was a clear distinction between "architecture" and "building", and concluded that architecture was, above all tectonically determined, that it was a structural art in which style is closely associated with the method of construction, its aim: "constructive unity". History, according to him, has produced two distinct methods of responding to "pressure": "depressile", which is based on the principle of the beam, which was perfected by the Greeks; "compressile", which is based on the arch and perfected in the Gothic period. The third principle, the "tensile", as represented by the "truss", was still in the process of being created. It was the way for the future:

> To this third system of constructive unity, there is no old style adapted. None was invented for it. It is a new thing and its treatment must be NEW – new, because subject to old principles; and to be effected only by a patient search into those old principles. Let us not mistake what we have to do. It is that which has been done only twice before; in the time of Dorus, and in the thirteenth century. […] a style never grew of itself; it never will. It must be sought and sought in the right way. […] A new style requires the generalised imitation of nature and of *many* previous styles; and a new system requires, in addition to this […] the binding of all together by a new *principle of unity*, clearly understood, agreed upon, and kept constantly in view.
>
> (Garbett 1891, pp.239-41)

Here, finally, the British architects had a rational aesthetic objective to aim for, and one that called for a progressive approach to metal structures. The profession's hand was forced more publicly the very next year by Paxton's novel solution for a building to hold the international trade fair in Hyde Park. The glazed, framed structure, which was conceived and erected in about four months, was 564 metres long and covered nearly 18 acres of ground. **(Figure 6)** The general public was astounded and enchanted and dubbed it the "Crystal Palace". The architectural establishment was perplexed, dismissing it as an overgrown greenhouse of no consequence to serious architecture; the engineers admired it more as a logistical feat than a structural one, and (quite correctly, it turned out) feared for its structural safety. Be this as it may, the Crystal Palace unquestionably made a huge impression at the time and its fame lived on. Henry Russell Hitchcock, writing in 1937, explained what was admirable about it from a modernist perspective:

> The Crystal Palace grew up outside architecture, almost, in a sense, outside engineering. It owed its aesthetic qualities to factors hitherto unrecognized – the repetition of units manufactured in series, the functional lace-like patterns of criss-cross trusses, the transparent definition of space, the total elimination of mass and the sense of tensile, almost live, strength as opposed to the solidity of previous masonry architecture.

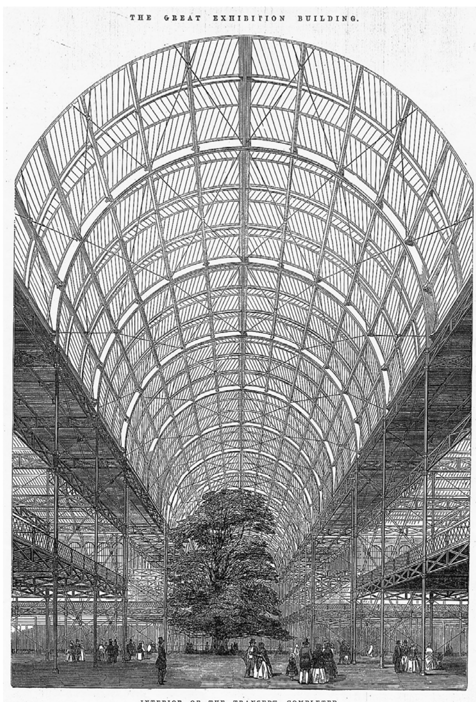


Figure 6. Crystal Palace, interior of the newly completed transept

(*The Illustrated London News,* 25 January 1851)

The question is often asked why the Crystal Palace did not have a greater impact on the contemporary building industry, considering its immense popularity. The short answer is that it was stronger in concept than reality. As Tom Peters has shown (Peters 2000), the originality of the building for the history of technology lies in the complex organization of the erection process and the structural system, an additive, three-dimensional module. This was a significant advance on contemporary greenhouse structures and earned the Crystal Palace a place in the "genealogy of modular construction". However, its hasty construction led to shoddy detailing and unresolved structural weaknesses, so much so that the building had to be virtually re-engineered when moved to Sydenham. (The problems related to the stiffness of the "portal frame" type of structure, projected for the Crystal Palace, were solved later in that decade by British engineers. (Skempton 2000)). From the architect's viewpoint the building, even as an exhibition building, fell short in terms of formal composition, materials and details. For example, only 45% of the outer skin was actually glass and the structure was a mixture of timber and iron trusses, painted to look alike. Despite professional criticism the Crystal Palace had its champions, most notable of these, the historian James Fergusson ((1808-1886), who hailed the building as the beginning of a new epoch in architecture. (Fergusson 1851)

Fergusson, as his later writings show, greatly admired the modern engineer, whom he thought surpassed the achievements of the ancients, in contradistinction to the contemporary architect, who could merely copy them: "[…] surely the men who do these things are giants", he wrote in his review of Samuel Smiles's, *Lives of British Engineers* (1862). (Fergusson 1863) Their works he considered "the best and most complete examples that exist in modern times of an art carried out on scientific principles". Because of the stranglehold of archaeology on architects' minds, they "[…] are quarrelling over Greek mouldings and Gothic pinnacles, and dreaming of reproducing the elegance of classical times, or the blundering enthusiasm of the Middle Ages, while the engineers are spanning our rivers with structures such as the world never saw." In Fergusson's view the solution was for the two professions to work more closely together, so that they could teach each other their respective skills, and in another publication, produced at about the same time, he used the reconstructed Crystal Palace as an example of the benefits of such collaboration. Paxton's original building he noted, "[…] though an admirable piece of Civil Engineering had no claim to be considered as an architectural design. Use, and use only pervaded every arrangement, and it is not ornamented to such an extent as to elevate it into the class of Fine Arts." As re-erected at Sydenham, the "building has far greater claims to rank among the important architectural objects of the world." Nonetheless, it still had some flaws: While it possessed,

> […] in a remarkable degree greatness of dimension – truthfulness of design – and ornamental arrangements – which are three of the great elements of architectural design, it is deficient in two others. It has not a sufficient amount of decoration about its parts to take it altogether out of the category of first-class engineering, and to make it entirely an object of Fine Art. But its greatest defect is that it wants solidity, and that appearance of

> permanence and durability indispensable to make it really architectural in the strict meaning of the word. Whether this quality can ever be imparted to any building wholly composed of glass and iron is very questionable […].
>
> (Fergusson 1891, II: 420)

The two decades following The Great Exhibition was a confusing time for architects on this issue. They continued experimenting with what Fergusson called, “Ferro-vitreous Art”, without being able to bring the matter to conclusion. In 1856 the Coventry master ironworker, Francis Skidmore, suggested that cathedrals could be constructed as iron frames with infill panels of ceramics, marble and frescoes, and decorated with crisp wrought iron foliage. (Skidmore 1856) Much was therefore expected of his attempt to “try how Gothic art could deal with those railway materials – iron and glass” in the roof of the inner court of the Oxford Museum in 1858-9 **(Figure 7)**, but the results were not entirely convincing.

Likewise the Ecclesiological Society’s projects for an iron church 1855- 1865 (Muthesius 1970, pp59-60), whereas with Brill’s Baths, Brighton (1866, demolished), Sir George Gilbert Scott achieved a minor masterpiece in the medium. During the 1850s Ruskin too became more ambivalent towards the use of iron and seems to have approved of the Oxford Museum project. However, his support for the material remained qualified. He admitted that the Sydenham Crystal Palace (1854) exemplified mechanical ingenuity, but maintained that this was not the essence of architecture. An architecture of iron and glass failed on account of it lacking the essential properties of natural colour and form. At best “you may have an architecture as noble as cast or struck architecture even can be: as noble, therefore as coins can be, or common cast bronzes, and other such multiplicable things.” (Ruskin 1854). Later in Ruskin’s life even this grudging recognition was withdrawn from iron as an expressive architectural material.

The argument was approaching stalemate, while in practice iron construction became increasingly more effective, as industrial wrought iron superseded cast-iron as the structural material of choice for roofs and floors, and its potential for achieving better daylight illumination in urban commercial buildings, realized and explored. (Hitchcock, 1951) **(Figures 8 and 9)** The RIBA organized periodic debates on the subject, at which there were both protagonists and antagonists. One of the most eloquent supporters of the progressive use of iron was George Aitchison Junior (1825-1910), President of the RIBA (1896-9), whose father, George Senior, had been one of the pioneers of iron construction in England. In 1864, after observing that “one rarely sees a large building being erected without iron columns and iron girders”, but without architects understanding much of the mechanics, he urged the profession to pay more attention to technical subjects in their education. Iron was different from other staple materials and required specific scientific knowledge. He listed a whole range of benefits its increased use could have in architecture, including a simplification of the formal language: “I think a purity of outline and elegance of proportion, with an almost total absence of ornament might gradually be made to pervade everything, from our buildings to our teaspoons."(Aitchison 1864) At the General Conference of Architects in 1871 Aitchison welcomed the progress in iron construction technique: "This happy couple, wrought and cast-iron, having been wedded in perfect equality, the most outstanding results were obtained". He encouraged architects to be more adventurous in their constructive as well as artistic use of the improved material:

> Once protect iron from rust, and what novel and beautiful buildings might be constructed of an iron framework filled in with glazed tiles on both sides with space in between. What charming ceilings might be made of ornamental iron ribs filled in with small domes of china or pottery! What spans of rib and panel vaulting! What domes filled in with thick glass in beautiful patterns.
>
> (Aitchison 1871, p.84)

Figure 7. Ironwork at the Oxford University Museum (*The Builder* 1860)

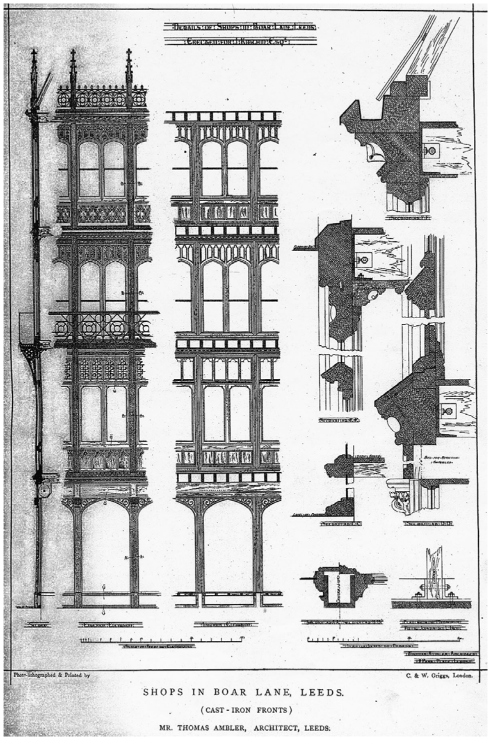


Figure 8. Details for a cast iron shop front in Leeds, by Thomas Ambler, 1875

(*The British Architect,* July 1875)

Others, like William White (1825-1900), President of the AA (1868-9), studied the potential of iron in its various forms as a decorative material during the 1860s (White 1866) but, by 1880, seems to have concluded that its basic intractability was a hindrance to architectural expression:

> Architectural form, as distinct from constructional form, must, in ironwork, be always harsh and rigid, cramped and limited by the necessities of the material. […] The proportionable distribution of masses, and the gradations or contrasts of shadow in outline, so readily and so admirably obtained with other materials, are inconsistent with the nature of the constructive force of this material. Under the use of iron a far greater effect of elegance and airy lightness may be obtainable; but give to iron a real or apparent massiveness, and you destroy at once its character and its ostensible use. […] The very lightness, airiness and expanse of the structure, preclude all idea of some of the higher characteristics of true architecture. […] We must not look to this material for a permanent embodiment of art, nor for the idealization or expression of imaginative or poetic thought.
>
> (*RIBA Transactions* 1880, pp. 178-9)

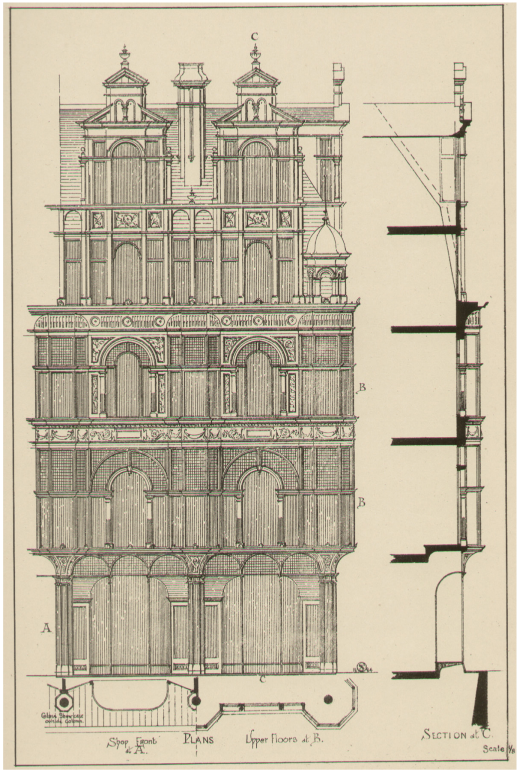


Figure 9. Design for a cast iron shop front, from W.S. Ogden, *Mercantile Architecture,* 1885

(*The British Architect,* January 1886)

At the same meeting at the RIBA, G.E. Street (1824-1881), doyen of the Gothic school, expressed his concern about the "enemies of all true construction", namely, "the use of concealed girders in the middle of our walls". This, he believed led to sloppy planning and a "false kind of architecture". He strongly disagreed with one of the speakers [Picton] that the "[…] the architect of the Parthenon would have liked iron better than marble, or that our own architects from the 13P^{thP} to 15P^{thP} centuries would have done anything of the sort." He then rounded on the engineers: "I am bound to say to the engineers candidly that in proportion as their art has become more scientific it has become less beautiful." He concluded:

> The business of the architect is to build as far as is possible something which will last. […] Our great object is to show the construction of our building in every possible way; hence, almost all the iron floors, joists and beams which are concealed in our walls are more or less hateful to us.

(*RIBA Transactions* 1880, pp.186-9)

In 1897 Henry Heathcote Statham, editor for 25 years (1883-1908) of *The Builder*, the leading professional journal of the British building industry, published a book entitled, *Modern Architecture: A Book for Architects and the Public*. At the end of this treatise - which was largely concerned with stylistic development in mainstream architecture as it had crystallized in the course of the 19P$^{\text{thP}}$ century - Statham added a chapter called, “A Note as to the Influence of Iron” (Statham 1897, pp.264-75), which can be taken as representative of the views held by the architectural establishment on this issue after nearly a century of experiment and debate.

Statham flatly denied that an engineering structure like the Forth Bridge could be considered equivalent to a cathedral, because it had entirely different cultural objectives and status. A bridge was, however, “capable of much architectural beauty”, and in urban situations this was an important consideration. Earlier in the book he had looked at some bridges in London and branded the popular Tower Bridge (1886-1894) - which was jointly designed by an architect and engineer – a “gigantic and tawdry sham”. (Statham 1897, p.172) He went as far as to produce an alternative design to show how the designer’s errors of judgment could be corrected by making the masonry piers actually carry the superstructure, rather than simply clothing it. **(Figure 10)**

As for the place of iron in future development, even the American example had failed to convince Statham that iron had any expressive role in architecture of the first rank. He concluded:

> With whatever new materials we have to deal, architecture must still remain the art of producing what is beautiful and expressive in building, which involves a great deal more than the mere question of economic structure. […] The idea that iron is to revolutionize modern architecture I hold therefore to be a complete fallacy, based on bad reasoning and on a confusion between engineering and architecture.

Iron was thus no longer a problem for the architect; it had been relegated to the domain of the engineer. For Statham and his generation “Architecture” meant working in one of the historical styles – this was not negotiable, but was it sustainable if you held structure and expression as indivisible in an age of iron? J. M. Crook called this the “dilemma of style”, i.e. “to find a new style in the past, *and* to equate function and propriety”. (Crook 1987, pp. 98-132)

It is clear from how Statham phrased the argument on iron that closure had not yet been reached on the matter. There was, evidently, still a significant body of opinion within the ranks that held high hopes for the material, furthering its cause, and only a few years after this book was written the steel frame proper belatedly entered the mainstream of British architecture with buildings like The Royal Insurance Company’s Building, at Liverpool, completed in 1903 after the designs of J. Francis Doyle and Richard Norman Shaw. **(Figures 11 and 12)** For British architecture the “Age of Iron” was just beginning – the “problem” had not gone away, and debates like those found in the pages of the professional press over the previous sixty years would continue to occupy the minds of at least two more generations of British architects as modernism gained ground against the forces of traditionalism.

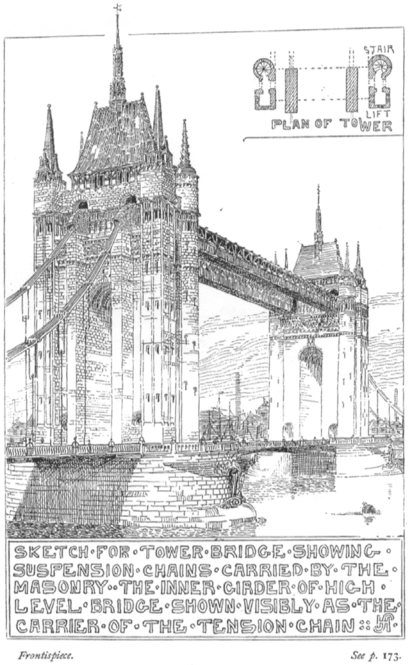


Figure 10. H. Heathcote Statham. The Tower Bridge “corrected”

(Statham 1897, “Frontispiece”)

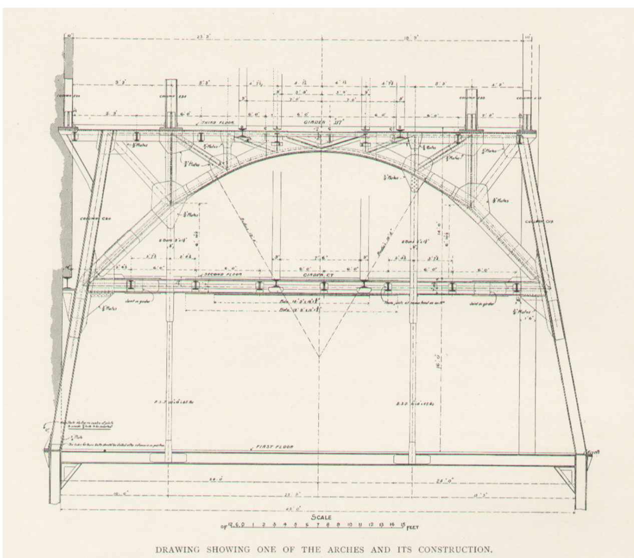
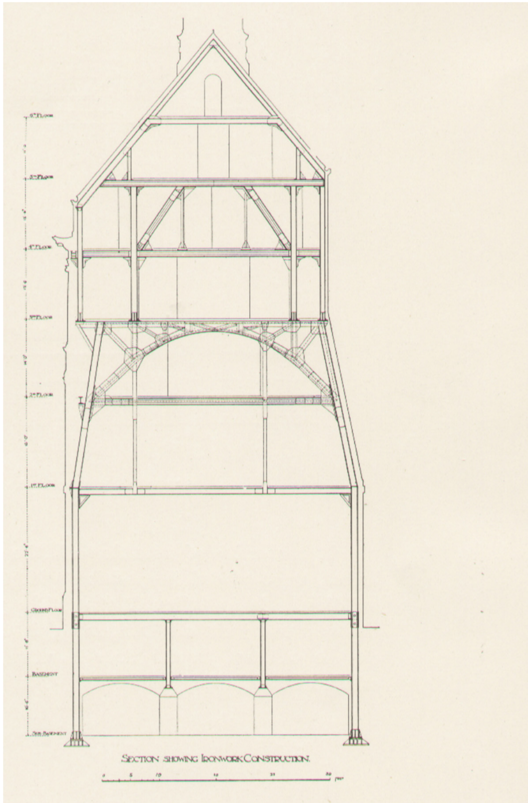


Figure 11



Figures 11 and 12. Steel frame construction for the Royal Insurance Company Building, Liverpool (Hetherington 1903, pp.11 and 12)

REFERENCES

Aitchison, G, 1864. "On iron as a building material." *RIBA Transactions,* 14, pp. 97-107.

Aitchison, G, 1871. "On the progressive use of iron in building." *RIBA Transactions,* 22, pp. 81-5.

Bowley, M, 1966. *The British Building Industry,* Cambridge: CUP, Chapters I, VI, IX.

The Civil Engineer and Architects Journal, 1842, "Review: 'Architecture of Machinery'. By Samuel Clegg Jnr, 1842." V, pp.235-6, 252-3.

The Civil Engineer and Architects Journal, 1843. "On the effects which should result to architectural taste, with regard to arrangement and design, from the general introduction of iron in the construction of buildings." VI, pp. 291-6

Crook, J M, 1987. *The Dilemma of Style,* London: John Murray, Chapter 4, pp.98-132.

Collins, P, 1961. "Metallurgic Architecture 1844." *Architectural Review,* 130, pp. 267-8.

Diestelkamp, E J, 1997. "Richard Turner and the Palm House at Kew Gardens." in Sutherland, RJM, (ed.), *Structural Iron, 1750-1850,* Aldershot: Ashgate, pp. 77-102.

Fergusson, J, 1851. "The Effect on Architecture of the Building of the Great Exhibition." *The Builder,* IX, pp.52-3.

Fergusson, J, 1863. "Lives of British Engineers. By Samuel Smiles, London 1862." *The Quarterly Review,* CXIV, pp.289-331.

Fergusson, J, 1891. *History of the Modern Styles of Architecture,* Third Edition, London: John Murray.

Garbett, E L, 1891. *Rudimentary Architecture,* Seventh Edition, London: Crosby Lockwood.

Hetherington, J N, 1903. *The Royal Insurance Company's Building, North John Street and Dale Street Liverpool*, London: Batsford

Hitchcock, H R, 1937. "Early Victorian Architecture." *RIBA Journal,* 11 September 1937, pp. 981-93.

Hitchcock, H R, 1951. "Early cast iron facades." *Architectural Review,* 109, pp.113-6.

Hope, A J B, 1863. *The Conditions and Prospects of Architectural Art,* London: John Murray.

Loudon, J C, 1837. "On the Effect which could result to Architecture, in regard to Design and Arrangement, from the general Introduction of Iron in the Construction of Buildings." *The Architectural Magazine,* 4, pp. 277-87.

Muthesius, S, 1970. "The 'Iron Problem' in the 1850s." *Architectural History,* 13, pp. 58-63.

Peters, T, 2000. "Some structural problems encountered in the building of the Crystal Palace of 1851." in Thorne, R (ed.), *Structural Iron and Steel, 1850-1900,* Aldershot: Ashgate, pp.1-15.

Pugin, A W N, 1841. *The True Principles of Pointed or Christian Architecture,* London: John Weale.

RIBA Transactions, 1880. "Iron as a material for Architectural Construction." By James Picton." ; "Mild Steel and its Applications to Building Purposes." By A B W Kennedy." 30, pp.149-192.

Ruskin, J, 1854. “The Opening of the Crystal Palace: considered in some of its relations to the Prospect of Art.” in Cook, E T and Wedderburn, A, *The Works of John Ruskin,* London: 1904, XII, pp. 417-432.

Ruskin, J, 1880. *The Seven Lamps of Architecture,* Second Edition, London: George Allen.

Scott, W B, 1928. “Constructional Steelwork: A Short History.” *The Architect’s Journal,* 68, pp. 19-23, 55-7.

Skempton, A W, 2000. “The Boat Store, Sheerness (1858-60) and its place in structural history.” in Thorne, R, *Structural Iron and Steel, 1850-1900,* Aldershot: Ashgate, pp.17-48.

Skidmore, F A, 1856. “On the use of Metals in Church-building and Decoration.” *The Ecclesiologist,* 17, pp.333-8.

Smith, S, 1999. “The design of structural ironwork, 1850-1890: education, theory and practice.” in Addis W, *Structural and Civil Engineering Design,* Aldershot: Ashgate, pp.285-304.

Statham, H H, 1897, *Modern Architecture: A Book for Architects and the Public,* London: Chapman Hall.

Sutherland, R J M, 1997a. *Structural Iron, 1750-1850,* Aldershot: Ashgate, “Introduction.”

Sutherland, R J M, 1997b. “The Age of cast iron, 1780-1850: Who sized the beams?” in Sutherland R J M, *Structural Iron, 1750 –1850,* Aldershot: Ashgate, pp. 65-75.

Thorne, R, 1990. *The Iron Revolution: Architects, Engineers and Structural Innovation, 1780-1880: Essays accompanying an Exhibition at the Heinz Gallery,* London, “Introduction”.

Westminster Review, 1849. “A new System of Architecture. By W. Vose Pickett, 1845.” 51, pp.104-45.

White, W, 1866. “On Iron: its legitimate uses and proper treatment”, *The Civil Engineer and Architects Journal,* XXIX, pp.25-7.

Wiener, M J, 1981. *English Culture and the Decline of the Industrial Spirit, 1850-1980,* Harmondsworth: Penguin.