The Invention of Glazed Curtain Wall in 1903 - The Steiff Toy Factory

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ABSTRACT: A pioneering iron and glass construction has been preserved in form of a multistorey building of the *Steiff* toy factory in the east Württembergian town of Giengen. Typical of this building is the continuous use of glass as a dominant building material. The construction, as simple as consistent in its type, anticipates attempts of new constructive and formal methods in industrial building, which emerged only in the 1920s in the work of the German architect Walter Gropius. The use of modern curtain walls planned as a double-skinned construction distinguishes the glazed box of the *Steiff* toy factory. It is the intent of this study to show how construction and innovation goes together not only in functional factors, but although in an appreciation for the aesthetic ideals of engineers and their emphasis on efficiency and processes.

INTRODUCTION

In the first decades of the twentieth century the increasing demand of their products forced the *Steiff* toy factory to build a new functional workshop outside the town of Giengen. The first new building was the three-storey industrial loft opposite the medieval city centre, nearby the small river Brenz and the railway station – see fig. 1.

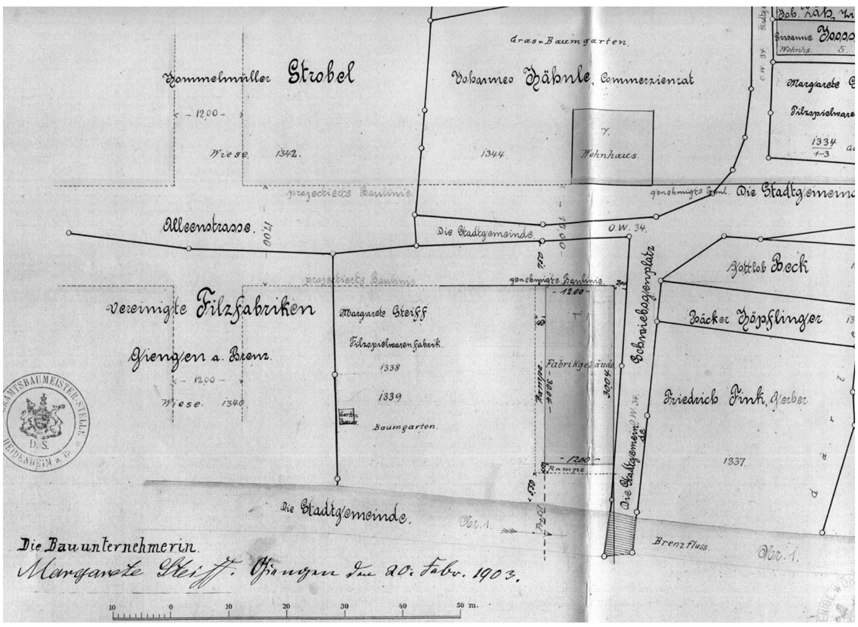


Figure 1: Site plan of the building permission, 1903; (Bauordnungsamt Giengen)

Typical of this iron skeletal construction, erected in 1903, is the continuous use of glass as a dominant building material, completely standing in contrast to the stately office building, constructed only a few years before. Yet the economical conditions that required the construction of further buildings became decisive only a year later. In 1904 the factory carpenter's shop designed a secondary building differing from its predecessor only in the material, a wooden load-bearing structure. In addition to these two workshops another building was erected behind the office building in 1908. All these three buildings were perfectly adapted for, and even erected for, industrial use – see fig. 2. Nevertheless, the *Steiff* toy factory intended the building to be representative of the considerable financial investment and hope for continuous economic success. The choice of a brand new aesthetic engineering ideal and a unique construction for the time hence shows the prominence of the manufacturing works in a rural location that Giengen was in these days. The construction of the factory buildings, as simple as consistent in its type, anticipates attempts of new constructive and formal methods in industrial building, which were to emerge only twenty years later with the glazed box of Walter Gropius`s Bauhaus School in Dessau, one of the icons of the new international style of architecture. In the following study the focus will be directed to the oldest building of the industrial complex, which was erected in 1903 next to the city.

Figure 2: Aerial view of the *Steiff* factory, 1910; (Historical Archive of the *Steiff* Factory, Giengen)

CONSTRUCTION AND FORMAL ANALYSIS

The eastern building of the *Steiff* factory represents the most advanced structural techniques available at the time. The riveted and wind-braced steel frame was the creation of the *Eisenwerk München AG*, but the man who fathered the original idea was the nephew of Margarete Steiff, Richard.
The three-storey industrial loft, covering an area of 12 to 30 meters, has a steel and iron skeleton with three naves and a slightly inclined single-pitch roof made of galvanised iron sheet. Inside it is divided in five bays by six load-bearing pillars each – see fig. 3.

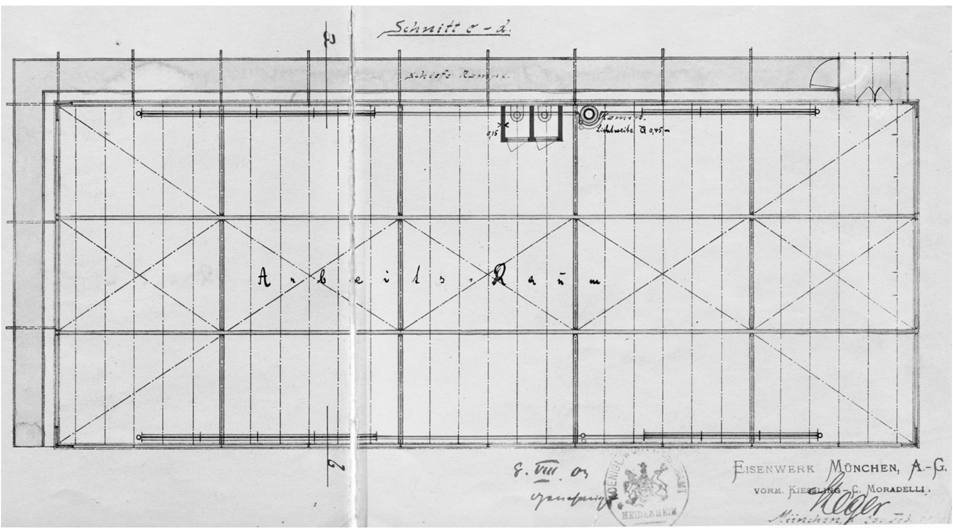


Figure 3: Second floor plan of the building permission, 1903; (Bauordnungsamt Giengen)

The single elements of the skeletal construction are formed according to their different functions. The main structure of the building consists of four L-shaped external pillars, riveted of several plates and angle steels according to the Grey system. They are linked with a lattice truss running around, which is set in concrete, thus guaranteeing the solid fastening of the frames. Additionally this lattice truss is the basement of nine columns of I-section in the longitudinal walls each, simultaneously transmitting the forces onto the building ground. Inside as well as on the two quoins, the load-bearing pillars are composed of two U-shaped beams, connected by small sheet metal strips. These pillars are connected each with two long I-shaped girders in each floor. Furthermore the weight-bearing structure is protected against wind pressure by diagonally buttressed Hourdis-ceilings. The longitudinal walls are additionally reinforced by two long diagonal braces on each side. This composition of rigid frames, diagonally buttressed ceilings and other bracing elements are giving a rigid three-dimensional structure to the building – see fig. 4 (Building application, Bauordnungsamt der Stadt Giengen).

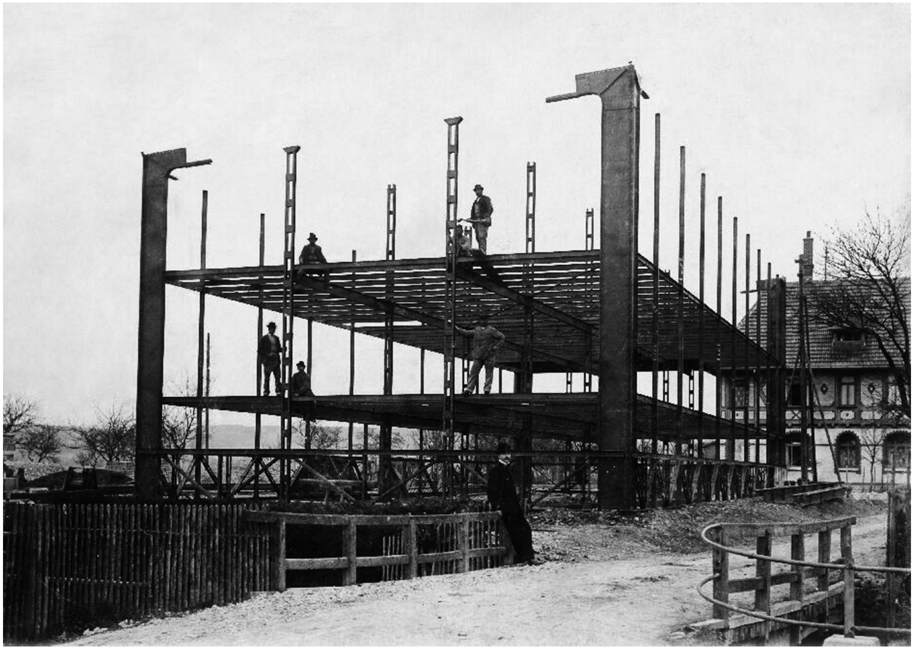


Figure 4: Construction site of the factory in 1903; (Historical Archive of the *Steiff* Factory, Giengen)

The external cover of the building was an innovative construction, consisting of a total floor-to-ceiling glazed double skin façade. The inner glazing of this façade goes from the upper edge of the floor to the lower edge of the ceiling, whereas the external façade covers the total height of the building. The specific characteristic of this external cover appears in its construction to be a pure curtain wall, as it is only fixed by butt straps punctually attached to the structure – see fig. 5 and 6.

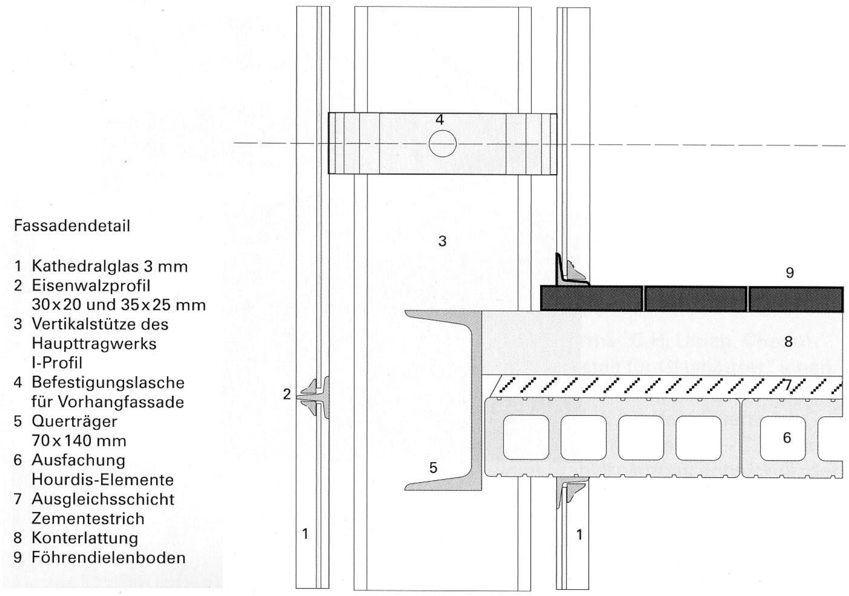


Figure 5: Section detail showing the butt strap (4) attached to the pillar; (Meyer 2003, p. 94)

Figure 6: Butt straps punctually attached; (Weidner 1970, p. 231, fig. 7)

Both glazings only have to carry their own weight and the wind pressure, but no load from the building itself. The double skin façade shows an independent, self-supporting construction. Based on an uninterrupted expanse of iron-framed sash, the curtain wall of the *Steiff* toy factory as well as the total construction of the building, shows a regularity of form and articulation imposed by a rationalised simplicity in design and the continuous use of prefabricated elements. But also with regard to structural physics this construction was an innovation, since from the very beginning the façade had been planned as a double-skinned construction for heat insulation. The thermal insulation is achieved through an air film of approximately 25 cm between the two glazings. The air exchange is effected by box-type windows in every floor, which don't reduce the insulating effect to the stagnant air film. Additionally, the building was equipped with a new heating system, a low-pressure steam heater, guaranteeing an ideal indoor temperature (Building application, Bauordnungsamt der Stadt Giengen; Weidner 1970, pp. 229-232).
The curtain wall engineered by Richard Steiff and built in Giengen is in accordance with the definition of a curtain wall given by Rolf Schaal in 1961. According to Schaal curtain walls are non bearing walls, enclosing a building and fixed in front of the structure. The dead load of the iron-framed sash and the wind pressure are transmitted by butt straps punctually to the construction. The design of joints between the single elements of the curtain wall and the way of fastening allows the production of uninterrupted walls of any dimension (Schaal 1961, p. 11). Thus, we can state that the *Steiff* toy factory has the first glazed curtain wall, erected fifteen years before the Hallidie Building in San Francisco, generally known as the earliest glazed curtain wall in the history of architecture (Wigginton 1997, p. 54).
In the last decades of the nineteenth century, due to a multiplicity of technical innovations in the field of building materials, iron and glass constructions asserted themselves mainly in industrial buildings. However, the majority of industrial lofts and production sheds were still built out of conventional materials like wood, brick, or stone. The consequence of using these materials is a quite simple method of construction with a system of load-bearing pillars inside and solid walls around the building. The load-bearing structure was often made of wood, assisted by solid masonry to ensure a sound basement for heavy machines stored in the upper floors of multistorey workshops. Not until the diffusion process of mouldings made from cast iron and a few years later of steel was developed, the industrial architecture started to change.
A closer look to the industrial architecture in the last decades of the nineteenth century and the first decade of the twentieth century, reveals that many "start-up" quarters of successful industries were arranged like small rural villages with a variety of different buildings. B. Hunter Bradley described the intention of these arrangements in the following way: "The importance of a good location and the adaptability of industrial lofts and production sheds to different kinds of manufacturing operations led to their use by several operations." (Hunter Bradley 1999, p. 26).
Neither specification for several manufacturing operations nor special type of building existed. The industrial lofts could be used for different purposes, for example, first as textile mills and later as machine factories. Irrespective of any use the most important parameter of planning was the supply of daylight in work areas. The natural consequence of this premise was a clear structured ground plan of industrial buildings. Most of these are divided by two rows of columns into three naves. The two naves along the external walls are reserved for the operations in need of the best lighting. The inner nave, where the lighting conditions were the poorest, was used for storage and as a transportation corridor. Opposite to that, the glazed façades of *Steiff* toy factory allows regular lighting conditions so that the three naves are only explained by constructive reasons. The external walls of the *Steiff* factory show a totally different and independent design in contrast to their surrounding architecture characterised by the use of local building traditions and materials.

The author of this industrial building, as impressively simple as effective, was Margarete Steiff`s nephew, Richard Steiff, who, after having finished an education at the Kunstgewerbeschule of Stuttgart and a journey to England, tried to create a new connection of form and function in industrial building. Perhaps Richard Steiff took over some constructive ideas from his father, Friedrich, who was employed in the constructive sector.
Friedrich Steiff might have been influenced by new iron-glass constructions when he visited the Great Exhibition in Chicago in 1893. Typical for office architecture in Chicago in these times was a steel-frame construction with masonry cladding, which allowed large glass window areas, the so called Chicago window. It fills the whole expanse between two columns and consists of three parts, a larger middle section and two sliding windows. We can assume that Richard Steiff absorbed the new ideas of industrial design and construction and not only tried to realise them, but also tried to improve them (Reiff 1992, pp. 2520-2522).
As well as the invention of the mechanically produced teddy bear the modern way of construction for his factory design allowed the realisation of new production methods and new working conditions. As can be seen from his application for planning and building permission, the working hygiene played a very important part. Especially daylight work was an important intention, which became practicable because of the glazing cover. The positive qualities of this special kind of architecture are, however, reversed by intensive solar irradiation. The application of curtains was thought to avoid the strong warming of the building; but only the later installation of ventilators made it possible to solve the problem. Symptomatic of the modernity of the architecture are the concerns of the authorising agency, which feared the workers would go blind in a glass house. But this was the only exception, when the *Steiff* company achieved the planning and building permission by the locale authorities. Even the Württembergian Ministry of Commerce and Industry had raised no objection. The construction was even so effective that in the following years the company was building other full glazed buildings.

PROTOTYPES AND INFLUENCES

Wheras the *Fagus* factory of Walter Gropius and Adolf Meyer, built in 1911 in Alfeld, obtained international reputation, the *Steiff* factory building fell into oblivion and was not given any attention in history of architecture for a long time. Most value was attached to the glazed corner of the three-storey high main building of Fagus factory, which was built without a pillar, but with a single glass panel and iron sheets on the level of the ceilings. In contrast to the *Steiff* factory the main building of *Fagus* was not used for production, but only for administration. Moreover its glazed façade does not consist of two, but only one glass panel – see fig. 7.

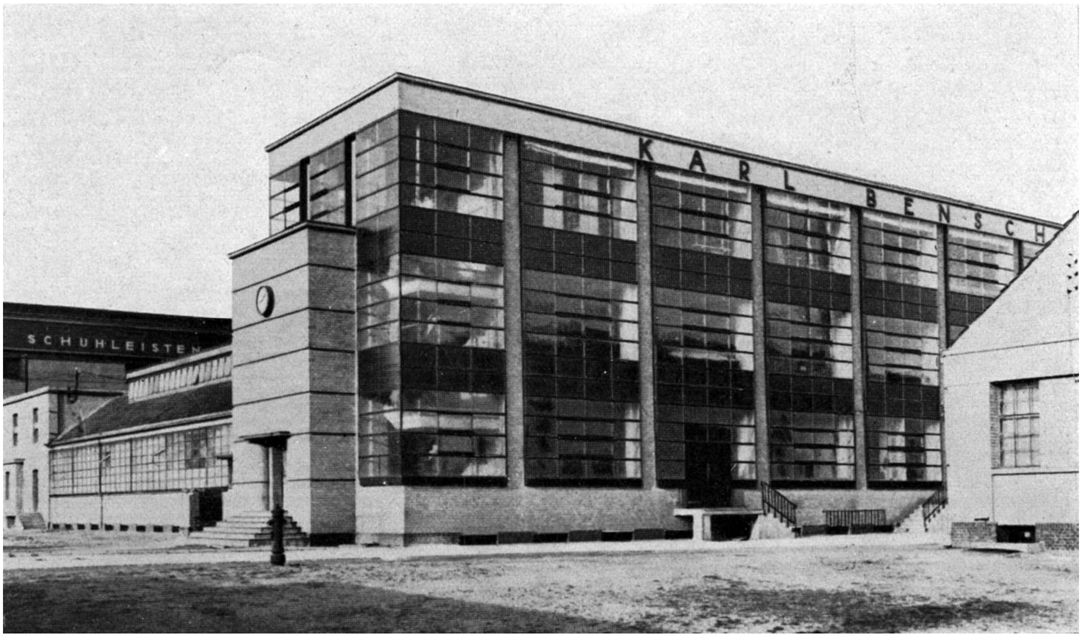
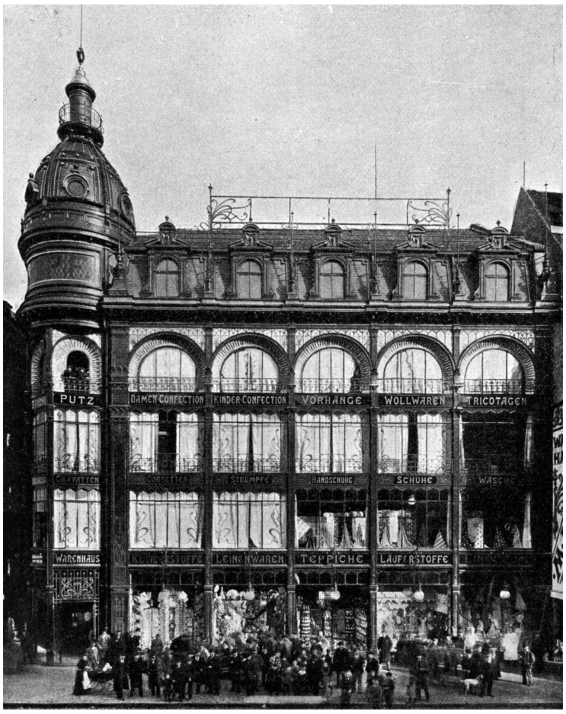
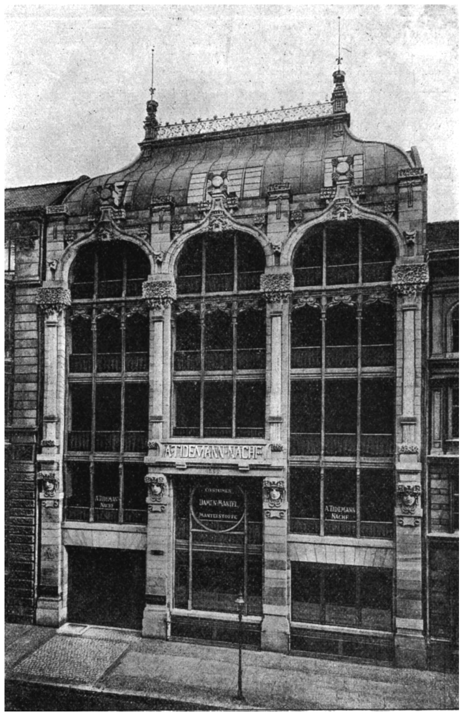


Figure 7: Glazed corner of the main building of *Fagus* factory; (Schulze 1929, p. 12)

Thermal insulation was therefore a problem, which was not solved. Still in the 1960s Walter Gropius, who might have known the *Steiff* factory building, describes himself as the first architect using a real glazed curtain wall ignoring the fact that the curtain wall construction of *Steiff* factory is eight years older and much more consequent in its use of a nonbearing transparent façade (Weber 1961, pp. 60-64).
Glazed façades covering several stories between load-bearing pillars had, however, already belonged to the repertoire of European department store architecture before. Fig. 8 shows the department store *Knopf* in Straßburg, build in 1898, where the glazing consisted of sashs separated only by iron sheets (Zaar 1902, S. 88).





Figures 8 and 9: Glazed façades of department stores, left *Knopf* in Straßburg, right *Tidemann* in Berlin; (Zaar 1902 , p. 95, fig. 153, p. 60, fig. 95)

In the same year the department store *Tidemann* was erected in Berlin. To obtain maximal incidence of light there were no fillings as parapets in its glazed façade – see fig. 9 (Zaar 1902, pp. 62-64). Exposed riveted- and plated-iron structures and glass infill were also used by Georges Chedanne in his Office Building for *Le Parisien* in 1903. There he used the load-bearing elements as well as the non-load-bearing fenestration with its corrugated-steel sheet spandrels. Famous for its iron-glass-construction became also the second industrial building of Walter Gropius and Adolf Meyer, the *Musterfabrik* for the exhibition of the German Werkbund in the year 1914 in Cologne. The stair towers and the whole upper back façade of the office building were designed by curtain walls. In 1926 the studio building of Gropius' Bauhaus School in Dessau describes the final development in curtain wall constructions.

Still the question remains how Richard Steiff was inspired to his radical way of design for the first *Steiff* building and where he came to know prototypes of iron-glass constructions. The American architecture of the last decades of the nineteenth century was the beginning of essential inventions in skeletal steel-framed construction and application of glass although real glazed curtain walls in multistorey buildings were not yet used. Between 1890 and 1891 the Berlin Iron Bridge Company in East Berlin-Connecticut used uninterrupted expanses of iron-framed sash above a lower brick wall for an 80 feet wide and 400 feet long production shed – see fig. 10 (Hunter Bradley 1999, p. 150).

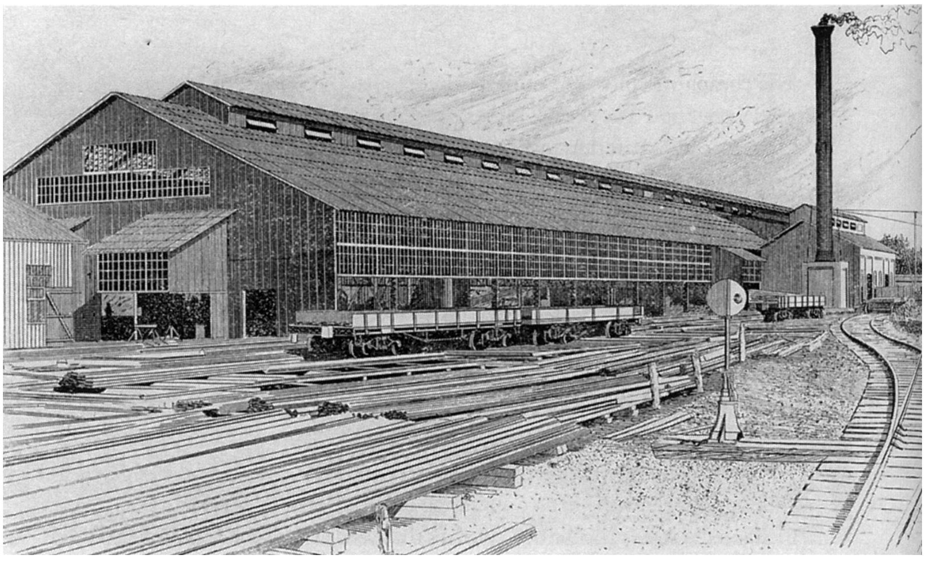


Figure 10: Production shed of the Berlin Iron Bridge Company in East Berlin-Connecticut; (Hunter Bradley 1999, p. 150)

These long building structures were mainly used for heavy metal working shops where cranes are necessary for heavy or bulky work, they had, however, only one storey. Additionally, these buildings required large spaces clear of columns. Only steel construction made it possible to realise long spans and to support the lateral forces of moving cranes. The crane as an essential element of the whole construction is erected together with the load-bearing structure. Because all bracing for the cranes are incorporated into the structures framing, it was difficult to fill the fields between the load-bearing pillars with masonry and to place the window openings the usual way. Furthermore, the protection against corrosion remained an unsolved problem. The invention of brick curtain was a logical consequence. Step by step the glazed expanse was increased, but there was always left a lower wall beneath the sash.
At the end of nineteenth century the production of metal sections enabled by the invention of new manufacturing techniques, like hot rolling processes, allowed standardisation of metal windows and their flexible serial treatment. The new possibilities due to this serial application of steel windows caused a completely change in architectural design. According to R. McGrath and A. C. Frost the curtain wall is only a logical extension of metal window technique (Mcgrath; Frost 1961, p. 164). Still, the invention of the glazed curtain wall must be rather seen as a result of skeletal construction, which not only implicated standardised and serial production methods, but also corresponded to the new requirements of factory buildings, daylight and improvement of work flow. For this reason the real glazed curtain wall was introduced only by multistorey buildings. The first appearance of this pure structure is the *Steiff* toy factory in Giengen.

CONCLUSION

The present example is definitely one of the most important industrial buildings of the first decade of the twentieth century. Far away from industrial regions Richard Steiff succeeded together with the *Eisenwerk München AG* to combine new American construction methods and innovative engineering to create a highly progressive building. Main aspect of his planning was the economically and fast realisation of the building project, which was guaranteed by a high degree of prefabrication and relatively cheap material, iron and glass. Ultimately the success of the teddy bear as a new children's toy in the United States motivated to build a totally new workshop in modern American design giving a new image to the small Württembergian company in the world.
In contrast to the well known modern buildings, like those of Walter Gropius, the *Steiff* toy factory wasn't designed by a famous architect. It was the result of a productive collaboration of the company manager and the engineers of *Eisenwerk München AG* – see fig. 11. In its accordance of form and function, its economically orientated production methods and its uncompromising modernity, which found its expression in the first-time application of the glazed curtain wall, the *Steiff* factory is considered a pioneer work of industrial building without any immediate succession.

Figure 11: The *Steiff* toy factory in the illustrated catalogue of the *Eisenwerk München AG in 1905;*
(Bayerisches Wirtschaftsarchiv, München, BWA, S 12 / 9)

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