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Idea of *Autopoiesis* in the Evaluation of Lithuanian Concrete Architecture

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***Abstract* – The article presents a theoretical model for evaluating architectural works artistic novelty of which is associated with concrete – the medium of the 20th century architecture. The theoretical model reflects the idea of *autopoiesis* and works as a network parameter system, which promotes the constant renewal of knowledge in the field of concrete architecture. The theoretical scheme consists of two levels: at Level I the object's aesthetic-technological type is identified; at Level II – specific features of interaction between artistic forms and reinforced concrete technologies in architecture are revealed through the net of aspects and indicators. Vilnius Palace of Culture and Sports as one of the iconic examples and the representative of *solid* aesthetic-technological type of the Lithuanian concrete architecture has been chosen to test the theoretical model.**

***Keywords* – solid type, artistic form, spatial concrete structures.**

Introduction

Many of the artistic innovations of the 20th century architecture are associated with concrete, which has passed the stages of admiration and criticism. The abundance of objects, their deteriorating physical condition, and still existing aesthetic non-recognition, encourage to search ways how to analyse concrete architecture, which is an important and integral part of the late modernism. Another problem is related to the evaluation realm of the second half of the 20th century architecture as a potential modern heritage, which is unsystematic and often limited to a description of general features of form or style, resulting in uneven, superficial evaluation. To solve these problems, a two-level theoretical model is introduced, which is based on the concept of *autopoiesis* and its principles of operation. *Autopoiesis* derives from Greek and means creation or production of self (*auto* (self) + *poiesis* (creation)) or else a system that is able to "produce" and sustain itself. The concept of *autopoiesis* is coined by biologists Maturana and Varela, and is defined as "*the dynamic system organized as a network of processes of production of components, which is self-producing and self-renewed*" [9], [79]. Besides, an autopoietic system has a clear structure, which functions recursively and is influenced by the environment [9], [12]. A clearly delimited structure means that the dynamic system consists of components that continually and recursively interact with each other in a self-producing way. Recursion means that the components create a network of interactions based on a feedback loop, which renews the components themselves. Systematic change is also related to an environmental impact, which is to say that if the environment changes, then the structure of the system mutates as well. In this case the autopoietic system is the entirety of concrete architecture, while the theoretical model is the "contextual" component, which encourages a recursive renewal of the system. Another important component is architects and researchers, who guarantee the viability and continuity of concrete architecture due to their participation, understanding and knowledge, which is an important subjective component (factor) of "self-creation" (on the basis of feedback).

It is important to note that this text is a part of a wider research, which analyses the interaction of artistic forms and reinforced concrete technologies in Lithuanian architecture. The broader research argues that three principles of composing aesthetic-technological forms are characteristic to concrete architecture: *solid, modular* and *combined*. This article focuses on the *solid* aesthetic-technological type.

I. Principle of the Theoretical Model

The theoretical model consists of two levels. The first level is dedicated to identification of the tectonic principles of the *aesthetic-technological* type. Meanwhile, the second level of analysis is dedicated to establishing specific and valuable attributes of the interaction between artistic forms and concrete technologies. In the first level, in this case, the identification of the *solid* aesthetic-technological principle, a net of aspects and indicators is compiled, which can be found in the spatial structure and surface design solutions [15]. The principle of *solid type* is based on complex spatial structures of concrete shells and folds, and is often used to cover large scale buildings [8]. For the execution of the *solid* type, *cast-in-situ* concrete technology and complex formworks are used; slabs are often composed using technologies of prestressed concrete and beamless solutions; columns can be both straight or tapered of various configurations; concrete surfaces can be with imprints of wooden boards (*béton brut*) or smooth, with exposed texture or concrete's naturally greenish-grey colour enhanced with pigments [2], [8], [13], [14] (Table I).

Table I
Level I: Idicators of *Solid* Artistic-technological Principle [Author of the Article]

TECHNOLOGY	*cast-in-situ*, *prestressed* concrete
SPATIAL STRUCTURE	complex spatial forms, shells and folds
SLAB TYPE	beamless slabs, single or double curvature shells
WALLS	solid, monolithic, curvilinear, leaning
COLUMNS	upright, tapered, of various forms
SURFACE	*béton brut*, smooth, exposed texture, pigmented

Level II analysis is devoted to determining the specific and valuable features of concrete architecture. Based on the results of Level I, the most prominent or exceptional object is selected and is further investigated by the net of qualitative aspects and indicators. The net is composed by taking into account the sym-

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biosis of *form* and *pattern* languages, the influence of *genius loci* (spirit of the place) and *zeitgeist* (spirit of the time), which helps to grasp the metaphysical dimension of artistic forms as well as the national, distinctive character of concrete architecture [1], [11], [12], [15]. The net analysis of Level II comprises four qualitative aspects: 1) *complexity,* 2) *innovative form*; 3) *variety*; and 4) *richness of surface design* and their indicators (Table II).

Table II

Level II: Network of Aspects and their Indicators [Author of the Article]

QUALITATIVE ASPECT	INDICATORS	
COMPLEXITY	1.	Ensemble
	2.	Integrity
	3.	Organic relationship with place
	4.	Relationship between interior and exterior spaces
	5.	Self-similarity
INNOVATIVE FORM	1.	Iconic form, orientation point, prototype
	2.	New functional scheme / model
	3.	New interpretation of solid-void
	4.	Original rhythm
	5.	Creator's style
VARIETY	1.	Multifunctionality
	2.	Unexpected combinations
	3.	Functional novelty
	4.	High quality communicational spaces
	5.	Potential for transformation
RICHNESS OF SURFACE DESIGN	1.	Ornament, pattern
	2.	"Raw" concrete surfaces
	3.	Technological seams, framings
	4.	Texture
	5.	Colour

Complexity refers to the qualitative aspect for determining how concrete technologies influenced the connection of artistic forms with place, topography, urban complex and its compositional complexity. The *innovative form* is dedicated to revealing the novelty of spatial design solutions, which convey the information about the worldview, new social models and technologies. The aspect of *variety* is used to determine how the object's functional, spatial and material combinations were influenced by reinforced concrete technologies. The variety of design solutions ensures the vitality of place, a person's physiological and psychological comfort, and the integration of all social groups by encouraging better socializing skills and the sense of unexpectedness. The qualitative aspect of the *richness of surface design* is intended to define the importance of small scale in architecture, which comprises *ornaments, texture, patterns* and *colour.* The rich surface design solutions act as local points of orientation and reference, factors enhancing psychological comfort and defining the basis of culture [15].

Fig. 1. a) – Kaunas *Sobor* (author of photo and date unknown, LCVA); b) – the interior of the *Šančiai* Church (photo by A. Černauskienė, 2019).

II. Spatial Concrete Structures in Lithuania

The origins of spatial concrete structures in Lithuania are linked to militaristic, engineering, industrial and public architecture. One of the first spatial concrete structures was realized in the forts of Kaunas (1889–1912) as well as in the architecture of sacral nature such as the Kaunas *Sobor* where one of the spaces was covered by a 16.3 diameter cupola of reinforced concrete (1891–1895, arch. K. Limarenka) (Fig. 1 a)). Several years later the construction of innovative concrete vaults began in the Church of the Heart of Jesus in Vilnius (1907–1912, arch. A. Vivulskis). Shell-like concrete structures were also used for the water reservoir in *Liepkalnis*, Vilnius (1916, engr. E. Šimanskis, E. Šenfeldas, O. Smrekeris), where the dome of concrete was placed upon a circular structure built five meters into the ground. In the interwar period, several public buildings were covered with spatial shell structures, including the Kaunas Cultural Palace (1934, arch. V. Landsbergis, engr. S. Milius), the halls of the *Romuva* Cinema (1940, arch. M. Mačiulskis, engr. P. Markūnas) and the space of the *Šančiai* Church (1938, arch. A. Šalkauskis and others, engr. P. Markūnas) (Fig. 1 b)); all of these employed the vaulted *Kreuzekrost* ceilings with square-shaped concrete coffers filled with glass.

In the post-war architecture, spatial concrete structures are used for the construction of chimneys, silos, water towers and reservoirs whose forms are cylindrical, conical, or complex [8]. The first public object in post-war Lithuanian architecture wherein the solid form is achieved using concrete is the building of restaurant-cafeteria *Vasara* (summer) (1964–1967, arch. A. Eigirdas) in Palanga (Fig. 2 a)). The interior space is organized by a central mushroom pillar, which grows out into a circular roof and is a thin concrete shell. Such spatial solution allowed to create an innovative curtain wall facade covered with transparent glass elements. The building was reconstructed in 2003, and the transparent facades were covered.

Another example of a spatial concrete structure was realized in Palanga, in the Summer Stage (1971, arch. V. Gerulis, engr. V. Vėlavičius, demolished) (Fig. 2 b)). The hyperbolic shell of double curvature was formed by using *cast-in-situ* concrete tech-

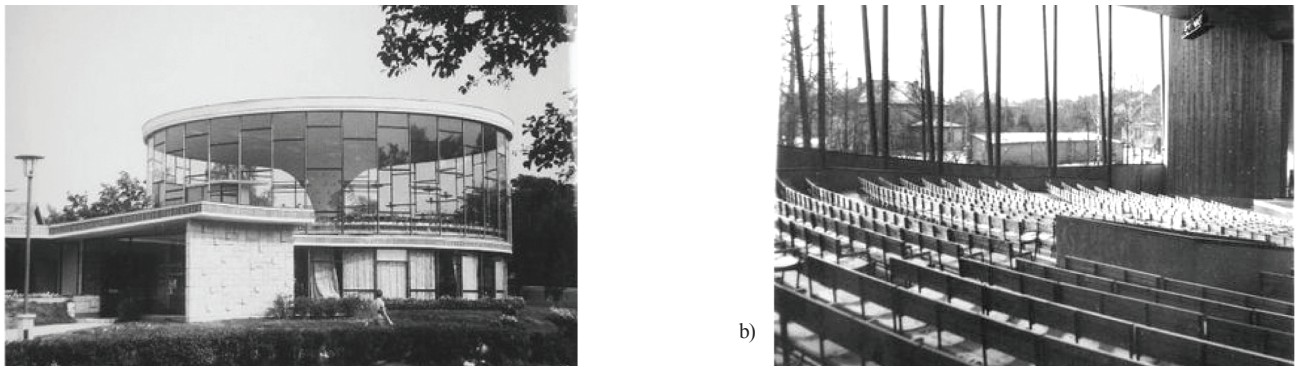

Fig. 2. a) – *Vasara* in Palanga (photo by B. Aleknavičius, 1968, LCVA); b) – Summer Stage in Palanga (photo by A. Grinčelaitis, 1971, LCVA).

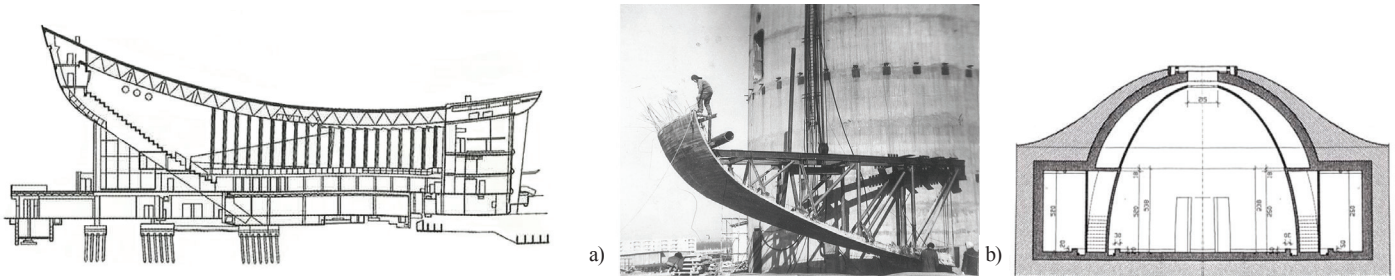

Fig. 3. Section of Palace of Culture and Sports (published in SA 1972/2) [10].

Fig. 4. a) – TV tower construction in Vilnius, 1978 (photo from Telecentre archive); b) – section of double concrete dome of the chapel-columbarium in Vilnius, 2003.

nology and a net of stressed cables. The cable supported the saddle-shaped roof in tension, where cables (in one direction) were suspended and tensioned by cables laid perpendicular to them. Concrete was poured on this cable net, which thus formed a thin shell (around 6 cm) as well as an expressive and light form. Due to cable-supported roof specifics, the Summer Stage may have had open side walls. Unfortunately, the unique, open-air construction was demolished in 2013, and in its place a cylindrical multifunctional concert hall was built.

The Palace of Culture and Sports was built in Vilnius (1971, arch. E. Chlomauskas, J. Kriukelis, Z. Liandzbergis, engr. H. Karvelis) at a similar time as the Summer Stage, and is characterized by its "inverted arch" roof and the concave shell, which employs a suspended structure where cables serve a load bearing function [14]. The cable-supported roof construction consists of cables suspended every three meters, concave metal trusses hanged under the cables (ensuring the resistance to wind loads) and light asbocement shields on the top (Fig. 3). This solution is 1.5 times lighter than other concrete shell constructions and allowed to create 60x60 interior space without supports [7]. *Cast-in-situ* concrete technology and wooden board formworks were used for design solutions of the rounded roof elements and sloped supports in the nothern façade.

Unique shell structures were also implemented in Vilnius TV Tower (1974–1981, arch. V. Obydovas, K. Balėnas) design solutions. The stem of the tower is a 190-meter tall hollow, tapering (from 15 to 8 m) cylindrical shell made of reinforced concrete. At the top of the concrete tube (at the height of 165 m) sixteen thin-walled shells of concrete were installed, which formed the so-called concrete chalice (Fig. 4 a)). This part of the building houses the exceptional rotating "restaurant in the sky" (similar solutions employed in Berlin TV tower).

Later on, a double concrete dome was implemented in the design of the chapel-columbarium in Vilnius (2004, arch. V. Čekanauskas, M. P. Šaliamoras and others, engr. V. Ražaitis). The chapel-columbarium is a part of the *Tuskulėnai* Peace Park Memorial Complex and stands as a circular underground structure (15 m in diameter) covered with a concrete dome. The execution of the double shell required unique wooden formworks and advantages of reinforced concrete technologies (Fig. 4 b)). All of the objects discussed above are representatives of *solid* type.

III. The Case of Vilnius Palace of Culture and Sports

The Palace of Culture and Sports in Vilnius is selected for the Level II analysis as the example that best fits the indicators of the *solid* aesthetic-technological type. Besides, it is the only remaining object that has been created by Lithuanian authors with a suspended cable-supported roof structure. The following section discusses research according to the net of Level II aspects and indicators (Table II).

Complexity. The Vilnius Palace of Culture and Sports was planned as part of a larger ensemble on an axis with the *Žalgiris* Stadium complex on the right bank of the *Neris* river, directly

facing the heart of the historical city – *Gediminas* Castle hill. The Palace of Sports is characterized by an intimate connection with the relief (the difference from the highest to the lowest terrace is 9 metres), since the horizontal part of the building organically descends toward the river via three terraces (Fig. 5). This factor *"allowed designers to imbue the building and its environment with more interesting and varied architectural traits"* [10, *1*]. Related to this are the many retaining walls installed around the viewing terrace that extends out onto the second level of the main entrance, and the monumental "hanging" staircases and ramp. To execute all of these elements, a technology of *cast-in-situ* concrete is used wherein thanks to a wooden formwork the surface design and form is created. The building's level of complexity is reinforced by a high-quality relationship between interior-exterior spaces, whereby very large glass panels ensure good visual ties with the *Gediminas* Castle Hill and plenty of natural light. The composition of the object is characterized by repetitive self-similar elements in colour and concrete, while the first fiddle is played by the rough concrete surfaces.

Fig. 5. General view of the Concert and Sports Palace (photo by G. Svitojus, 1977, LCVA).

Innovative form. The object is marked by its iconic form and functions as a point of orientation in the city centre artistic idea of which is emphasized by the innovative cable-supported roof construction. The team of creators of the Concert and Sports Palace was awarded the LSSR State Prize for achievements in architecture soon after the opening of the building in 1973, and the unique cable-supported roof structure, which the author (constr. H. Karvelis) refers to as an *inverted arch*, was recognized as an invention in Lithuania [7]. Design solutions demonstrate the possibilities of features of *cast-in-situ* concrete, rounding out the roof elements, which are "held" by the tapered columns of the northern facade and primary vestibule, which thereby reveal the technological principle of stressing cables. Characteristic of the object's design solutions is an interpretation of solid-void contrasts whereby the clear glass plane creates a seeming sense of emptiness compared with the heavy concrete roof (Fig. 6 a)). Specific characteristics of the object also include rhythmic cable-stressing tapered upright supports in the northern facade; the protruding vertical planes forming rhythmic swarms, and the groups of circular apertures on the side facades (Fig. 6 b), c)). The main entrance to the Sports Palace building is expressive and intuitively easy to find: it is marked by a wide hanging stairwell across a decorative pool (symbol) and two bent planes at the entrance.

Variety. Vilnius Palace of Culture and Sports was planned as a universal city hall, the scale of which was formed around the ice-skating rink (61×31 m) and a tribune of 28-rows rising on one side along the rising part of the roof (Fig. 7 a)). Because the hall was foreseen as having a universal use, in front of the tribune a transforming stage was also built (16×17 m) for cultural events. The object hosted not only many sports competitions, concerts, theatre productions and art installations, but also many events related to the reclamation of Lithuania's independence. The uninterrupted functional zoning of the hall is characteristic and enabled by the cylindrical suspended roof. At the same time different and contrasting spaces are also characteristic of the building: the large-scale hall with the concave ceiling and the easily and quickly accessible lower foyer with a large source of light – the glass panes and view of *Gediminas* castle. Inside, the steep construction of the rising roof creates a comfortable space for the viewers (Fig. 7 b)). The possibilities of transforming inner spaces are linked with the universality of the hall and the mobile stage, which rolls on wheels and lifts and folds against the wall like a book (it can be changed over half an hour, whereas the usual stage was assembled over three days). The main structure of the hall allowed for efficient reconfiguration of the hall, depending on the event and audience numbers.

Specific to this building are the *surface design* solutions, which express the spectrum of concrete's plasticity. The novelty of the Palace of Culture and Sports surface design is related with the

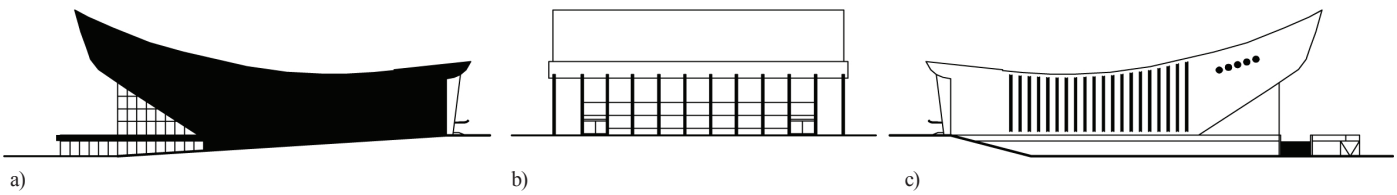

Fig. 6. Formal analysis: a) – contrasting solid-void interpretations; b) – rhythm of the rear facade; c) – rhythmic swarms on the side facades (created by the author).

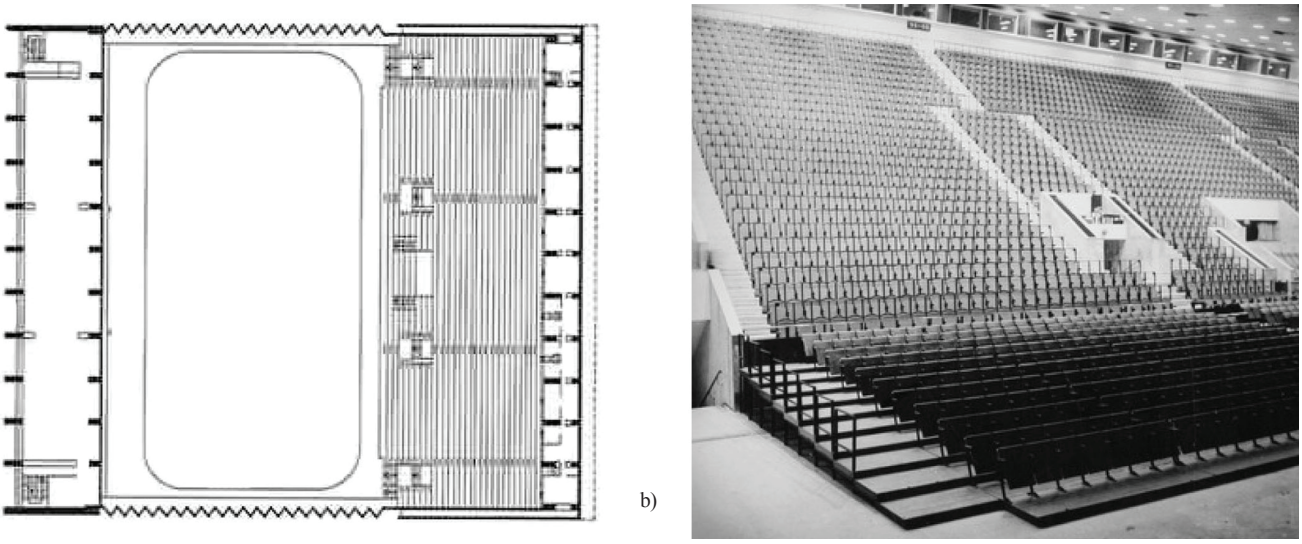

Fig. 7. a) – Plan of the Palace (published in SA 172/1) [10]; b) – interior view (photo by V. Knyva, 1973, LCVA).

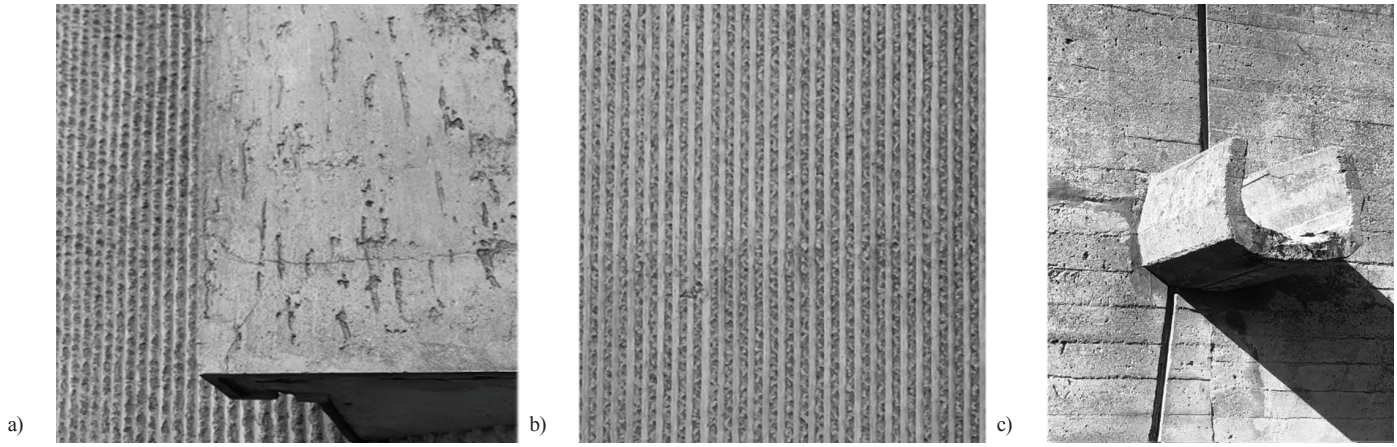

Fig. 8. Surface design: a) – "scratch" plaster; b) – "Rudolf style" plaster; c) – *béton brut* (photo collage created by the author).

application of *cast-in-situ* technology and rough exposition of concrete surfaces. Unfortunately, because of the poor quality of monolithic works, many improvements were made to the concrete. Many wall and roof planes were sprayed with "cement milk" because of the poor labour skills of casting concrete [10]. Seeking to give the building a unified image, the side facade planes were covered with a scratched and furrowed plaster that resembled concrete in colour: the scratched plaster was used for the decoration of the protruding vertical planes, and the furrowed plaster was used for the remaining planes of the side facades (Fig. 8 a), b)). Apparently, the aesthetics of the furrowed plaster was an experiment to make the surface resemble the work of American architect P. Rudolf, who developed the technique of vertically furrowed concrete surface texture as an alternative to the wood formworks prints. Also specific to Vilnius Palace of Culture and Sports is the framing of different textures and details: circular windows have a spatial edging, different textures are used for different planes. Most of the original *béton brut* surfaces are exposed in the retaining walls, on the surfaces of the hanging outer staircase and in the basement spaces (Fig. 8 c)). Moreover, monolithic terrace floors were implemented with chunks of concrete. The interior of the Palace of Culture and Sports is characterized by a combination of cold shades of concrete and wood with the warm tones of brown (dolomite) or green. A combination of concrete, dolomite and glass is predominant in the exterior of the building.

Conclusions

Even though concrete architecture is becoming more widely recognized and considered to be one of the cultural mediums of the 20th century [3], [5], [6], however, the value of such objects still needs to be proven. For this reason, the concept of *autopoiesis*

as a constantly evolving knowledge, which is stimulated by the clearly structured theoretical model, is especially important for practicing architects and researchers. Applying the theoretical model of Level I and Level II parameters, it can be argued that the Vilnius Palace of Culture and Sports is one of the most prominent impulses of concrete architecture in Lithuania, which reflects international tendencies to build massive, novel cultural objects in the central parts of cities using the possibilities of concrete's plasticity as the main tool to expose the main artistic idea of the building [3], [5], [6]. Secondly, a very rare and the only authored (engineer H. Karvelis) cable-supported structure was selected for the implementation of such an idea in Lithuania, which expresses the *zeitgeist* of the time and enables a design solution for composing a *solid* aesthetic-technological form.

Specific to the Palace of Culture and Sports is a high level of *complexity* that reveals *genius loci* and the local character of the object, which is expressed when landscape design solutions and the building together organically descend toward the river via terraces; through high-quality visual ties and a feature of self-similarity using concrete material. The *innovativeness of form* is related to contrasting solid-void solutions, rounded elements and rhythmic swarms, which creates the elegant monumentality of the building. While the *variety of design solutions* include different combinations of huge unsupported and small spaces, as well as material combinations. The sense of *zeitgeist* is enhanced by the *béton brut* surface aesthetics, different examples of decorative plaster, and the mosaic-like concrete ground covering.

The case of Vilnius Palace of Culture and Sports only confirms that a two level theoretical model reflects the *autopoietic* unfolding of the unique features of Lithuanian concrete architecture and brings an opportunity for the object's survival in terms of heritage conservation, as it could be a useful tool helping to formulate the valuable features of the buildings.

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