RESOLUTION

Auf einem Internationalen Kolloquium des Deutschen Nationalkomitees von ICOMOS 1981 in Bad Ems wurde die Rolle des Eisens in der historischen Eisenarchitektur der zweiten Hälfte des 19. Jahrhunderts wissenschaftlich behandelt.

Anwesend war u.a. auch der Präsident von ICOMOS, Monsieur M. PARENT, Paris.
Eine Übersicht der Themen und Redner ist beigefügt.

Die Kolloquiumsteilnehmer hatten die Gelegenheit, sich anhand eines Lichtbildervortrages mit dem Kurhaustheater von 1886 in Augsburg-Göggingen zu beschäftigen. Sie erkannten, daß der Rohbau des Kurhaustheaters nach dem Brand von 1973 in einer Weise instandgesetzt worden war, daß der Bestand nicht mehr unmittelbar gefährdet scheint. Dies ist außerordentlich begrüßenswert und sehr verdienstlich. Jedoch mit Bestürzung mußte man erfahren, daß derzeit an eine Wiederherstellung des für die europäische Architekturgeschichte so wichtigen Baudenkmals offenbar nicht gedacht ist.

Die Bedeutung des Kurhaustheaters liegt sowohl in seiner für die Erbauungszeit höchst modernen Konstruktion als auch in der farbigen und dekorativen Innenausstattung. Diese ist weitgehend rekonstruierbar.

Die Teilnehmer des Kolloquiums bitten deshalb, Planung und Finanzierung einer originalgetreuen Wiederherstellung zur Wiedergewinnung des Gebäudes und seines Innern sicherzustellen. Eine moderne Nutzung des so bedeutenden Bauwerks wird sich dank dessen Vielfalt finden lassen.

THE ROLE OF IRON IN ARCHITECTURAL THEORY IN THE SECOND HALF OF THE NINETEENTH CENTURY

Georg Kohlmaier

The second half of the nineteenth century can rightly be called the grand era of iron. This statement refers to the emerging industrial complex of machines beginning to move "under their own steam", such as the locomotive, and to reproduce themselves, as it were, namely the machine tools. In architecture, the inner frames of the large buildings made of cast iron and steel are products as well as initiators of industrial mass production. For, as iron moves into buildings, forming their backbones, buildings successively become fabricated products: Building construction leaves the construction yard for the shop floor. These iron components, which are cast,forged, riveted, bolted, punched, smooth or embossed with ornaments, are not designed for use on one individual building lot, but for the world market; they no longer represent an individual's subjective wishes but sheer economy, mass production. In view of this real, and effective, revolution of building brought about by iron in the second half of the past century, the question arises about the role iron played in contemporary architectural theory.
We are interested here in the specific ideal or ideological, abstract scientific conditions attempting to accompany, or rather indoctrinate, building practice.
This question would be superfluous, if theory and practice were a pair of identical twins, like Castor and Pollux, always pursuing the same goals, which used to be one of the favorite concepts of an early scientific age. But especially architectural theory in the nineteenth century is much more a theory of the science of perception, an aesthetic theory, than a theory guided by the production and the needs of industrial society and in this respect trying to influence building practice, as the discipline of the engineering sciences tries to.From today's point of view, the theory of architecture in those years seems to be science involuntarily appearing as a product of the division of labor already inherent in the very process of building construction: in the factory, as a domain of the engineer, and the attempt at a craftsman's synthesis in his studio as the domain of the architect. The more narrowly the objective "form of work" is predefined, the more the individual "form of art" becomes the main subject of theory. Architectural theory as a pure theory of nineteenth century form exhibits a remarkable lack of interest in material processes of building construction, a lack of concern often turning into a downright hostile attitude towards practice, i.e.,against technology. One can even go one step further and, with respect to our subject, state that it was almost hostile vis-à-vis iron construction. On the whole, architectural theory of the nineteenth century to us seems to be deeply imprisoned in pre-industrialized thinking. Readers of the aesthetic treatises devoted to problems of the "real style" and "moral impact" of building construction are given the illusion of a world beyond capital and its economic exploitation. Readers on the subject nowhere will find any confirmation of their living in the middle of the "iron century".
We are, of course, referring to the writings of officially recognized general architectural theory, such as those published by the Academie des Beaux Arts, the histories of building and style, etc. Yet, in the shade of esoteric evolutions of theory there can be found reflections on the role of iron for a new architecture, remarkably often in connection with the revolution of space design brought about by iron: a materialistic approach in the midst of an idealistic

superstructure of matters of style, for the concept of space encompasses both structural design and the social need that produced it. In an abstract form, those treatises advocate building in accordance with the characteristics of materials, a concept originating in crafts. However, at the same time, the same treatises consider iron a mass product of industry, the banished soul of new space, to be concealed behind stucco and ornaments. Cases in point are the writings by Boetticher, Romberg, Semper, Baumeister, Gurlitt. Outside this theory of architecture which, although proposing materialistic concepts, yet remains firmly tied up in pre-industrial aestheticism, there are a small number of monographs by pragmatics who regard iron as a material, perceiving its new possibilities with engineers' eyes. They ardently advocate visible and, at the same time, filigree iron architecture. Since they must fight against the official theory of architecture, these monographs express the Utopian moments of iron architecture, whose possibilities remain inexhaustible, which makes them polemic pamphlets. Let us only recall the early writings by Loudon, the proposals by Horeau, McIntosh, the "Sketches in Cultural History" by Bucher, the architectural visions of Baudot and Wagner and, last but not least, the "Aesthetics of Iron" by Meyer and Jordan. Both schools, considering the use of iron, want a truly modern architecture. However, they remain irreconcilable as far as meeting this goal is concerned. In this connection, also the writings by the declared opponents of the use of iron are important, because also negation clearly shows the actual role of iron in building construction. This applies to Ruskin and the arts-and-crafts movement he initiated in Britain.

The methodological backbone of a theory of architecture as learned applied archaeology is furnished by Germany, Berlin being the center of theoretical work. The thinking developed there about iron grew less from an industrial background which, as we know, was less developed before 1850 than it was in Britain and France, but from idealistic philosophy, the writings by Kant, Fichte, Schelling and Hegel, especially Hegel. In his aesthetics outlined in the chapter on the art of building he considers all earlier epochs of architecture to be incorporated as results in the following one, i.e., raised to a higher level. While buildings in the "symbolic architecture" of early periods and in "classic architecture" still have their contents in themselves, i.e., are absolute, abstract spaces, "romantic architecture," i.e., building by the bourgeoisie, creates spaces whose contents for the first time are the concrete, self-conscious needs of society.

In the aesthetics of architecture in German idealistic philosophy we, for the first time, find a fundamental expression of the concept of progress in space design and building construction mentioned as corresponding to the development of societal needs:

"Romantic art cannot work for sensual perception, but for subjective introspection," for bourgeois individuality.

"Introspection triumphs over external appearance."

The concept of regarding the design of space and building construction, not the style, as a criterion of progress is advanced by Schinkel and his school. The discussion about style uses the aspects of "tectonics", structural aspects, space design and adequate structural design, thus dominating the theory of architecture in Germany well into the second half of the century. Of course, in practice this discussion often was only an excuse for releasing styles from the past and applying them in experimental ways. "Emulating the old is certainly a very modern activity," (Gurlitt, p. 650).

The theoretical conscience of Schinkel's school and of its approach towards "practiacl aesthetics" is represented by Carl Gottlieb Boetticher (1806-1899). As late as in 1879 Tuckermann confirmed, "Boetticher must be regarded as the writing hand of Schinkel."

In his chief work, "Die Tektonik der Hellenen" (Berlin, 1843), Boetticher expresses the thesis that, in accordance with ancient art, each part of architecture not only had a specific service function within the whole space, but also should represent that function. Ornaments are assigned the function to express and interpret the way of design. With his concept of the dialectic interrelationship between "form of work" and "form of art," Boetticher at the same time develops the early dogma of functionalism, the dogma of the adequacy of form and function. However, this is still an aesthetic functionalism inasmuch as not man is directly regarded as the content, but the logical design of space, which means a static purpose and its representation by art. However, Boetticher's theory of building as a function of material and design did preserve the societal element, yet without referring to it explicitly. Thus, Romberg, the editor of "Praktische Baukunst", in his article entitled "On Building our Present Dwellings," in 1850 demanded that "houses be built from the inside out, starting from the needs of their inhabitants."

In 1846, Boetticher held his speech on Schinkel, in which he further expanded the theory that it is ultimately the mode of design and construction which determines space and all its components, from which he draws conclusions about the ways in which a new art of building could be made to work: "He postulates an architecture of tensile stresses, saying that the future belonged to iron architecture .... In 1846, this is not really a revolutionary view, but to the best of my knowledge nobody has found more valid reasons for the need for iron architecture than Boetticher." (Posener, 1981, p.11).

In the same speech, following up on the battle of opinions in the theory of architecture about true style, he raises the decisive question: "How is a new way of building conceived?"

His reply is the thesis that the key to each new way of building, be it Hellenic-Roman or Germanic-Gothic in its structural design principles, especially lay in the system of the ceiling, which formed space. For: "The essence of any original style of building is expressed in the system in which the ceiling covering a space is organized in distinct sub-units or structural elements and arranged spatially ...." He is correct in remarking that there are only three structural forces "which can be exploited in building and .... which are included in matter as absolute, relative and reactive strengths against rupture, fracture and compression."

In the course of history, the "Hellenic way of building" used relative strength in the form of a stone span ceiling. In Roman arches and vaults, reactive forces were already exploited, but only in the pointed arches of Gothic-Germanic buildings were they fully expressed structurally.

At the same time, Boetticher finds that the historic mission of stone building construction had been fulfilled in its "cantilevered ceiling systems". A new structural system could not be "formed" of stone only. "Both the moments of reactive and relative strength of the stone have been fully exploited. A new, still inexistent system of a ceiling which, of course, will immediately entail a new thesaurus of forms of art, therefore can materialize only as soon as a material not unknown, but not primarily used for such application hitherto, begins to be accepted. It would have to be a material which, in a static structure, produced a lighter and, at the same time, wider

spanned and yet more reliable ceiling system than could be achieved by the exclusive use of stone. When employed to create spaces and design structures, it should be able to match any form of plan and space meeting the needs of human life. At the same time, at a minimum of material expenditure for the enclosing walls, especially the tremendous masses of abutments weighing so heavily on stone arch systems would no longer be necessary. Finally, the whole load of the ceiling system could be reduced to a vertical pressure, that is to say, to the reactive strength of the walls and supports." (Boetticher, 1846, p. 23).

"Such material indeed is iron, the use of which for such purposes has already begun in this century. It will certainly be iron which will be used as a basis for ceiling systems, once its structural properties have been more thoroughly examined and more fully recognized, and for structural purposes it will rise above Hellenic and mediaeval building construction systems in the same way as the floor and ceiling systems of the Middle Ages were superior to the monolithic stone span ceiling systems of the old world. Aside from easily destroyed wooden ceilings, which cannot be used for comparison in this respect, and expressing these statements in mathematical terms, one can say that indeed it is iron which introduces into the art of building construction also the last of the three structural forces, hitherto unused, namely absolute strength." (Boetticher,1846, p. 24).

After this plead in favor of a new iron architecture, which is advanced with an engineer's logic, readers now would expect that Boetticher, in seeking to achieve the truth in building construction he had demanded as a function of the material and of structural design, would help iron to come into its own. He might be expected to demand visible iron architecture with its structural members, such as stanchions and load bearing components, fully visible. After all,there already existed in those years large halls made of glass and iron, which embodied this principle; just remember the work by Labrouste, Fowler, Rouhault, Turner, etc. However, Boetticher hesitated to take this step towards "practical aesthetics," which would have helped to launch an individual style of iron architecture. His proposal of "a completely new way of building" was satisfied with using the tensile strength of iron only in anchor beams. Essentially, Boetticher stuck to types of application that had already existed in Renaissance building, a style he had never estimated very highly.

As far as outward appearance is concerned, he insisted that the Hellenic principle of form be applied according to which "the members of structural forces" had to be represented and explained by ornaments of art. The result of this surprising synthesis is the "veiling" of iron. One of its main functions is to ensure the "most extensive spans" for the star rib design.

"For, how and in what artistic shape the structural and space forming character could be expressed in that newly structured system of ceilings is a question answered very easily by anybody thinking about this concept. Nor is there a need to explain, from the technical side, that iron as a material prepared for structural forms not only can be completely protected against destruction by oxidation when galvanized or coppered chemically, but such cladding would also enclose the iron in a thickness necessary to allow the decorative forms to be expressed in it which each part of the ceiling should have," (Boetticher,1846, p.24).

We quoted so extensively from the writings of Boetticher published shortly before the beginning of the second half of the century because sentences clearly indicate the dual nature of aesthetic theory in the

nineteenth century, which also influenced the practice of iron construction.

On the one hand, building is to be modern, practical and true, but the truth of the time, namely growing industrial production, was not recognized. The consequence of this suppression was even stricter submission to the laws of industry: Mass ornaments made of tin, copper, plaster and stucco were the renaissance of the "decorative form". Structural designs are not explained, but removed from view in artistic "transfiguration". Eclecticism in the second half of the century could not have thrived, even economically, without ornaments manufactured on an industrial scale.

In the case of Boetticher, the disparity between the ideal art of building and reality can still be explained by the sluggish development of industry as reflected in the production of iron. However,it is surprising to see that, roughly at the same time, 1849, a theoretical tendency was articulated in Britain, against the background of a growing industry, which radically rejected the use of iron in architecture.

The illusion, still fostered by Schinkel's school, that building could be reserved to the crafts, could no longer be maintained in Britain, where the destruction of crafts by mass production was going on. In view of the complete revolution of the methods of production and, thus, also of culture, architectural theory can no longer exist for its own sake, which it still could in Boetticher's case, but must expand into comprehensive social criticsm.

In this way, John Ruskin's treatise, "The Seven Lamps of Architecture", becomes an accusation against "technical progress" threatening to overthrow the established social order.

Ruskin's views about the emergence of a new art of building are pessimistic compared with Boetticher, but he also expresses himself in favor of ethics of architecture, "a true art of building," which gets rid of all "petty dishonesty."

Among the main architectural deceits he counts structural deceits, deception about the material employed, and the use of "cast or machine made ornaments." His view, as that of Boetticher, is trained by looking at Gothic architecture: To him, architecture is structural design improved by ornaments. Architecture, in his view, is produced by what, basically speaking, is dispensable. This reminds one of the sentence by Karl Kraus that architecture represented things superfluous elevated to the level of necessities. All the more important is the truth of ornaments, which is human labor turned into objects. Viewers enjoy them by experiencing once more the trouble and the time taken to make them.

"This results from our consciousness of its being the work of poor, clumsy, toilsome man. Its true delightfulness depends on our discovering in it the record of thoughts, and intents, and trials, and heartbreakings - of recoveries and joyfulnesses of success: all this <u>can</u> be traced by a practised eye; but, granting it even obscure, it is presumed of understood; and in that is the worth of the thing, just as much as the worth of any thing else we call precious. The worth of a diamond is simply the understanding of the time it must take to look for it before it is found; and the worth of an ornament is the time it must take before it can be cut ... Machine ornament pretends to a worth which it has not; it is an imposition, a vulgarity, an impertinence, and a sin. Down with it to the ground, grind it to powder, leave its ragged place upon the wall, rather; you have not paid for it, you have no business with it, you do not want it. Nobody wants ornaments in this world, but every body wants integrity... Leave your walls as bare as a planed board, or build them of baked mud and chopped straw, if need be; but do not rough-cast them with

falsehood," (Ruskin, 1849, p. 49).
Ruskin extends his rejection of machine punched ornaments to all machine production, consequently also to iron as a building material. For, if truth were demanded in an ornament, application to iron architecture would introduce into this concept the hateful machine work of ornaments. In his rejection he personifies iron and, referring to the collapse of Woodwich Pier, talks of the "anarchy of iron", a substance over the crystalline components and decomposition processes of which no builder had complete control (Ruskin, 1849, p. 76). On the role of iron as a building material, Ruskin comments as follows:"This rule is, I think, that metals may be used as a cement but not as a support .... But the moment that the iron in the least degree takes the place of the stone, and acts by its resistance to crushing, and bears superincumbent weight, or if it acts by its own weight as a counterpoise, and so supersedes the use of pinnacles or buttresses in resisting a lateral thrust, or if, in the form of a rod or girder, it is used to do what wooden beams would have done as well, that instant the building ceases, so far as such applications of metal extend, to be true architecture," (Ruskin, 1849, p. 38).
Now, basically also Boetticher is against the use of iron, if its structural function, e.g., when used as a girder, does not express a structural principle that is new compared to stone building. However, Ruskin' s criticism points in a different direction: True architecture in principle excludes the use of iron as a structural material, (Ruskin, 1849, p. 39).
At the time this utterance was made, Britain produced 2.25 million tons of iron, which was half the world's production (for comparison, Germany produced 0.210, which is less than one tenth the British output) (Kohlmaier/Sartory, 1981, p. 228).
Despite his bias, Ruskin is much too intelligent to fail to predict in theory a propagation of iron building construction, namely, in connection with the development of "a new system of architectural laws adapted entirely to metallic construction," (Ruskin, 1849, p.36).
After all, he has already been a passenger on some of the trains leaving from Paddington Station. Here he must tolerate physically what he rejects from the bottom of his soul. Out of this shock, he clairvoyantly formulates one of the fundamental reasons for rejecting iron structures. As in the case of ornament, it is again the concept of time:
Like trains, the station hall with its busy life represents the restless world of production, the endless turnover of persons and goods, the utilization of time as the most important factor. How should this leave architectural space untouched? The death of ornaments has already been prepared by the increased haste of movement, the impossibility of contemplative perception, by new viewing habits. "Another of the strange and evil tendencies of the present day is the decoration of the railroad station. Now, if there be any place in the world in which people are deprived of that portion of temper and discretion which are necessary to the contemplation of beauty, it is there. It is the very temple of discomfort, and the only charity that the builder can extend to us is to show us, plainly as may be, how soonest to escape from it. The whole system of railroad travelling is addressed to people who, being in a hurry, are therefore, for the time being, miserable. No one would travel in that manner who could help it - who had time to go leisurely over hills and between hedges, instead of through tunnels and between banks; at least those who would, have no sense of beauty so acute as that we need consult it at the station. The railroad is in all its relations a matter of earnest business, to be got through as soon as possible. It transmutes a man from a traveller into a living parcel ... Do not ask him to admire

anything ... Carry him safely, dismiss him soon; he will thank you for nothing else. All attempts to please him in any other way are mere mockery, and insults to the things by which you endeavour to do so... Give large salaries to efficient servants, large prices to good manufacturers, large wages to able workmen; let the iron be tough, and the brickwork solid, and the carriages strong ... to increase expense in any other direction is madness. Better bury gold in the embankments than put it in ornaments on the stations. Will a single traveller be willing to pay an increased fare on the South Western, because the columns of the terminus are covered with patterns from Nineveh? He will only care less for the Ninevite ivories in the British Museum .... Railroad architecture has or would have a dignity of its own if it were only left to its work. You would not put rings on the fingers of a smith at his anvil," (Ruskin, 1849, p.111).

The debate between the architect, as the carrier of aesthetic theory, and the engineer was won by the latter. Engineers implemented in practice what the proponents of architectural aesthetics basically did not want to do, despite their theoretical insights: Their aesthetic systems, developed in seclusion from the engineering sciences, firmly rooted in the past, could not be transferred to iron construction. The old structural system of stone building, the rigid systems of structural members, which did not know bending stresses and made only limited use of tensile stresses, still were the concrete ideal of beauty in art: Its secret lies in the anthropomorphic equation expressed by this architecture, in its representation of imposing and carrying loads.
Every break in a brickwall has been wrestled from statics, light is admitted to rooms only in carefully chosen ways. Iron structures with their possibility to create absolutely bright spaces are based on completely different viewing habits, which had to be synchronized with industrial development.
This process adaptation of the eye and, at the same time, the abandonment of dear former viewing habits were slow and painful experiences in the lives of people in the nineteenth century, just as their accommodation to the new types of work and the value put on time: The concepts of space and time are most closely interrelated. For, space can be opened up by human action. Without any compassion, the new space designed by iron architecture is displayed where the intersections of urban traffic form: not in cultural buildings, but in buildings owing their existence to a large city, such as railway stations, factories, market halls, world exhibitions - giant bazaars on the move.
The theory of architecture, with its orientation chiefly towards the preindustrial era, ever disinterested in profane architecture, was unable to supply an aesthetic theory of iron even for the mere purpose of supporting practical reality. As a consequence, engineers and anonymous military designers were left to cope with the aesthetic design of their structures almost without any outside help. What is so striking about the architectural theory of new rationalism,which extends from Durand, Boetticher, Semper to Viollet-le-Duc, is the dual face of its utility concept: The needs of the time should be met by the simplest and most straight-forward means and structural design and ornament should become a unity. At the same time, people like Semper regarded iron architecture as being devoid of any power to create a style, which means that they disregarded the simplest and safest means of modern architecture.

Notes

Carl Gottlieb Boetticher, Die Tektonik der Hellenen, Berlin, 1843.
Julius Posener, Schinkelreden, Berlin, 1981.
Romberg, Über den Bau unserer heutigen Wohnungen, in "Zeitschrift für parktische Baukunst," 1850, 10, pp. 195 ff.
John Ruskin, The Seven Lamps of Architecture, London, 1849.
Gottfried Semper, Wissenschaft, Industrie und Kunst, Mainz and Berlin, 1966.
Eugène Viollet-le-Duc, L'Architecture raisonnée, Paris, 1964.
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PROTAGONISTS OF IRON BUILDING CONSTRUCTION IN THE SECOND HALF OF THE NINETEENTH CENTURY

Barna von Sartory

Protagonists of iron building construction are characterized less by so-called inventions of a technical or artistic nature than by their ability to absorb the existing historic substance of architecture, namely structure and space, and adapt it to changed social conditions in the light of new problems.
What is called progress in architecture basically stems from modest, but specific, interventions by individuals step by step elevating building design to higher technical and aesthetic levels and creating new, different spaces.
Thus, the use of iron as a building material in architecture per se does not constitute progress. It all depends on the way in which the very nature of this material is conceived and brought into harmony with the essence of a building.
In a fundamental distinction relative to stone and wood building, iron construction can develop only in an existing industrial production environment, as is well known. At a certain level, the nature of iron is developed not only by intuition, but by the exact sciences initiating and controlling its production process. The work incorporated in a structural component made of iron assigns to that part a high value, thus forcing it to be used only sparingly in most applications, i.e., restricted to the optimum structural minimum. Where iron is used in building construction, new problems are involved: The needs for enlarged spans and reduced structural cross sections as required for bridges, railway station halls, markets, factory halls. The ability of iron to accommodate high tensile, compression and bending forces and the possibility to shape iron and thus, as in the parabolic arc, almost retrace the flow of forces inside the material, has enabled this material to fulfill these new duties.
In solving these problems, the man to control iron construction from the beginning was not the architect, but the engineer. For only he was accustomed to making full technical use of the characteristics of a material not yet fully investigated and, in doing so, proceed along unconventional lines: He dared to risk experiments. Above all, however, he was always able to build as a function of the material. Nevertheless, the right way towards developing an iron architecture fitting the needs and characteristics of the material and having a correspondingly useful thesaurus of forms was not at all clear from the outset.

Unencumbered with questions of style, the designing, as a function of the material, of such structural parts as beams, arches and girders, the shaping of sections with optimum load bearing characteristics, but also the aesthetic appearance were debated violently and controversially. The results obtained in practical building construction were very rapidly publicized in the engineering journals and included in the theoretical discussion. A particular position in engineering designs made of iron was held by the girder and beam systems made of cast iron or wrought iron and the lattice work known for a long time in timber construction. Initially, the correct shape of a beam as a ceiling support played a main role. The shape was the I-beam with a web, a top and a bottom flange, whose load carrying behavior could be improved even further by shaping it as an arch when using brittle cast iron of low tensile strength.
Although spans were then still relatively modest, straight beams could be extended by bottom trusses consisting of a central stiffener and a round bar. This type of beam, a fixed triangle, was combined by