RATIONALISM AND ECLECTICISM; ON THE ROLE OF IRON IN BRITAIN IN THE SECOND HALF OF THE NINETEENTH CENTURY

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Being an architect, I would like to preface my statements with a brief comment on the situation of today's architecture before turning to the second half of the nineteenth century. I think this will make rediscovery and re-evaluation of the buildings of this much neglected century more understandable.
Its rehabilitation in the Federal Republic of Germany had assumed a very definitive shape in 1977 when a prize was awarded to a historicizing design of the Stuttgart State Gallery and its implementation.The architect is the Englishman James Stirling. Since then, such terms as eclecticism and rationalism have been the focal points in discussions about architecture in the Federal Republic. They enjoy the same widespread use today as sociological slogans did in the sixties. History, that is history of the arts, not social history, has become the platform for debates among architects. The reason is dissatisfaction with, and withdrawal from, the so-called modern, functional architecture. Its thesaurus of forms, those of the industrial revolution, which the modern movement had hoped to produce a major educational impact upon the renewal of architecture, today is being accused of this very industrial applicability. These are hopes and accusations as old as building with industrially prefabricated elements; in the nineteenth century, they were raised again and again especially in connection with iron architecture.
But there are other phenomena to indicate the proximity of the 20th to the 19th centuries. Thus, Eduard Beaucamp in the "Frankfurter Allgemeine Zeitung" of July 14, 1980 wrote under the heading "The Future Lies in the Past:" "Contemporary art is full of indecision, ambiguity, full of eclecticism and historiscism... The loss of firm goals and trends, it appears, has resulted in a greater lack of orientation than the loss of style in the 19th century ever did."

Two examples: In 1851, Joseph Paxton had built the Crystal Palace, the very symbol of modern architecture. At the same time, jointly with other colleagues, he built Mentmore House in approximately four different styles. Today, the American architect Philip Johnson, a disciple of Mies van der Rohe and one of the founders of the "International Style," boasts of simultaneously erecting, in twelve different styles of architecture, among other buildings an office high riser with a tallboy-like Renaissance gable in New York, another one, with Victorian gothic towers, in Pittsburgh. Charles Jencks, the historian and architectural critic, in his book titled "The Language of the Post-Modern Architecture," demands: "The intellectual honesty of the architect can be measured by his ability to work in a plurality of styles." (1) With his demand for radical electicism, Jenck turns against the rational, functionalist tradition of modern architecture. A comparable development is characteristic of the second half to the 19th century. In the sixties of the 19th century, a change in the attitude to iron construction marks the transition from early Victorianism to the culmination of the Victorian period. Iron had lost the touch of the novelty, of progress, which had adhered to it in the early Victorian phase. In the taste of the public, it acquired the connotation of something cheap, to be used for rational purposes only and, for the same reasons which had resulted in its widespread application, was now no longer used for representative public buildings, at least not as an externally visible material dominating the outward appearance. Yet, when the Crystal Palace had

been completed for the 1851 Great Exhibition, iron seemed to have become eligible as a structural material for representative buildings. This would have been a logical extension of a development that had grown out of engineering construction, independent of traditional architecture, in the early years of the century. In a large number of contemporary reports, reference is first made to the beginnings of a new architecture. Thus, Lothar Bucher in his widely quoted "Kulturhistorische Skizzen aus der Industrie-Ausstellung aller Völker 1851," wrote: "When seeing this first building not erected out of solid brickwork, visitors realizes that all rules by which architecture had been assessed so far had now ceased to be valid." (2) Also "The Times" confirmed: "A completely new architectural order had been created." (3) In addition, the Crystal Palace met the demands by many architects, in search of a new beginning for truthfulness in design, strict simplicity, in line with the spirit of the time. However, in their final opinion they yet expressed the conviction "that this is not architecture: It is a piece of engineering of the highest value and at the highest level, but it is not architecture. The work is completely lacking in form, devoid of the very idea of stability and solidity." This is a summary published in 1851 by the British architectural journal, "Ecclesiologist." Paxton himself accepted this verdict on his building, acknowledging that iron and glass structures would have to be limited to certain defined buildings. Consequently, the expected revolution in architecture did not take place. Already in the second Crystal Palace built 1853 by Paxton in Sydenham out of parts of the 1851 building showed the attempt, in the complex use of forms, to adapt it to traditional concepts of architecture. This likewise applies to the glass palaces, except for the Munich Glass Palace of 1854, built subsequently: 1853 in Dublin and New York, 1864 in Amsterdam.
Engineers and producers of cast iron used the chance offered to them by the emerging craze for glass by marketing prefabricated iron structures. Thus, passages, market halls and winter gardens covered with glass roofs were built all over Britain in the sixties and seventies of the 19th century. Prefabricated residential houses, theaters, market halls were shipped from Britain into the world. Paxton himself tried to make use of his popularity in proposing a wide variety of projects for glass structures: the roofing of the Royal Exchange in London, a Crystal Sanitarium 200 ft. long and 72 ft. wide. His last project of a large glass house was the draft design of an exhibition in St. Cloud near Paris in 1861. However, none of these proposals were implemented. Yet, Paxton continued to work as an architect, although he had never had a formal education. He began by building Norman and Elizabethan mansions and palaces, but also small railway stations. He devoted himself to those activities without ever attempting to transfer to them the technical and design expertise he had developed since 1828 and which had permitted him to design and build the Crystal Palace. Disintegration and indecision between bold progress and timid conservatism, between the rational and scientific engineer and the architect as a representative of the fine arts, as we find it in the person of Paxton, is not limited to 19th century architecture. Thus, the "Illustrated London News" edition of Mai 24, 1851, commenting on the works of the fine arts displayed in the Crystal Palace, found that "they were no longer of any importance to man, offering no stimulation. Common and useful objects by far outnumbered the works of fine and great art." (4) These common, useful things, the products of bourgeois culture, were of such a high standard of design that they have been produced almost unchanged to this day, from simple Wedgwood pottery to Thonet's bentwood furniture and on to men's clothing and blue jeans.

Such approaches towards an industrial culture recognizing the character of the period and reacting to it appropriately can be found throughout the 19th century. They appear to have been implemented especially by engineers and designers in areas free from any pretensions to art. Thus, mainly bridges, railway station halls, exhibition halls and market halls, industrial installations, ships, railway engines, etc. document the tradition of functional design. However, all these tentative approaches were unable to stop historicism or prevent it; towards the end of the century, it also invaded engineering construction and functional building.

Besides the London Coal Exchange built by Bunnings in 1849, the Crystal Palace had been the building to turn iron construction into representative architecture. But it also marks the point at which architecture divided into functional buildings, for which iron henceforth was permitted as a visible material, and representative buildings with pretensions to art, which were made out of traditional materials. Let me show you a few examples of the repercussions of the Crystal Palace on buildings in Great Britain after 1851, which have survived to this day. They will reveal that especially railway engineers absorbed Paxton's developments, used and advanced them.

King's Cross Station in London was erected 1851, simultaneous with Paxton's building, according to a design by the engineer Lewis Cubitt (1799-1883). The structure of the two parallel, barrel shaped roofs consisted of glued timber trusses similar to those used by Paxton.In 1870 and 1887, they had to be replaced by rolled arched trusses made of wrought iron, which did not alter the original impression in any way. King's Cross is London's only terminus with the roofs of the halls visibly constituting parts of the architecture. As far as design goes, it is an extraordinarily independent example of the functional tradition of the 19th century in Great Britain.

Fox and Henderson, who were the contractors contributing greatly to the construction of the Crystal Palace, used the girders developed there also for Oxford Station built in 1852.
I.K. Brunel (1806-1859), the engineer, and M.D. Wyatt (1820-1877), the architect, both members of the committee which had entrusted Paxton with the construction of the exhibition building, erected Paddington Station in London in 1852-1954. Fox and Henderson again were the contractors responsible for the shed. It is therefore hardly surprising to see that the glazing of the original three-aisle hall design followed the "ridge-and-furrow" system of the Crystal Palace. For the color concept, the architect Owen Jones (1809-1874) was commissioned, who had been responsible for the colors used in the Crystal Palace. Brunel, who was a celebrity even at that time, calling in an influencial architect to design his shed may be regarded as a first symptom of the apparent loss of confidence in his own abilities, a consequence of the destruction of belief in progress. However, Paddington Station is still wholly in the tradition of early iron construction. The bright interior is reminiscent of the greenhouses of Chatsworth or Kew and the Crystal Palace, which had been Brunel's models.
Another building in the wake of the Great Exhibition Palace, but one whose fate reflects the changed attitude towards iron buildings, is the former Museum of Science and Art. It was to be erected in Brompton, which is now South Kensington, on the site of the present Victoria and Albert Museum, from the financial surplus of the Great Exhibition. Britain at that time was engaged in a war against Russia, the Crimean War, which helped France to dominate the continent, and

thus was unable to afford costly planning. Consequently, according to the concept of the Department of Practical Art, the new building was to be an iron structure easily dismantled, very much like the Great Exhibition building in Hyde Park. The design was completed in 1855-1856 by D. Young of Edinburgh under the supervision of Sir William Cubitt (1785-1861), who had already been responsible for supervising the construction of the Crystal Palace. The building, which has a rectangular floor plan, consists of three aisles, each 42 ft. wide, which are spanned by light, crescent shaped wrought iron trusses resting on cast iron stanchions 26 ft. high. While the inner stanchions, which varry a recessed upper floor in the two side aisles, have circular cross sections, the stanchions in the outer wall have H-shaped cross sections, which is a remarkable innovation over Paxton's design. The facade elements between the supports visible from the outside were made of corrugated sheet metal paneled with wood on the inside. Cantilever brackets ensured the longitudinal stiffness of the building. In his criticism, the editor of the "Builder" called it "Brompton Boilers," thus expressing the general lack of enthusiasm on the part of the public about this functional building that was to be a museum. Today, clad behind brickwork, it stands in the London East End as the Bethnal Green Museum.
The eclecticist concept of a museum of science using also iron and glass for architectural design purposes is evident from the Oxford University Museum built at the same time. It was designed in 1855-60 by Thomas Deane (1792-1871) and Benjamin Woodward (1815-1861) in cooperation with John Ruskin (1819-1900) as a Gothic monastery arranged around a courtyard covered with glass. The architects made iron obey their Gothic revival concepts of style, thus demonstrating how,unlike engineers, they handled a material necessary to solve certain structural problems.
On the basis of the design experience accumulated in building the Crystal Palace and the Museum of Science and Art, despite criticism by the public, which more and more rejected the use of iron for purposes of architectural design, the final decisive step was taken in Britain in the sixties of the 19th century in building multiple-story iron frame structures.
In Glasgow, then the main center of iron trade, a four-story commercial building was erected at the corner of Jamaica Street/Argyle Street in 1855-56, completely unnoticed by contemporary technical publications: Gardner's Building with cast iron facades facing both streets. The other gables are made of brick. Inside, cast iron stanchions carry box-type reinforced girders on which the iron foundry and probably also the designer, Robert McConnel, had acquired patents. They consist of cast iron frames and forged flat iron bars, allowing relatively wide spans to be designed, compared with American examples of the same period. The "Builder" ignored this building, much in the same way in which it had made fun at the "Brompton Boilers" as examples of non-architecture. The contemporary public in the High Victorian period did not like the impression of lightness, openness, regularity and the precision necessarily going with the use of iron. "Although they used iron for everything, short of street facades,and constantly talked about it, they did not like it." (5)
In Liverpool, another center where iron had been used at a very early stage also for purposes of traditional architecture (let me remind you only of the churches built by Thomas Rickman: St.George's,1813; St. Michael's, 1814; St. Philip's, 1816, whose interior was made all of prefabricated cast iron elements),some glass and iron facades were built in the fifties and sixties. The logical step to the aesthetics

of iron frame structures was taken by the architect Peter Ellis (1804-1884), who remained unknown outside of Liverpool, in two buildings violently criticized, as usual, by the London "Builder", Oriel Chambers, 1864, and 16th Cook Street, 1866.
Oriel Chambers owes its name to the glazed cast iron oriels suspended between extremely thin stone pillars and extending beyond the floor level. Already the two facades facing the street are remarkably independent solutions to find in a commercial building. Inside, cast iron frames composed of square H-shaped stanchions and girders with the cross sections of an inverted T constitute the load carrying structure. The surprising structural and aesthetic consequences which can arise from an open mind working on a problem are visible in the structural and formal solutions found for the facades on the courtyard side. They are suspended in front of the cast iron stanchions, a real curtain wall and the first of which I know. From bottom to top it recedes further at each floor level, thus providing additional lighting through skylights. This constituted an important improvement in lighting conditions in the narrow courtyard.
Ellis adopted the same solution for the rear front of the building on 16th Cook Street, which stands in an even narrower courtyard surrounded by buildings all around. The fascinating feature in this instance is especially the spiral staircase of cast iron standing in front of the facade and glazed and clad with iron plates. No other buildings are known for which Ellis had been responsible as an architect. After the biting reviews in the "Builder" he worked as a civil engineer for another eighteen years.
Peter Ellis' withdrawal is quite illustrative of the change in public taste over to the traditional forms of historic architecture in the sixties of the 19th century. Consequently, it is no surprise that the first truly consistent multiple-story iron frame building of a modern type, which was free from any contemporary influence, had to be an industrial building, the Boat Store of Sheerness. It reflects design and structural aspects of functional architecture, which have remained valid to this day. Although ten years earlier, 1848-49, James Bogardus in New York had built a four-story factory out of cast iron elements which, formally, was a building of its time, no precise documents are available about the structural design, for the building was pulled down again as early as in 1859. Also the Crystal Palace after all was not a multiple-story frame structure in the modern sense of the term and, without detracting from its importance, formally must also be regarded more as part of the 19th century.
The Boat Store (6) was built in H.M. dockyards of Sheerness in 1858-1860, seven years after the Crystal Palace. It has been preserved practically unchanged; the original slate roofing has been replaced by corrugated asbestos cement, the corrugated sheet metal paneling and the windows have been renewed. The architect was Godfrey Greene (1807-1886), since 1850 Director of Engineering and Architectural Works responsible for the buildings of the Admiralty. His buildings after 1851 reflect the influence of the Crystal Palace. Three other reasons could have favored the use of an iron frame structure in Sheerness: short building time, larger window areas and thus better lighting, and lower loads on the foundations, for the building had to be founded on piles.
The tree-aisle building is 210 ft. long, 135 ft. wide and has an overall height of 53 ft. The nave, which is a hall lighted from above, is spanned by one traveling crane each at the levels of the three upper stories. In the two four-story aisles, four rows of cast iron stanchions spaced 16 ft. apart laterally and 30 ft. apart longitudinally, which were bolted together with cast iron cross

beams and riveted wrought iron sheet metal supports in the long direction, constitute the load carrying and, at the same time, rigidifying structure. The stability of the building is ensured solely by the framing effect of the boltes connections. One condition for this to work is the H-shaped cross section of the stanchions, which had been used already in the Museum of Science and Art and the buildings by Peter Ellis. This design allows the solid rigid connection of the stanchion to the beam. Each stanchion consists of two parts bolted together at the level of the second story. The outer, box-shaped corner stanchions bolted together of four elements to a total height of 40 ft. are hollow. They carry the rain water. The windows and the parapet elements made of corrugated sheet metal are attached between the stanchions by iron cleats. Three saddle roofs top the space. The trusses, each spanning 45 ft., consist of bending and tensile members of wrought iron, while all elements subjected to compression loads are made of cast iron.
Besides the quality of detail, the factor decisive for the development of framing construction is the design of the rigid connection between the stanchions and the beams, which ensures the stiffness of the building both in the longitudinal and transverse directions. The structural elements employed up to that time had been braces, arched trusses or St. Andrew's crosses. Green's structural and architectural achievements remained almost without any consequences until the nineties of the 19th century. Only when the high risers of the first Chicago School were built, they became the state of the art of frame structures.
The history of the first iron frame structures is also a history of the mounting resistance against iron architecture. However, this affected not only architecture, but was also directed against railroads, steam engines, technical innovation in general and any belief in progress. It was accompanied by a loss of confidence in engineers and by an increasingly stronger position of architects as forces conserving traditional culture. A well known example is St. Pancras Station of London. The shed, next to New York Central Station the widest spanned railway hall in the world (234 ft.), which had been built by P.W. Barlow (1812-1892) and R.M. Ordish (1824-1886), had been completed in 1865, when the competition was opened for the entrance hall and the hotel. Owen Jones, who had collaborated with Paxton on the Crystal Palace, in his proposal arranged the new buildings in such a way that the front of the huge hall dominated the facade. All other drafts, including that by Gilbert Scott (1811-1878), which was realized in 1868-1874, shielded the entrance side of the hall because, being only an engineering structure, it could not at the same time also be a piece of architecture. Cladding light and transparent iron structures with heavy stone architecture became the common way of combining the functional requirement for wide spans, light rooms and thin structures with the pretension at permanent, representative architecture. The leading role of the architect, namely assigning to the engineer a clearly defined problem as part of the architect's design concept, can also be seen in the Royal Albert Hall, a concert hall for 8000 built in London by F. Fowke (1823-1865). The spectacular feature of that building is the dome of forged iron topping an elliptic floor plan with a span between 185 ft. and 219 ft. Towards the auditorium, it was shielded by a suspended ceiling, thus not influencing space in any way. Its engineers had been R.M. Ordish, who had also designed the hall of St. Pancras, and I.M. Groover. Fowke's building for the 1862 Great Exhibition in London, a quasi-successor to the Crystal Palace, was a particularly striking example of the way in which iron had been replaced as a material influencing form. The solid brick building had an inner iron frame structure. However, unlike its

predecessors, this did not contribute to the further advancement of the building problem at hand. The Royal Scottish Museum in Edinburgh, built in 1861, also by Fowke, is an attempt to combine the lightness and brightness of an iron frame structure, such as the Crystal Palace, with solid stone Renaissance style architecture.
The wish to influence the form of building construction finally also had an impact on representative engineering structures. R.M. Ordish adapted Albert Bridge across the River Thames, built in London 1873 as one of the first cable-stayed bridges, to the Gothic style concepts of his period. When awarding the contract for construction of Liverpool Street Station in London, 1875, the railway company placing the contract expected the engineer, E. Wilson (1820-1877), to assign a churchlike character to the shelter. Certainly the most famous example of this development is Tower Bridge, 1886-1894. The engineer J.W. Barry (1836-1918) and the architect H. Jones (1819-1887) are the creators of this famous symbol of London. Jones was knighted for his design. The towers of the mediaeval drawing bridge are the seats for the solidified suspended frame structure of the two side arms. The hydraulic system of the movable back elements is enclosed in the foundations of the towers.
The development I sketched for the period of time mentioned above is particularly true of London and the cultural centers in Britain. Yet, functional buildings in the best tradition of the early Victorian period continued to be built right into the nineties: shelters, such as Piccadilly Station in Manchester, 1862; Temple Mead Station in Bristol, 1875; Queen Street Station in Glasgow, 1880. Brighton Station, 1883, and the last of its kind, the shelter of Darlington, Bank Top Station, 1887. Market halls were built in Derby, 1866, Carlisle, 1889, Halifax, 1895; to mention must a few.
Bridges, such as the Royal Albert Bridge near Saltash, 1859, near Cambus O'May, 1905, and the greatest achievement in engineering since the construction of Britannia tubular bridge forty years earlier: the Firth of Forth railway bridge built by J. Fowler and B. Baker in 1890. It marks a final culminating point in British engineering construction. Like R. Stephenson, who had introduced the use of wrought iron in large structures in Britannia Bridge, Baker for the first time used steel, which was more than fifty percent stronger, for a bridge of this size. In 1851, the Crystal Palace had met with the greatest approval everywhere. One generation later, Baker had to defend the Firth of Forth railway bridge against the most violent attacks. William Morris called it "the supremest specimen of all ugliness." (7) He was concerned about the radical interference with the environment by the structure, which was two and a half kilometers long, which could not be designed to any subjective form because of the inherent structural laws that determined its shape. Baker replied that the beauty of a wide spanned bridge could not be compared to that of a silver chimney ornament. One had to understand the functions of its elements to be able to judge(8).
Buildings in Britain in the 19th century are characterized by a style facing backward and, at the same time, by a openness in developing contemporary architecture in the light of a building problem, structural design and material. That this is also very true of the 20th century is borne out by the most recent trends in modern architecture. Historicism cannot be restricted to the 19th century, just as functional building cannot be regarded as an invention only of the Bauhaus.

Notes

1. W. Pehnt, Neue Frivolität. Frankfurter Allgemeine Zeitung, August 13, 1977.
2. Weltausstellungen im 19. Jahrhundert. Ausstellungskatalog Neue Sammlung, Munich, 1973, p. 2.

3. Weltausstellungen, op. cit., p. 9.
4. T. Buddensieg, Das Alte bewahren, das Neue verwirklichen. Zur Fortschrittsproblematik im 19. Jahrhundert. In: T.Buddensieg (ed.), Die nützlichen Künste, Berlin, 1973, p. 62.
5. H.-R. Hitchcock, Early Cast Iron Facades. In: Architectural Review, February 1951.
6. A.W. Skempton, The Boat Store, Sheerness (1858-60) and its Place in Structural History. (Read at the Science Museum, London, February 3, 1960).
7. L.T.C. Rolt, Victorian Engineering, Aylesbury, Bucks.m 1977, p. 194.
8. L.T.C. Rolt, op.cit., loc.cit.