Necessity of Modernization of Modern Buildings

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Abstract

Due to the environmental and economical processes of the world the architectural thinking is started to change radically in the last decades. The danger of the global warming and the climate change motivated us to revalue our activity and its impacts. The concept of sustainability came into being and its role became more and more important in the architecture. It isn't visible that the sustainable architecture will emerge as a new architectural style in the future or only its tool system will build in the architectural practice. Anyway the environmental problems are waiting for the reaction of the mankind, especially of the architects having a special role, because they can form the built environment. So architects have to know, use and improve the tools of the sustainable architecture. The new buildings have to comply with strict norms today. They have to be cost and energy efficient. These features are also welcomed at the existing buildings, which represent the dominant part of the built environment. Unfortunately there are a lot of modern houses among the energy wasting buildings. This is especially true in the case of the buildings of the 1970s and 1980s. This paper presents two case studies on Hungarian public buildings, which were designed in the 1970s. It reveals the origins, concepts and values of the buildings, then it summarises their problems emphasizing the necessity of their modernization. It is visible from the description of the designed modernizations how the houses will be able to fulfil the recent functional and energetic requirements.

Keywords: modernization, energy efficiency, existing building stock, public buildings.

1. New challenges of architecture

The contemporary architecture is under pressure. The aspect system of the architectural design is getting more difficult during the last century. It does not mean architects have to mind new aspects, but some requirements existing throughout all ages are as emphasized now as never before in the architectural history. These new emphases have an influence on the character of the buildings, and in some cases these become important elements of the architectural concept.

The energy efficiency of buildings associated with the maintenance cost is a more and more important demand today. At the beginning of its existence humanity started utilizing the gifts of nature. Due to the populating of Earth and the increased demands of the customer society the utilizing of the goods of Earth changed to the exploitation of it, which took humanity on thin ice and threatened with global disaster. This threat is the idea of sustainability originated from. Sustainability is a very complex concept, which came from economics, but nowadays it has got also a social and environmental meaning *(Figure 1).* According to the usual definition sustainability aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but in the indefinite future, too.

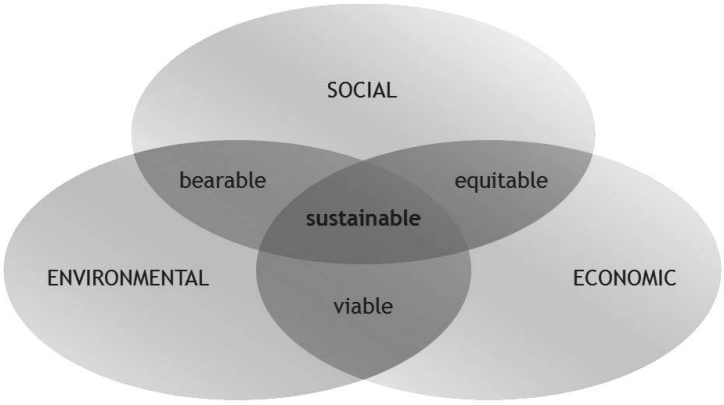

Figure 1: Complexity of sustainability

A significant part of the raw material consumption of mankind is related to the production and the maintenance of the built environment. Execution of buildings needs the 40-50% of the raw material consumption of the word in a year and the maintenance of residential and public buildings requires more than 40% of the world energy consumption. Having these facts it is understandable that using of the sustainability principle is important in the architectural design.

In the twentieth century a lot of trends of modernism emerged. After the turn of the century a completely new direction seems to advance on non-aesthetic basis, which is called as sustainable design. But sustainable architecture has to mean more than a new architectural style in all likelihood, the realization of sustainability is a global social demand, which have to influence all architects related to whatever style or direction. By now a lot of concepts were formed in order to reach the

sustainability. The two most important concepts are the ecologic architecture and building passive houses. Former one thinks in autonomic settlements living in harmony with their environment. On these settlements the houses are made of natural building materials of the local area corresponding to the average energetic requirements. The energy demand of the whole settlement is usually satisfied in an ecologic and centralized way. In contrast of this the passive house concept thinks in individual buildings. Passive houses can save the heat which was generated inside using special building structures. To reach this goal extremely good heat-insulated building bordering structures, excellent heat-insulating windows and doors, reduced thermal bridges and air-tight details are needed. In this kind of buildings innovative building service system operates in which the heat recovery ventilation is an obligate element.

In the recent architectural practice new buildings are not made according to these sustainable concepts, but the rules become even stricter expressing the demands and possibilities of the society. Therefore new houses are usually built based on much stricter energy aware aspect having a high level of comfort and low maintenance costs. Designing a new building architects have to satisfy indispensable strict demands according to the actual standards.

Usually an existing building cannot fulfil these actual standards so the designers also have the task to determine which features of the building should be improved in which rate. In this view the protected old, historical monuments have moderated demands also in laws and in standards. For modernizing a not protected building the requirements of energy and cost efficiency are quite as strong as at a new building. Because of these strong requirements building modernization is getting to be more and more important and frequent task today. In order to increase the energy efficiency of existing buildings difficult conversions are needed with a lot of trouble. Such problems can be solved only by means of good architectural and structural designing. The physical survival of the buildings can be ensured with their precise renovations besides the spiritual worth, hidden and coded in materials, in spaces, in masses, in forms *(Winkler and Fejérdy, 2005)*.

There are a lot of great masterpieces among the not protected buildings waiting for modernization. The products of modernism are in a special situation. They were made in an architectural age in which structural knowledge increased as never before. The static exploitation of bearing structures reached the extremity. Bearing and dividing structures started to be separated. More and more layers were built in structures having different functions. These changes caused that some modern buildings don’t have so good energy efficiency than the former built ones. The modernization of these buildings will be a very important and interesting object for the architects.

In the main part of this paper two case studies are summarized presenting the necessity and the possibility of the modernization of modern buildings. Both of them are public building for education and they were made in the 1970s. But they represent different architectural values and they have different problems. Therefore the answers for the problems are also different.

2. Modernization of herman ottó primary school

2.1 Building description

The Herman Ottó Primary School is located in Budaörs, in a suburb of Budapest *(Figure 2, 3)*. In summer of 2009 an architectural competition finished which had the goal to find the right way of the expansion and the facelift of school *(Csík, 2009)*. The presented design participated in the competition. It was not remunerated but it was praised its energy aware aspects.

The school is situated on the south downhill of Budaörs, between a panel housing estate and a shopping area and a gardened residential area is on its west side. The surround shows heterogeneous image, but it is good to see that the vegetation is very abounding on the area.

Figure 2, 3: Herman Ottó Primary School in Budaörs

The design of the school was probably made adapting a design of a ready-cut school at the end of the 1970s by the Council Consulting Company of Pest County. On the site of the school the buildings stand in north-south direction. The buildings are situated on the north side and the play-field is on the south side. The school has three parts: an educational building, a kitchen and dining building and a gymnasium. The house bears the marks of the preferred building practise of the era: It was made using a precast reinforced concrete building system so the fixity of the system is clearly visible on the building. The design concentrates only to satisfy the rational demands. It hasn't enough large and functionally good public spaces. The appearance of the house is very simple. A number of defects can be found in the execution.

2.2 Necessity of modernization

The modernization of the primary school in Budaörs is enforced by a complex process as it is usual. The reasons of modernization can be classify into two groups: one reason is the physical ageing, which appears in the degradation of structures, the other reason is the moral ageing, which occurs from the changing of the requirements connected to the building. According to the call for

competition the main reasons of the modernization belongs to the second group because the house is in a quite good condition *(Csík, 2009)*.

The most important new demands connected to the school are the followings:

- The capacity of the school is not enough.
- In the last years the number of children arriving by car is increased therefore a new entrance is needed.
- The building is not accessible for disabled people.
- The public spaces are small.
- The school doesn't have an entrance hall.
- The area per pupil is low, only 5.21 square meters per person in contrast with the ideal 10 square meters per person.
- Important special classrooms are missing.
- The facade isn't aesthetic.
- There are lots of defects on the prefabricated panels.
- The joints of the frontal panels need revision.
- Windows are outdated.
- The energetic features of the building are disadvantageous.
- The heat insulation was made according to the standards of the 1970's.
- The structural details have medium-strong thermal bridges (Szabó and Nyíri, 1999).

2.3 Concept of modernization

The goal of the architectural competition was to expand the educational building in such a way that the modernization of the whole building would be solved as well. During the designing process of the school for the competition several different aspects were considered, for example: to support of the educational program of the school, to create a harmony between the natural and the built environment, to design a house having low consumption, to meet the sustainability, to design an ergonomic building, to consider the interest of the children, the teachers and the owner. The design

thinks over the space organisation, the mass forming and the face-work of the existing building *(Figure 4)*.

Figure 4: Modernized Hermann Otto Primary School

To reach a better functional operation the public spaces are converted: new main entrance is designed on the south end of the building where a new entrance hall is situated having visual connections to the schoolyard and the library as well. The spaces opposite to the staircases get back their original function as lounge, in this way the illumination of the corridors get better. Now some matching functions are located in different places of the building. This situation is eliminated by the reorganization of the functions. The toilets get new place at the north end of the building. In this way valuable places can be used as new classrooms and new up-to-date toilets can be built. The mass of the designed building can be separated into three units. The south one contains the entrance and the important public spaces. The middle one contains the classrooms. And the north one operates as a vertical block with the toilets and the elevator.

The suggested facade modernization has three main goals.

- The design does not suggest removing the frontal panels, but significantly improving the heat insulation of the face-work. In this way no building waste is generated, the heat capacity of the frontal wall is maintained; the execution of the facelift is easier. The existing windows should be replaced to new three-ply ones. In order to reduce the ventilation heat loss artificial ventilation should be provided.

- The main goals of the structural design were to make the solar profit maximal in winter and to reduce the heat admission minimal in summer. Therefore on the external side of the glassing shading structures are installed to regulate the incoming light.

- One of these shading structures is a green facade, which lives in front of the classrooms on a steel framework. This vegetation can solve the shading in a natural way. The green

facade and the wood covering with its natural colour on the south and north parts of the building are predestined to create harmony between the building and the natural environment.

The building expanded significantly due to the redesign. But the careful structural and mechanical design can reach that the energy consumption of the new house is less than the existing one as the preliminary dates show.

3. Modernization of Széchenyi István University

3.1 Building description

The other examined building is the main building of the Széchenyi István University in Győr beside the river Mosoni-Danube, which was designed in 1969-74 and built in 1971-77 *(Figure 5)*. The building complex of the former college was the biggest educational investment of the decade in the country. One of the major Hungarian architectural and engineering consulting companies, KÖZTI (Public Building Designer Company) was commissioned to design this project (leading architect: Miklós Hofer, structural engineer: Kálmán Z. Horváth) *(Hofer et al, 1975)*.

Figure 5: Main building of Széchenyi István University

The building has a very strong concept and order expressing strictly the spirit of the architectural and historical age in which it was made. Miklós Hofer preparing the design process made a scholarly program analysis in which he considered the communications and telecommunications as the most intensive developing technical sciences. Therefore the possibility of the expansion and the flexibility became his main goals, as he considered the college as a permanently developing and changing organization where buildings were the spatial frames of the changing function *(Hofer et al, 1978)*. In

addition to this elevated aim the designs had to fit the building-trade of the socialist period, which preferred prefabricated large-sized elements in construction.

According to these principles Miklós Hofer created a functional and (mega)structural composition in which high dual towers were made for non variable, vertical functions and 18 m spread slabs were made between the towers for variable spaces: seminar rooms and offices. The house was formed with four similar units. In each unit the different functions are separated into different levels resulting a terraced cross-section where auditoriums are on the first floor, seminar rooms are on the second and third floors and offices on the other ones. Structures are strongly emphasized in the visual image of the house. Movements of masses and structural units give a deep plasticity of the facades on which the concrete elements appeared with several different surfaces *(Hofer et al, 1975)*.

This building is classifiable as a masterpiece of the movement of New Brutalism. This style emerged mainly based on Le Corbusier's life-work in England in the years of 1950s and 1960s. Later Le Corbusier's principles returned in England, where Alison and Peter Smithson became the leading advocates of the new movement (McKinstry, 2008). In 1966 the architectural critic Reyner Banham described the purposes of the new style as follows (Banham, 1966):

- the building was a unified, clear and memorable visual image;
- the building exhibited its structures clearly;
- raw, untreated materials got high valuation at the design.

Other architects can also be associated with Brutalism as Ernő Goldfinger, Denys Lasdun, Louis Kahn, John Andrews, Ralph Rapson and Paul Rudolph. Miklós Hofer could get first hand experiences about the principles of New Brutalism in 1962-63 working in London in the architect studio of Ernő Goldfinger *(Marosán, 2000)*. Hofer most important architectural design intent for the educational building was to introduce the enormous structure openly, almost brutally *(Hofer et al, 1975)*. The intent became truth and the concrete structures expressed this brutal aesthetics well. Therefore people usually find the university buildings unfriendly but the profession acknowledged the worth of this design and Miklós Hofer was awarded with the most significant Hungarian architectural tribute, Ybl Prize in 1978 *(Schéry, 1995)*.

3.2 Necessity of modernization

The possibility of the expansion and the flexibility were the main elements of the concept from the beginning so changing of the building was an accepted necessity by designers *(Hofer et al, 1980)*. They thought about the college building as a complex of structures ordered in a hierarchy, which had three levels according to the moral lifetime of elements. By now the university building is almost 40 years old so the revision of the structures and the modernization is surely needed at least related to the secondary and the tertiary categories.

Management commissioned a preparing study, which examined the condition of the building and its service systems *(Galambos et al, 2008)*. According to this study the service systems are considerably outdated. Therefore the study suggested changing almost all service networks. But to reduce the maintenance cost the energy wasting structures of the house should be also converted because the way of energy saving is dual: the new service systems will use less primary energy with better efficiency and the produced fewer secondary energy will be saved by the improved thermal shell of the building.

Based on the recommendations of the comprehensive study including chapters about functionality, building constructions *(Zádor, 2008) (Somfai and Molnárka, 2001)*, mechanical and electrical engineering *(Galambos et al, 2008)* and fire protection *(Szűcs, 2008)* university management ordered the architectural plans of frontal modernization. Architectural design should react to several different practical problems caused by the radically changed requirements and degradation. The original solutions of the building structures are equal to the standard of the 1970s and the quality of the execution was almost average. These circumstances and the destructive impact of decades resulted to the actual problematic condition of the building.

Main problems of the building in a short list:

- Several damages of the concrete structures are observable on the facades.
- The designed terrace roofs are still not walkable.
- Flat and terrace roofs often leaked.
- Whole facade shows almost homogeneously significant heat losing.
- Structures have strong thermal bridges.
- Complete external heat insulation is strongly recommended.
- Heat insulation of the window structures is poor, glasses are blurred.
- Steel windows have not sealing between the window frame and the casement.
- Steel frames of windows started corroding.
- Windows of rooms are designed with a special unpractical vertical section.
- Southern windows should be designed with external shadowing.
- Acoustic problems make difficult the education in the seminar rooms.
- Building is not able to fulfil the recent fire protecting requirements.

- Building has to be divided into four fire-sections.

- Conditions of the safe escape at an emergency should be improved.

3.3 Concept of modernization

The architectural design job focused on the frontal modernization of the educational building reacting all aforementioned practical aspects which were related to this part of the conversion (leading architect: Attila Bodrossy, Tamás Czigány). Architectural design had to find out solutions of the existing problems so that the architectural quality of the building would not be changed significantly. Therefore the main goal of the architectural redesign was to save the spirit of the building (Cságoly, 2006), which was possible if the way of the conversion had emphasized the original concept of the house (Figure 6). Keeping the following conceptual elements was the most important objects to reach this goal in the case of this building:

- to keep the contrast between vertical and horizontal functions, which appeared in the building as double towers and floors between them;

- to keep the visibility of the heaviness of elements, which are originally made of concrete, but they will be covered with the needed external heat insulation;

- to keep the character of a building made of precast panels having gaps between the elements;

- to keep the deep plasticity of the facade, which is given from the movements of masses, from the formation of the towers and from the double breaking of the windows vertical section.

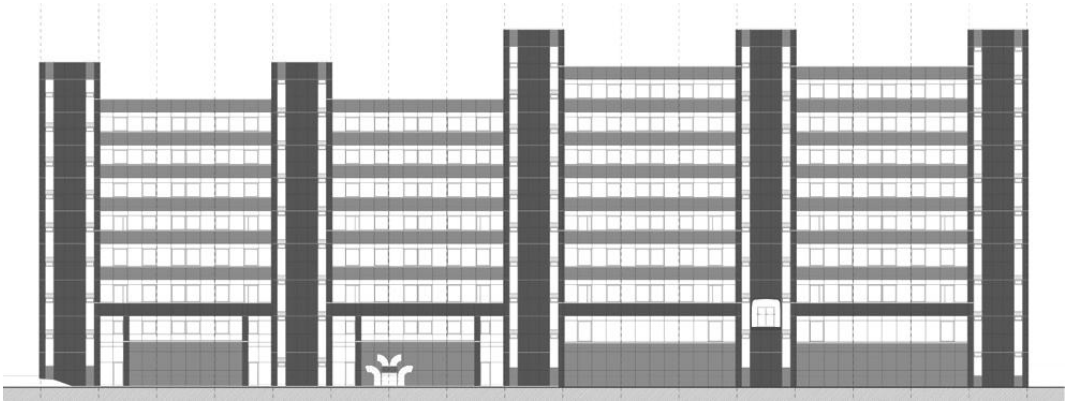

Figure 6: Modernized north elevation of Széchenyi István University

This redesign of the house planed an exterior continuous thermal shell around the building. The bounding structures of the house are redesigned to fulfil the current requirements of the Hungarian

decree with a big allowance. The over-fulfilment is about 120-140%. The heat insulation is uniform on each structure, so thermal bridges are eliminated.

Unfortunately the task doesn't allow preserving the concrete of the frontal structures as visible material so such covering should be selected which can give a similar impression as the fair-face concrete. The manufacture of new prefabricated concrete covering would be an ideal, but very expensive, solution of this problem so designers have to select a kind of light, thin frontal panel system. Fibre-cement boards have good fire-resistance so the application of it seems to be the favourable. According to the architectural goals of the facelift the panels are used in two different tones of grey to keep the contrast between the vertical and horizontal functions. The tones can intensify the visibility of the heaviness of the elements as well. Fibre-cement face work is mountable with smaller panels, so the gap image of the fronts will be denser than the original was. Therefore the fronts are designed using two types of gap: a normal thin gap and a stronger one to sign the levels of the floors.

In the designed frontal modernization the window structures are completely renewed with aluminium framed windows and curtain wall structures. These up-to-date products will be able to radically reduce the heat loss of the building. The double breaking seminar room and office windows are removed in the plans, but to keep the plasticity of the facade the new window structures are mounted in a deep position over the around heat insulated parapet panels. The building has more fix windows than before because of some reasons of heat insulation and fire-protection. On the southern fronts the windows get external blinds as shading devices to protect the rooms from the heat of the summer sun.

4. Conclusion

Although both presented projects are modernization tasks, they seem to be completely different. Both modernized buildings are public buildings for education, so the connected rules and requirements are quite similar. They were made in the same age, during the socialist era of Hungary. This time using of large-sized precast reinforced concrete elements were preferred in the building trade by the government. These buildings are designed under this pressure, so the used structures show several similarities. Houses are about 30-40 years old and they are still in use despite to some functional problems, which need some modification or sometimes expansion. This continuous operation is the cause, why the idea of demolition and building of a new house was not raised as an issue, this can value up the worth of the structures. Structures have several defects, but in both cases the renovation seems to be economical. The energetic modernization of the buildings, the consequent heat-insulation and the change of service systems, hold out to save about 40% of the energy cost. Due to these reasons the execution of the modernization is expectable in the near future.

The studies illustrate well, that the decision about the modernization is a mainly financial question. Reviewed the scopes of modernization they can be ordered into three categories by their purpose. These three categories are: comfort, safety and economy. The categories are in similar relation with us as those three parts of the determination of sustainability: social, environmental and economical. Positioning the actions in this system there is no one which has only an economic aim, but it is

clearly visible that the most important tasks have a strong economic impulse. If an action is reversionary that has better chance to be realized. So modernization is mostly an economical stress *(Figure 7).*

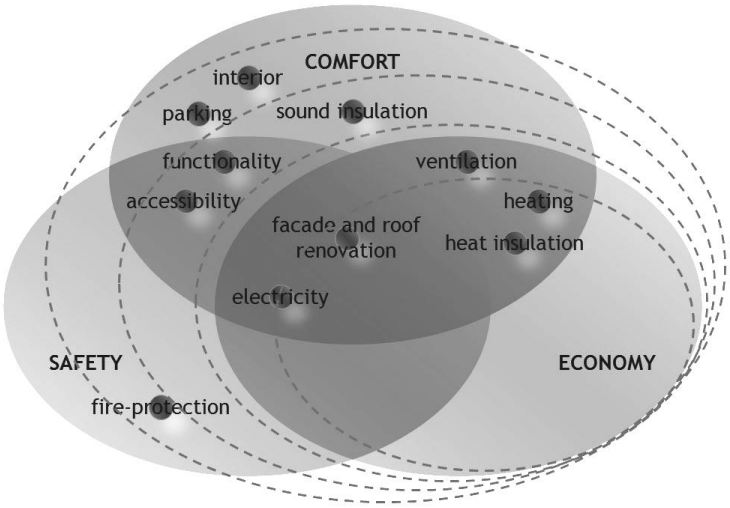

Figure 7: Scopes of modernization

The differences of the two projects are few in number, but they are significant. First the motivation of the modernization is other and other. The school has mostly moral degradation, and it needs new area for the education. The school management wants to do the frontal modernization together with expansion. In case of the university the physical degradation plays the major role. University management commissioned the design of the modernization to improve the physical condition of the building. Questions of moral degradation are in the second position in this design.

The two buildings represent different architectural values. The school is a ready-cut building in contrast with the university which is an individual design. At the modernization of the school designers could concentrate the functional problems and they could modify the building if it had been favourable. The university with its size, significance and its elevated architectural concept is an important building in the Hungarian architectural history. Recognising this situation the concept of the modernization concentrated to keep the original character of the university as it was possible.

As these case studies show nowadays the architects stand before a new and interesting job in which the buildings of the near past have to be modernized according to the recent requirements. Good solutions for this kind of problems can be found only by responsible decisions overviewed all aspects of the building waiting for modernization.

References

Banham R (1966) *The new brutalism: ethic or aesthetic?* London, Architectural Press

Cságoly F (2006) “The spiritual determinations of the architectural product” (Hungarian), *Régi-Új Magyar Építőművészet*, **6**(2):7−22.

Csík E (editor, 2009) Budaörs, Hermann Ottó Általános Iskola emeletráépítéssel történő bővítése, átalakítása, call for competition, Budaörs Város Önkormányzata, Főépítészi Iroda, 20.

Galambos A, Kovács I, Hornung P (2008) Preliminary mechanical engineering expert’s opinion and energetic conception for... (Hungarian), unpublished, KondiCAD Mérnökiroda Kft, Győr

Hofer M, Horváth Z K, Magyar V (1975) “Technical College for Communications and Telecommunications” (Hungarian), *Műszaki Tervezés*, **15**(5):16−23.

Hofer M, Horváth Z K, Solymosi A (1978) “Technical College for Communications and Telecommunications” (Hungarian), *Magyar Építőművészet*, **69**(2):20−27.

Hofer M, Horváth Z K, Solymosi A (1980) “Technical College for Communications and Telecommunications” (Hungarian), *Műszaki Tervezés*, **20**(4):21−28.

Marosán Á (editor, 2000) *Szentendrei arcképcsarnok*, Szentendre, Pest Megyei Könyvtár, 227.

McKinstry S (2008) “Re-framing a ‘subfusc’ institute: Building on the past for the future at chartered accountants’ hall”, *Critical Perspectives on Accounting*, 19(8):1384–1413.

Schéry G (editor, 1995) *Évek, művek, alkotók. Ybl Miklós-díjasok és műveik. 1953-1994.* Budapest, Építésügyi Tájékoztató Központ, 307.

Somfai A, Molnárka G (2001) “Energy conscious frontal window reconstruction – building structure study” (in Hungarian), *Magyar Építőipar*, **51**(9-10):269−277.

Szabó L, Nyíri I (1999) Herman Ottó 16 tantermes Általános Iskola, Budaörs – Statikai és általános épületszerkezeti vizsgálat, unpublished expert’s opinion, Alkotó Építész Kft., 49.

Szűcs L (2008) Fire-protection technical description (Hungarian), unpublished expert’s opinion

Winkler G, Fejérdy T (2005) “Protection and increase of values in the architecture” (Hungarian). Finta J (editor) *Épített jövőnk. Magyarország az ezredfordulón.* No. 15. 213–255.

Zádor O (2008) Preliminary examination of roofs and facades for the energetic modernization of... (Hungarian), unpublished expert’s opinion, ISO-Média Kft, Győr