

Large-unit machine works of the A. E. G. in Berlin.



Turbine factory of the A. E. G. in Berlin.

The Aesthetics of Industrial Buildings

Beauty in Perfect Adaptation to Useful Ends

By Prof. Peter Behrens

A DISCUSSION ON "Aesthetics and Industrial Buildings," on account of its close connection with the problem of modern civilization, is one of the most important of present-day unities. While our age is in its achievements inferior to no other age, its characteristics are of a different kind. The most imposing manifestations of our capacities are, in fact, the results of modern engineering. Our advances have created an astoundingly high standard of material life, such as had never been reached before in history.

While life without the material benefits of modern engineering and its unceasing progress would be now unthinkable, modern life exhibits a pronounced craving for culture and a keen longing after civilization in all fields of art. Still, modern life fails to show the characteristics of a mature civilization, there being no contact between the realms of art and engineering. While architects frequently are still intent on deriving their æsthetical values from the forms of past centuries, engineers in their constructions are only interested in construction itself, and are content with this result obtained by mere calculation. The two important fields of human activity, art and engineering, are thus unfortunately left side by side without any mutual influence, and this dualism of our age prevents the unity in form which is the condition and at the same time the proof of existence of a style, from coming into being.

The last fifty years have placed before the engineer tasks so difficult that his ingenuity was alone at work, leaving him no thought for æsthetic creation. Still, his productions often are not lacking in a certain beauty, e. g., in large iron halls with their lofty roofs, which give an impression of grandeur. To these may be associated extensive factors and other buildings, that are closely connected with industry or traffic.

In connection with the high-tension works of the Allgemeinen Elektrizitäts Gesellschaft, near the Humbolthain, built by myself in 1909, I endeavored so to arrange the various parts of the building in the ground-plan that they might form with the existing structure compact courtyards

as large as possible, which would be of importance not only from an æsthetic point of view but at the same time for the operation of the works. Moreover, the forms of the façade had only to be adapted to the laws of proportion without using any ornamental decoration, so as best to become an exterior expression of the interior. The working out of the designs for the turbine-hall of the Allgemeinen Elektrizitäts Gesellschaft, in Huttenstrasse, offered special interest from the combined use of the two materials, iron and glass. Iron has facilitated the present success of statics in allowing the minimum of material to be ascertained for each given construction. It exerts, as it were, a dematerializing influence. Architecture is formation in space. In order to insure space effects as complete as possible with iron and glass as building materials, the hall was constructed of three-joint arches, warranting the greatest obtainable clearness of space. In order to insure the desirable compactness of form in external appearance, an impression of plane walls limiting the structure had to be obtained. This seemed to be best realized by combining the iron and glass mainly in one plane. The compact surfaces thus obtained will more largely give the impression of true surfaces, as the elements of some structural importance produce stronger shadow effects. These binders, visible at the outside, are not made up of a framework, but in order to produce a compact impression, comprise continuous walls.

A compact surface was also produced in connection with the huge front window, which seemed the more imperative as the window of the façade is the carrying part that the heptagonal gable is allowed to rest on. The two corner pillars, being only intended to connect and to close, are made of a different material, concrete, its horizontally arranged structure forming an intentional contrast with the verticality of the construction.

These and similar principles alone will allow compactness and a feeling of æsthetical stability to be produced by means of an iron-glass structure. Without such means this stability, which is distinct from that of the constructive, would be hidden

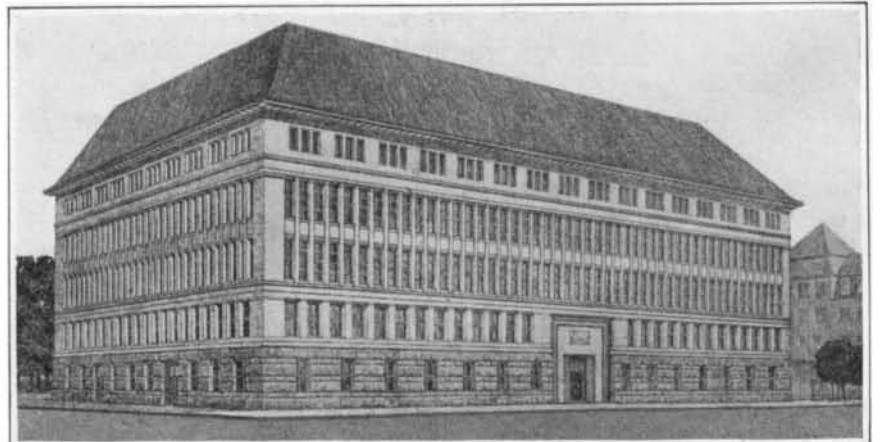
from the eye used to sensuous impressions. Engineering structures are the results of a mathematical mind. Nobody doubts their stability based on calculation, but it is another question whether our eye perceives a dynamical impression of stability, which is an æsthetical condition perfectly complied with, for instance, in the Doric temple.

Architecture always has a tendency to uniformity and compactness. This, instead of by surfaces, can be complied with by a uniform sequence of structural elements. An instance of this is the administration building of the Mannesmann Tube Works at Düsseldorf built by myself, the architecture of which comprises a continuous sequence of pillars. However, this æsthetical intention was at the same time bound to benefit the practical requirements of the building, the arrangement of the ground-plan being based on the idea that instead of delimiting rooms of a given size, by means of masonry walls, each story was to be considered as a free area to be subdivided at will. The powers of organization and the personal liberty of the director of a large industrial works were in fact to be hampered by no pre-established boundaries. The various stories had to be adapted for subdivision into rooms of any dimensions in accordance with actual requirements, producing either a number of small offices or a few straightforward large halls. In the place of outside walls into which the windows are cut, an open system of pillars determining the terminal points of a standard room is therefore arranged, and these standard rooms are separated from one another by removable sound-proof double walls, the space left between the pillars on the window side being used for the installation of shelves for the files. As the corridors are kept clear by the open row of pillars and as they lead in gallery fashion round the courtyard, they can be of a comparatively small width.

It is now interesting to decide who is to design an industrial building. All buildings of previous epochs came from one hand, the architect designing and carrying out simultaneously the expression of beauty and the grandiose constructive idea. This



High tension factory of the A. E. G. in Berlin.



Office building of the Mannesmann Tube Works at Düsseldorf.

is how Signardo the artist used to build fortresses and military machines. Neither the artist nor the engineer can at present combine several special professions. Engineering is a difficult scientific profession which, in view of present-day requirements, demands an absolute devotion. But artistic creation is likewise a profession in itself which fills the thinking and feeling capacities of a man and which like any other profession requires protracted study. However, an adequate appreciation of new creative ideas and higher aims is first of all to be expected from the engineer. I think that the engineering buildings of the future as well as the products of industry will have to be developed to perfection of form. We all feel the incongruity of an industrial building suddenly arising in beautiful scenery, a structure of a style which even in a suburb or industrial town would hurt our feelings, and we therefore think that artistic care should be bestowed on such buildings, to insure a simple

style subject to artistic laws. The question, however, is: Who will have to design such buildings? It is not likely that before a generally recognized artistic tradition has been restored, a special profession, that of the "architect-engineer" should be developed; the nearest future will rather witness a close co-operation of artists and engineers. If our feelings are now hurt by a power-house interrupting the rhythm of lines and materials in an architecturally well arranged street, it is likewise a mistake for the architect designing an industrial building, to cover by his materials all cleverly-calculated constructions, thus adding something quite strange to the purpose and to the internal organism of the building. In fact, the internal organism of a building set apart for industrial use, should be kept especially straightforward, and this organism should give rise to a new beauty, characteristic of the spirit of the times. All great things that have been produced in the world have been the results not of

conscientious professional work, but the outcome of the energy of great and strong personalities. In my opinion it is indifferent whether the conception of important modern works is due to the initiative of a broad-minded technically-skilled architect or of a rhythmically feeling artistically-skilled engineer, or whether a third one as a broad-minded organizer supplies the fundamental idea, associating the architect and the constructor with himself and his work. The main thing is that the character of modern style should be realized and carried out and that such architects and engineers as possess the required creative power and sure stylistic feeling, should get recognition. Industry is in a position to create great values of national and economical importance, the general rise of taste being after all an economic problem. This entails a conversion of intellectual work into material factors. The culture of taste pervading a whole nation is after all a testimonial of the capacities of the nation.

Gustave Eiffel

Builder of the World's Highest Structure and One of the Foremost Authorities on Aerodynamics

ALEXANDRE GUSTAVE EIFFEL was born at Dijon, December 15th, 1832. Immediately after graduating from the Ecole Centrale des Arts et Manufactures, in 1855, he devoted himself to the study of construction in steel, which was destined to form his life work.

In 1858 he was intrusted with the construction of a steel bridge at Bordeaux. In the foundation of this bridge Eiffel was one of the first to make use of compressed air. He afterward built the bridges at Bayonne and those of the main line of the Orleans Railway at Floirac and Capdenac, where he applied an improved system of sinking hollow piles with compressed air and the aid of a hydraulic press.

In collaboration with M. Krantz, the Director of the Paris Exposition of 1867, Eiffel made the calculations for the arches of the machinery building, verified, by experiment, the results of his theoretical studies and determined practically the coefficient of elasticity for large iron constructions which is now generally used.

In 1867 Eiffel founded at Levallois-Perret an establishment for iron and steel construction which was operated under his direction until 1890, when it was transferred to a stock company. This company is still engaged in executing very noteworthy constructions in steel and great contracts in general under the direction of Eiffel's former engineers. M. Clery, whose sketch of M. Eiffel is here quoted from a recent issue of *L'Aerophile*, regards the improvements which Eiffel introduced in assembling his structures as the most remarkable part of his work. By these improved methods Eiffel succeeded in placing with boldness and precision trusses and bridges of lengths which were then quite exceptional. In particular, he improved the placing of straight bridges by devising a tipping frame and applying it to spans for which this method was considered impracticable, notably in the case of the Tarde viaduct, which included a span of 330 feet. Eiffel subsequently introduced and made common in mountainous regions the employment of the method of indirect bearing for long straight bridges, like the bridge at Cubzac, and for great steel arches, like those of the bridges at Porto and Garabit. Finally, Eiffel invented and made popular demountable and portable bridges for military and colonial use. He constructed bridges of this type to a total length of many thousands of yards, for which he received a number of prizes.

It is proper to observe that most of Eiffel's commissions were granted as a result of international competitions in which the most important European constructors took part.

In the construction of the first viaducts supported by steel piles at Neuvial and the Sioule River on the railway line connecting Commentry and Gammat, Eiffel perfected this type of construction, which he afterward applied to the viaducts of the Beira Alta and the Douro railways, in Portugal, and to the lateral viaducts at Porto and Garabit, where the highest pile reached the then unknown height of 200 feet.

Among Eiffel's great works may be mentioned the viaduct of the Oise, the railway bridge over the Tarde, the railway and carriage bridges over the Tagus and at Vianna in Portugal, the Cubzac bridge over the Dordogne, a number of bridges in Cochin-China, the great arched bridge at Szegedin in Hun-

gary, the bridge at Porto over the Douro, in Portugal, and the bridge of Garabit on the railway line between Marvejols and Saint-Flour, one of the most important and remarkable works of the kind in France.

Among other constructions of Eiffel may be mentioned numerous steel frame churches, markets, gas works and railway stations in France and abroad, the Ecole Monge, the Hotel du Credit Lyonnais,



Mr. Gustave Eiffel standing in the experimental chamber of his new laboratory.

the Musée Galliera, part of the Bon Marché shops in Paris, the Custom House buildings at Arica, Peru, the monumental railway station at Budapest, the monumental gallery forming the principal façade of the main building of the Paris Exposition of 1878, the wharves of the Paris Gas Company at Clichy, the Port-Mort and Port-Villez dams on the Seine, and the dome of the great equatorial telescope of the observatory at Nice. For this last-mentioned work the Academie des Sciences awarded to M. Eiffel the Monthyon prize in mechanics, in 1889.

In 1887 the Panama Canal Company, having decided to abandon the construction of a tide-water canal, intrusted to Eiffel the general plan for a system of locks. Eiffel performed the necessary work with an energy which was universally recognized and which should have assured the accomplishment of the great enterprise, but the work was unfortunately arrested in 1889 by lack of funds and the bankruptcy of the company. In the course of the judicial investigation which followed M. Eiffel was fully exonerated and the injustice of the attacks made upon him was demonstrated by the Court de Cassation from the judicial point of view and by the Council of the Legion of Honor from the moral point of view.

With the exception of the Garabit viaduct, the

most important work of M. Eiffel is the tower, one thousand feet high, which bears his name and stands on the Champ de Mars in Paris. Constructed in connection with the Universal Exposition of 1889, this colossal tower which M. Alphand, at the time of its erection, called the masterpiece of iron construction, has furnished to science a valuable observatory where numerous meteorological and physical researches are continually carried on, and it also affords to the public the most interesting of panoramas. The Eiffel tower, furthermore, is destined to play an important part in wireless telegraphy because of the exceptional height to which the antenna can be carried. The new equipment which is now being installed in the tower by the War Ministry will make this the most powerful station in the world.

Eiffel has acted as president of the Society of Civil Engineers and of the Association of Graduates of the Ecole Centrale. He is an honorary member of most of the great scientific societies of Europe and America, a laureate of the French Institute, an officer of the Legion of Honor, an officer of Public Instruction, a Chevalier of the Austrian Order of the Iron Crown, a Commander of the Orders of Concepcion (Portugal), of Isabella the Catholic (Spain), of the Crown (Italy), of the Holy Saviour (Greece), of Saint Anne (Russia), Saint Sava (Serbia), etc.

Since 1890, after the completion of his career as engineer and constructor, during which he had executed contracts of a total value of \$28,000,000 and had used more than 100,000 tons of iron and steel, Eiffel has devoted himself entirely to scientific research. He has published many scientific works, including an exhaustive monograph on the Eiffel Tower, Practical Studies in Meteorology, a Meteorological Atlas of France, Experimental Researches on the Resistance of the Air, and a great number of articles on meteorology.

Eiffel has undertaken the elucidation by rational and methodical experiments of the aerodynamical problems which the progress of aviation is constantly making more urgent. His studies, which began in 1903, and are still in progress, have already yielded results of the very greatest interest by reason of the errors which they have corrected, the new and unsuspected facts which they have revealed, and their immediate applicability to the practice of aviation. Thus, after so industrious and successful a career, the illustrious engineer will enjoy the additional glory of figuring among the founders of experimental aero-dynamics, and of contributing in large measure to the improvement of purely mechanical aerial locomotion.

Volume of Water Upon the Earth

It is calculated by Halbfass that the total volume of water upon the earth's surface amounts to about 313 million cubic miles, which are distributed as follows:

Ocean	312,000,000 cubic miles
Polar ice masses	840,000 cubic miles
Lakes and ponds	60,000 cubic miles
Rivers	12,500 cubic miles
Atmospheric moisture	2,952 cubic miles
Marshes	1,440 cubic miles
Snow	67 cubic miles

Since the total volume of the earth is 259,000 million cubic miles, it follows that the water constitutes about 1/830th of the earth's total capacity.—*Cosmos*.