

# Determining factors for the architectural development of factory buildings in Budapest between 1860 and 1918

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## Abstract

*The advent of factory building as a construction task in the 19th century was an international phenomenon and soon determined the silhouette of whole cities and landscapes. An understanding of historic factory buildings cannot be obtained solely through the visual approach – albeit these buildings often have their own aesthetic qualities and make a strong graphic expression. In Budapest, it was mainly the food and engineering industries that shaped industrial development in the period under investigation. Identifying the complex factors that led to the construction of this type of building is the first step towards gaining an understanding of such architecture. Technical innovations, new forms of factory organisation, and novel developments in the production process exerted a formative influence on the internal layout of these buildings. The manner in which power was transmitted also served to determine building structures. It should be noted that a factory is established through the combination of machinery and an organised flow of production. At the turn of the century, American models of factory organisation exerted the primary influence on the construction of factories in Europe. At the same time, the transition from traditional craft industries to modern modes of industrial production also resulted in the development of new types of buildings.*

## Keywords

*Historic factory buildings · factory development in Budapest · industrial architectural research in Budapest*

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## Introduction

Research on the history of industrial architecture in Budapest is still in the initial stages. Indeed, the history of this type of building has largely been ignored by researchers, who only in recent years have begun to address the topic and provide an initial impression of the development of industrial architecture in the Hungarian capital. Moreover, most of the industrial buildings that might serve as primary sources for research no longer exist; they can no longer inform us of their design and aesthetics. The demolition of historic industrial buildings represents an irrevocable loss of historical structures with their characteristic details. Further, in the course of my documentary research, I have found that in many cases even the planning documentation and other written records for these buildings are unavailable or inaccessible. Thus, in an effort to broaden the scope of documents relating to the topic, I am currently exploring various public and institutional archives as well as libraries and private collections. The range of potential sources is not limited to planning documentation, but also includes photographic and film material as well as various other secondary sources. Such exploratory research is time-consuming, but it is a fundamental prerequisite if one is to make informed statements on architectural history [11].

Architecture is not neutral. If architecture is an expression of the social mindset, then industrial architecture indicates society's attitude towards working people. For this reason, the emergence of industrial architecture in the 19th century Budapest should not be considered in isolation and can only be understood within the historical context. Therefore, in the course of further research, the following questions need to be answered:

How did the architectural and spatial features of industrial buildings develop in the 19th century? How was building design and structure influenced by the production process and by factory organisation? How did this process unfold?

## Factors influencing industrial architecture

This study deals mainly with the principal factors influencing the architectural design of factory buildings in the period under investigation. In the 19th century, the majority of such factors were new phenomena that only gradually took their final shapes.



Source: Fővárosi Szabó Ervin Könyvtár, Budapest Gyűjtemény

**Fig. 1.** Steam mill in Rákos/Pest, 1862

The factors influencing the architectural design of factory buildings may be divided into four main categories:

### A Technical innovations

- 1 Power source
- 2 Power supply/transmission
- 3 Drive systems
- 4 Mechanical engineering industry

### B Laws and legal regulations

### C Innovations in factory organisation

- 1 Transition from workshop to factory
- 2 Standardisation
- 3 Taylorism
- 4 Taylorism and the impact on building layout
- 5 Structural organisation of the workshops
- 6 Single-storey and multi-storey buildings

### D Innovations in the production process

### A Technical innovations

#### 1 Power source

The source of power had a major impact on the architectural design of industrial buildings, often significantly shaping the external appearance of a building. In historical sequence, the sources are human and draft animal power, wind power, water power, steam power, and electricity.



Source: MÁV archivuma Budapest, rajz szám 6020.0

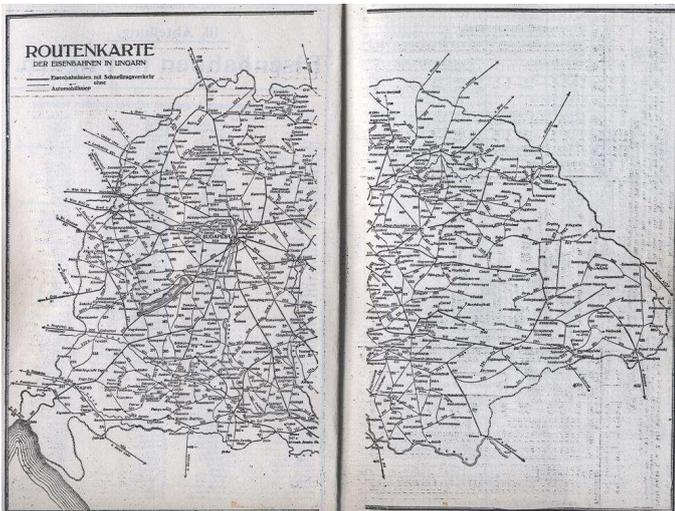
**Fig. 2.** Royal Hungarian Railways, boiler house of the locomotive assembly hall, Budapest, 1845

## 2 Power supply/transmission

In early industrial buildings, the layout of machinery (e.g. spinning machines in the textile industry) was dependent on power transmission and the arrangement of the drive system. By the end of the 18th century, the layout of machinery in the production process and in relation to the power source already had a major impact on the floor plans of factory buildings. Knowledge of an effective layout of machinery and the shortest routes for the transport of semi-finished and finished products was first obtained and implemented in British cotton factories. For instance, when water energy was used, in order to ensure that the transmission belts were not too long, the paddle wheel needed to be placed in the middle of the factory building, in the cellar, or directly in front of the factory. The location of such a factory was also determined by the need for a flowing body of water.

In the early 19th century, wind-power and water-power machinery was replaced by steam-driven machinery. Indeed, in all production fields, steam power became a leitmotif of the industrial revolution, and the chimney a symbol of industrial architecture. Steam power allowed for a degree of flexibility regarding the location of the site, whereby for the first time it was possible to establish large factories in urban areas.

The placement of the power source (whether water-driven or steam-driven machinery) in the middle of the factory represented a transition from the water wheel to the turbine, which increased flexibility. Separate buildings were erected for boilers and steam-driven machinery, and these were mostly accessory buildings with their own chimneys. The machinery and the boilers were placed in separate buildings. In consequence, floor plans were changed, and the powerhouse and the boiler house formed separate buildings. An example is the boiler house of the locomotive assembly plant in Budapest, which dates from 1845. In this instance, the energy source was steam.



Source: www. Magyar vasut.hu (2011-01-15)

**Fig. 3.** Development of the railway network in Hungary between 1846 and 1914

### 3 Drive systems

The introduction of the electric motor in the 1890s resulted in greater flexibility in terms of the manufacturing and tool machinery, as they no longer had to be driven by drive belts, transmission wheels and gear rods. Consequently, a large number of construction solutions, such as brackets, beams and columns, were no longer needed. In the 1890s, the resultant flexibility in planning served to promote the process of rationalisation,<sup>1</sup> establishing forms of rational production. In this context it should be noted that as a result of such developments, factory buildings were no longer dependent on a power centre [15].

### 4 Mechanical engineering industry

At the turn of the century, mechanical engineering was – alongside the food industry – the dominant industry in Budapest; it was also an important site of innovation [7]. An important reason for the establishment of engineering works in Budapest was the increasing demand for high-quality industrial equipment and machinery – a consequence of the development and expansion of the railway network. The first railway in Hungary was built between Pest and Vác in 1846, and the line was extended to Vienna via Bratislava in 1851. By 1914, the national railway network extended to over 22,500 kilometres.

Through the connection of Hungary's railways to the international rail network, a dynamic interaction was created between investment in infrastructure and access to European markets. Raw materials and manufactured products were increasingly transported by rail, and so the proximity of production sites to the river Danube was no longer of major significance.<sup>2</sup> The construction of railways and the awarding of contracts to local companies served, in turn, as a decisive impulse for the

<sup>1</sup> See also the section on Taylorism

<sup>2</sup> The river Danube provided the engineering factories on Váci út and Soroksári út with water for production

development of new industries in Hungary.

Companies that were founded in Hungary as a direct consequence of the boom in railway construction included the Magyar-Svájci Vagongyár (Hungarian-Swiss Carriage Factory) and the Magyar-Belga Gép- és Hajóépítő Társaság (Hungarian-Belgian Machinery and Ship-Building Company). In the 1870s (i.e. shortly after their foundation), both these companies became a part of the Magyar Államvasutak Gép- és Kocsigyár (Hungarian State Railways Machinery and Carriage Company). At first, production focussed on steam boilers, steam machinery and various types of mechanical equipment; subsequently, steam locomotives were built under licence. Finally, at the World Exposition in Vienna in 1873, the first steam locomotive to have been developed in Hungary was presented. By 1880 the Hungarian State Railways Machinery and Carriage Company had produced 38 steam locomotives, in a series production. The production of such a high-tech product serves as evidence for the rapid acquisition of technical know-how – in direct connection with modern manufacturing and assembly processes.

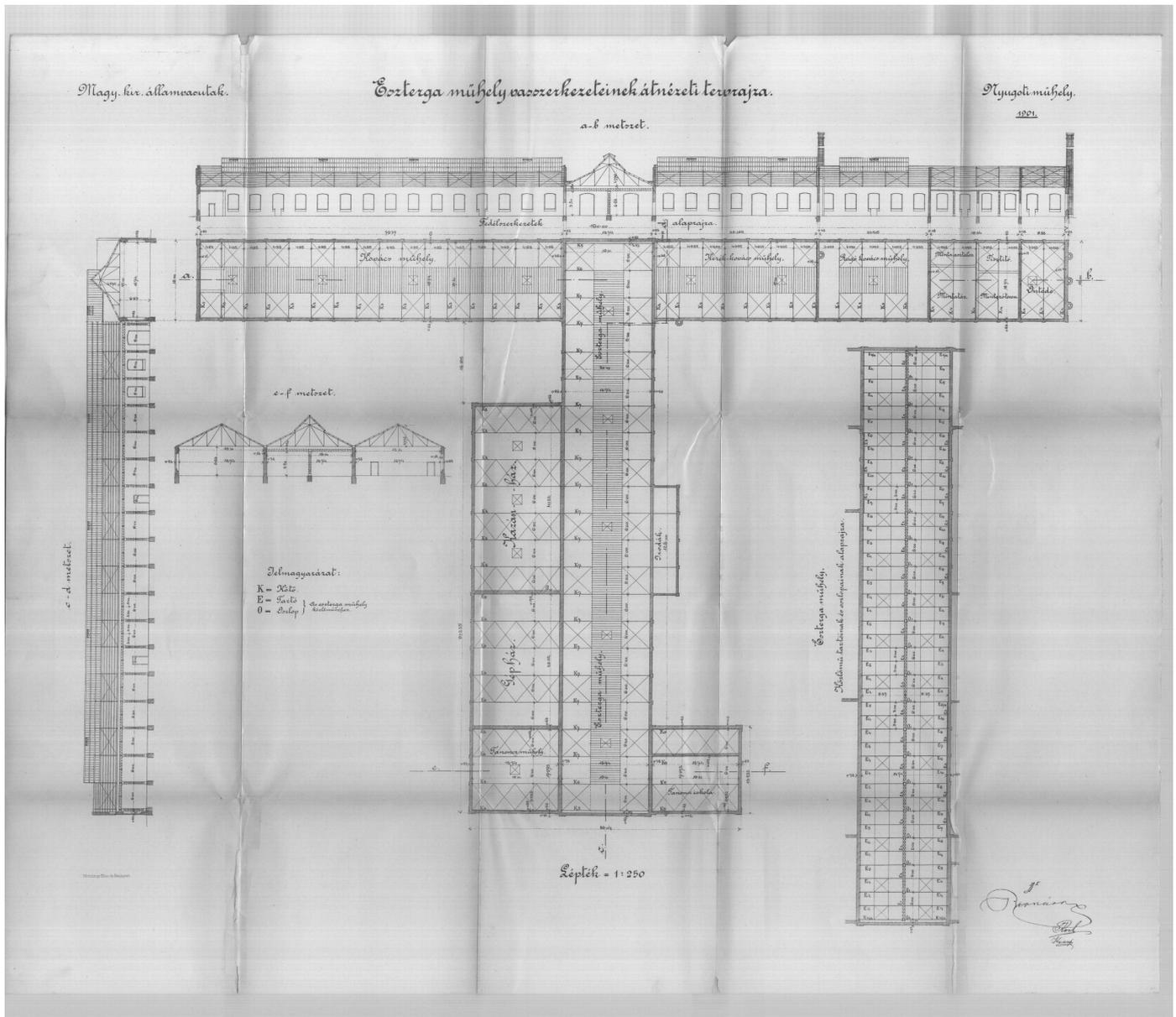
Manual modes of manufacturing – even when such were already mechanised – could not ensure the accuracy and precision required by the components used in locomotive production and engineering. When a series was being produced – such as the previously mentioned 38 steam locomotives – spare parts of consistent quality needed to be available in sufficient quantities, and this factor decisively influenced the production process as well as storage [1]. Terms such as “standardisation”, “consistent quality”, “series production”, and “storage” were introduced at this time, and were indicative of the new forms of factory organisation that were required in order to produce high-value technical products and ensure the profitability of the enterprise. MÁV's specialisation on locomotive production was groundbreaking not only for its use of cast steel and the manufacture of boilers, but also for the construction of large assembly halls. Because Royal Hungarian State Railways produced and serviced the locomotives in its own assembly halls, this enterprise should be classified as mechanical engineering.

In view of its need for precision, the machine tool industry is often considered to be the zenith of mechanical engineering. Hungary's first machine tool factories were established by Gutjahr and Müller, two Swiss entrepreneurs, in Budapest in 1872. These enterprises gave rise to the establishment, in 1894, of the “Vulkan”-Werke. Other important machine tool factories in Hungary were the factories owned by Hirsch und Frank – the Fe gyver és Gépgyár (Arms and Machinery Factory) and the Első Magyar Csavargyár (First Hungarian Bolt Factory).

### Training

In contrast to the textile industry,<sup>3</sup> which tended to employ unskilled workers, the engineering industry (and particularly the

<sup>3</sup> The textile industry otherwise had only a minor impact on industrial development in Hungary



Source: MÁV archivuma Budapest, rajz szám 6021.1

Fig. 4. Royal Hungarian Railways, workshops for lathing and forging, Budapest, Nyugati (Western) Railway Station, 1901

machine tool industry) required skilled workers, who were capable of producing products based on complex technical drawings and who knew how to assemble machinery [10]. A prerequisite was the transmission of technical knowledge. Accordingly, the period saw the establishment of technical universities as well as industrial schools and colleges specialising in the training of skilled workers and technicians. Although reference is made to such developments in this paper, they are not considered in detail.

## B Laws and legal regulations

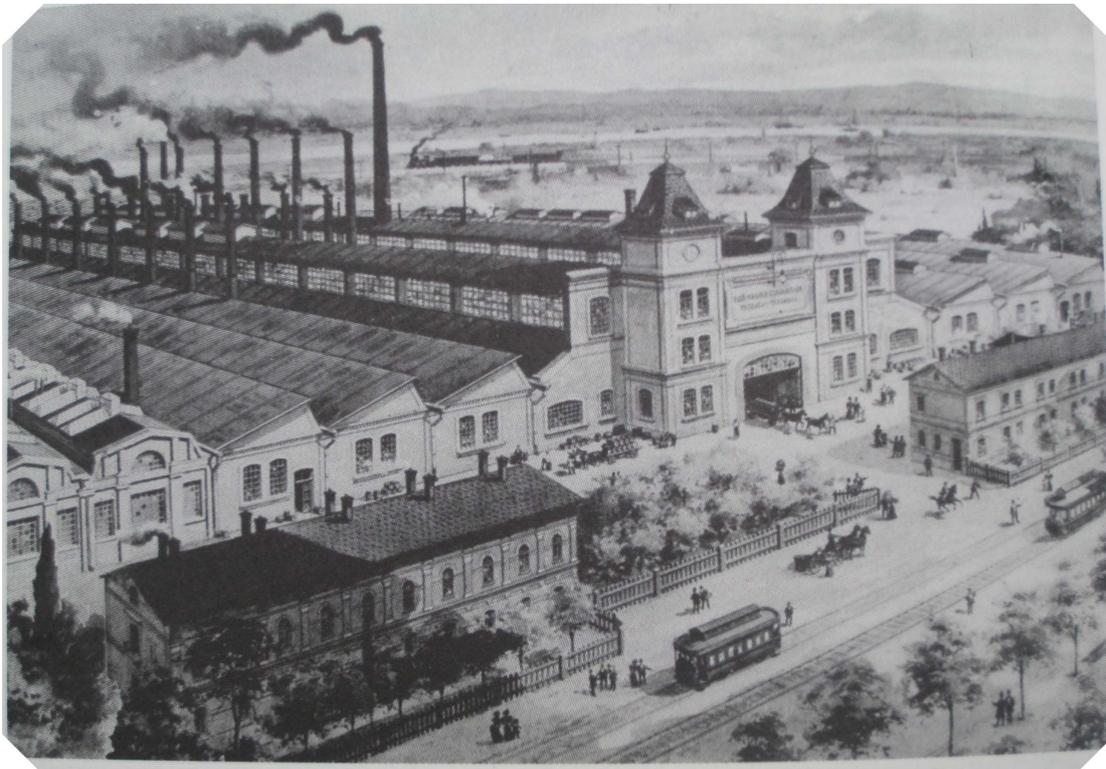
This present paper will merely refer to building regulations – above all, fire regulations – as a factor influencing the architecture of factory buildings during the period under investigation. The topic is to be examined in more detail in a separate article.

## C Innovation Factory organisation

The presence of a lathe does not turn a workshop into a factory. One can speak of a factory when machinery begins to determine the production process based on structured organisation.

### 1 How a workshop becomes a factory

Until the end of the period under investigation, the development of factory buildings in the case of the metal processing industry and mechanical engineering, can be divided into separate stages. One should note that this division relates less to a time schedule than to the status and use of technology and organisation within the factory. Within each stage, large differences can be identified for factories within each specific industrial period, while for the period under investigation (1860 to 1918), all stages are present.



Source: 2 Bencze G, Váci út, a magyar gépipar főutcája, Budapest, 2006, p. 72

**Fig. 5.** First Hungarian Bolt Factory, Budapest, Váci út 168, 1889

### The first stage

In the early stages, a significant proportion of the mechanical engineering plants that subsequently became factories were developed from artisan workshops. In such plants, custom-made and artisan production modes of machinery were predominant until the latter part of the 19th century. At best, such production sites were organised in a manner that resembled a factory; that is to say, labour-saving machinery was present in the plant, but factory organisation made only limited use of the division of labour. Another factor to consider is that the price of land exerted a greater influence on production costs in Budapest than in rural areas. For this reason, factories were often housed in existing factory sheds or in buildings used by other industries. This had no immediate drawbacks during this stage, as small-scale industry – which closely resembled craft industry in terms of its production methods – produced under the same spatial conditions (i.e. that were not function-linked) as craft industry; that is to say, it had no need for a special building type. The company Árkai Sándor (Csengeri Utcza 47-49) was one such plant. The factory lay in the inner city, in the vicinity of Andrásy Street and the Grand Boulevard, producing various iron structures.

### The second stage

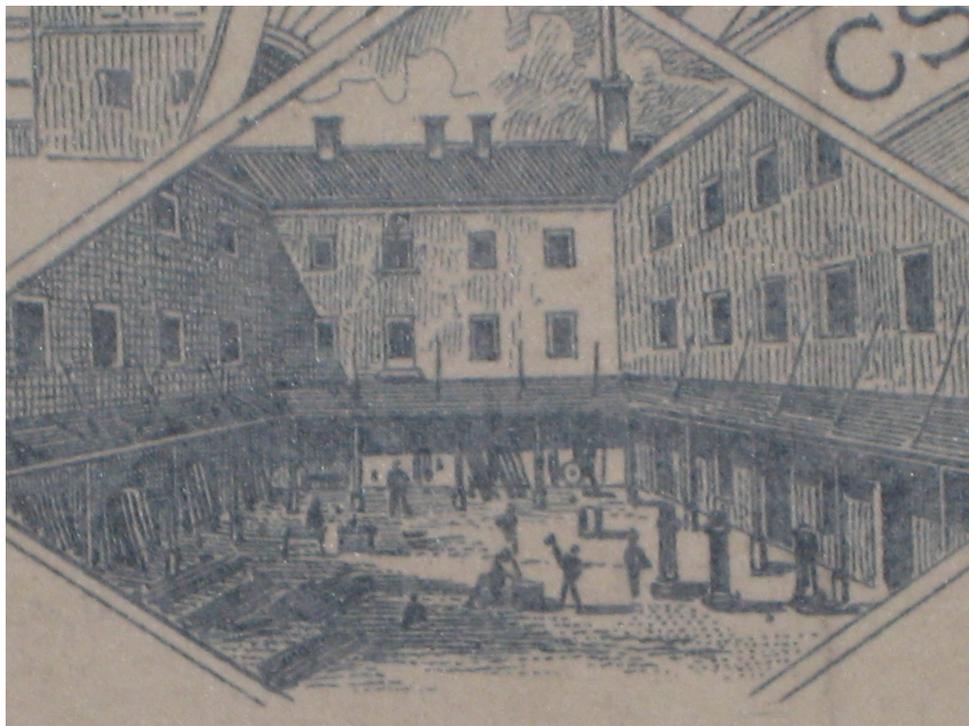
Since the artisan mechanical engineering workshops suffered from a shortage of capital during the next phase of their development, they were often established behind an existing building as a backyard plant. This phase of development differs from the previous one in terms of the spatial division of the production areas – which was far more specific. A former steel furnace fac-

tory in the Seventh District (Kazinczy utca) is an example of this factory type. Such inner city plants represented a special site of production within the metal processing industry – of which a survey should be carried out soon.

### The third stage

The introduction of new machine tools such as universal and special lathes and milling and planning machinery enabled the production of parts with greater accuracy. Artisan production was gradually replaced by factory production; that is, it was converted into mechanical engineering with a division of labour resembling that of a modern factory. For the new machinery to increase productivity and thereby ensure the economic success of a factory, the following factors had to be considered when designing the work areas:

- All machines were to receive daylight
- There should be good ventilation within the plant
- Large and heavy machinery should be separated spatially from lighter items
- The machine tools were to be placed in a sequence, whereby the item being worked upon could be passed directly from one process to the next without duplications
- The processing of larger items had to be undertaken near the inputs, so that the finished product could easily be transported out of the workshop.



Source:Fővárosi Szabó Ervin Könyvtár Budapest Gyűjtemény

**Fig. 6.** The Árkai Sándor company, Csengeri Utcza 47 ... 49, 1889



Source: Photo by the author

**Fig. 7.** Steel oven factory in Kazinczy utca

Such requirements seem, from today's perspective, self-evident, but in the second half of the 19th century they represented novel changes that were introduced in line with technological progress and factory organisation considerations.

The layout of a plant and the manufacturing facilities were determined by the production process of a product, whereby a factory's layout reflected the organisation of work and the production process.

The floor plan of a mechanical engineering factory was based, in principle, on the following premises:

- Assembly workshop or assembly hall
- Hall for the engineering department
- Commercial division
- Storage rooms for raw materials, machinery and machine parts.

This dynamic third stage of development also saw an exodus of companies from the inner city to the suburbs (above all to Váci út); thus, for example, the engineering workshop owned by Ede Pick. In 1879, Ede Pick founded a locksmith workshop on Podmaniczky utca in the Sixth District. Around 1890, the company moved to Külső Váci út 40,<sup>4</sup> where, by 1898, 100 workers were producing machinery and machine tools for the wood processing industry<sup>5</sup> [2].

Towards the end of this stage of development, engineering centres were built that were founded as engineering works [6].

## 2 Standardisation

Production in the engineering factories was initially determined by the needs of individual customers – rather than by the division of labour and the production of series which were then sold from stock.<sup>6</sup>

The standardisation of production was an idea that took hold in the manufacture of sewing machines and then in bicycle and armaments production (above all, guns and ammunition). In these industries, manufactured items were not produced for individual customers, but for sale from stock. Arms and munitions, for instance, were produced for the army. In these fields, series production was the norm, with large quantities being produced. In special areas of engineering, such as steam engine production, series production took place but with smaller quantities. Within factories, this represented a new challenge for architectural design. Individual parts were no longer stored, but finished products.

Architecturally, the mechanisation of production first exerted an impact on the design of the assembly halls and overhead cranes. The inclusion of this latter device greatly influenced the design of assembly halls. The plants received the typical form of a “nave” with three aisles, including a wide central nave with a diagonal overhead crane and two lower and narrower side-aisles that were bordered by two parallel rows of columns. The side-aisles were the location of the workshops of fitters, plumbers and toolmakers. This building type may be described as an “industrial cathedral”. The movable overhead crane enabled the lifting of locomotive boilers and the assembly of wheel axles. The depth of the assembly hall increased with the span of the crane. The side-aisles had, for functional reasons, low pitch roofs. The best-known international example of this type of building is the turbine hall of the AEG Company in Berlin. In addition to Peter Behrens, another important designer of this forward-looking construction type was Karl Bernhard.

While the development of the mechanical engineering industry was initially influenced by British manufacturing methods,

<sup>4</sup> Source: the original company papers dating from 1900

<sup>5</sup> In his book *Váci út, a magyar gépipar főutcája* [Váci Road, the main road of the Hungarian engineering industry], Géza Bencze states that the company was located at no. 34, while no. 40 was the address of the engineering factory Brogle and Müller.

<sup>6</sup>Mislin 2002 [9, p. 174]

at the turn of the century American rationalisation principles (Taylorism) acquired greater significance. The new methods were made known to a wider public at the world exposition in Philadelphia in 1876.<sup>7</sup>

The adoption of American rationalisation methods demanded the construction of suitable buildings and technical facilities. In this way, production was arranged in such a manner that the production process moved in one direction through the plant. The layout of a factory building reflected the need to ensure that transport distances were as short as possible.<sup>8</sup>

The resulting layout of freestanding factory buildings resulted in greater fire safety. More importantly, however, it established a clear division of labour. In each factory building, an independent production task was completed.

## 3 Taylorism

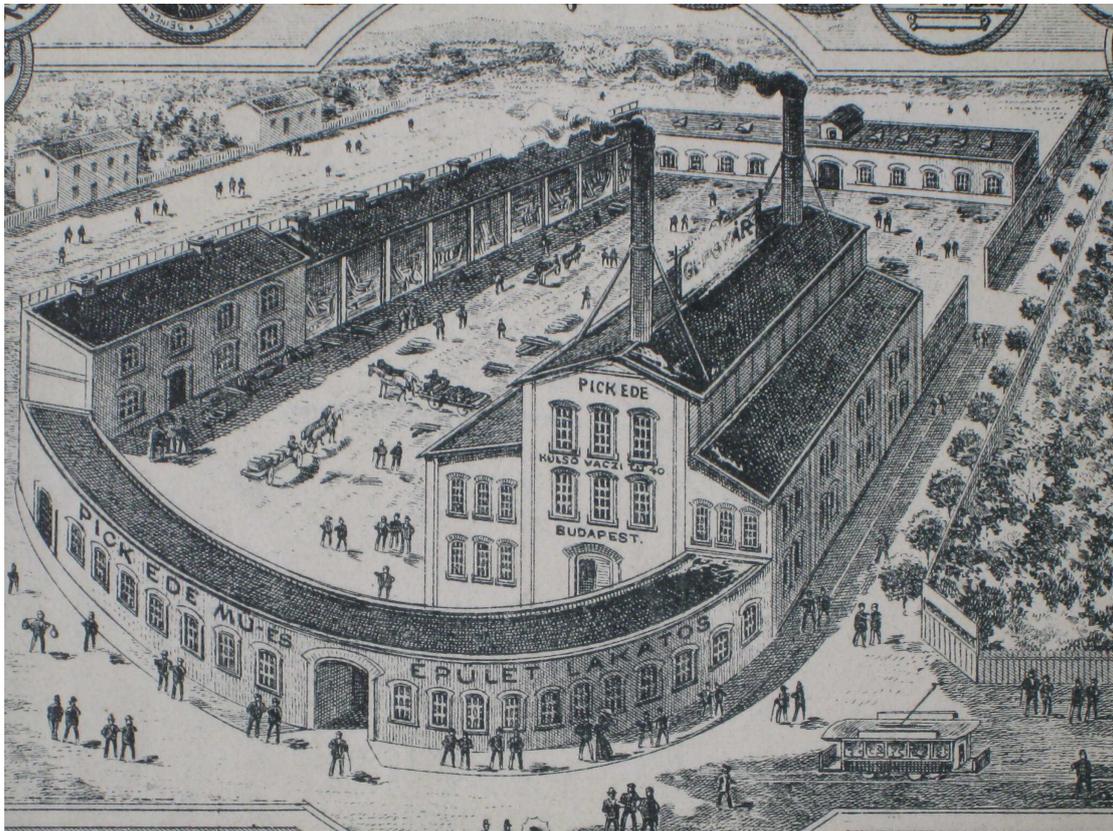
The theoretical and operational organisational principles that served as the prerequisites for the development of a layout of freestanding factory buildings, were elaborated principally by F.W. Taylor (United States) [5]. Towards the end of the 19th century, Taylor, having researched the management of production processes, elaborated the conditions whereby the management of a company could be placed on a scientific foundation (Scientific Management). In his work published in 1911 – *The Principles of Scientific Management* – Taylor addressed scientifically-based rationalisation measures at industrial plants. His aim was to further develop, in a controlled manner, the “evolution” in working methods that had begun several generations before. The goal was to bring economic success – or failure – under control [13].

Taylor was convinced that management, labour and business could be optimised through the application of a purely scientific approach. With regard to production in factories, Taylor believed that the customary single-line system with its rigid, military-like features was not effective and needed to be replaced by a functional division of labour (“modern factory organisation”). Starting in 1882, Taylor carried out large-scale time studies and introduced a system of wage bonuses, while also developing new, scientifically-based and detailed work and time-motion processes with the aim of increasing productivity. In consequence, the rationalisation of factories became a major trend. Workplaces were fitted with standardised lighting, tools and operational processes, resulting in the development of normalised working environments. The aim was to eliminate any disturbing influence from the workplace. Workers were to be responsible for the work itself – rather than for solving problems related to the workplace (Fig. 10).

Taylor’s ideas rapidly spread abroad. By 1907, his standard work *Shop Management* had been published in France, where his ideas were implemented by Michelin and Renault. Shortly

<sup>7</sup> Wegeleben 1924, [17, p. 3-9]

<sup>8</sup> Wegeleben 1924, [17, p. 99]



Source: Fővárosi Szabó Ervin Könyvtár Budapest Gyűjtemény

Fig. 8. Ede Pick's engineering factory, Váci út, 1895

thereafter, *Shop Management* was published in German and in Dutch [14].

#### 4 Taylorism and the impact on building layout

With regard to production buildings, the new and revolutionary factory organisation resulted in the manufacture of various machines in various factory buildings. Even the raw material stores were to be decentralised according to this work principle. Specifically, this meant that a steel store was to be placed immediately next to the tool factory. Auxiliary material stores, required by various factory divisions, were placed in the vicinity of the largest division. In contrast, the power supply was centralised. Overall, the system consisted of a main building with several outbuildings and a power supply centre.

The assignment of several outbuildings to a main building with central facilities, gave rise to a pavilion-like design, and resulted in the decentralisation of factory organisation [16]. The transport facilities became hugely significant in the production process. According to W. Franz, a factory required: "...consideration principally for the movement of raw materials, work pieces, and products."<sup>9</sup>

A clear example of the implementation of the principle of linear processes in manufacturing is the bridge-building division of the Pennsylvania Steel Co., Steelton, Pa. (1900-02). Work pieces were cut and marked in the preparation workshop and then brought to the western end of the main hall, where they

were – in sequence – drilled, reamed and riveted. Single pieces were brought in from the transverse buildings as they were required. This organisational set-up coupled with the production process gave rise to a fork-shaped floor plan.

The engineering works of the company Allis-Chalmers Co., West-Allis, Wisconsin, also have an interesting layout, which can only be explained in the context of the production method: The foundry received models from the carpentry workshop, which was situated opposite. The castings passed through the preparation workshops and the cast and forged pieces came together in the assembly hall.<sup>10</sup>

The assembly process in the case of these American plants was such that single tool divisions were arranged so that the heaviest machinery was located next to the assembly hall, whereby the large planes and lathes were situated in the halls. A further fundamental principle of manufacturing technology was that work pieces arrived first to the milling, planing and filing machines and only thereafter to the machine tools – which required the presence of a work surface.

#### 5 Structural organisation of the workshops

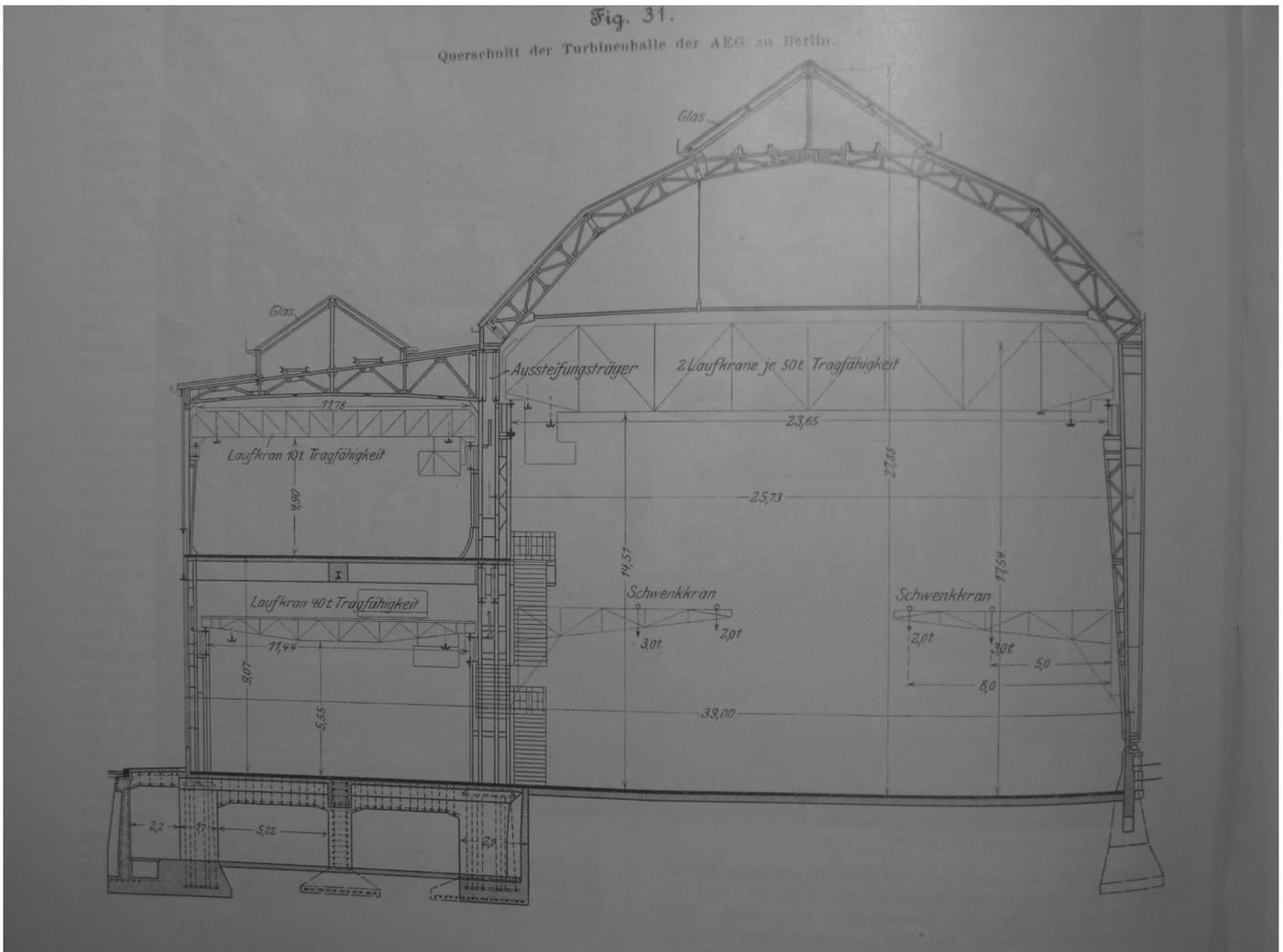
Two architectural possibilities existed for the structural organisation of workshops:<sup>11</sup>

##### 1 Freestanding

<sup>10</sup> American Machinist, issue of 28 September 1899

<sup>11</sup> Mislin 2002 [9, p. 176.]

<sup>9</sup>Franz 1914,[6, pp. 8 – 10]



Source: www.AEG Turbinenhalle.com (1011-01-10)

Fig. 9. The assembly hall of the AEG Company in Berlin, 1911

2 Block buildings – with several principal workshops under a single roof.

### 5.1 Freestanding

The advantages of freestanding production workshops lay in the architectural and microeconomic independence of the various factory divisions, the reduced risk of fire, better lighting, and improved oversight of factory costs.

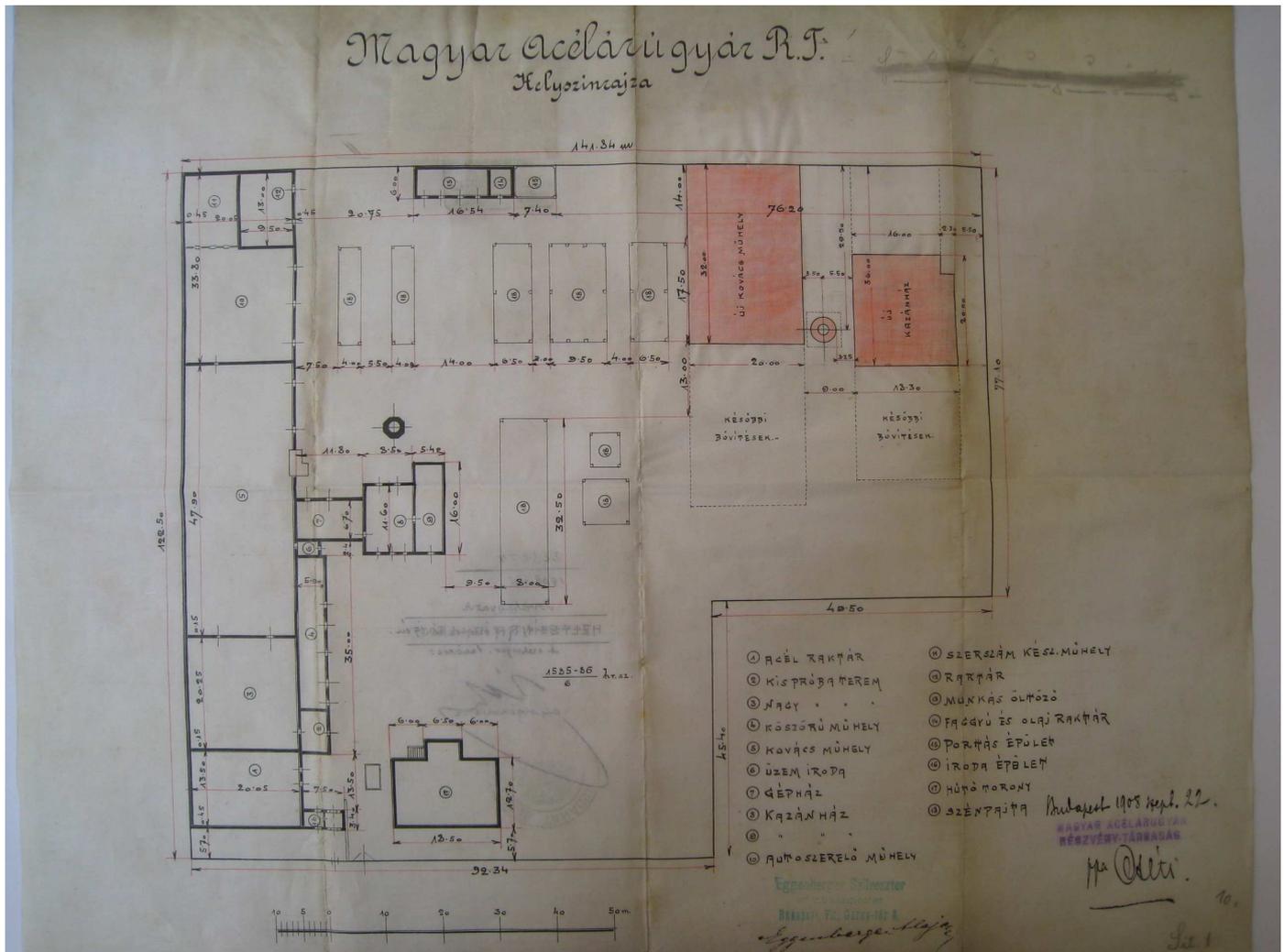
An example of a metal processing plant with separate factory buildings on its site was Magyar Acélárú gyár Rt. (Hungarian Steel Factory Co.), at Váci út 65 in Budapest's Sixth District (land registry no. 1608). In 1896, the company built a production hall on this site, which in subsequent years was supplemented by several other workshops.

### 5.2 Block buildings

Blocks allowed for a more flexible layout and use of space. The company Dávid Károly és Fia Rt. (Károly Dávid and Son Co.) on Mészáros Utca had a patent for metal brackets. The figure shows a block development in which several workshops and production rooms were located under one roof (Fig. 12). Also of

interest in this illustration is the industrial rail link – which provides evidence of how this industrial plant was connected with public infrastructure.

Originally, both principles of structural organisation were employed in the United States, where they were tested and further developed by General Electric, Schenectady, N.Y., and by Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa. The production site lay alongside a main road, while the individual factory buildings were placed on side streets. At the same time, in the lathing workshop and the boiler shop, several workshops were spatially joined together under one roof. The unlimited expansion possibilities of separate production buildings proved to be advantageous. Furthermore, it was possible to place the track for the main crane along the central main street. The manufacturing and factory organisational principles were reflected in the layout as U-, L-, T- or fork-shaped structures. In relation to such mammoth American concerns, the examples in Budapest were of more modest dimensions. Nevertheless, here too, the same principles can be detected.



Source: Budapest Főváros Levéltára XV. 15.b.275 185 47

Fig. 10. Magyar Acélárú gyár Rt. (Hungarian Steel Company), Váci út 65, 1896

### 6 Single-storey or multi-storey buildings

The construction of single-storey buildings, such as production halls, increased the flexibility of the production process and of subsequent building alterations. For instance, a double-ridged roof (north-light roof) could be extended in two directions – either by extending the existing aisles or by building new halls.

At the turn of the century, economic factors determined whether a single-storey or multi-storey building would be built. At the time, multi-storey buildings were cheaper to build (foundation and roof) and easier to heat. On the other hand, transportation in single-storey buildings was more effective and an expansion of facilities was less expensive and technically more feasible [8].

The installation and operation of heavy or vibrating machinery on the upper floors of multi-storey buildings represented a further problem for ceiling construction – a problem that was absent in single-storey buildings or that could be solved in a cost-effective manner with appropriate foundations.

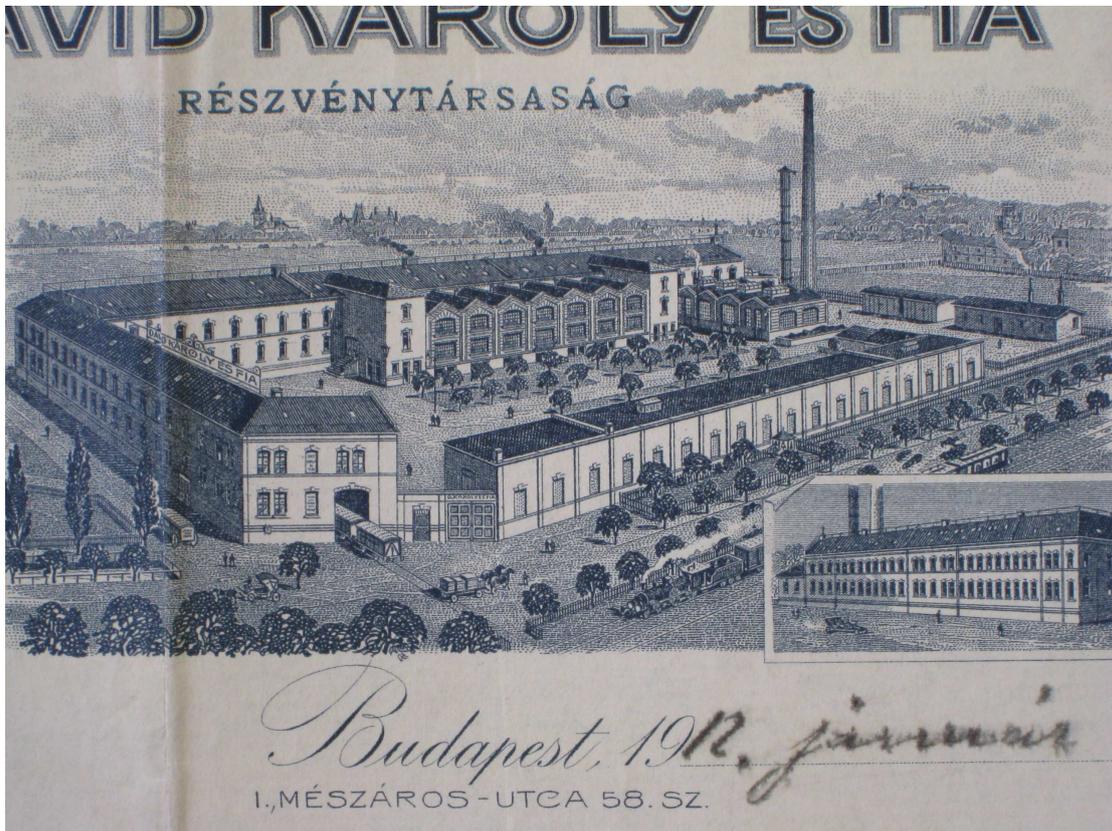
A further aspect of industrial production is the relatively short lifespan of industrial products, which meant that production buildings needed to be designed with an eye to accommodat-

ing future changes in the original function and a different use of the building [15]. The idea of ensuring the highest degree of flexibility and the possibility of making changes at the least cost (thereby accommodating new production methods or products) was new at the time, but it subsequently became a factor of central importance to the construction of industrial buildings (Figs. 11, 12).

### D Innovations in the production process

The impact of new industrial production processes on building design will be presented in what follows by examining the example of breweries in Budapest. It is worth noting in this context the changes in the working methods of architects, who needed to gain knowledge about technical production, as this was the factor that determined the construction and layout of buildings.

The brewing industry in Budapest underwent a gradual change in its structure in the second half of the 19th century. A concentration took place, whereby a smaller number of industrial breweries emerged. Because there had been little real change in the brewing process – from the processing of the in-



Source: Fővárosi Szabó Ervin Könyvtár Budapest Gyűjtemény

Fig. 11. Dávid Károly és Fia Rt. (Károly Dávid and Son Co.), Mészáros utca 58, 1912

ingredients (hops, malt and other ingredients) to the production of the final beverage – since the medieval period, the transition from small-scale beer production to industrial brewing had a particular impact on the layout and shape of brewery buildings. Examples of modern industrial breweries are the Dreher Brewery, the Haggermacher Brewery, and the Első Magyar Rézvény sárfőzde (First Hungarian Share Brewery) [3].

### The first companies and factories

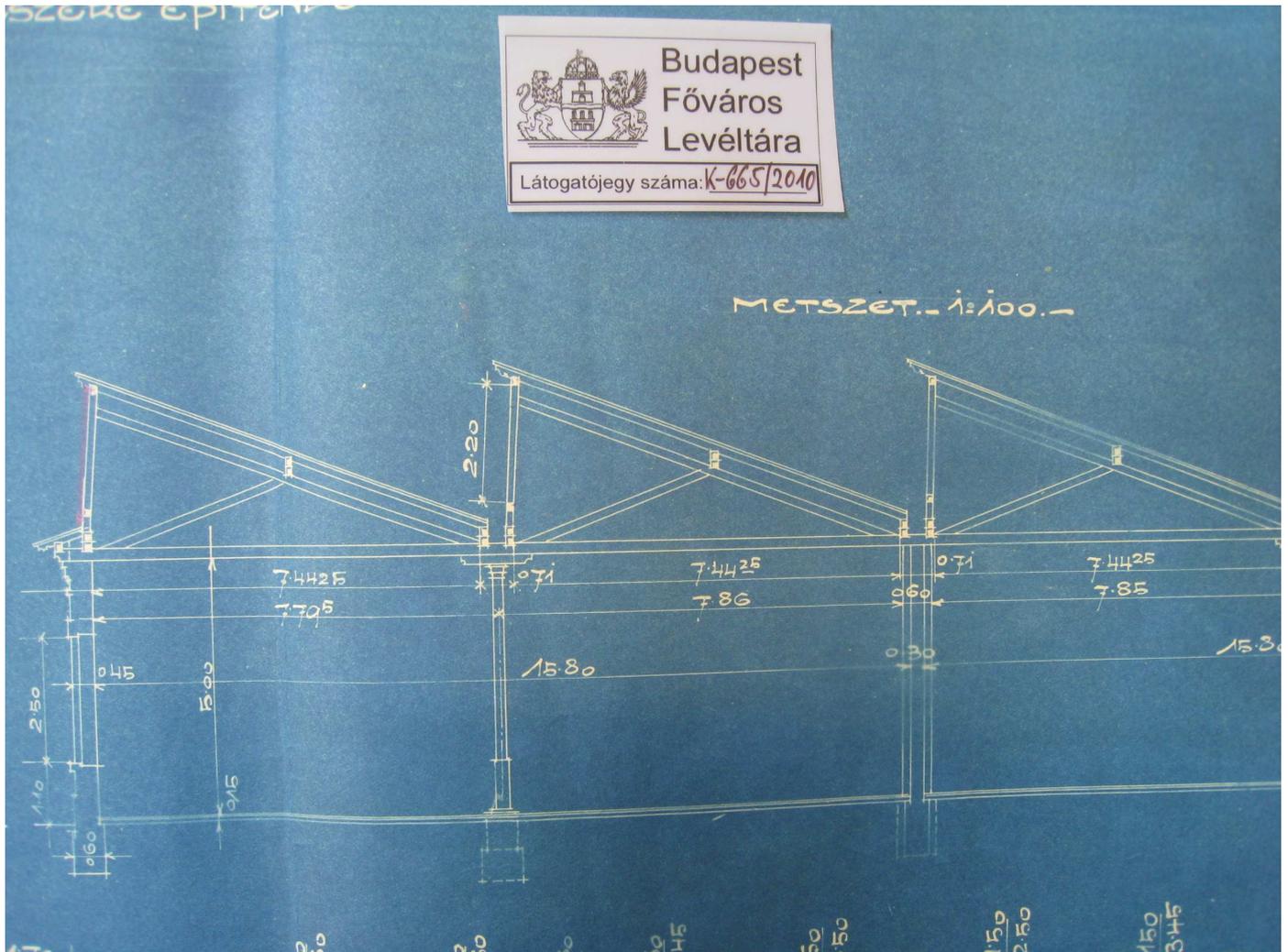
The former premises of craft beer production were located in urban residential areas and were often linked with a public (drinking) house. The brewing process took part in the back courtyards or on the ground floor next to the bar. The required space was limited to a room for malting and drying, a second room for the container for the mashing process and the fire with a kettle for cooking the hops and the seasoning, and a further room – often placed in the cellar to ensure a cool temperature – housed the fermentation tank for the maturing of the beer. Doubtless, in many cases, there was only one room to accommodate all aspects of the brewing process. Rigid guild regulations controlled the number of workers at a brewery – as well as the maximum quantity of beer that could be produced. In the 19th century, the growing public demand for beer led initially to an increase in the number of artisan microbreweries (rather than an increase in larger breweries). Most of these small-scale breweries were family-run businesses.

### New production processes changed the brewing methods

When the rigid guild system rules (Céhrendszer) were abolished in 1872, the small family breweries were already being replaced by a lesser number of large and efficient commercial breweries. This development is directly linked with the general industrialisation of the production sector. Machinery specially designed for the various stages of the brewing process now replaced the manpower that had been a key factor at small-scale artisan breweries. In addition to the mechanisation of the breweries, a change in consumer tastes also had a decisive impact on the development of large-scale breweries. For many centuries, top-fermented beer had tended to be consumed – which artisan brewers could relatively easily produce. From 1850, however, top-fermented beer was squeezed out of the market by bottom-fermented lager beer, which originated in Bavaria. The production of this new type of beer imposed many requirements, which, for technical reasons, the small-scale breweries were unable to meet. Meanwhile, the modern large breweries were able to produce large quantities of the light top-fermented beer in a cost-effective manner and in consistent quality.

### Brewing as a task of planning

To achieve maximum profits for the brewery owner, the plant was organised like a factory and equipped with the most modern facilities. It is from this functionalist viewpoint that we can derive the task of the architect.



Source: Budapest Főváros Levéltára, XI.10.c.175 215 12

**Fig. 12.** Weiss Manfred Company, Csepel, cross-section of single-storey production hall with saw-tooth roof, 1908

To ensure the smooth-running of the production process, a brewery – as a factory building – could not be placed in a single “monumental” structure. The planning tasks were related to the complex production process. To achieve the optimisation of the planning tasks the architect needed to understand in detail how beer was produced in a factory. Indeed, an understanding of the chemical production processes was a prerequisite for the planning tasks – this was a novel aspect of the work of an architect. At the same time, the designer was participating in the development of a new type of building.

The complete beer production process may be divided into three parts:

- 1 Treatment of the grain (malting)
- 2 Extraction of the sugars from the malt (Mashing)
- 3 Fermentation of the sugars and storage of the young beer.

To optimise the production process, there was a need to ensure the availability of rooms/spaces for each of the tasks. Such rooms/spaces needed a specific shape and an optimal location within the overall site. A further requirement was planning for the necessary technical facilities (e.g. heating and ventilation

systems). These main steps can be further subdivided into sub-steps (such as cleaning, germination, moisture removal, milling, etc.), which, however, lie beyond the scope of this article [12].

The individual (successive) processes of beer brewing were accommodated in buildings with specific ground plans and elevations.

**Stage 1** Function: Treatment of the grain (malting)

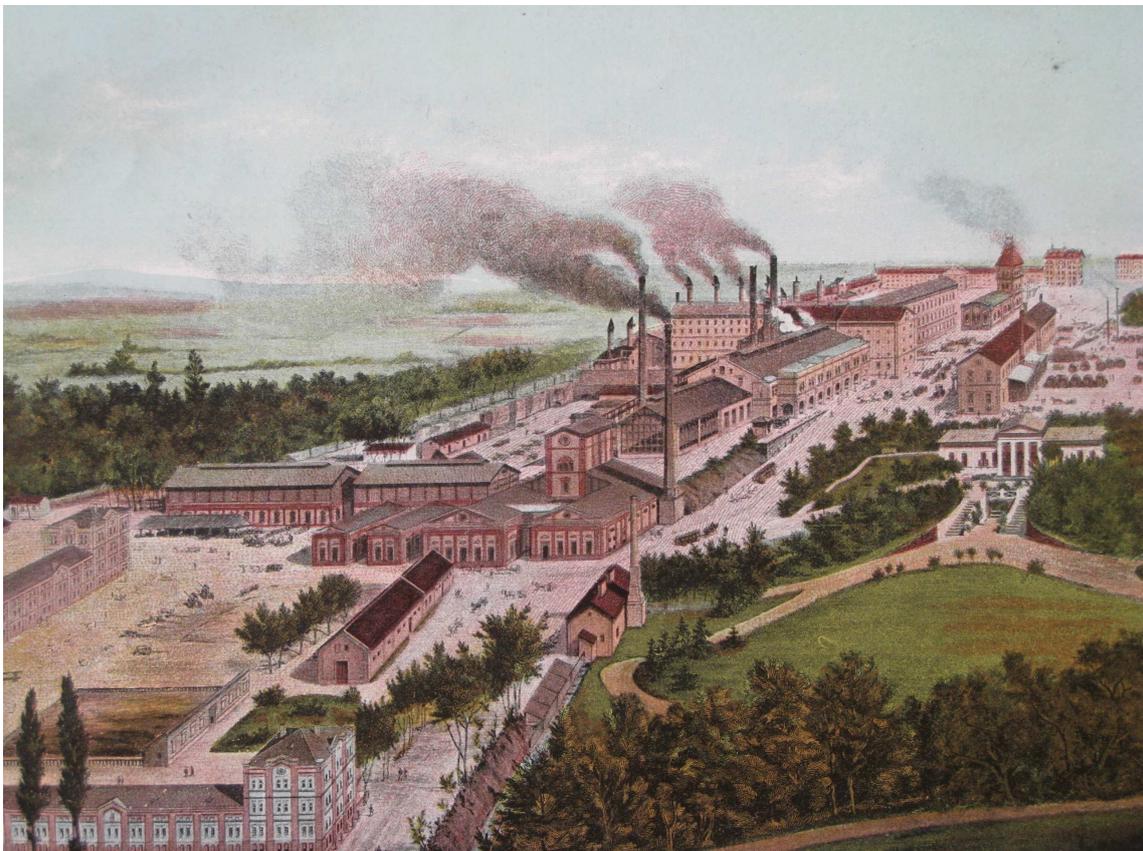
Building: The malting room

Malt is produced from various grains and water. The malting process comprises several sub-processes. In terms of efficiency, it should start on one of the upper floors of the brewery and then be continued in a vertical manner downwards from the top to the bottom floor. As far as structural design is concerned, this meant a multi-storey building with a basement, including technical facilities for the cleaning of grains for processing, water supply access, for the fermentation tanks, and for the drying facilities. While the technical equipment for the oast-drying process developed in line with technical progress, the basic structure of the building, recognisable from the outside on account of its characteristic vent stack, was rather consistent. The wooden malt silos



Source: Fővárosi Szabó Ervin Könyvtár Budapest Gyűjtemény

**Fig. 13.** Pál Kollerich and Sons Co., Márton utca 15, View of the multi-storey factory building, 1897



Source: Dreher Sörmúzeum archivuma

**Fig. 14.** Dreher Brewery, Kőbánya, 1900

represented a further characteristic construction element at this stage in the production process. The company Gschwindt had its main plant at Ipar utca 15, where various alcoholic beverages were produced using malt. Fig. 15 presents a cross-section of the drying room for malt. Worth noting is the wooden roof structure, which ensured the dry storage of the malt grain.

**Stage 2** Function: Preparation of the extract from the malt (mashing)

Building: The brewing house

The brewing house was located between the malting room and the fermentation cellar. The massive multi-storey building was equipped with large kettles and vats, most of which were placed on columns made of cast iron at a height of two metres (above the floor). The brewing house had a large ventilation dome in the roof. The basement housed other technical equipment such as pumps and filtration systems.

**Stage 3** Function: Fermentation of the sugars and storage of the young beer

Building: Fermentation and storage cellar

The brewing process ends with fermentation. In well-insulated and cooled fermentation cellars, fermentation took place in large fermentation vats (1,000 – 2,000 litre capacity). Here, at the final stage in the beer production process, there were also storage cellars – in part, cooled with ice. The beer was stored in vats until completion of the primary fermentation process. Until it was sold, the beer was kept here at a maximum temperature of 5 degrees Celsius. To ensure such cool temperatures, the cellar needed to be located deep underground, with various narrow rooms that lay adjacent to each other but were separated. In Kőbánya, the breweries used old abandoned wine cellars for this purpose [4].

### Auxiliary buildings

Another important building included in the factory system but not directly linked with the production process, was the power station with its boiler and engine house (usually placed in the middle of the brewery site). Industrial chimneys represented a characteristic feature of this building. Other secondary buildings were the offices, workshops and storerooms – the precise locations of which depended upon the features of the individual site.

### The building material

In terms of construction material and detail, brewery buildings did not differ from other factory buildings, which were usually built from bricks, with the resulting characteristic small brick shapes that are so typical for brick architecture. Iron was used – until the end of the 19th century – in the cast-iron columns and as crowbars in the vaulted structures. A separate study will examine the building material and construction of factory buildings in the period under investigation.

Overall, an attempt has been made to demonstrate the decisive influence of production techniques on building type. The sequence of the individual processes necessarily gave rise to the general form of a brewery and the order (or arrangement) of its constituent parts: The consistently linear scheme of the layout sequence corresponds to the graduation from high to low (from the multi-storey malting building to the storage cellars located deep underground). Ideally, there was an additive arrangement comprising the production facilities, the malting building, the brewing house, and the cooling facilities. In the final quarter of the 19th century, in the case of some breweries, the first stage of the production process – malting – was undertaken elsewhere. The removal of the malting building from the production site led to the collapse of the rigid layout of facilities – this led, in turn, to the positioning of the brewery buildings in an axial-symmetric arrangement, consisting of three wings.

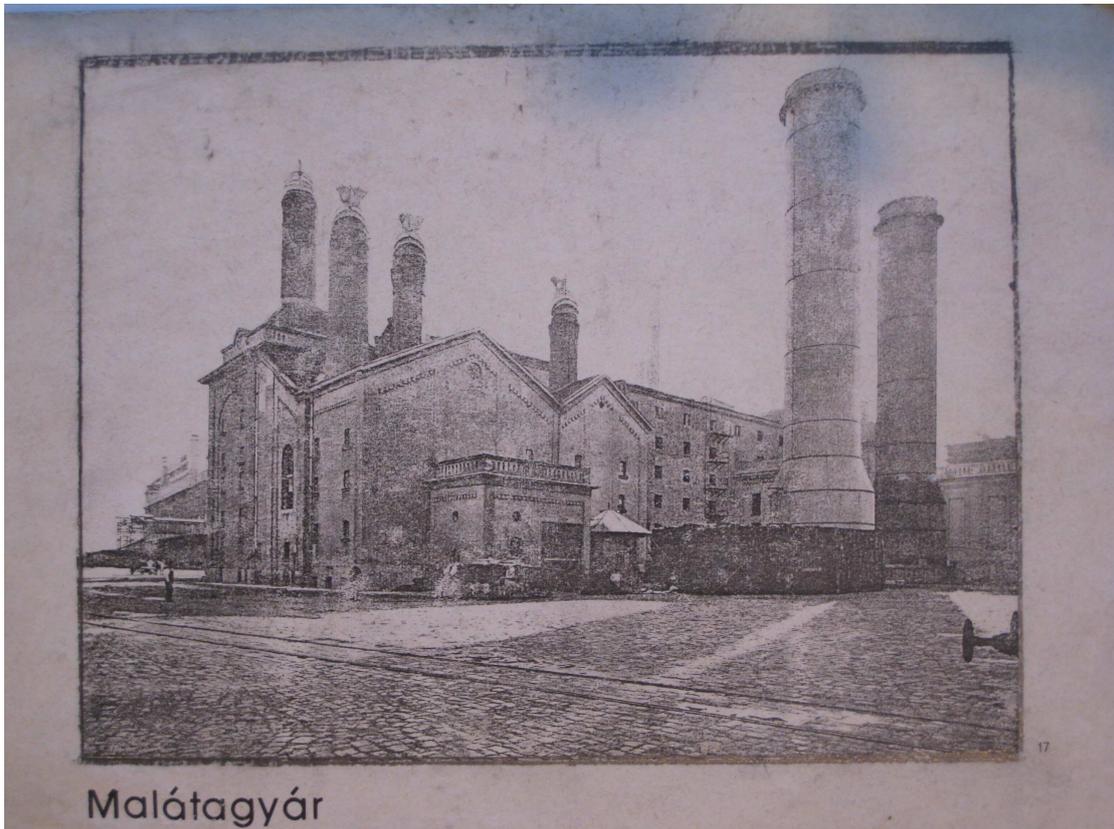
### 7 Summary

The factors determining the architecture of factory buildings in the period under investigation are innovations in the fields of technology, factory organisation and the production process. The impact of laws and legal regulations is an additional factor affecting the form of this type of building.

By way of summary, one can state that information concerning the effective layout of machinery and the production process became, in the late 19th century, a determining principle of the design of factories in diverse industries. The introduction of the electric motor in the 1890s meant that production and tool machinery could be freely arranged in the factory halls. This led to the abandonment of production machinery in separate buildings with their visible elements such as shaft linkages, supports, brackets and beams.

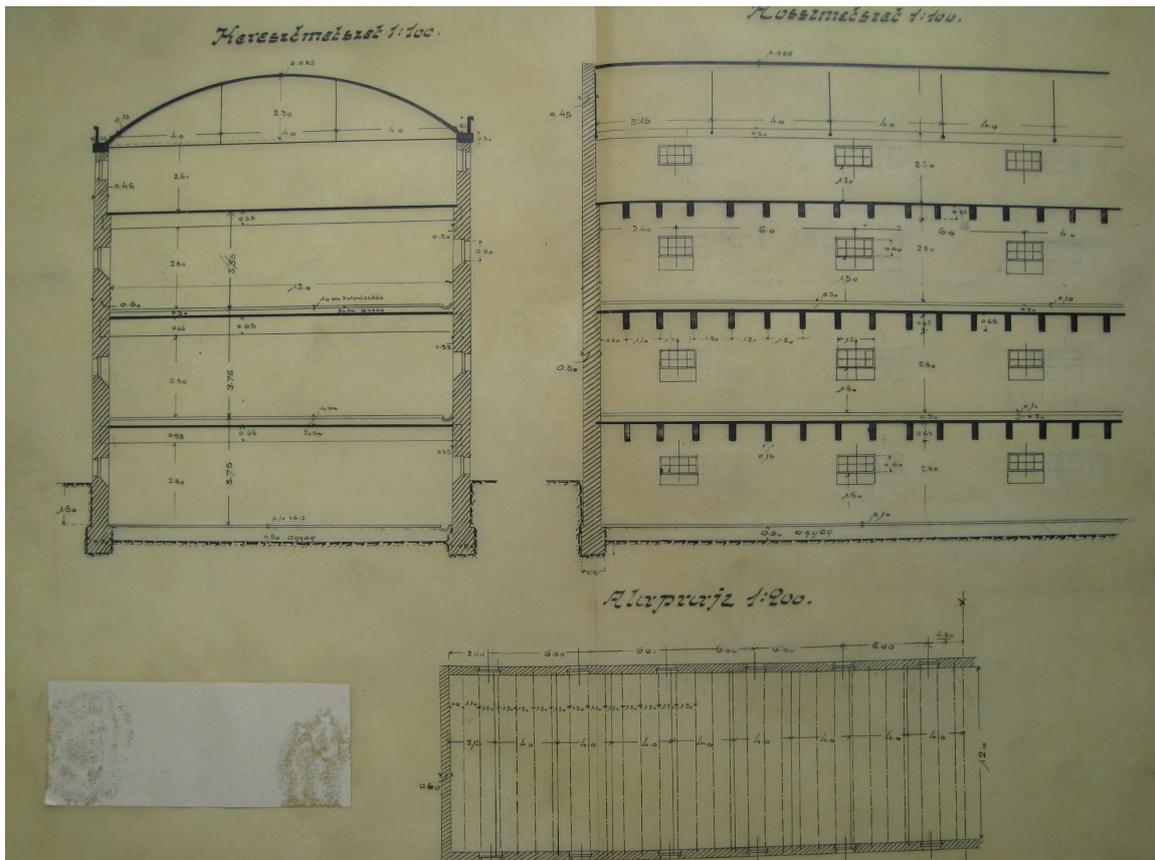
The technical criteria for production, that is, rationalisation concepts (Taylorism), as well as increased requirements in the field of fire safety, led, from the mid-1880s onwards, to new building forms: Single buildings used in decentralised factory organisation, and blocks of buildings with several workshops under one roof.

Innovations in the production process had a particular impact on the layout and form of factory buildings in the chemical and food processing industries, as a result of the replacement of artisan procedures by industrial processes.



source: Dreher Sörmúzeum archivuma

Fig. 15. Dreher Brewery, the malting room, 1900



source: Főváros Levéltára, XV.17.d.329 27784

Fig. 16. Drying room for malt, Budapest, 1900



source: Dreher Sörmúzeum archivuma

**Fig. 17.** Dreher Brewery, brewing house

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