periodica polytechnica

Architecture
43/2(2012)57-75
doi:10.3311/PPar.7289
http://www.periodicapolytechnica.org/ar

Expression of energy

The architecture of power stations in Hungary between 1945 and 1970 part II.

Péter Haba

RESEARCH ARTICLE

RECEIVED 20 DECEMBER 2012

Abstract

Part I of this study reviewed the architecture of power stations in Hungary in the period from 1945 to 1955. The introductory sections gave a summary of the architectural and technological background to power station design in the quarter of a decade that followed World War II. Through the analysis of power stations in Inota, Dunaújváros, Kazincbarcika and Tiszapalkonya, the first part highlighted the interplay between the structural and formal characteristics resulting from on-site concrete precasting – which defined industrial architecture in Hungary in the Rákosi era –, the technological requirements imposed by the electricity industry and the stylistic expectations of socialist realist ideology that led to a kind of classicizing monumentality, which also manifested in the area of engineering.

The second part of the study discusses the developments from the mid-1950s to around 1970. From a structural, technological and aesthetic point of view, these fifteen or so years can be divided into two periods. The first and shorter one, lasting up to 1960, was characterised by new solutions linked to a change of direction in structural innovation and to the fresh ambitions of Hungarian architecture that returned to modernism. This stage represents a type of transition between the period of 1949-1955 and the 1960s, burdened by serious architectural problems created by the so-called open-air technological systems.

Keywords

power stations · industrial architecture · architectural theory · on-site precasting · structural aesthetics

Péter Haba

Department for History of Architecture and of Monuments,
Faculty of Architecture, Budapest University of Technology and Economics,
Műegyetem rakpart 3. K 282, H-1111 Budapest, Hungary
Institute of Theoretical Studies,
Moholy-Nagy University of Art and Design Budapest,
Zugligeti út 9-25. H-1121 Budapest, Hungary
email: phaba@mome.hu; haba.peter@gmail.com

1 From Pécsújhely to Oroszlány: the period of change (1956-1960)

The overall intellectual and stylistic changes that began in Hungarian architecture in the middle of the 1950s foreshadowed a period of radical transformation, which was also indicated by some of the characteristics of industrial architecture, and especially by the generally applied structural systems. A particularly fast and spectacular transformation could be observed in the area of power stations: after a large-scale modernisation attempt, on-site precasting was replaced by new technologies in the construction of power stations; this was partly linked to the emergence of new architectural solutions required by the radical technological changes that occurred at the time. This process opened up opportunities in the architecture of power stations to formal and aesthetic rejuvenation and facilitated the opening up to contemporary trends. The radical technological change that generated the increasing break-up of the design of buildings built around technological systems and thus urged the radical re-interpretation of formal considerations, began to exert an increasing impact in Hungary from the end of the 1950s. Inspired by the approach of a new era, Hungarian architects came up with transitional solutions, drawing partly on international examples, that can be evaluated as paving the way for the developments of the next decade.

Political changes and power station constructions

In addition to technological development and the various trends in the building industry and architecture, the previously mentioned processes were also impacted by the rather turbulent industrial policy of the time. Although the reforms of Imre Nagy's government (1953-1955), aimed at lifting the country out of the economic crisis brought on by industrialisation on an unrealistic scale in the early 1950s, were short-lived, they were an eye-opener for the Rákosi-Gerő circle, which gained absolute power again in 1955, warning them not to repeat the mistakes they had previously made. The circle fundamentally followed the industrial policy that was implemented prior to 1953, but significantly decreased the volume of development

projects. In contrast to the concept of Imre Nagy, they again shifted the emphasis to the heavy and electricity industry. This was illustrated by, for example, the launching of the massive development projects for the power stations in Pécsújhely and Ajka in 1955-1956 and restarting the construction of the Tiszapalkonya facility that had been suspended [26, pp. 275-292].

The restructured power relations, following the events of 1956, also strengthened the reform spirit in the economic arena. The new government, led by János Kádár, initially adhered to the policy of moderate industrialisation adapted to Hungary's circumstances, but around 1958 – despite all the negative experiences of the past – the political trend focusing on the extensive development of the heavy, chemical and building industries again became the dominant one. In the meantime, the government implemented welfare measures to win over wide layers of the population; this included the modernisation and mechanisation of households among its main objectives. This generated a continuously increasing energy demand, both in industrial and public consumption. The constant energy shortages called for further development projects representing a vast proportion of the country's total industrial investment, at times amounting to 30-40%; between 1958 and 1960, work began on the Oroszlány facility as well as the Dunamenti Power Station in Százhalombatta, with the completion of the Pécsújhely and Ajka stations also assigned a high priority [26, pp. 534-544].

An attempt at the renewal of on-site precasting: the power station in Pécsújhely

By the middle of the 1950s, the special structural systems based on on-site precasting that were used in large power stations no longer satisfied the new economic needs of the period. It became clear that the system founded on separate load-bearing frames and self-supporting panels had reached its final limit in the case of the Tiszapalkonya power station, beyond which it could not be developed either in economic terms or structural engineering aspects [20, pp. 27-28; 14, p. 4].

As part of the design work carried out for the Pécsújhely facility in 1955-1956, the architectural team at Iparterv – Gyula Mátrai, Károly Pászti, Árpád Szécsi and Ödön Szakács – had already begun to develop a radically new system that ensured a further decrease in the number of the type of elements as well as the actual number of the elements used. (Figures 1-5.) They replaced pillars, beams and panels by hollow, triangular, rectangular and U-shaped reinforced concrete elements that could fulfil multiple functions in both structural and architectural design aspects. They merged the function of pillars and panels, while similarly to the panel construction of the Tiszapalkonya power station, they also integrated the pipes of the machines into the design; these not only required a lot of space but were also visually obstructive. Neither the lattice girders and trusses spanning the halls, nor beams were necessary in this system, since the building was covered with precast concrete shells [24].

Fig. 1. Pécsújhely power station. Designers: Gyula Mátrai, Árpád Szécsi, Ödön Szakács. 1955-1959. (By kind permission of Foundation for Modern Industrial Architecture – IPARTERV Photo Archive / A (Modern) (Ipari) Építészetért Alapítvány – IPARTERV Fotóarchívum)

Fig. 2. Pécsújhely power station. (By kind permission of Foundation for Modern Industrial Architecture – IPARTERV Photo Archive / A (Modern) (Ipari) Építészetért Alapítvány – IPARTERV Fotóarchívum)

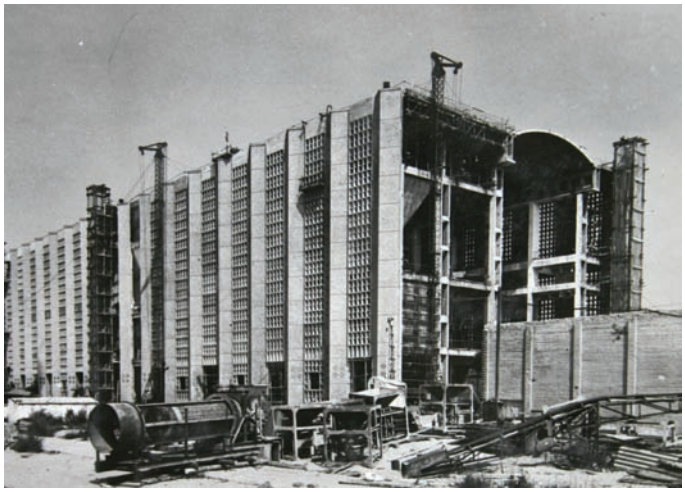

Fig. 3. Pécsújhely power station. Structure. (By kind permission of Foundation for Modern Industrial Architecture – IPARTERV Photo Archive / A (Modern) (Ipari) Építészetért Alapítvány – IPARTERV Fotóarchívum)

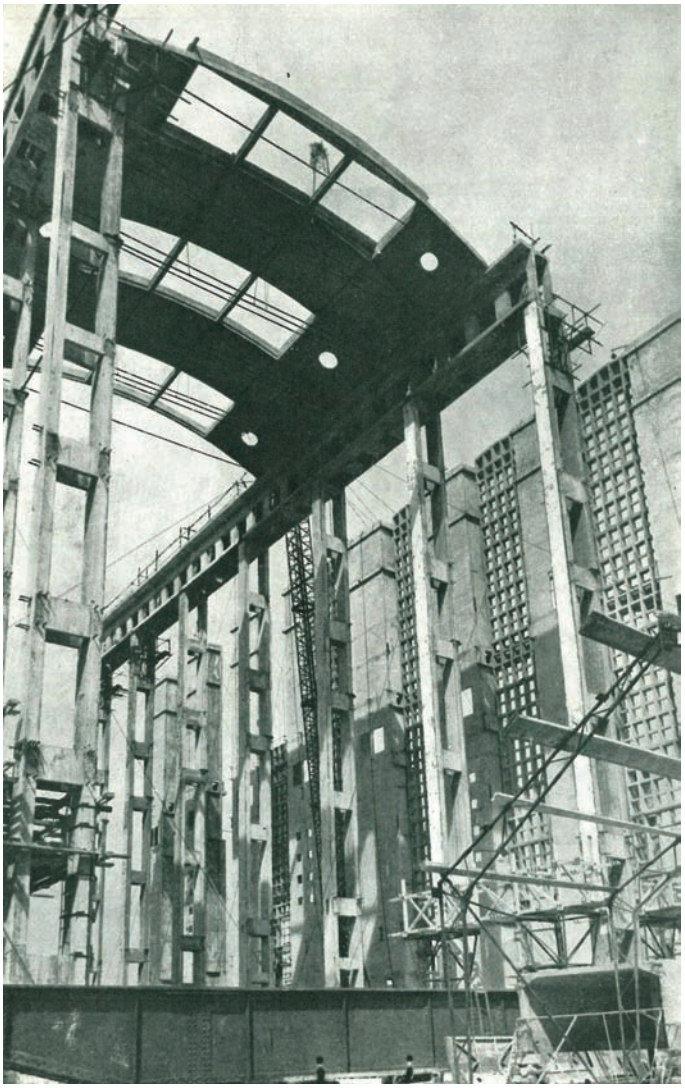

Fig. 4. Pécsújhely power station. Structure. [24, p. 47]

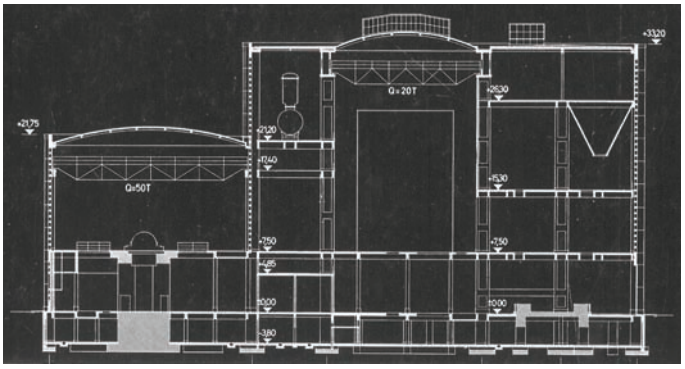

Fig. 5. Pécsújhely power station. Cross Section. [33, p. 218.]

Although the technological disposition of the Tiszapalkonya building – and thus its massing – resembled those of the Kazincbarcika facility, it had an altogether different architectural character. The lack of a traditionally partitioning 'framework' and 'wall' can be clearly perceived in the building's entire exterior and interior – i.e. the building's supporting structure, its 'shell', and its technological system are one and the same construction. This synthesis is extremely impressively realised in the facade: the huge (21 and 33 meters high) elements protruding in the shape of a triangle and rows of windows between them, extending along the full height of the building, mirror the complexity of the architectural and mechanical structure required by the technological system inside. The building maintained its aesthetic coherence and in its outlines, preserved a kind of simple integrity. The web-like grid of windows balances the monotonous repetition of the hard edges of the protruding elements and other subtle details such as the small openings of the ventilation ducts arranged in a linear pattern design, the fabric-like texture of surfaces treated with washed colour stones, and the zigzagging contour of the facades produced by the triangular pillars. Analysing the 'source' of the unique combination of these structural forms, it can be seen that the structural and technological necessities were intertwined with architectural ingenuity: the captivating dynamics of the closed-heavy and reticulated-graceful elements, as well as the consistent application of the details, go beyond mere engineering considerations.

Thus, the architects not only provided a creative answer to the question of economy but also found a new solution to the problem concerning the relationship between the internal structure and the enclosure walls, and thus eliminated previous conflicts in this regard. Similarly to the Dunaújváros, Kazincbarcika and Tiszapalkonya facilities, the construction in the case of the Pécsújhely power station is clearly aestheticized: the architects strove to remove the system of concrete elements from their primary, engineering quality with the help of carefully considered design 'knacks' and thus spiritualise and monumentalise it. However, the intention of the designers in the Pécsújhely power station was to achieve an altogether different architectural quality. Even though the Pécsújhely power station did not significantly attract the attention of the architectural community as a prominent industrial building, at the time when it was designed and built – in the period of breaking away from socialist realism – it brought powerful evidence to support the importance of the inherent aesthetics of constructions and the opportunity to emphasise this quality. The construction methods that exploited the full technological potential of the domestic building industry, and the highly impressive engineering innovations applied in the case of the Pécsújhely facility, must have ultimately suggested that industrial architecture in Hungary was the most successful in meeting the long-desired goals set by "socialist building industry development", i.e. fully mechanised systems

based on the assembly of series manufactured components. This 'image' – which was also promoted by the building industrial literature of the period – was further enhanced by the virtuoso shell structures of the Pécsújhely power station, which were probably the first important and large scale representatives of their kind in post-World War II Hungary. Despite their many economic and technological advantages, shell structures were only used in Hungarian industrial architecture to a limited extent in the ten years after 1945.

Since, in the Rákosi era, monolithic shell structures could only be manufactured at a very high cost, in some cases, the designers at IPARTERV experimented with systems constructed from on-site precast elements, but none of these produced widely applicable solutions[1]. In contrast, the shell structures used in the Pécsújhely facility seem to have generated change, since from this time onwards, an increasing number of industrial halls were covered with shell structures – growing both in number and size – in the design of which, the knowledge gained by the Mátrai Group during the construction at Pécsújhely was exploited[2]. This trend was undoubtedly influenced by similar aspirations in the Eastern Bloc countries and in Western Europe, as well as the rapidly growing popularity of monolith shell structures, which made the greatest impact in Hungary at the end of the 1950s and the beginning of the 1960s – not only in industrial architecture but also in the design of public buildings. The lightweight yet spectacular shell structures that were suitable for spanning large distances created the impression that within the bounds of its possibilities, Hungarian architecture and the Hungarian building industry strove to keep up with the latest international trends, especially in the area of industrial development. The Pécsújhely power station might have caused a sensation not only with its engineering solutions that were outstanding in comparison with the building industrial technologies used in Western Europe at the time, but to a certain extent also with its unique forms that were probably reminiscent – presumably without any conscious intention on the architects' part – of the latest, ever-renewing international trends in concrete architecture in which elemental forms were combined with virtuoso engineering constructions. Moreover, the Hungarian constructions might have even reminded people of the sombre and awe-inspiring Gothicising-expressionistic power stations of the 1920s. At the same time, quite remarkably, the composition of the building's facade – especially the alternation of pillars and grids of windows – slightly resembled the power stations that had been built a few years earlier and still in the spirit of socialist realism. This created a kind of transition between the architecture of the Rákosi era and that of the first ten or so years after 1956. The structural system of the Pécsújhely power station undoubtedly represents a kind of apex in Hungarian on-site precasting – which enjoyed international fame by that time – in regard to dimensions as well as the structural complexity and the formal diversity of the elements, yet it was neither widely used in Hungary's industrial architecture, nor in the construction of later power stations. This was only partly due to the fact that the system required elements of such a significantly increased size and weight, that the feasibility of the implementation became questionable. [34, p. 11] The other reason in the background was the radical change in industrial architecture regarding the direction of structural innovation, which was increasingly perceivable at the time of Pécsújhely power station development project, i.e. from the mid-1950s.

Structural eclecticism and formal renewal

From the second half of the 1950s, the dominance of on-site precasting – the generally held view that this technology was the single most cost-effective solution for large-scale development projects – wavered due to the changes in Hungary's economic situation, the new development concept in the building industry and newly gained engineering knowledge. [29, pp. 78-79] Ever greater opportunities opened up for methods that had been side-lined in the Rákosi era for economic reasons especially the further development of monolithic technologies, experiments regarding the use of the already mentioned shell structures in industrial architecture, as well as research into potential new uses inherent in steel structures and glass wall systems. [9; 14; 18; 29] The industrial prefabrication of structural elements and the development of standardisation methods linked to it increasingly came to the fore both in the design of residential buildings and in industrial architecture; this was connected to the new direction the development in the building industry took in the entire Eastern Bloc. Due to the deficiencies of the Hungarian building industry, noteworthy results were only achieved in this regard from the first half of the 1960s. [2; 3; 7; 9; 34; 36] Experts in the building industry urged designers to combine concrete, steel and brickwork structures, and although this had previously been discouraged, it was not unusual that monolithic and prefabricated elements were used together. [29, p. 79; 14, pp. 10-11.]

This new wave of engineering experimentation produced an extremely wide diversity of structure and form in Hungarian industrial architecture at the end of the 1950s and the beginning of the 1960s, which gave designers the opportunity to look for new ways of architectural forming inspired by the modernist revival after the 'collapse' of socialist realism and the period's fresh international trends. This process also significantly

1 The main examples of these experiments are the refrigerating towers in Ajka and Debrecen (1949), both desgined by Gyula Mátrai, and the covering of one of the halls of the leather glue factory in Újpest, designed by Miklós Gnädig (1954). For the description of the buildings, see: [19, pp. 352-353, 360-363] . Regarding the difficulties involved in covering shell structures in the Rákosi era: [14, p. 7]

2 Included among these, for example, are the Ikarusz bus factory in Mátyásföld [22], the gas silicate plant in Kazincbarcika [21] and the buildings of the Újbuda cabel and wire-rope factory [23].

impacted the architecture of power stations: from this time on, not only were there no power stations in Hungary built exclusively with on-site precast elements, but there were none constructed with solely concrete structures either. It is likely that in the changing situation of the building industry, on-site precasting was only partly cost-effective in the construction of power stations characterised by monumental dimensions and varying configurations. [35, p. 17.] These changes were bound to lead to the replacement of professionals involved in the design of power stations: the task of designing power stations previously carried out by the group that gathered around Gyula Mátrai and Károly Pászti – specialised in on-site precasting – was now given to other architects and engineers at IPARTERV.

The peculiar 'structural aesthetics' of the period and the experiments to find a replacement for on-site precasting by cost-effective building methods is well exemplified by the second Ajka power station (designed around 1955-57, built in 1956-1960) led by Kálmán Vörösmarty, an architect, and József Nagy, a structural engineer[3]. (Figures 6-10.) This highly important design also foreshadowed the major technological changes that emerged in the electricity industry at the time. The technological and architectural disposition of this facility was at great variance with previous designs: here the two-naved hall incorporating the room for the feedwater system and the coal bunkers occupies the middle section of the building, and is flanked by a taller boiler house and a lower turbine room. The construction housing the precipitator equipment was joined to the longitudinal side of the boiler house. [37] Although with this arrangement, the architects broke away from the principle of compact massing, which they had previously often stressed in connection with power station design (a four-stepped mass came into being), the opportunity opened up to realise a structure that would be more material- and time-efficient than ever before.

The row of frames used in the middle section – comprising the hall for the feedwater system and the coal bunkers – was built with monolithic reinforced concrete elements combined with special steel structures that were able to bear a huge amount of weight despite their slender shape. In this way, it became possible for the row of frames to support the roof structure (made with precast concrete elements) of the boiler house and turbine hall (exclusively made with steel structures) as a kind of backbone for the building and a centre of the distribution of structural forces, thus resulting in significant cost-saving. The article on the building emphasised that given the time that was available for the construction, the characteristics of the plot and the specifics of the building industry, this system proved to be the most effective. [37, p. 21] Confirming this point, the architects also suggested solutions for the design of the enclosure walls

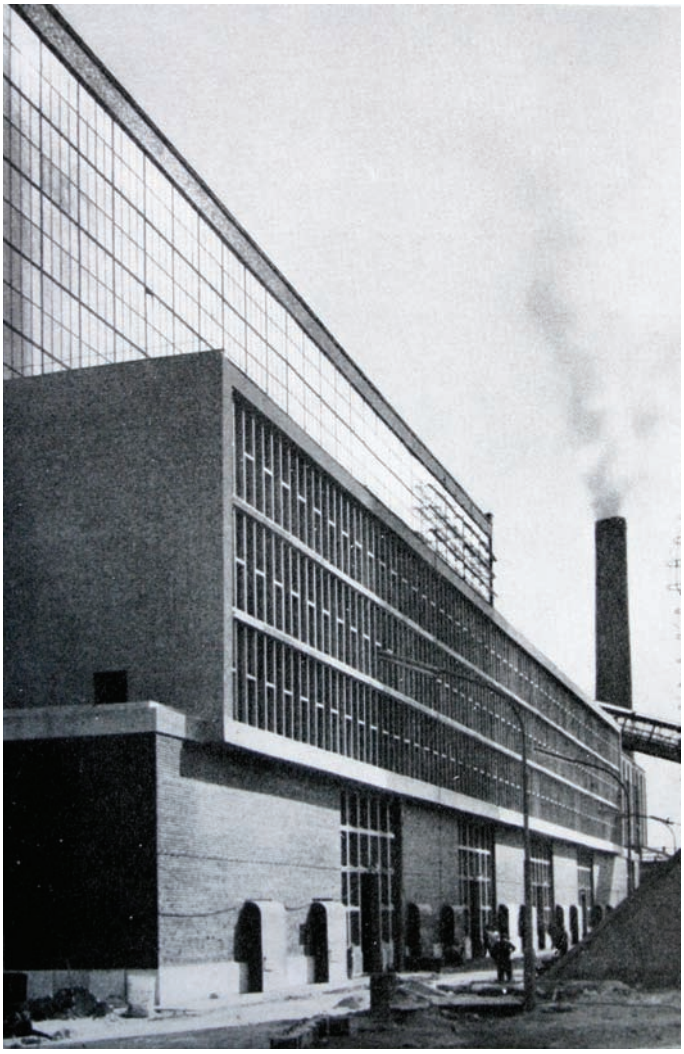

Fig. 6. Ajka power station. Designers: Kálmán Vörösmarty, József Nagy. 1955-1960. [33, p. 221.]

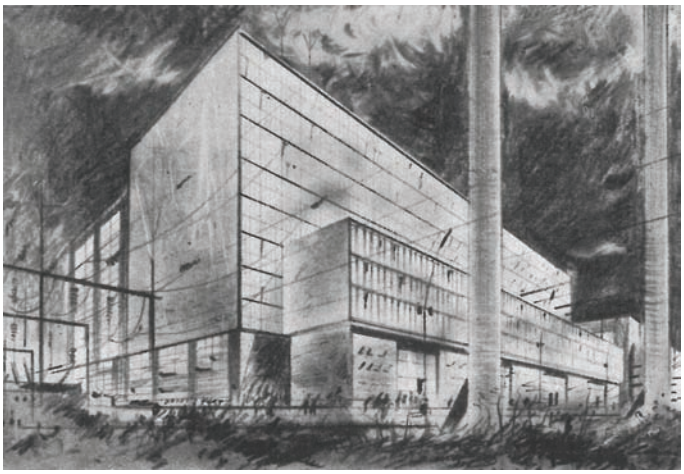

Fig. 7. Ajka power station. Rendering. (Lévai, A. ed.: Nagy erőműveink tervezése. Erőmű Tervező Iroda, Budapest, 1959)

3 The building was erected in the immediate vicinity of the power station built in the early 1940s according to Béla Egyedi's design.

that differed from previous design practice. The longer sides of the boiler house, the hall for the precipitator equipment and the turbine room were opened up almost along their full expanse with steel-framed glass walls, while the shorter sides were closed with brick walls. As the architects explained, the main reason for using glass walls was that they could be installed more time-efficiently than any other wall structure; however, they added that it was the best solution for properly lighting the wide halls. [37, p. 21] An interesting observation can be made at this point: in the power stations constructed only a few years earlier, halls of the same dimensions were built without glass walls since they were not justified on technological grounds. Similarly to these earlier power stations, it can be suspected in the case of the Ajka facility that besides technical considerations, it was ideological and formal preferences as well as – yet again – the changed situation of the building industry that played a role: the glass wall was no longer seen as the embodiment of cosmopolitanism and aesthetic elitism to be defeated. It is also likely that the players of the building industry and economic experts were not opposed to such structures either. Thus, the structural innovation realised in connection with the Ajka power station was motivated by several factors: the influence of new tendencies in the building industry, the constraints specific to this project, the rapid easing up of ideological pressure and the lifting of the 'ban' on modernism.

Although the aspiration of the architects to adhere to the formal principles of modernism 'in its purest form' is manifest in every detail of the building, it is perhaps still the most perceivable in the arrangement of the masses and its crystal clear geometry, this impression being further confirmed by the constructivist aesthetics applied in the facade compositions. It seems that the characteristics of the structures used for the building facilitated this ambition of the architects, since the diversity of structural systems made it possible for them to break away from the previous practice – linked to structural systems based on on-site precasting – of merging individual parts of the building into compact masses, differentiating the forms of the distinct technological units – meeting the requirements of functionalism – and expressing the building's interior and functional disposition directly through the architectural design.

The designers of the Ajka power station exploited this opportunity as much as they could; they realised that now they were able to create compositions drawing on the interplay between architectural forms, materials and structures resulting from the various functions and mechanical systems. The architectural concept is most clearly expressed by the northern facade of the power station. On one hand, the dual composition of the vast mass of the towering boiler house and the horizontally extending mass containing the precipitators firstly reflect the interior technological disposition of the facility and the significantly differing heights of the equipment it houses, thus projecting the 'amount' of space they require onto the exterior. On the

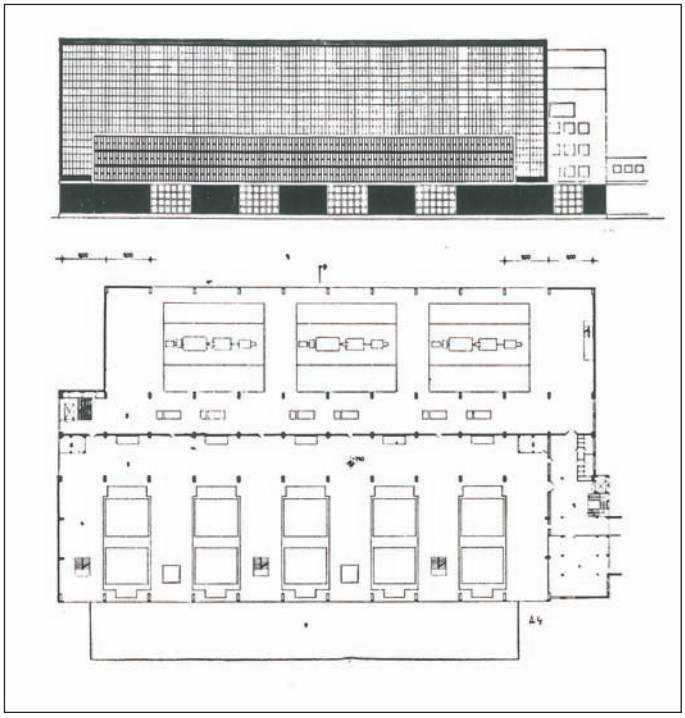

Fig. 8. Ajka power station. Facade and ground plan. [33, p. 221.]

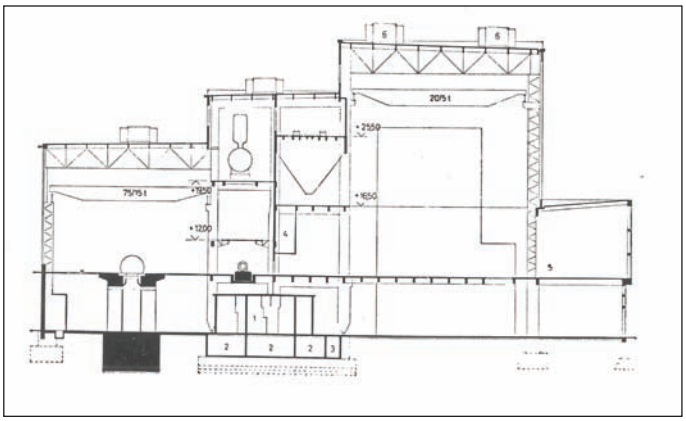

Fig. 9. Ajka power station. Cross section. [33, p. 220.]

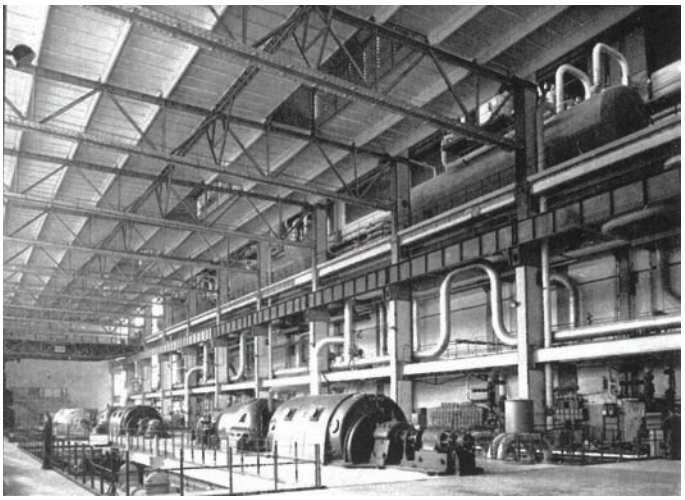

Fig. 10. Ajka power station. Turbine room. [33, p. 220.]

other hand, due to the special aesthetic relationship between the two parts of the building, the architectural composition is removed from the primary technological and structural considerations. The sharp contrast between the 'ethereal' glimmering of the taut surface of the boiler house's glass wall as well as the virtually floating web of lines of its frame structure, and the multi-layered quality and vivid chiaroscuro effect created by the artificial stone grid covering the openings of the precipitator hall, produces the most striking visual effect of the entire building. Thanks to this dual composition, the observer's eye is directed to the absolute geometrical clarity of the masses and the details, as well as the 'metaphysical' quality conveyed through the interaction of the different materials, surfaces, proportions, lights and colours, and at the same time communicates the markedly different functions of the two component parts. The dynamic composition of masses and structures is enhanced by the southern facade of the power station, during the design of which Vörösmarty and Nagy courageously used a stepped form, required by the technological features of the building. This architectural solution was regarded as unsuitable in power station architecture both structurally, economically and aesthetically in the first half of the decade, due to the special circumstances of the time. Although the architects strove to harmonise the various 'steps', they failed to achieve a convincing unity of form between the southern side and the far more carefully composed facade of the northern side. Yet, this dissonance is not so conspicuous: the rhapsodic dynamism 'radiating' from the mechanic systems into the forms of the building is soothed by the uninterrupted brickwork surfaces extending across the building's side walls and the facades of the lower level of the precipitator hall, holding the masses of different scales together in a composed order. The structural system of the building also determined the architectural character of the interior spaces: the architects exploited the interplay between the web-like steel structures and the massive concrete members to create a unique and diverse design. The spatial effect of the interiors is at least as much defined by the great amount of light flooding into the building, in contrast to previous power stations, which entirely redefines the relationship between the machinery and the architectural spaces.

The previous description unambiguously shows what constitutes the monumentality of the Ajka power station and how it differs in this respect from previous facilities. The architects successfully turned into an advantage what could have ended up as a disadvantage to the design: the engineering rationality that can be observed behind the diversity of forms and structures resulting from the close connection between the construction and the machines, exudes a kind of 'static tranquillity', which in turn creates a dramatic tension.

The benefits related to the economic aspects inherent in the structural principle first used in the case of Ajka could not be fully exploited because, at this time, the implementation process was still somewhat inefficient and was not fully harmonised with the building of the technological system [37, p. 21]. However, in the subsequent development projects of the Kőbánya and Oroszlány power stations, the system was developed in the desired direction and fulfilled the promise linked to it. [17, pp. 541-542.; 34, p. 11.] However, it must be noted that the unique aesthetic dichotomy of the Ajka facility did not appear in these two projects, since the somewhat different structural and technological characteristics led to a far more subdued design of forms and an architectural attitude that used significantly fewer visual enhancers.

The Kőbánya power station (designed by: Endre Resatkó, architect; Frigyes Völgyes, structural designer; Sándor Szűcs, structural engineer; design and implementation: 1958-1960) resembles the Ajka facility both in its structure and technological disposition. (Figures 11-13.) However, unlike its predecessor, the structure of the hall for the feedwater system and the coal bunkers were successfully included in the same block with the turbine house through altering the shape of the coal bunkers and significantly lowering them. Thus, a far tauter and more sedate composition was achieved. [27] The building differs from its predecessor in yet another respect: since the turbine room-feedwater system hall is longer than the boiler house, due to technological and functional reasons, it represents a significantly greater mass than it had in previous power stations and thus becomes architecturally equal to the boiler house wing. The balance exuded by this composition was further enhanced by the panel construction of the walls. The grid of precast concrete elements consistently applied on all the facades, and the pattern created by the frames of the glass walls – also built with precast concrete elements – that break up the boiler house and the turbine hall along their entire widths virtually repeat the pure geometry of the building. At the same time, the vertically defined panels and rows of windows add an upward thrust to the composition, thus counterpointing the quiet order of the forms. This architectural approach is also manifest in the Orosztány power station, although the building has an overall different character: the significant modification introduced in the link between the structure and the technological systems exerted a great impact on the design of forms.

The integration of machines and structures: the first steps towards open-air technologies

The great technological change around 1960, the first signs of which already manifested – as previously discussed – in the mechanical structures of the Ajka and Kőbánya power stations, exerted its influence on the facility in Oroszlány (designed by: architects László Bereczky, József Pomogáts and Dénes Domaniczky; structural engineers Vilmos Péry, Miklós Ugrai and István Ivits; construction: 1959-1960) even more powerfully, since it also affected the architectural design. (Figures 14-16.) It was the first 'block power' station built in Hungary,

in which separate production lines operated simultaneously, i.e. all the turbines and generators were supplied by one boiler (previously they were connected to several boilers). [6, pp. 545] The development of the technological equipment provided the opportunity to install the feed tanks in the space between the coal bunkers. In this way, there was no need for a separate hall for the feedwater system, which resulted in a significant reduction in the building's volume. [6, pp. 547-548; 17, pp. 541]

Fig. 11. Kőbánya power station. Designers: Endre Resatkó, Frigyes Völgyes, Sándor Szűcs. 1958-1960. [33, p. 223.]

The architects based the design of the building's structure on the principle that had been used in the case of the Ajka facility; however, they developed a more differentiated system built with special 'hybrid' parts. While the coal bunkers and the row of frames bearing the load of the feedwater equipment were built with self-supporting steel elements (pillars and beams) cast in concrete, the structure of the turbine house was made with lattice girders constructed from precast concrete elements and steel members, resting on steel pillars. The facades of the building were brick walls up to 8 meters, with industrially precast concrete panels above that height. [6, pp. 546-551]

The main innovation of the Oroszlány power station was the structure of the boiler house, since the boilers themselves were actually integrated into the structure of the building. The rear walls of the machines were built in with the building's facade, while their side walls and frames bore the load of the roof and the interim slabs of the boiler house. [6, p. 551] This solution clearly indicates that Hungarian power station architecture had joined the trend that was followed by a growing number of countries worldwide in this period. From the 1950s, the technological development of the power stations necessitated the breaking up of closed spaces, since around this time the size of boilers increased quickly and their innovation made them obsolete so rapidly that it was increasingly difficult to find cost-effective architectural solutions for the structures that encased them. At this point, architects not only considered reducing the volume of buildings and optimising the size and cost of the loadbearing structures, but also opening up the facilities. This aspiration directly preceded the introduction of open-air

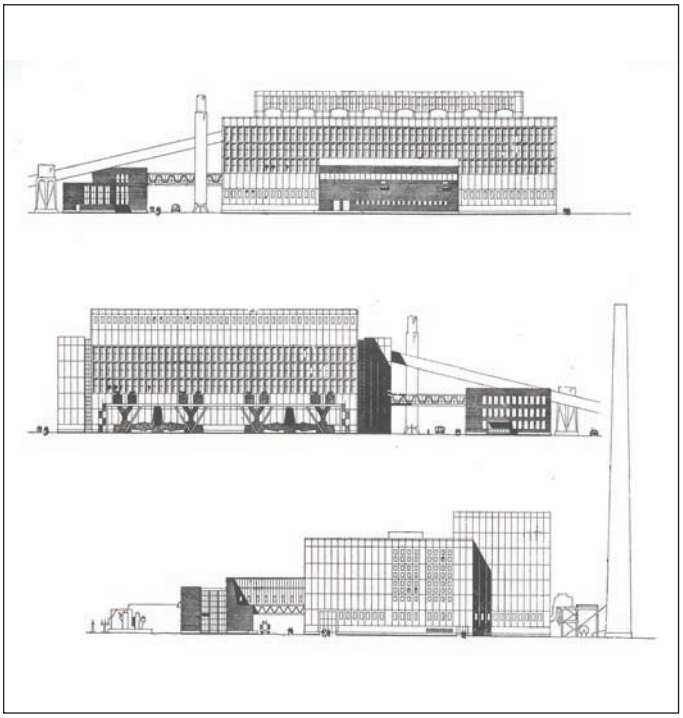

Fig. 12. Kőbánya power station. Facade plan. [27, p. 53.]

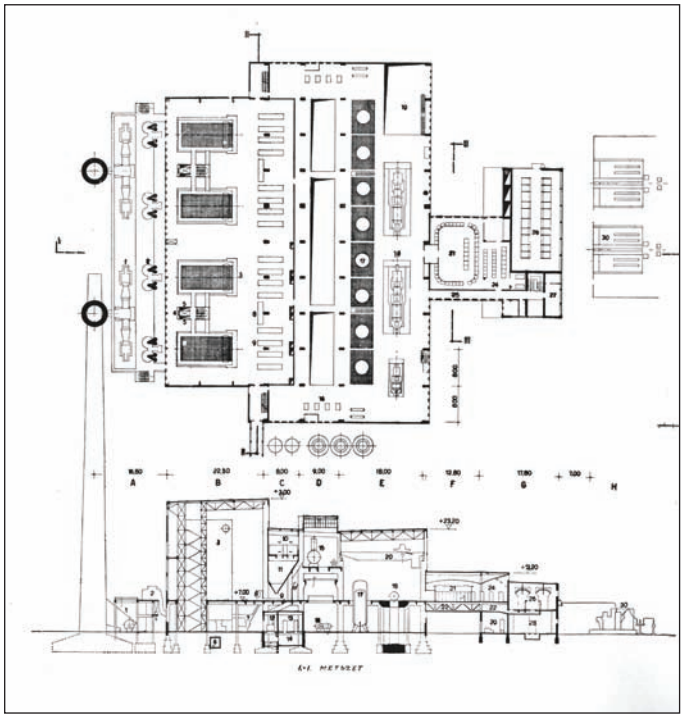

Fig. 13. Kőbánya power station. Ground plan and cross section. [27, p. 52.]

systems and led to a series of experiments in structure, as well as to ongoing conflicts that arose from the uncertainty that surrounded the changing relationship between architectural and technological systems. The boiler house of the Oroszlány power station was the Hungarian application of the aforementioned worldwide trend, and focused attention on the new dilemmas concerning the theoretical aspects of design. The integration of architectural structure and machines had already anticipated the grave problems inherent in the design of power stations built in the 1960s with predominantly open-air technical systems, namely the dissolution of the autonomous building and the transformation of machines into constructions of an architectural character.

Although the volume and the form of the boilers are not directly repeated in the building's composition (since the spaces around them are closed off by enclosure structures), the massive (almost 40 meters high) shiny surfaces of the machines' sides alternating with the light glass walls on the longitudinal facade of the boiler house, must have created a sensation in the context of the period's Hungarian architecture. Of course, there had been other examples in Hungarian industrial architecture for the direct (structural) linking of machines and buildings of such a huge scale. However, in the case of the Oroszlány power station, a new aesthetic quality emerged through this solution: the rectangular walls of the boilers fit in with the overall design of the building with surprising naturalness, as if 'rhyming' with the blocks of the coal bunker hall, the turbine room and the boiler room, with their different proportions counterpointing each other. The square grids of the bright white wall panels and the strictly geometrical order of the continuous windows further enhance the impressively taut composition of the right angles, into which only the jutting-out masses of the staircase towers introduce some movement. That is, the architects integrated the machine into the architectural concept not merely in a structural but also an aesthetic sense.

The monumentality of the Ajka power station was created by the machines, which were concealed but nevertheless deeply pervaded and even 'spiritualised' the architectural forms, and also by the new structural systems that induced dynamic compositions. In contrast, in the case of the Oroszlány facility, it was the harmonious co-existence of the directly visible machines and the calm order of the rational architectural forms that lent the building its monumentality. Thus, in spite of sharing many similarities, the two power stations are different in aesthetic terms, which is clearly linked to the circumstances of their coming into being and their technological dispositions.

The documentation (published in 1959) of the architectural competition announced for the Dunamenti Power Station in Százhalombatta, suggests that according to the initial concept, the facility was to follow the structural, technological and formal design of the Oroszlány power station. [31] The competitive projects reveal a lot about how much creative freedom

Fig. 14. Oroszlány power station. Designers: László Bereczky, József Pomogáts, Dénes Domaniczky, Vilmos Péry, Miklós Ugrai, István Ivits. 1959-1960. (By kind permission of Foundation for Modern Industrial Architecture – IPARTERV Photo Archive / A (Modern) (Ipari) Építészetért Alapítvány – IPARTERV Fotóarchívum)

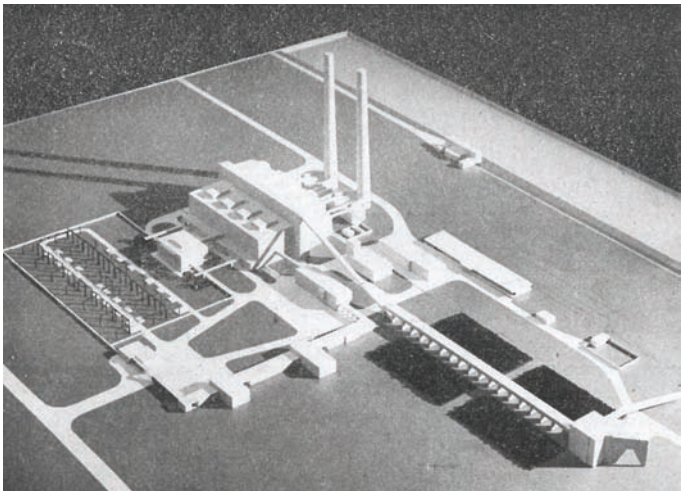

Fig. 15. Oroszlány power station. Model. (Lévai, A. ed.: Nagy erőműveink tervezése. Erőmű Tervező Iroda, Budapest, 1959)

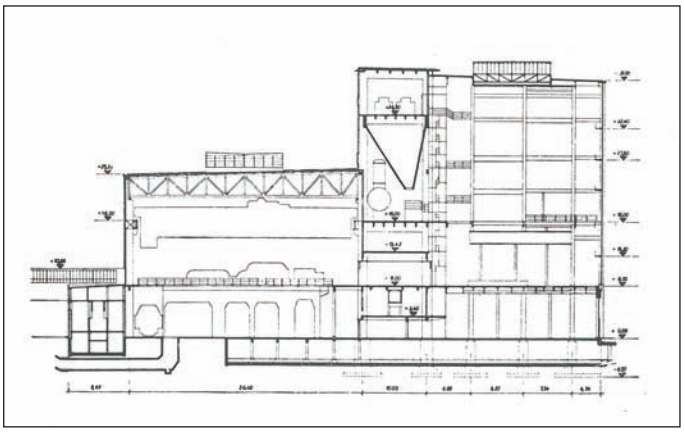

Fig. 16. Oroszlány power station. Cross section. [33, p. 213.]

designers were granted in power station architecture, when they had to adjust an architectural composition to a predefined spatial and structural configuration. Regarding massing, they were able to introduce formal variations to a certain extent in the staircase towers and the roofs, while the volume of the turbine house and its floor plan also provided some flexibility. They were afforded a definitely greater degree of artistic freedom regarding the size, forms and arrangement of the openings and the division of the surfaces.

The expressionistic design made by Árpád Szabó and Egon Payr probably tested the limits imposed by technological constraints. (Figures 17-18.) They broke up the glass wall of the turbine house by obliquely jutting out wall sections – thus significantly increasing the volume – and articulated the monotonous wall panes with a rich chiaroscuro. This idea also proposed a solution to the old problem of lighting the turbine house: these wall sections averted direct sunlight, which is not beneficial for the machinery, thus letting the maximum amount of diffused light into the interior. The roof of the boiler house and the staircase tower also boldly break away from the conventions of form previously adhered to: the diagonally rising coal conveyor belt is given an important role in the composition built on the sharp contrasts created by the pent-roofs sloping in opposite directions. The design by Márton Bíró is characterised by a delicate diversity of surfaces, structures and materials: the brick-faced facade of the coal bunker hall is reticulated by tiny windows arranged in a geometrical pattern, while the turbine room is opened up by a glass wall divided by densely arranged vertical lines, and the control room is covered with a sculpturally formed folded plate system. (Figure 19.) The interplay of geometrical forms and the diverse, colourful details of Attila Emődy's design evoke one of his principle works, the grain cleaning plant in Orosháza. (Figure 20.) Zoltán Gulyás's competitive project is dominated by vast glass walls that are rich in sophisticated, fine details and at the same time retain a unified structure, thus simultaneously dissolving large masses and letting the visual effect of their clear forms be manifest. (Figure 21.) In contrast, the design by Rudolf Petz, Ottó Almstaier and Antal Mischl proposed a composition akin to that of the Oroszlány power station. (Figure 22.)

This abundance of creative ideas was not exploited in the finally built power station at Százhalombatta, as the concept of the development project was fundamentally changed in the meantime, opening a new chapter in the history of Hungarian power station architecture.

The Oroszlány power station provides numerous lessons in regard to structure, technology and form, similarly to the analysis of the international context of the previously discussed architectural competition – primarily a comparison between the characteristics of power station architecture in the countries of the Eastern Bloc and the domestic developments. It can be seen that in the period around 1960, the development of power station technology generated architectural solutions akin to those used in the Oroszlány facility, although the integration of the mechanical systems and the buildings was implemented at various degrees and was coupled with different structural tendencies than in Hungary. This difference is best exemplified by the power station architecture of the German Democratic Republic, where the open-air installation of boilers was far ahead of Hungary. Power station no. III in Trattendorf (from 1953), the so-called eastern power station of the Spremberg Schwarze Pumpe industrial zone, and the Cottbus facility, demonstrate the shared elements of the processes that took place in the GDR and Hungary at the time (although the size and number of newly built power stations in the GDR was significantly bigger, and the boilers were by far more 'liberated' from the architectural structures). [15] Czechoslovakia followed the same path: the Tusimiče power station (1962-1964) closely resembles its Oroszlány counterpart not only in its technological disposition but also in its structure and forms, although it is very comparable with the facility of the chemical plant in Kralupy (K. Šlapák, Fr. Nikl). [10]

2 Százhalombatta and Gyöngyösvisonta: the disintegration of the power station as a building (1960-1970)

The new system of energy management and the construction of power stations

The new industrial development policy launched in 1958 determined the entire 1960s, i.e. the period of the second and

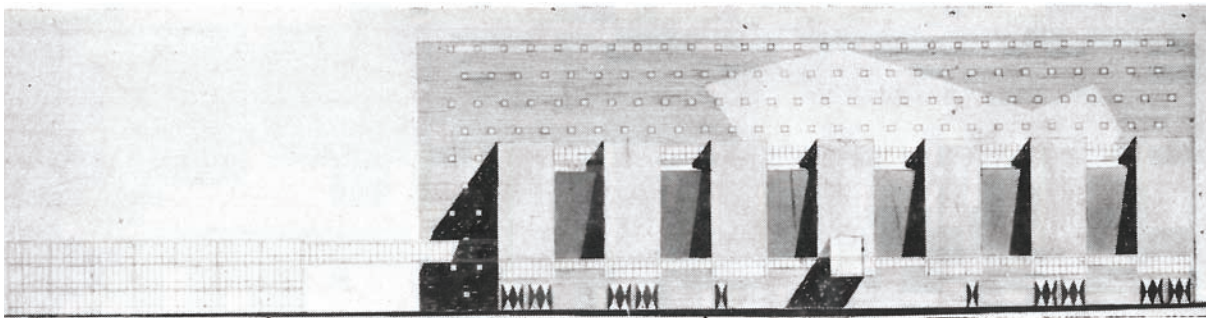

Fig. 17. Competition for the design of the Dunamenti power station in Százhalombatta. Competition entry by Árpád Szabó and Egon Payr. 1959. [31, p. 108.]

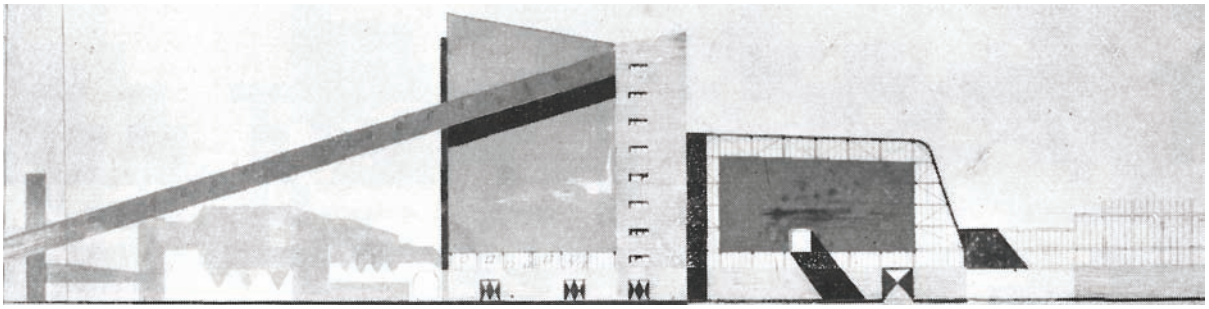

Fig. 18. Competition for the design of the Dunamenti power station in Százhalombatta. Competition entry by Árpád Szabó and Egon Payr. 1959. [31, p. 108.]

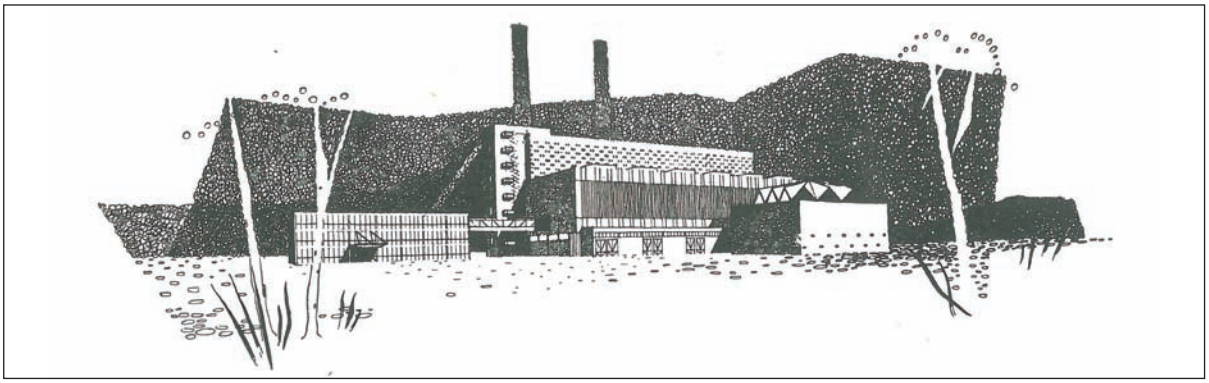

Fig. 19. Competition for the design of the Dunamenti power station in Százhalombatta. Competition entry by Márton Bíró. 1959. [31, p. 105.]

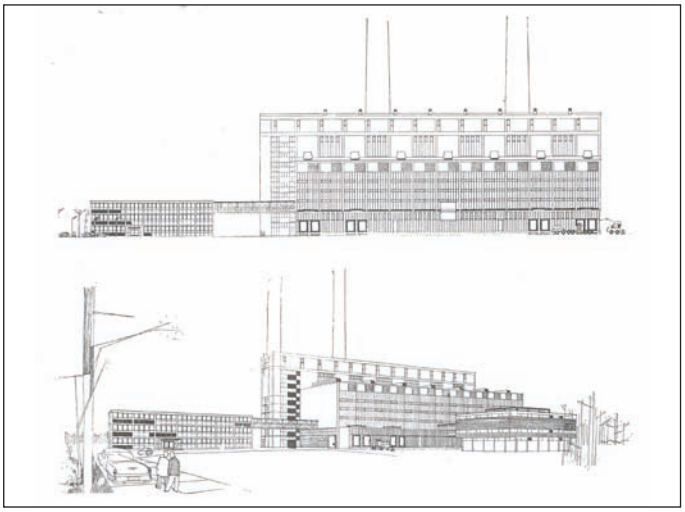

Fig. 20. Competition for the design of the Dunamenti power station in Százhalombatta. Competition entry by Attila Emődy. 1959. [31, p. 107.]

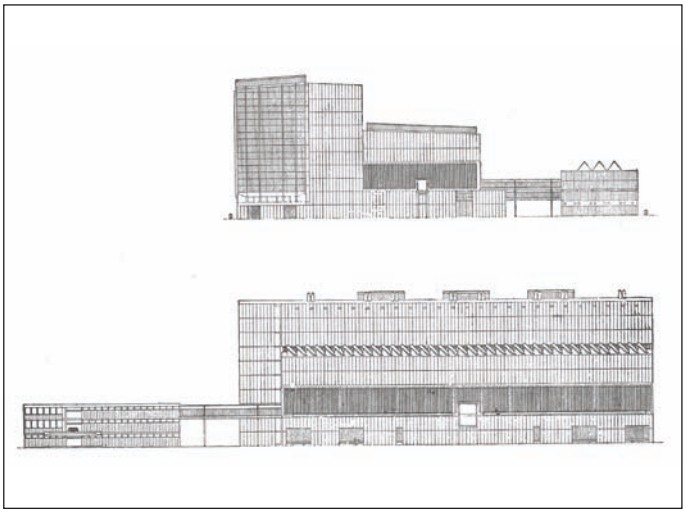

Fig. 21. Competition for the design of the Dunamenti power station in Százhalombatta. Competition entry by Zoltán Gulyás. 1959. [31, p. 109.]

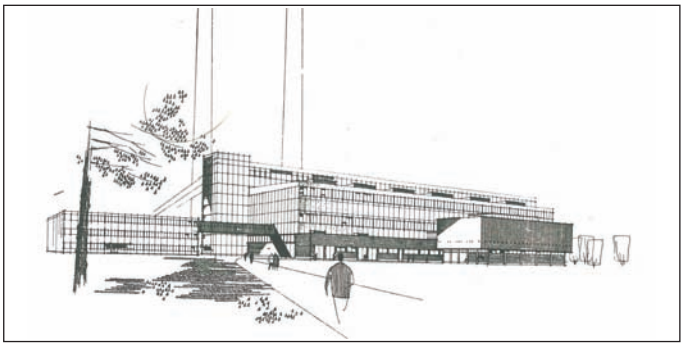

Fig. 22. Competition for the design of the Dunamenti power station in Százhalombatta. Competition entry by Petz, Ottó Almstaier and Antal Mischl. 1959. [31, p. 104.]

third five-year plans (1961-1965, 1966-1970) with only minor alterations. The steeply growing energy supply required by the massive wave of factory constructions at that time and the ever-expanding modernisation of households (electrification, mechanization) necessitated more power station projects – firstly, the Dunamenti power station in Százhalombatta and the Gagarin thermal power station in Gyöngyösvisonta, and secondly, the large-scale enlargement of the facilities in Pécsújhely and Bánhida (1966 and 1968).[4] [26, pp. 534-544]

Although energy management in this period in Hungary, similarly to other Comecon countries, was based to a far greater extent on coal than the international average, they strove to follow the global trend from the early 1960s, and began to use greater supplies of oil and natural gas. This change in the industrial structure and technology was partly linked to the increasing exploitation of domestic hydrocarbons supplies and partly to the laying down of pipelines transporting natural gas and oil from the Soviet Union. [28, pp. 430-431] The Százhalombatta power station, which deviating from the initial concept was eventually built on oil-based technology, primarily facilitated this restructuring. In contrast, the power station in Gyöngyösvisonta, which was the largest-scale development project of the second half of the 1960s, was built as a coal-based facility.

Building-machine or machine building? Power stations with an open-air system

As previously discussed, the tendency to omit architectural structures enclosing the technological equipment in power stations gradually transformed power station architecture all over the world in the 1950s and 1960s, resulting in several transitional versions. [11, pp. 81-82] The structural and technological system of the Oroszlány power station represented the first stage in this process, since getting rid of the enclosure walls around the boilers and the increasing elimination of the wings housing the turbo generators and the auxiliary equipment predominantly took place later. In the last stage of this transformation process, architectural structures were only erected around those parts that were exposed to weather conditions or required permanent monitoring, such as control and measuring equipment, stairs, elevators, pavements around taller machines, etc. These structures were typically joined to the open frames that supported the machines, or were built as lightweight structures suspended from the machines. [12]

Hungarian power station construction did not go through all the stages of the transformation process but introduced almost entirely open-air systems with one single leap. The Dunamenti power station at Százhalombatta (leading architect: László Irsy; implementation in several stages: 1960-1968) has seven boilers, all of which are free-standing, without any covering; only the lightweight supporting structures of the pavements and protective 'casing' envelop them like a kind of 'web'. (Figures 23-25.) The previously common turbine house was also left out of the design, although the auxiliary equipment on the level below the turbo generators were placed in a building with a monolithic structure and surrounded by closed walls. The turbo generators are protected against environmental hazards by parabolically bent 'tents', with a steel structure and sliding on rails. A five-storey concrete structure between the turbo generators and the boilers bore the load of the switching equipment, the machines operating the feedwater system and the various amenities catering to the workers. Joined to this structure – as if continuing it – was the building for the administrative, community and laboratory functions.

This solution radically reduced the architectural cost of the development project to 20-22% of that of the Tiszapalkonya power station, and the implementation also took almost one year less than it had in previous power station projects. [8, p. 28] This huge economic advantage was extensively praised by the contemporaneous daily press and specialist literature, proudly stressing repeatedly that it was the first power station in Central Europe that was built as an almost entirely open-air system.

Although the architectural design of the Gagarin thermal power station in Gyöngyösvisonta (designed by: architect Antal Springer, structural designer Béla Csíki; designed and implemented: 1965/66 – 1970) resembles that of the Százhalombatta facility in several elements, as they both use coal-based technology, there are also several differences. (Figures 26-30.) Introduced as a brand new technological solution in Hungary, the equipment of the coal bunkers and the feedwater system did not run parallel with the boilers but was installed in between them. This enabled the open concrete frame carrying the load of the coal bunkers to also function as the loadbearing structure for the boilers, which resulted in significant cost-saving. At the same time, the lower part of the boilers were enclosed to fully protect the various auxiliary equipment. Similarly, walls constructed from precast concrete panels and purpose-made glass elements surrounded the level below the turbo generators built with a monolith concrete structure. The turbo generators were covered by similar, steel structured sliding tents as in the Százhalombatta power station. [30] It can be clearly seen that the architects built on the experience gained during the Százhalombatta project, both in an economic and structural sense.

The new, open-air system required an entirely new strategy on the part of the architects, whose creative freedom in satisfying architectural considerations and salvaging the values inherent in architectural design was severely limited. Architects who specialised in the design of power stations and had striven to create monumental compositions and a unified order of forms, needed to find new solutions: the means of formal expression and aesthetic ideals of the past, as well as the old structures

4 Since the latter two projects are not autonomous designs but 'appendices' to larger facilities, they will not be discussed within the scope of this study.

Fig. 23. Dunamenti power station at Százhalombatta. Leading architect: László Irsy. 1960-1968. (Szabó, J. ed.: Nagyipari létesítmények 1945-1970, Budapest, 1975)

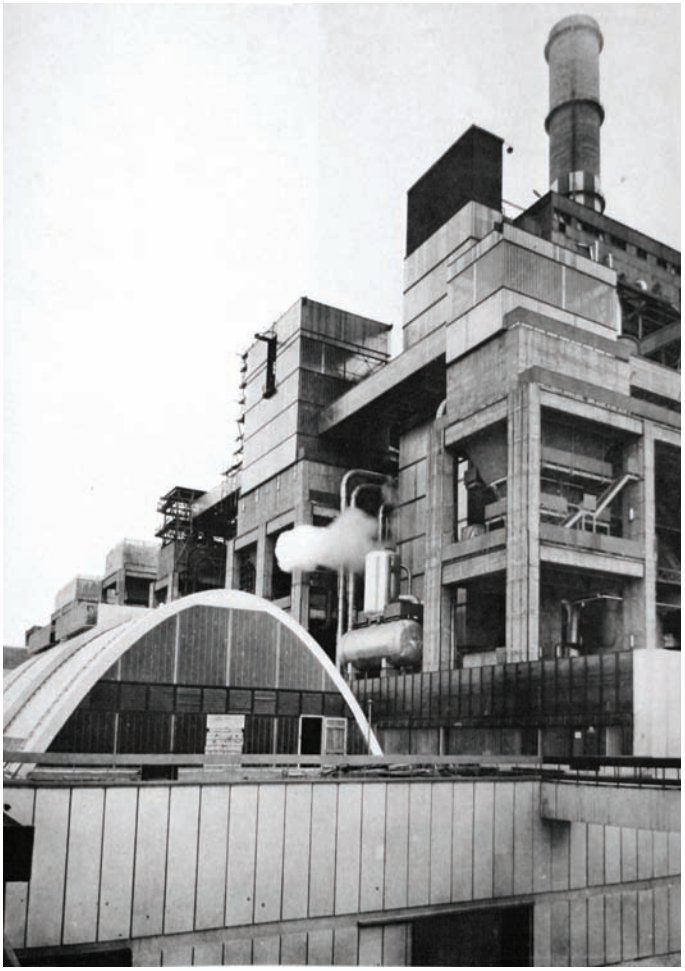

Fig. 26. Gagarin power station in Gyöngyösvisonta. Designers: Antal Springer, Béla Csíki. 1965/66 – 1970. (By kind permission of Foundation for Modern Industrial Architecture – IPARTERV Photo Archive / A (Modern) (Ipari) Építészetért Alapítvány – IPARTERV Fotóarchívum)

Fig. 24. Dunamenti power station at Százhalombatta. (Szendrői, J. ed.: *Magyar építészet 1945-70*, Budapest, 1972, p. 187.)

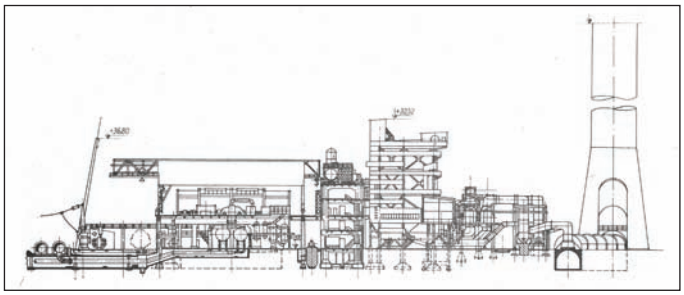

Fig. 25. Dunamenti power station at Százhalombatta. Cross section. [16]

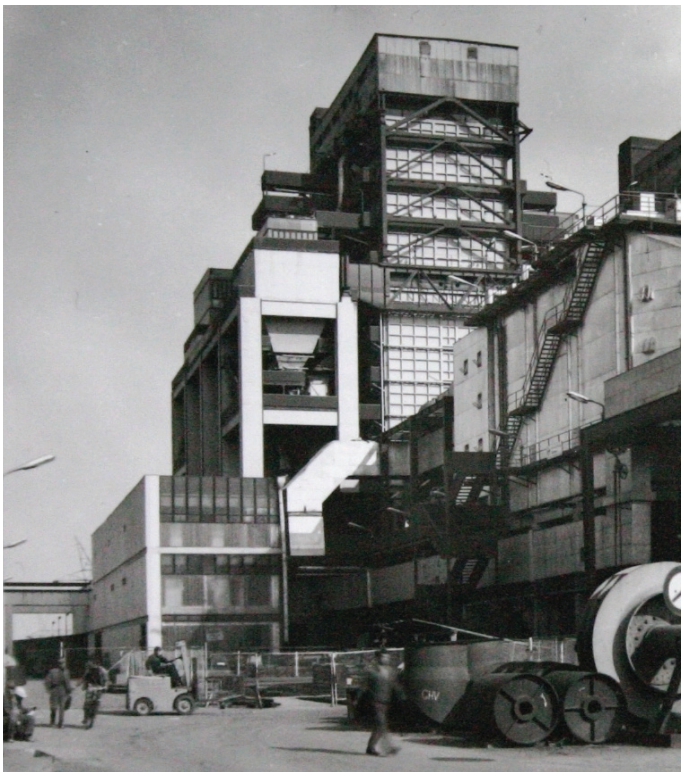

Fig. 27. Gagarin power station in Gyöngyösvisonta. (By kind permission of Foundation for Modern Industrial Architecture – IPARTERV Photo Archive / A (Modern) (Ipari) Építészetért Alapítvány – IPARTERV Fotóarchívum)

and technological dispositions seemed to have reached a definite end. The challenges faced by architects looking for new directions are well expressed by László Isry's lines about the Százhalombatta power station: "Due to the open-air solution, it is exactly the main building that functioned as the power station's dominant architectonic unit that has lost its character as a building the most and now basically only supports the technological equipment (…); this necessitated a massing solution that can still communicate the importance of the building to a satisfactory degree. (…) We decided to join the office building to the main building – now of a reduced mass – as a kind of supplement" in order to have a "stronger architectonic unit". [12, pp. 8-10] In addition to exploiting the exciting contrasts created by architectural structures, the 'naked' machines and the open-structure frames, as well as the merging of masses, architects also strove to use a new "aesthetic means" to achieve an "architectural appearance", "namely colour dynamics that [played] an ever increasing role in architectonic design [at the time]". [12, p. 10] The method of using colour dynamics aimed at creating a kind of unity between the forms of the seemingly fully autonomous 'building fragments' and the ramifying mechanical structures was enabled by the complex anti-corrosion treatments required by open-air equipment, i.e. it was actually made possible by the new construction method of power stations. From this time on, colour dynamics exerted an increasingly important influence in all areas of industrial architecture, which was facilitated by the findings of psychological research on the use of colours in the work environment.

Although László Irsy seemingly tried to express his view about the new role of the architect convincingly, and went into detail about the importance of the potential use of using colours, a certain level of professional frustration can be felt in his words as he writes about solutions necessitated by technological constraints, and the pressure of "welding into architecture" what limited opportunities make possible (note the use of the word "supplement"). Interestingly, the 'machine-topos' of modern architecture, i.e. the architectural approach according to which machines are seen as sources of inspiration with their own inherent aesthetic and unique expressive power, was not conveyed in Irsy's words, even though it would have 'come in handy' in this situation. (Alternatively, perhaps that is exactly why he did not refer to it?)

The technological structure and the machines' forms provided more opportunities for the architects of the Gyöngyösvisonta power station to design impressively articulated masses, and to create a design that was overall akin to traditional architectural compositions yet was largely defined by the forms of machines. The sombre masses of the gigantic (60 meters high) boilers are counterpointed by the open-structure concrete frames carrying the funnel-like coal bunkers. On the side where the turbogenerators were placed, every boiler is accompanied by a slender, glass-walled staircase tower connected to the structures of the

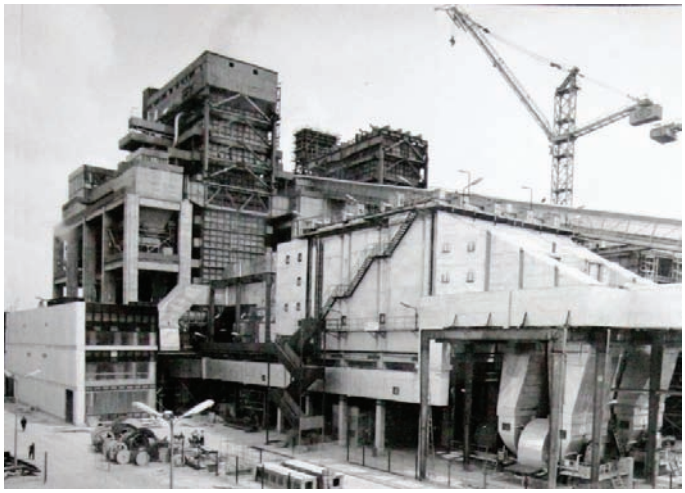

Fig. 28. Gagarin power station in Gyöngyösvisonta. (By kind permission of Foundation for Modern Industrial Architecture – IPARTERV Photo Archive / A (Modern) (Ipari) Építészetért Alapítvány – IPARTERV Fotóarchívum)

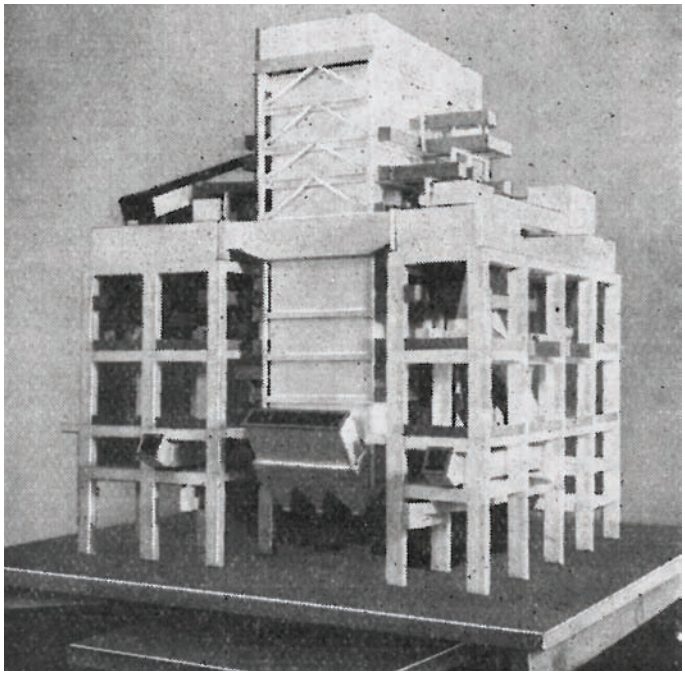

Fig. 29. Gagarin power station in Gyöngyösvisonta. Model. [16]

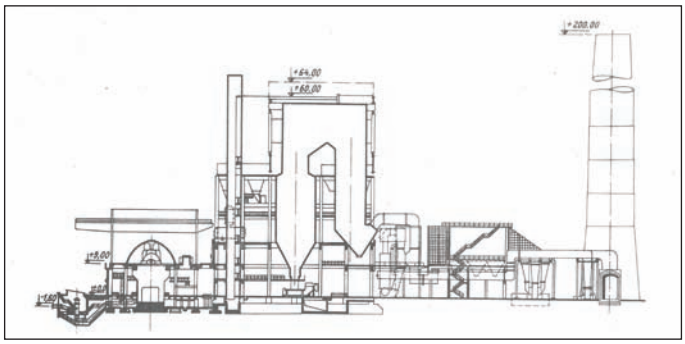

Fig. 30. Gagarin power station in Gyöngyösvisonta. Cross section. [16]

glass-walled coal bunkers by graceful bridges. The repetition of the ensemble of boilers, staircase towers and coal bunkers adds a spectacular rhythm to the overall appearance of the power station. In the overall design, the closed lower level gives the impression of a plinth on which the machines rise up, with heroic effect enhanced by the white wall surfaces counterpointed by the darker, metallic tones of the equipment. This special, dynamic quality of the building is further enhanced by the steel tents enveloping the turbo generators, the gentle parabolic curves of which are contrasted with the strictly linear 'tower ensembles'. Thus, it can be seen that the technological structure enabled the design of an extremely impressive composition. The design brings to mind futuristic architectural visions thanks to the virtually unharnessed expression of the 'brutal monumentality' inherent in machines and perhaps to the elements that – obviously unintentionally – lent a kind of pathos to the building (a pedestal-like lower level, tower-like parts, dramatic contrasts, etc.).

Theoretical context: architecture looking for a direction in the world of open-air technologies

In order to gain a more in-depth understanding of the two power stations studied in this chapter, besides the analysis of form and structure, we need to become familiar with the general theoretical background that pervaded industrial architecture in the 1960s in Hungary and all the other Eastern Bloc countries. The theoretical issues were closely linked to the passionate aspirations to solve the problems generated by the new relationship between industrial buildings and technological systems, as well as technical, economic and functional issues resulting from the different lifespans of the buildings and equipment.

First and foremost, it was the presentations held at the 1st Industrial Architecture Conference in 1961 that highlighted the two fresh trends that defined industrial architecture at the time, namely solutions linked to the introduction of the 'universal halls' assembled from precast standard structures and the growing use of open-air plants, which were two sides of the same coin. One of the key aspirations in industrial architecture was – unlike in previous periods – to make buildings structurally as independent as possible of the technological system that it housed and thus enable it to flexibly adapt to the ever more frequent technological changes. [13, p. 13; 35, pp. 16-19; 33, p. 23] In his book titled *Ipari építészetünk* (Our Industrial Architecture), published in 1965, Jenő Szendrői, who was the chief architect of IPARTERV at the time, drew attention to the fact that this newly arising need – connected to the increasing degree of automation – induced opposite processes in architectural terms. While in some industries the functional and technical requirements concerning production halls had become far more complex than before, in others – in the electricity industry and chemical industries in particular – technological development encouraged architects to increasingly move away from the concept of closed buildings and omit them as much as possible. [33, p. 77]

During the analysis of the two facilities, it must also be considered that various methods of the open-air installation of technological equipment had been previously used in power station architecture, but in most cases, they were limited to certain parts of the technological process (transformers, precipitators, etc.). Thus, it can be clearly seen that the turnabout around 1960 brought a qualitative change in every respect in the architecture of power stations, since now a significant part of the central technological system was moved into the open air. It must also be kept in mind that besides the electricity industry, the same change took place in Hungary in the architecture of the chemical and building industries, which were undergoing large-scale development at that time. Hence, the issues pertaining to open-air plants affected an especially large proportion of architects who worked on industrial projects.

Despite the fact that due to the changes, the role of the architect needed to be radically redefined, most of the professionals did not stir themselves up over these issues, at least not in their writings. However, it is worth quoting some of the contemporaneous views regarding open-air plants, in order to form a general picture about the area, and thus get an insight into the role played by the Százhalombatta and Gyöngyösvisonta power stations in the complex processes of Hungarian architecture in the 1960s.

The majority of contemporaneous sources written about open-air plants mainly focus on the economic aspects. However, many of them also highlight that the close co-operation between architects and technologists gained more importance in this segment than in any other types of industrial construction projects. This is because the factors that hold the key to the success of the given project – determining the right proportion of production units installed in open-air and closed buildings, adjusting the technological disposition of the building to the natural features of the ground, choosing economically and functionally appropriate structures, etc. – are primarily based on the expertise of the architect. [35, pp. 16-18; 16, p. 124; 25, pp. 40-41; 32, pp. 116-117] The majority of authors believed that the role of the architect was to be a kind of 'facilitator of order'. Someone who designs an installation plan for the machines that is characterised by clarity, easy accessibility, is harmonised with the production lines, and if necessary, makes sure the various supporting frames and enclosed rooms have the appropriate function and form; but, their responsibility does not extend beyond this.

István Száva saw somewhat greater room for creativity in the new industrial architecture. He even referred to the modern 'machine topos' in his presentation held at the 2nd Industrial Architecture Conference in 1968. He wrote the following: "The joint appearance [of the enclosed and open-air spaces of plants] can be moulded into a unique architecture. In industrial architecture, architects have to work with masses and spaces that are new to them." However, "the completed design has the potential to express the technological level of our age without being over imposing and disproportioned. In any case, a kind

of unique architecture is inherent in these complex systems of machinery. The supporting frames are covered by pipes, cylindrical bodies and the silvery web of curves. The strong verticality and the complex mass of these facilities convey an aesthetic value. For example, at night the outdoor production equipment create a magical ambience by their smaller or bigger dots of light, the shimmering as light is reflected on the shiny surfaces that had been turned inside out. This light effect is different from that of city lights, but also akin to it, since both are a manifestation of the level of technology." [32, p. 117] Similar ideas were included in the guidebook titled *Hőerőművek III.* (Thermal Power Stations III). In its chapter on architecture, it is stressed that in order to achieve a unified design of form in the case of open-air power stations, which have virtually entirely lost their "buildingness", the application of colour dynamics is not the only possible architectural means. "Architectural quality should be more than merely finding aesthetic solutions for facades; we should also try to arrange the masses of the building favourably (…). Similarly, there is potential in shaping the design of the technological equipment (their covering), through which a more favourable aesthetic appearance could be achieved. This kind of design played a far from negligible role in the appearance of the interior architecture, what is more, (…) in the design of the exterior architecture, too; that is why the architect needs to actively participate in the approval of designs and the direction of the design process." [16, pp. 120-123] By writing these lines, the author took an important step in significantly broadening the role and impact of the architect, since he saw the architect's activity as a kind of industrial design work. This is despite that it must have seemed utterly naive and idealistic in the context of the Hungarian technical culture of the period – during which he designs a well-functioning, user-friendly and artistic form for a machine constructed by a group of technologists and engineers. The author is no longer led by the 'old reflexes': he realised that having moved away from the traditional concept of the 'compact building', architects had to base their work on the essence of open-air systems and the 'inherent nature' of the forms of machines. He also emphasises that power station architecture enabled the architect's task to become more flexible, regardless of the extent to which the technological system of the facility was designed as open-air: "in the continuous interaction between technology and architecture *the determining role is played by technology*, and in some respects it might even be less dominant or be turned around." [16, p. 124]

In his recollections written in 1988, György Balázs describes the changed role of the architect from a practical perspective, when he relates his experiences in connection with the kiln building (completed: 1966) of the lime works in Hejőcsaba, which had mostly open-air design. (Figure 31.) He writes, "it was fortunate that the technology enabled us to create a design which not only had to strictly satisfy requirements, but one in which we were also able to achieve an interesting appearance without having to use any unnecessary or stilted solutions regarding the forms and structure. (…) [The building] was basically an industrial design achievement that […] faithfully reflected those opportunities that were at our disposal at the time during the construction of a building like this." [4] Although these lines were written about a project in which the architect was also able to successfully use the inherent value of the technological equipment as a means of artistic expression, they suggest that it was merely a 'state of grace'. This being the personal experience of an architect who was given an important role in a 'not quite average' situation, even further emphasises the lost role of architects in general who had been reduced to minor players (note the use of the word "fortunate").

In his analysis of a half open-air transformer station in Budapest (designed by: Ernő Lestyán, constructed: 1966-1969) – which falls under the category of power station architecture – he talked with some resignation, yet optimistically, about what had been lost from the role of the industrial architect in carrying out such a task, one that was new and might have seemed as something forced on architects. As he writes, although during the design process "today's architectural designers were surrounded by the architectural and technical approach of technologists, it all formed an integral whole (…). And what about technologists? Did they start out from a building-centred approach or from a 'machine' one? Obviously, if in the present, technologists think in terms of the former, the future in this genre definitely belongs to the latter, since even in this project, the team of engineers and architects have already moved in this direction (…) because here the transformers are installed in the open-air (…). Yet, (…) this transformer is not entirely a building, and is definitely not a machine either. While I am musing over these things, my eye (…) is caught by my pre-war Telefunken radio (…). It is a piece of furniture still, with a design that furniture requires. But time has passed judgement upon it: the radio of the present, and that of the future especially, will only be a machine. In the case of our [transformer] station, the architect's way of thinking was already shifting in the direction of a building with a somewhat machine-like appearance. I wonder if it will be followed up by a more pronounced step taken by technologists. Will it? We think it will. If technological equipment becomes smaller thanks to some small and some bigger ideas, (…) the entire mass (…) will have a new form, and if the technologist and the architect will take this step together, a facility like this will have a tasteful design and an appropriate form, (…) similarly to cars and other vehicles (…)." [1] Thus, Lajos Arnóth was hopeful that amidst the rapid technological innovation, the architect would not be left out of the design process, and that there was hope for a kind of creative convergence between the two 'sides'. This raises the issue of professional responsibility

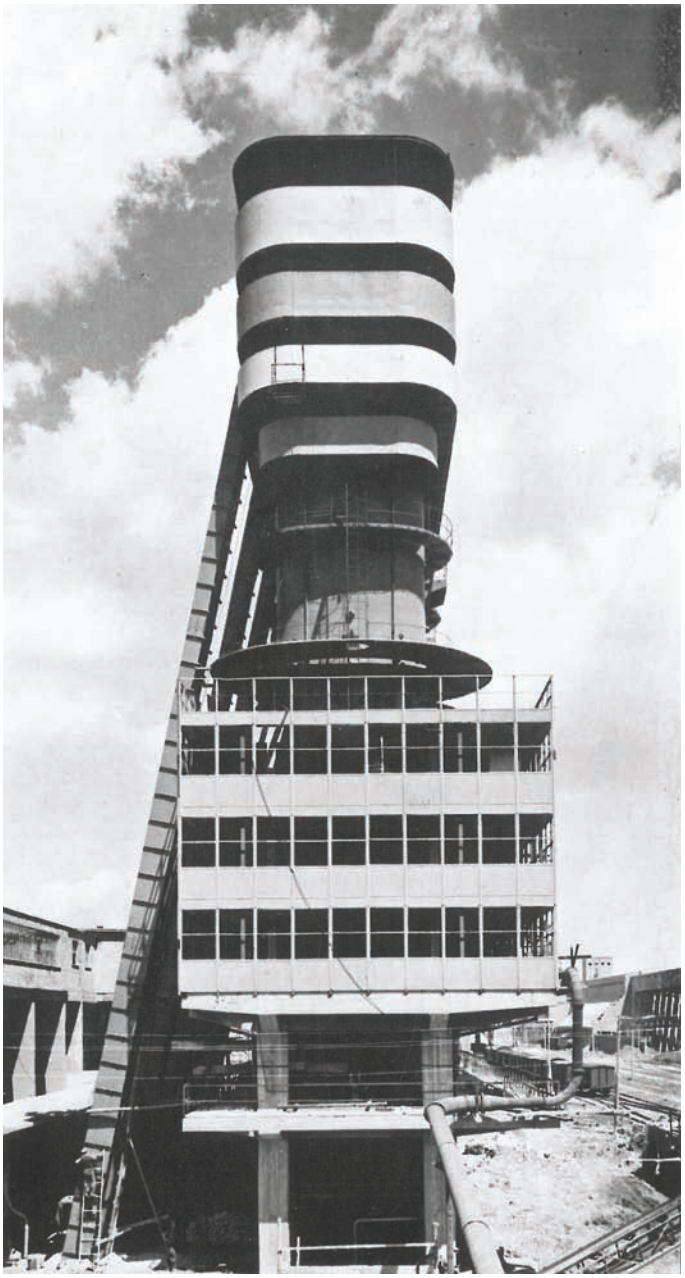

Fig. 31. Kiln building of the lime works in Hejőcsaba. Designer: György Balázs. (Szendrői, J. ed.: *Magyar építészet 1945-70*, Budapest, 1972, p. 190.)

from both parties. As there would be fewer traditional buildings in some of the industries – and the ones built would function as replaceable bodyworks in factories instead of autonomous architectural works – technologists would paradoxically have to increasingly open up the protected territory of their profession and acquire in-depth knowledge about the diversity of needs and human factors that existed alongside technical functions. Similarly, architects would have to become more open to the ongoing processes of technological innovation in order to be able to give well-founded and flexible architectural solutions to the rapid changes. In connection with this, Arnóth referred to automotive design, which is similar to the volume written by Lévai and the views held by György Balázs, who seems to regard industrial design as a creative activity developing together with technological progress as a role model for the future. The same idea is suggested by Reyner Banham, who also cites the history of automotive design as an example to follow – in the afterword of his *Theory and Design in the First Machine Age*, which discusses the confrontation of the technological 'race' of "the second machine age" and the principles of modern architecture. In this regard, the often quoted sentence of this book, which reflects the general experience of the architects of that period – regardless of them living in the Western world or in the Eastern Bloc – is especially apt: "The architect who proposes to run with technology knows now that he will be in fast company, and that, in order to keep up, he may have to emulate the Futurists and discard his whole cultural load, including the professional garments by which he is recognised as an architect. If, on the other hand, he decides not to do this, he may find that the technological culture has decided to go on without him." [5, pp. 329-330]

These lines of Lajos Arnóth and György Balázs also confirm that the experience described by Banham was bound to be felt the most powerfully by industrial architects who had to face the gaining ground of open-air technologies, since in this area technology becoming totally autonomous was no longer an uncertain prediction but reality. Due to their enormous size and complexity, power stations demonstrated unambiguously, more than any other type of building, how the definition of the industrial building per se, as well as the complex relationship between man, machine and building, were transformed in this new situation alongside the opportunities for the unfolding of artistic ingenuity, the various ways of monumentality and the expression of energy. Undoubtedly, power station design in the 1960s encapsulated the most important structural, technological and aesthetic problems of industrial architecture in the Rákosi era and in the first few years of the Kádár era. Power stations – whether architects wanted it or not – turned into icons: the icons of industrial architecture at any time.

References

1 **Arnóth L.**, *Megjegyzések a transzformátorállomás kapcsán*. Magyar Építőművészet, 3/19, 32 (1970).

2 **Bajnay L.**, *Tipizált vasbeton szerkezetek tömeges üzemi gyártása*. in 'Nagyipari létesítmények 1945-1975'(ed.: Szabó J.), Műszaki Könyvkiadó, Budapest, 256-270 (1975).

3 **Bajnay L.**, *Többcélú üzemi épületek tervezési irányelvei*. Ipari Építészeti Szemle, 22, 32-36 (1964).

4 **Balázs Gy.**, *A Hejőcsabai Mészmű kemenceépülete*. Magyar Építőművészet, 3/37, 28 (1988).

5 **Banham R.**, *Theory and Design in the First Machine Age*. Architecural Press, London, 329-330 (1960).

6 **Bereczky L., Péry V.**, *Oroszlányi erőmű üzemi épülete*. Ipari Építészeti Szemle, 22, 24-29 (1964). Budapest (1957).

7 **Böhönyey J.**, *A tipizálás kérdései*. Magyar Építőipar, 4/1, 145-156 (1961).
8 **Molnár A.**, *Erőművek, Ipartelepek építészete V*. in 'Ipari üzemek technológiája és építészete' (ed.: Rados K.), Akadémiai Kiadó, Budapest, 9-51 (1979).
9 **Egyed F.**, *Gondolatok a magyar ipari szerkezettervezés 15 évéről*. Magyar Építőművészet, 2/13, 64-67 (1964).
10 **Göpfert M.**, *Elektrárna Tusimiče*. Architectura ČSSR, 3/21, 163-165 (1962).
11 **Hoffmann C.**, *Korszerű külföldi hőerőművek tervezése*. Ipari Építészeti Szemle, 1, 79–84 (1960).
12 **Irsy L.**, *Dunamenti Erőmű*. Műszaki Tervezés, 10/6, 8-10 (1966).
13 **Kardos A.**, *Beruházó és generáltervező szerepe az ipartelepek megvalósításában*. Ipari Építészeti Szemle, 20, 12-13 (1961).
14 **Katona J.**, *A magyar ipari építészet fejlesztésének lehetőségei*. Ipari Építészeti Szemle, 16, 1-18 (1957).
15 **Kiss W., Schmidt G.**, *Erőművek tervezése az NDK-ban*. Magyar Építőipar, 10/17, 675–685 (1968).
16 **Lévai, A. (ed.)**, *Hőerőművek III*. Műszaki Könyvkiadó, Budapest (1970).
17 **Lévai A.**, *Az első hazai szabadtéri hőerőmű kialakulásához vezető út*. Magyar Építőipar, 12/9, 541–544 (1960).
18 **Menyhárd I.**, *Túlhaladott-e a monolitikus építési mód?* Magyar Építőipar, 2/9, 73-76 (1960).
19 **Mokk L.**, *Helyszíni előregyártás. Ipari épületek, csarnokok (2nd ed.)*. Műszaki Könyvkiadó, Budapest (1961).
20 **Pászti K.**, *Előregyártott hőerőművek szerkezeti fejlődése és anyagmutatóinak alakulása*. Ipari Építészeti Szemle, 16, 19–28 (1957).
21 **Pászti K.**, *Gázszilikágyár, Berente*. Magyar Építőművészet, 2/13, 56-57 (1964).
22 **Pászti K.**, *Ikarusz üzemi csarnok előregyártott épülete*. Ipari Építészeti Szemle, 18, 33-38 (1960).
23 **Pászti K.**, *Kábel- és Sodronykötélgyár új üzemi csarnoka*. Ipari Építészeti Szemle, 20, 55-60 (1961).
24 **Pászti K.**, *Pécsújhelyi erőmű üzemi épülete*. Ipari Építészeti Szemle, 17, 36–48 (1959).
25 **Péntek L.**, *Az építőanyagipari üzemek szabadtéri telepítéséről*. Műszaki Tervezés, 6/7, 40-41 (1967).
26 **Pető I., Szakács S.**, *A hazai gazdaság négy évtizedének története 1945-1985. I. Az újjáépítés és a tervutasításos irányítás időszaka*. Közgazdasági és Jogi Könyvkiadó, Budapest (1985).
27 **Resatkó E.**, *Ellennyomásos kooperációs erőmű*. Ipari Építészeti Szemle, 17, 52-54 (1959).
28 **Romsics I.**, *Magyarország története a XX. században*. Osiris kiadó, Budapest (2000).
29 **Ruzicska B.**, *Az ipari építészet teherviselő és térlezáró szerkezeteinek fejlődése Magyarországon*. Ipari Építészeti Szemle, 25, 78-80 (1969).
30 **S. A.**, *Gagarin Hőerőmű üzemi főépülete*. Magyar Építőművészet, 5/19, 9-12 (1970).
31 **Schall J.**, *Erőmű tervpályázata*. Ipari Építészeti Szemle, 17, 102-109 (1959).
32 **Száva I.**, *A szabadtéri termelés építési vonatkozásai*. Magyar Építőipar, 1/18, 112-117 (1969).
33 **Szendrői J.**, *Ipari építészetünk*. Műszaki Könyvkiadó, Budapest (1965).
34 **Szendrői J.**, *Ipari épülettervezés sajátosságai*. Ipari Építészeti Szemle, 20, 3-11 (1961).
35 **Takács Gy.**, *Ipari beruházások komplex gazdaságosságának kérdése hazai viszonylatban*. Ipari Építészeti Szemle, 20, 14-19 (1961).
36 **Valkó Ö.**, *Ipari épületszerkezetek előregyártása*. Ipari Építészeti Szemle, 15, 1-10 (1957).
37 **Vörösmarty K.**, *Ajkai erőmű*. Ipari Építészeti Szemle, 22, 20-23 (1964).

List of figures

1 Pécsújhely power station. Designers: Gyula Mátrai, Árpád Szécsi, Ödön Szakács. 1955-1959. (By kind permission of Foundation for Modern Industrial Architecture – IPARTERV Photo Archive / A (Modern) (Ipari) Építészetért Alapítvány – IPARTERV Fotóarchívum)
2 Pécsújhely power station. (By kind permission of Foundation for Modern Industrial Architecture – IPARTERV Photo Archive / A (Modern) (Ipari) Építészetért Alapítvány – IPARTERV Fotóarchívum)
3 Pécsújhely power station. Structure. (By kind permission of Foundation for Modern Industrial Architecture – IPARTERV Photo Archive / A (Modern) (Ipari) Építészetért Alapítvány – IPARTERV Fotóarchívum)
4 Pécsújhely power station. Structure. [24, p. 47]
5 Pécsújhely power station. Cross Section. [33, p. 218.]
6 Ajka power station. Designers: Kálmán Vörösmarty, József Nagy. 1955-1960. [33, p. 221.]
7 Ajka power station. Rendering. (Lévai, A. ed.: *Nagy erőműveink tervezése*. Erőmű Tervező Iroda, Budapest, 1959)
8 Ajka power station. Facade and ground plan. [33, p. 221.]
9 Ajka power station. Cross section. [33, p. 220.]
10 Ajka power station. Turbine room. [33, p. 220.]
11 Kőbánya power station. Designers: Endre Resatkó, Frigyes Völgyes, Sándor Szűcs. 1958-1960. [33, p. 223.]
12 Kőbánya power station. Facade plan. [27, p. 53.]
13 Kőbánya power station. Ground plan and cross section. [27, p. 52.]
14 Oroszlány power station. Designers: László Bereczky, József Pomogáts, Dénes Domaniczky, Vilmos Péry, Miklós Ugrai, István Ivits. 1959-1960. (By kind permission of Foundation for Modern Industrial Architecture – IPARTERV Photo Archive / A (Modern) (Ipari) Építészetért Alapítvány – IPARTERV Fotóarchívum)
15 Oroszlány power station. Model. (Lévai, A. ed.: *Nagy erőműveink tervezése*. Erőmű Tervező Iroda, Budapest, 1959)
16 Oroszlány power station. Cross section. [33, p. 213.]
17 Competition for the design of the Dunamenti power station in Százhalombatta. Competition entry by Árpád Szabó and Egon Payr. 1959. [31, p. 108.]
18 Competition for the design of the Dunamenti power station in Százhalombatta. Competition entry by Árpád Szabó and Egon Payr. 1959. [31, p. 108.]
19 Competition for the design of the Dunamenti power station in Százhalombatta. Competition entry by Márton Bíró. 1959. [31, p. 105.]
20 Competition for the design of the Dunamenti power station in Százhalombatta. Competition entry by Attila Emődy. 1959. [31, p. 107.]
21 Competition for the design of the Dunamenti power station in Százhalombatta. Competition entry by Zoltán Gulyás. 1959. [31, p. 109.]
22 Competition for the design of the Dunamenti power station in Százhalombatta. Competition entry by Petz, Ottó Almstaier and Antal Mischl. 1959. [31, p. 104.]
23 Dunamenti power station at Százhalombatta. Leading architect: László Irsy. 1960-1968. (Szabó, J. ed.: Nagyipari létesítmények 1945-1970, Budapest, 1975)

24 Dunamenti power station at Százhalombatta. (Szendrői, J. ed.: *Magyar építészet 1945-70*, Budapest, 1972, p. 187.)

25 Dunamenti power station at Százhalombatta. Cross section. [16]

26 Gagarin power station in Gyöngyösvisonta. Designers: Antal Springer, Béla Csíki. 1965/66 – 1970. (By kind permission of Foundation for Modern Industrial Architecture – IPARTERV Photo Archive / A (Modern) (Ipari) Építészetért Alapítvány – IPARTERV Fotóarchívum)

27 Gagarin power station in Gyöngyösvisonta. (By kind permission of Foundation for Modern Industrial Architecture – IPARTERV Photo Archive / A (Modern) (Ipari) Építészetért Alapítvány – IPARTERV Fotóarchívum)

28 Gagarin power station in Gyöngyösvisonta. (By kind permission of Foundation for Modern Industrial Architecture – IPARTERV Photo Archive / A (Modern) (Ipari) Építészetért Alapítvány – IPARTERV Fotóarchívum)

29 Gagarin power station in Gyöngyösvisonta. Model. [16]

30 Gagarin power station in Gyöngyösvisonta. Cross section. [16]

31 Kiln building of the lime works in Hejőcsaba. Designer: György Balázs. (Szendrői, J. ed.: *Magyar építészet 1945-70*, Budapest, 1972, p. 190.)