ENGLISH SUMMARY / ANGLICKÉ ABSTRAKTY

LEGO® SET AS A TOOL: Enhancing creativity in architecture, urban planning and design

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Keywords: Lego® set, architecture, urban planning, design, education, creativity, Lego® brick

Architecture as a discipline has the inherent potential of overlapping with areas that do not appear related to its own scope of functions at first sight. Along with town-planning, the discipline is closely linked with mass evaluation, mutual relations of buildings' volumes impacting on the users' and inhabitants' everyday life. Contemporary IT technologies enable architecture to "materialise" in virtual space (to be performed *in silico*, , i.e. on computer or via computer simulation, transl. note) but the creative design process calls for the direct connection between the hand and the mind – using a *"thinking hand"* whenever one is in need of inspiration, as Juhani Pallasmaa argues. The idea is that, by suspending one's critical faculties and letting one's hand simply roam free, one's fingers might fashion something unexpected. Besides sketching or modeling there exist other tools which can be applied in the design process. The aim of the article is to explain the relation between the Lego® set and architecture, urban planning and design, to identify its potential for creation, creativity, and design innovation, and also to justify it as a teaching tool.

HISTORY OF LEGO®

The Lego® Brick is a cultural phenomenon with its own history. It was designed by a carpenter Ole Kirk Christiansen in Denmark during the Cold War that followed WWII. First patented on 28 January 1958, the use and popularity of The Lego® Group (hereinafter referred to as "the LEGO Group") has grown exponentially through the decades. Taking its name originally by a derivation from the Danish phrase *leg godt* (meaning "*play well*"), Lego® mainly produced wooden toys. Following the trend of those years, the company's expansion into the plastic toys segment took place between 1940 and 1949. It was not before in mid-1950s that the company's production predominantly consisted of plastic while wooden toys were discontinued in the 1960s. Today, the LEGO Group has developed a worldwide community of enthusiasts from a diverse set of age groups and backgrounds. *AFOLs* (*Adult Fans of Lego®*) and youngsters organize fairs where they display their Lego® MOCs (*my own creation*). By the way, this toy has its lovers also among artists, architects and designers.

LEGO® IN ARCHITECTURE DESIGN

The Lego® Architecture's Edition, very popular mainly among architects, aims to celebrate the past, present and future of architecture through the Lego® Brick. From the beginning of 2009 until 2019, 45 sets with 10 special editions were released, including the Villa Savoye, Empire State Building, Sears Tower, Sydney Opera House, the Leaning Tower of Pisa, Guggenheim Museum and many others. The latest edition – *Lego® Architecture Studio* – comprises white block sets, using primarily the smaller "plate" pieces rather than the larger "brick" pieces. This allows creating very compact, yet highly detailed replicas designed to scale. The main aim of this edition is to get young and old bricksmiths across the world over to thinking about the core concepts of architectural design.

The Lego® Company also supports many other projects and competitions, such as the *Inspireli Awards*, the world's biggest global student contest in architecture, urban design, landscape and interior design, involving 136 countries around the world. This year was a very special one for the Faculty of Architecture, Slovak University of Technology, Bratislava, Slovakia, and two of its students, Jana Hájková and Kristína Boháčová, who were awarded a special prize in the *"Design a real project"* section in October 2019.

In relation to design process, the Lego® set has many advantages such as modularity and variability with a high number of various types of elements which can be very quickly and easily assembled and disassembled. Among disadvantages one can include mainly a high price.

USING LEGO® FOR MEDICAL PURPOSES

It is invaluable that the Lego® set is also applied to treat communication disorders of autistic children. The *Lego®®-based therapy* (also known as Lego® therapy) was originally developed by US psychologist Daniel LeGoff followed by Professor Simon Baron-Cohen, and Dr. Gina Gómez de la Cuesta from the

University of Cambridge Autism Research Centre. Within this therapy, all persons involved take turns to play different roles – such as *Engineer, Supplier, Builder* – and immediately have a joint focus on the same thing. As a result, children work together, interact one with another and can learn without fear or anxiety. In 2019, the LEGO Group developed a brick version with printed letters and numbers from the Braille alphabet which are compatible with Lego®'s wider collection. Therefore, blind and partially sighted children can learn to read while playing with the Lego® set.

IMPACT OF LEGO® ON EDUCATION PROCESS

If one speaks about the positive effects of Lego® related to teaching architecture, urbanism and design, some specific learning approaches have to be mentioned. Many pioneers of this unusual teaching procedure are of the opinion that through Lego® sets students are able to:

- Compare the difference between towers by differing heights and base sizes and discuss other ideas to improve building stability. Hence, they are learning the basics of architecture, engineering, physics and creativity;
- Construct one or more Lego® models that can mimic a real-world software process that consists of many interrelated activities;
- Learn about the need for flexible design to accommodate stakeholder needs;
- Quickly and simply model the effects of large-scale urban-planning decisions – like through the *CityScope project* developed by MIT which enhances teamwork and intervention design using data-based physical and digital tools.

Therefore, the Lego® set can be enthusiastically embraced by teachers at the FA SUT who can become the AAFOLs (adult architect fans of Lego®) and who /will implement the sets along with contemporary information technologies into the early stages of the architectural, town-planning and design education process. After all, Lego® has inspired children and adults alike around the world to develop spatial vision and a love for building, development and engineering, which represent crucial elements of our everyday life.

SOLAR FACTOR OF SHAPE

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***Keywords**: shape factor – surface area to volume ratio, solar potential, carbon-dioxide imprint, sustainable design*

The paper focuses on the possibilities of energy performance of buildings in relation to the production of greenhouse gasses during the construction and use of buildings. The discussion is aimed at the options the architects have when preparing the mass designs in the conceptual phase and the reconsideration of the indicator used in laws and regulations (the building shape factor calculated as): *surface area to volume ratio of building*. The argumentation is based on the exclusion of surface's ability to produce solar energy, where this type of calculation is used in contrast to similar indicators, for example *Entwurfsgütezahl für Solarhäuser (EGZ)* that includes also approximation of the solar energy production ability of the object surface. The (shape factor) indicator of the *surface area to volume ratio of building* used in laws and regulations is thus an outdated method that only optimizes the thermal-insulation properties, without any regard for active solar systems and carbon-dioxide imprint (generated during the construction and general use of building). Simultaneous optimization of both aspects of the building form: the active solar gains and thermal-insulation properties could achieve further carbon-dioxide imprint minimization. The question is whether it is possible to create a similar indicator to surface area to volume ratio – the solar factor of shape, which would simply connect architectural form with the potential of the object to produce solar gains, even before the effectivity of active solar devices is taken into account, and thus connect the architectural form with the energetic side of the design.

The introductory section of the paper describes the process of the research, which has led to the development of two alternative methods of calculation suitable for conditions in Slovakia that include the missing potential gains by the surface of the building. To cover both sides of the problem (potential solar gains and thermal loses), the paper defines a new indicator, the solar potential of the object's form, calculated as a proportion of solar effective surface (potential gains) and entire surface area of the object (potential losses). The first method of calculation is similar to EGZ and it is based on projections, the second one directly uses simulations of solar radiation in Grasshopper Ladybug software. As this new calculation is defined as proportion of surface area of an object, unlike the shape factor, it is not dependent on its volume. The comparison of the projection and simulation methods has shown that the simulation technique seems to be more precise.

The next part of the research has focused on the development of an algorithm with quicker, more effective calculation of the solar potential, based on a more precise method of simulations. Such a tool could be used for solar potential calculations without computer technology or for making the otherwise time-consuming evolutionary optimization of the form faster. The algorithm was developed in defined model conditions on the model building form – a model block representing the mass of a building with variable proportions and horizontal rotation (orientation with respect to the cardinal directions). Since the solar potential is not dependent on volume, the model block had defined exemplary volume of 1000 m3. The acceleration and simplification of the calculation was achieved by means of the function of the potential and the object's surface orientation. This function was created based on numerous simulations. This way the time-consuming simulation was avoided, while the precision of the calculation was preserved.

The output of the research is an algorithm that uses this function to determine the object's solar potential in defined, model conditions, expressed as a percentage. The algorithm was created from these steps: break-down of the object to its surfaces and calculation of the individual potentials of these surfaces in the percentual values of their areas with the mentioned function of the solar potential and rotation. The sum of these partial potential areas is the resulting total solar potential surface area of the object. The final indicator is defined as the proportion of this solar potential area to the entire area of the object. The outcome of the calculation is thus a non-dimensional percentage value. This algorithm was used to calculate and record all the possible solar

potentials of the model block via graphs and tables. Subsequently, the maximum of solar potential was determined - an object with ideal proportions and orientation which also optimizes the potential solar gains and thermal loses. The optimum found was compared with some of the significant states of the object (e.g. an ideal shape for surface area to volume ratio).

The paper also describes the usage of the algorithm without computer technology, which further widens its possible utilization. The next section clarifies the algorithm's usability in the evolutional optimization of the object's form, which changes the static, normative value of the indicator into a dynamic tool, offering automatic improvements of the form.

The conclusion of the paper analyses the paradigmatic shift, based on the beliefs that in relation to the carbon-dioxide imprint, we have reached the limits of the thermal-insulation properties of the building structures (the thermal insulation width and glazing). The question of active building input in the energetic balance has gained in importance. There are also well-known cases of objects producing more energy than they are able to consume. They represent the models of independency (island systems) and decentralized energy production at the place of its consumption, which minimizes loses caused by transport. Improvements in solar energy management and distribution lead to dynamic cooperation between objects without the need for energy storage. Internet of things thereby creates a system with automatized sharing of the gained energy between the objects. The objects that are locally without energy are supplied by the objects with local energy surplus. It is even possible to predict the process with respect to meteorology, where the aim is to integrate solar energy more effectively into the distribution network – and to optimize the distribution network management during fluctuations of energy sources. It is the growing phenomenon of virtual power plants. The quality of the environment during the summer season, in contrast to the heating season, is now another frequently discussed topic. Air-conditioning and cooling devices consume more energy than the heating. Therefore, searching for new energetic sources and design principles could help to optimize the annual cycle of buildings. One of these principles could be the application of the integrated PV systems in the building envelope.

The coming paradigmatic shift thus also brings gradual limitation of the thermal-insulation properties of structures and increasing effectivity of the transfer and usability of "green" energy with lower carbon-dioxide imprint and ecological impact. The consideration of the energy effectiveness of the buildings can be expected to free the way for calculations of carbon-dioxide imprint.

AVION RESIDENTIAL COMPLEX

Building interior and elements of technical equipment as factors of genius loci of interior spaces

Adam Tóth

***Keywords**: Modern Movement Architecture, inter-war architecture, Avion residential complex, interior design, space, authenticity, quality of housing*

The purpose of a building is primarily to create an interior space designed to meet the needs of people. The essence of interior design is to create and arrange the basic elements of architectural composition with the aim of creating a quality interior space. The quality of the interior only has relevance in relation to people, and therefore the resulting indicators are the feelings and perceptions conveyed by them. However, the starting point for creating any interior is the basic space provided by the building structure, which is further defined by qualitative factors such as shape, dimensions, proportions, materials, light, colours, etc. These factors, unlike the sensitivity, are quantifiable and their mutual relationships constitute a certain objective indicator of the quality of space. The basic architectural space is collectively called the building interior. Thus, in spaces for long-term use, such as residential spaces, architectural elements and their details are of great importance. The building interior is part of an architectural concept reflecting the contemporary context through the personality of the architect. In the modern architecture (Modern Movement Architecture) the constructional-technical aspect plays a special role and the construction and technical elements and details form an unique part of its essence and in case of historical buildings and objects of Functionalism, they also comprise the essence of their historical value. The issue of preservation and authenticity also plays a role in the quality of residential premises. In such a residential building it is necessary to resolve apparent or real contradictions of the inhabitants' requirements for quality and comfortable housing, requirements for compliance with technical and safety standards and the requirements for the protection of the historical value of the building. In addition to the interiors of the apartments that form our microenvironment, an apartment house also comprises spaces shared by all residents – entrances and halls and passageways. The analysis of the building interior and technical equipment in both types of premises, private and common, objectifies the research by evaluating the same interior parameters. While the residential interior with its furnishings mainly reflects the personality of the apartment user, the building interior reflects the characteristic spirit of the architectural object. In addition, if it is a historical building, such as the Functionalist Avion apartment complex, on the interior of which we focus in the paper, the authenticity of its interiors is a particularly important factor in genius loci. Avion has been in the list of national cultural buildings and monuments since 1985, and since 1994 it is also in the list of the most important European monuments of modern architecture DoCoMoMo. In 2001, it was declared the building of the century in the nationwide survey in the category of residential buildings. Since the completion of its construction in 1932, it has been continuously inhabited, and at present the 80-year-old complex is still a lively home for many people. With the exchange of the generations of its residents, and the accompanying changes in their housing requirements, Avion has also changed in response to these changes. It does not change on the outside; the biggest changes concern its interiors. The issue of Avion's interiors, in particular their ongoing modifications, covers all the above-mentioned aspects – protection of historical buildings, the age and related wear and tear and its deterioration as well as the quality of living in such an object at present. However, the authenticity and characteristic atmosphere of the residential complex disappears hand in hand with the demise of the building interior. The presented research focuses on these issues and our goal is to document the authentic interior features that have been preserved, to prevent their permanent and irreversible disappearance and that of the genius loci as the major historical value, while preserving the housing complex as a lively residential building that meets the current standards of quality housing.

When evaluating the quality of residential environment, in addition to evaluating interiors with respect to their material and technical aspects, primarily in terms of the interior design profession, we supplement the research with additional information and feedback from residents of the housing complex and their perception of Avion interior, as well as perception of interpersonal relationships. As the long-term residents leave and the authentic material elements are lost, the characteristic community spirit of the inhabitants of Avion gradually disappears. Therefore, another objective of the work is to increase the awareness of the residents and thus increase their familiarity with both the material and social and cultural value of the place they inhabit.

The Avion residential complex was built in the interwar period when new democratic states were built and for Slovakia it was also a period of search for its own identity within the newly-established Czechoslovak Republic. The new philosophy, materials and technologies in construction were incorporated in the new formal expression of buildings, although the layout of the building interiors has also changed considerably.

In Bratislava, which was trying to establish its place as the economic, political, social and cultural centre of Slovakia, many residential buildings had to be built in a short time, together with administrative and other public buildings. The Avion apartment complex represents a type of cooperative housing construction of above-standard housing for the middle class. In its design, which was selected as the winner of an architectural competition (1929), architect Josef Marek replaced the original design of the block of flats in the Blumentál suburb with a single building with a semi-open facade. The complex consists of three comb-shape-connected objects. The south-west facade opens into the area of today's Americké námestie with a park and closes with the higher north-east facade facing Májková Street. On the ground floor, there are offices and commercial spaces and entrances to the residential section that is divided into six separate blocks. The residential part occupies higher floors, whereas the basement contains the technical facilities – cellars belonging to the flats, storage space for commercial purposes, the boiler room and extensive premises of the former coal-fired boiler room, the laundry room, drying room and mangle room. Nowadays they are unused, but at the time of their creation they embodied the top of technical equipment. Marek oriented the layout of the residential part of the complex to the cardinal directions, and with the floor gradation and semi-open facade he ensured good natural light throughout the whole day and good ventilation of the interiors. He tried to follow the principle of direct ventilation and natural light in the layout of apartments and all their premises, including toilets, bathrooms and pantries, although this was not completely possible in all the apartments. The negative is the partial walk-through layout of the rooms. A very distinctive feature of apartments on the southern and western corners is the massive supporting circular column in the corner room. In addition to windows and interior doors, the interiors comprise characteristic elements of technical equipment and facilities such as plumbing, radiators and wiring end points.

Throughout the existence of the complex, all its parts have been interfered with for various reasons. These interventions, under the concept of "routine maintenance", have been happening up to this day, often without any supervision by an architect. What is more, the latest significant changes to the authenticity of the common interior areas have been performed since 2003, based on an architectural design, and resulted in the disappearance of the until-then preserved elements of the building interior that were replaced with some new ones. The basis of Avion's common communication space is the location of an open passenger lift shaft in the stair well of a generously sized staircase. The shaft is separated from the staircase by only one meter high wall and steel mesh that is two meters high, which creates the impression that the space of the staircase is uniform, spacious and airy. Such a compositional principle is typical of interwar Modernism. The passenger elevator is currently the interior element that has undergone the most changes. The original portal was made of coffered wood, covered with oak veneer, with a glazed upper part, and the lift cabin was made of the same type of wood and glass, with a sliding wooden grille. The original material design of the elevator ingeniously matched with the other materials used. At present, it has been replaced by a roughly welded steel sheet portal with standardized steel doors with a vertical window.

The quality of the premises and the air of timelessness were created with a balanced architectural composition, a balanced scale and proportions of the premises and matching materials, which evoked the feeling of harmony and unique atmosphere. During the 1990s, some authentic elements, whether for moral or physical wear and tear, disappeared, and it does not make any sense to replace them with copies. Therefore, the first step towards preserving the unique atmosphere of Avion is to map and document the preserved authentic interior elements and to identify the characteristic elements of the building interior and technical equipment these days. An overview of the research results so far is provided in the tables showing the original and current materials used and characteristic interior elements, both authentic and new. The task for the future is the treatment of interior spaces, both residential and common, that preserves the characteristic authentic elements and completes the interior with contemporary features so that the main value of the interiors – the character of the place – is preserved. We believe that the design of the future renovation should be close to the original design and concept at the time of construction, while respecting current regulations and standards. The new design of the elements, while retaining the principles of the original design, will mainly focus on the portal materials and the elevator cabin, which must comply with current legislation in terms of fire safety and safety of the elevator operation. The most important aspect of the problem in terms of interior design is the harmonization of approach to the residential complex as a historical building and the current standards of quality housing.