

Discussions on Structural Aesthetics with Reference Engineers of Cluj-Napoca

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Abstract

Within the research we conducted on aesthetics in the field of civil engineering, it was also approached the method of direct discussions with reference professionals of Cluj-Napoca. At the suggestion of the PhD mentor, Mr. Prof. Dr. Eng. Ludovic Kopenetz, we interviewed eight engineers, almost all of them professors at TUCN: Ildikó Bucur-Horváth, Dorottya Makay, Pavel Alexa, Anton Ionescu, Zoltán Kiss, Eugen Panțel, Petru Rus and Bálint Szabó. The discussions were guided by 11 questions that sought to outline the vision of each specialist on the beautiful of structures and the way this one is generated. In the present paper the answers of the interviewed specialists are synthetically presented, while the full interviews are being published in the Revista Construcțiilor, starting in 2018. The various answers are the most valuable, as we could see from the specialists' replies. In the same time, different or divergent opinions help the reader to shape up a rich framework with profound meanings on the subject of the structures' aesthetics. At the end of the outcomes' synthetic presentation, several conclusions are presented, that round up our research.

Rezumat

În cadrul cercetărilor pe care le-am derulat pe tema esteticii în domeniul ingineriei civile a fost abordată și metoda discuțiilor directe cu profesioniști clujeni de referință națională. La sugestia îndrumătorului de doctorat, domnul prof. dr. ing. Ludovic Kopenetz, am purtat discuții cu doamnele și domnii ingineri, aproape toți profesori în cadrul UTCN: Ildikó Bucur-Horváth, Dorottya Makay, Pavel Alexa, Anton Ionescu, Zoltán Kiss, Eugen Panțel, Petru Rus și Bálint Szabó. Discuțiile au fost ghidate de 11 întrebări care au urmărit conturarea viziunilor fiecărui specialist asupra frumosului structurilor și a modului în care acesta este generat. În lucrarea de față sunt prezentate sintetic răspunsurile specialiștilor intervievați, iar interviurile integrale sunt publicate în Revista Construcțiilor începând din anul 2018. Variatele răspunsuri sunt cele mai valoroase, așa cum putem observa din răspunsurile pe care specialiștii ni l-au acordat. Opiniile asemănătoare, diferite, respectiv divergente ajută la conturarea unui cadru bogat și cu înțelesuri profunde pe marginea subiectului esteticii structurilor. La sfârșitul prezentării sintetice a răspunsurilor primite, sunt înfățișate concluziile noastre care încheie cercetarea.

Keywords: structural aesthetics, structure-beauty link, conceptual approach, conditions of

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structure's beauty, evolution of structural beauty, stimulation of beauty in design, successful structure

1. The purpose of the research and the approached methodology

At the suggestion of Prof. Dr. Eng. Ludovic Kopenetz, the mentor of our PhD thesis on aesthetics in the field of civil engineering, eight engineers, recognized at national and international level for their outstanding contributions to the design, consolidation, restoration or expertise of structural objectives, were invited to a general discussion on the beauty of structures and how to integrate beauty into structure projects. The discussions were guided by 11 questions that supported the theorization on the subject.

The study specifically sought on how the engineers look to the integration of the aesthetic value into structure projects. The theoretical basis is, of course, essential to carry out the work of a specialist, but the ways in which this basis is put into practice denotes the talent, passion, performance and discernment of the professional.

Having only a guiding role, the questions were wanted to allow the freedom of expression for each interviewed engineer, and therefore the perspectives through which some subjects are viewed differ from one respondent to another. This variety of perspectives was an objective of the undertaken research, precisely because it reveals several angles of view of the same subject, widening the horizon of its understanding.

The specialists interviewed in this study were: Prof. Dr. Eng. Ildikó Bucur-Horváth [1], Dr. Eng. Dorottya Makay [2], Prof. Dr. Eng. Pavel Alexa [3], Prof. Dr. Eng. Anton Ionescu [4], Prof. Dr. Eng. Zoltán Kiss [5], Prof. Dr. Eng. Eugen Panțel [6], Prof. Dr. Eng. Petru Rus [6] and Prof. Dr. Eng. Bálint Szabó [8].

The full interviews have been or will be published in the *Revista Construcțiilor* during the year. Here, we will present our general interpretation of the answers given by the interviewed engineers, to which are added some explanations of the questions, short comments and some figures-diagrams illustrating the essence of the received answers.

In order to streamline the text and the presentation of the analyzes, only the surnames of the engineers invited to these discussions, without their name and their addressing formula, were used in order to mention them in the necessary moments, but our esteem for them is, of course, still a special one.

2. The discussions' interpretation

2.1 The structure's clarity

The guiding question was "*What sense do you give to the concept of clean structure?*". Since in the field of civil engineering the attribute of beautiful is not often associated with the structure, the term *clean* is easier to integrate and interpret it in this context.

The preferred expression to define a clean structure calls for the loads and their transmission to the ground. In particular, it reflects the simple transmission of loads (Kiss), or the shortest path of external mechanical actions (Panțel), it responds optimally to the loads (Rus), respectively it relates to the smallest crossing index (Makay and Ionescu).

Other answers and comments are addressed again to the range of mechanical criteria that a clean structure satisfies, namely: it ensures stability and stability (Szabó), it is mechanically stable (Panțel), it has the most appropriate static scheme (Makay), it is clear from the mechanical point of view (Bucur).

There have been some references to the technological aspects that a clean structure implies, namely at a general level: it is technologically clear (Bucur), appropriate to the foreseen technologies (Alexa); and in particular: it includes modular elements (Makay) and, with reference to mechanical aspects, it includes elements that are similarly stressed (Makay).

Several responses have taken into account the link between the clean structure and the structural concept that: creates harmony between the structural concept and the laws of mechanics (Rus), allows a clear view of the structural concept (Kiss).

The clean structure was associated with:

- the respect for the environment (Alexa) and keeping it clean (Alexa);
- certain visual aspects, because: it gives pleasure to sight even to a non-specialist (Alexa), it is the most elegant solution (Makay);
- references to materials, making it the most suitable choice of building materials (Makay).

To characterize it, the clean structure was associated with a series of:

- practical concepts, being: appropriate to the hosted functions (Alexa), geometrically clear (Bucur);
- abstract concepts, denoting a structure that is: intelligent (Ionescu), rational (Panțel), minimal (Panțel), correct (Panțel); or it was answered that the structure was not described as clear (Szabó).

The diagram that reflects the essence of the answers to question 1 is visualized in Figure 1.

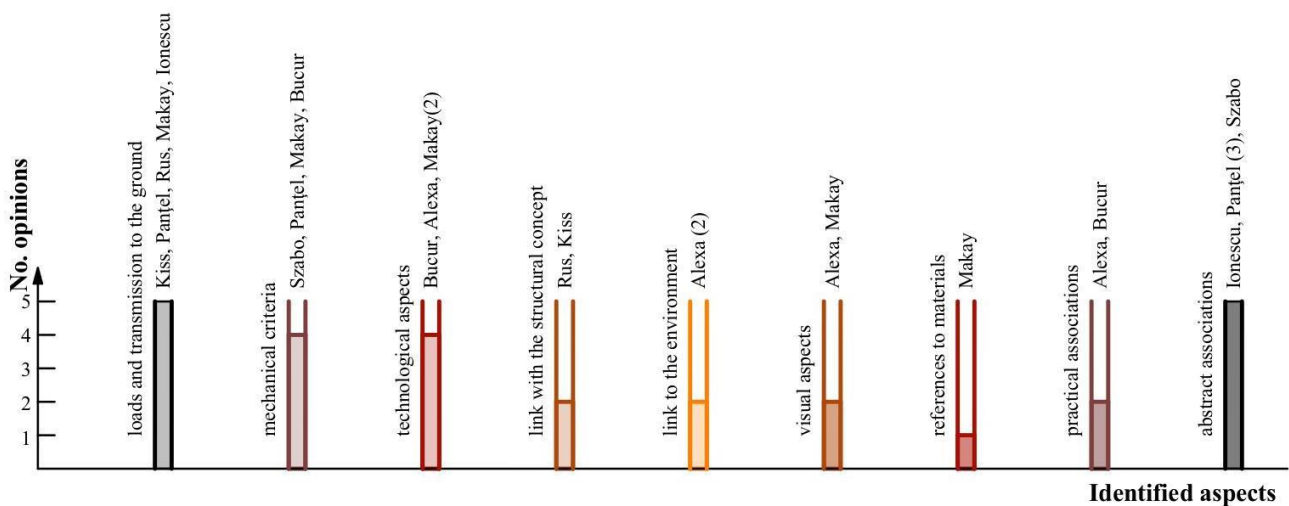


Figure 1. Synthesis diagram of the responses on the *clear structure*

The content of the diagram in Figure 1 points out that a clean structure relates to or consists of the following:

- the loads and their transmission to the ground: Kiss, Panțel, Rus, Makay, Ionescu;
- mechanical criteria: Szabó, Panțel, Makay, Bucur;
- technological aspects: Bucur, Alexa, Makay (2);
- the link with the structural concept: Rus, Kiss;
- the link to the environment: Alexa (2);

- visual aspects: Alexa, Makay;
- references to materials: Makay;
- practical associations: Alexa, Bucur;
- abstract associations: Ionescu, Panțel (3), Szabó.

2.2 The connection between the structure and the beautiful

The guiding question was "How do you see the connection between the structure and the beautiful?", trying to lead the discussion to the center of our topic, the beautiful in the structure, the way an engineer sees the connection between the two concepts.

Two categories of visions were segregated from the replies, namely on mechanical requirements, respectively on sincerity. In detail, the connection between the structure and the beauty is given by satisfying some mechanical requirements: this exists if the structure is correctly designed and meets some requirements (Szabó), it depends on complying to the system of constructive conditions (Bucur), it consists in the connection between the structure and the laws of mechanics (Rus). The connection between the two concepts is based on sincerity and given by: the honesty with which the structure is treated without being masked (Makay), the sincerity which the structure is conceived with (Ionescu), the sincerity and clarity which the structure is read with (Alexa).

The connection is a natural one: given by the naturalness which the structure is provided with (Ionescu), it is the connection between beauty and natural (Rus). It finds itself in a connection with architecture: it is related to the architectural conception that highlights the structure (Panțel), it is the link between structure and architecture (Alexa). It is based on harmony: it is conditioned by the harmony within architecture, functions, appearance etc. and structure (Kiss), it is due to the harmonious structural concept (Rus). This is in a certain type of connection with the passing of time: the connection changes with the society's evolution (Bucur) and it is ensured by the viable approach of the structure (Rus).

The link between structure and beauty can be based on several elements:

- the ornament: the ornamentation of the structure (Makay), the exploitation of the decorative potential of the structure (Makay);
- the associated emotional values: the engineer is in love with a beautiful structure (Szabó), the connection appears through the appreciation given by the specialists to a structure (Makay);
- the intrinsic intention of aesthetic valorization of the structure: the connection is generated by the engineer using the structure in order to become a determinant of aesthetics (Makay);
- it has a compulsory character (Ionescu).

The diagram that reflects the essence of the answers to question 2 is visualized in Figure 2.

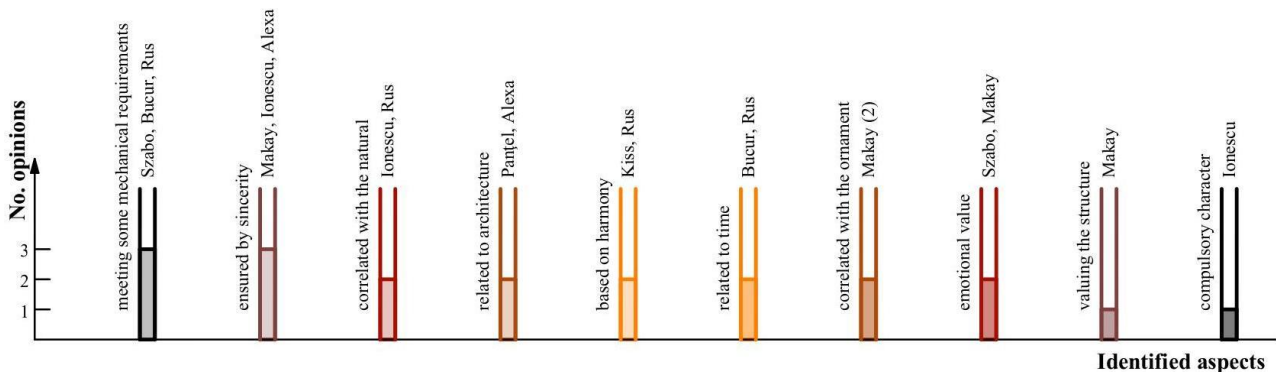


Figure 2. Synthesis diagram of responses on the connection between the structure and the beautiful

The content of the diagram in Figure 2 shows that the link between structure and beauty is given by, is or owns the following aspects:

- meeting some mechanical requirements: Szabó, Bucur, Rus;
- ensured by sincerity: Makay, Ionescu, Alexa;
- correlated with the natural: Ionescu, Rus;
- related to architecture: Panțel, Alexa;
- based on harmony: Kiss, Rus;
- related to time: Bucur, Rus;
- correlated with the ornament: Makay (2);
- emotional value: Szabó, Makay;
- valuing the structure: Makay;
- compulsory character: Ionescu.

2.3 The communication between the beautiful and the structure

The guiding question was *"In practice, is there a communication between the beautiful and the structure?"*. Two entities communicate whether they have something in common, they work together, they have a common language, they interact and condition each other. If one asks, the other replies and vice versa. If one increases, the other decreases. If one gives priority to one another, one is more pronounced and the other is blurred or masked.

Of the eight engineers interviewed, everyone answered *yes* to this question, only one with reservations, saying that there is rather a communication between function and structure (Szabó).

Five engineers associated the communication between the beautiful and the structure with the one between the architect and the engineer: it is ensured by the professionalism of the engineer and of the architect (Panțel), it consists in the communication between the architect and the engineer during defining the structural aspects of the project (Makay), it is based on the communication between engineer and architect (Kiss), it is based on the common language, the communication and the negotiations between architect and engineer (Ionescu), it is the communication between architect and engineer (Alexa).

Some comments have been made regarding:

- the accents shown in this communication, giving priority to: the structure – sometimes the structure has the word and is displayed in the foreground (Szabó); the architecture – when it is the engineer's response to the architect's proposals for achieving a beautiful structure (Makay);
- the conditions generated over the communication: this one is conditioned by the structural creation (Rus) and by originality (Rus);
- the communication's features: it is extraordinary (Ionescu), essential for ensuring the success of a structure (Kiss);
- the lack of communication, as: a necessary stage in the process of creation – the communication is missing in the first stage of the creative process that is carried out by the architect (Ionescu); as an unwanted situation – when the communication between beauty and structure is missing, the latter is only associated with the useful, functional and the cost-benefit relationship (Rus);
- the communication's reflection: this is translated by the pleasure that the structure produces to its viewer (Ionescu).

The diagram that reflects the essence of the answers to question 3 is visualized in Figure 3.

The content of the diagram in Figure 3 shows the answers *yes / no* to the question if there is a communication between the structure and the beautiful:

- the existence of communication: Bucur, Makay, Alexa, Ionescu, Kiss, Panțel, Rus, Szabó;

- the existence of communication with reluctance: Szabó.

And the comments on the communication between the beautiful and the structure from the point of view of the following aspects (the communication is, is defined by, presents):

- defined by the communication between architect and engineer: Panțel, Makay, Kiss, Ionescu, Alexa;
- the awarded priority: Szabó, Makay;
- conditions: Rus (2);
- defining features: Ionescu, Kiss;
- the lack of communication: Ionescu, Rus;
- the reflection way: Ionescu.

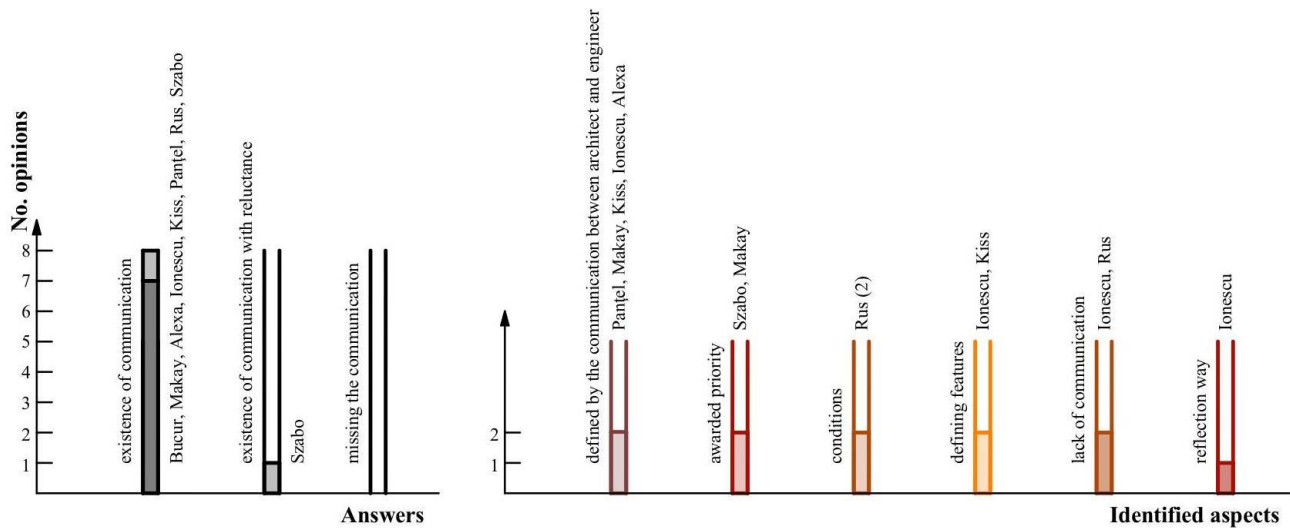


Figure 3. Synthesis diagram of responses on *the communication between the beautiful and the structure*

2.4 The conceptual approach of the aesthetic structure

The guiding question was "What is the conceptual approach to the achieved structure/structures?" and aimed to identify the path the engineer chooses in the process of creating a project, both from the perspective of the choices he makes, and from the perspective of the recommended path. The essence of the question relates to the steps that are taken in conceiving a structure in a theoretical manner. However, it leaves room to be interpreted and answered from three types of perspectives:

- theoretical – referring to the steps that are followed in order to go through the conceptual process;
- psychological – answering the question of how the process is carried out;
- methodological – highlighting aspects that contribute to achieving the best results.

After analyzing the engineers' replies to this question, 23 theoretical ideas provided by 5 people (Makay, Alexa, Ionescu, Bucur, Szabó) resulted, 18 ideas offered by 5 people from the psychological perspective (Rus, Bucur, Alexa, Szabó, Makay) and 16 methodological ideas offered by 6 people (Ionescu, Rus, Alexa, Bucur, Panțel, Kiss).

The content of this information provided by the specialists, summarized by us, is briefly described below, on the three types of perspectives, while for the psychological vision, respectively the methodological vision, they were divided into subcategories.

From the theoretical perspective, the path for designing a structure includes the following steps:

- making an inventory of the current resources related to: types of structures, structural systems, national and international trends, building materials (Ionescu);
- performing a comparative study of appropriate functional solutions (Bucur);
- presentation proposals by the architect and by the engineer (Alexa);
- generating the concept, the central idea of the project (Ionescu) or choosing, on logical criteria, the best solution (Bucur);
- extracting the structural concept from the architectural one (Makay);
- obtaining the assembly layout (Makay);
- receiving from the architect or creating the functional-aesthetic concept (Makay);
- settling the chosen structural system (Alexa, Ionescu, Szabó);
- identification the structural schemes (Makay);
- establishing the elements density (Alexa);
- establishing the vertical, horizontal and covering structural elements (Alexa, Ionescu);
- selecting the building materials (Makay);
- identifying the loading schemes (Makay);
- pre-dimensioning the structural elements (Makay);
- dimensioning the structural elements (Makay, Alexa);
- designing the structural elements (Makay) and the details (Szabó);
- optimizing the load bearing elements (Makay);
- driving the negotiations with the architect (Makay);
- passing the interventions to the architect (Makay).

From the psychological perspective, the process of designing a structure should take into account the following aspects:

- intrinsic aesthetic concerns:
 - the conceptual path is strictly individualized (Rus);
 - it must start with a concern for the aesthetic value of the structure (Szabó);
 - it aims to eliminate repetitiveness and monotony (Rus);
 - it takes place in such a way that the aesthetics results from the construction's structure (Bucur);
 - it must pay a special attention to the density of structural elements (Alexa).
- the link between structure and architecture:
 - the aspects settled by the architect must segregate from the ones settled by the engineer (Makay);
 - it leads to the resonance of the structure with the architectural concept (Rus);
 - it is achieved through the mutual support of the structure and of the architecture (Rus);
 - it is accomplished by reporting the structure and the architecture to one another (Rus);
 - it takes place so that the structural concept becomes part of the architectural concept (Rus);
 - the development of the structure must take place in parallel with the development of the architectural and the functional conception (Szabó);
 - it consists in the collaboration between the architect and the engineer (Alexa).
- the link between structure and functions:
 - it is sought to conceive the structure that ideally supports the function (Bucur);
 - it must meet the functional requirements (Bucur).
- complying the laws of mechanics:
 - the path must be adapted to the structural performances of the building (Rus);
 - it complies with the principles that ensure the proper behaviour of the structure (Rus);
 - it is carried out in a mechanically controllable manner (Bucur).
- the technological concerns:
 - the project should use highly performant technologies (Bucur).

From a methodological perspective, the design process of a structure is supported by or with:

- selecting tools, models and methods:
 - searching for the new items from the field (Ionescu);
 - the contribution of the designer's solid knowledge, talent and persuasiveness (Bucur);
 - the use of logical criteria in order to make choices (Bucur);
 - importing solutions (Ionescu);
 - the optimization of the chosen structural solution (Ionescu);
 - the availability of the mathematical models for structures (Bucur).
- ensuring the engineering-architecture synergy:
 - the resonance between architect and engineer, since this one is important and defining (Rus);
 - the continuous collaboration between architect and engineer (Alexa);
 - adapting the architect to the structure, when the structure implies high performances (Rus);
 - the integration of the structural concept into the architectural one, made by the architect (Rus);
 - framing up the structure in the architectural and the environmental concept (Alexa);
 - looking for the appropriate structure of the project's architecture (Kiss).
- the functional compliance:
 - meeting the functional requirements (Alexa, Panțel) and the height regime (Alexa).
- the mechanical reasoning:
 - searching for the most simple, easy to calculate and to predict structures (Kiss);
 - searching for the structure with the smallest crossing index (Panțel).

The diagram that captures the essence of the answers to question 4 is visualized in Figure 4.

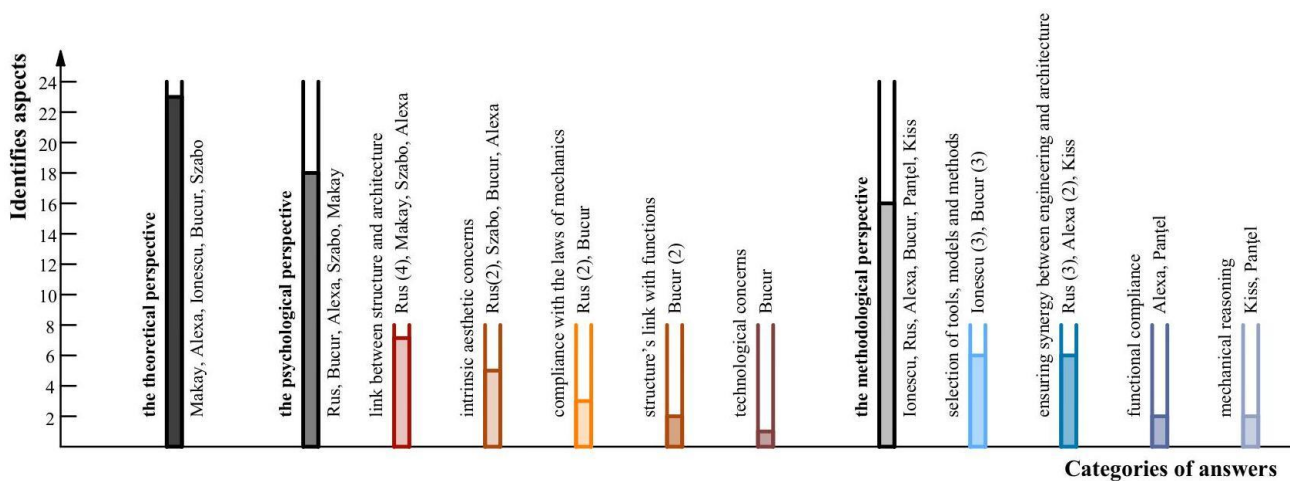


Figure 4. Synthesis diagram of responses on *the conceptual approach of the aesthetic structure*

The content of the diagram in Figure 4 shows the three types of approaches to the question, with the subcategories of mentioned aspects:

- the theoretical perspective – 23 steps are offered for the conceptual approach of the aesthetic structure: Makay, Alexa, Ionescu, Bucur, Szabó;
- the psychological perspective – 18 ideas are offered, divided into 5 sections:
 - the link between structure and architecture: Rus (4), Makay, Szabó, Alexa;
 - the intrinsic aesthetic concerns: Rus (2), Szabó, Bucur, Alexa;
 - the compliance with the laws of mechanics: Rus (2), Bucur;
 - the structure's link with functions: Bucur (2);
 - the technological concerns: Bucur.
- the methodological perspective – it contains 16 suggestions of aspects that can contribute to the achievement of an aesthetic structure, divided into 4 categories:
 - the selection of tools, models and methods: Ionescu (3), Bucur (3);
 - ensuring synergy between engineering and architecture: Rus (3), Alexa (2), Kiss;

- the functional compliance: Alexa, Panțel;
- the mechanical reasoning: Kiss, Panțel.

2.5 The conditions for achieving beautiful and successful structures

The guiding question was *"What are the conditions for achieving a successful structure and a beautiful structure? Is there a difference in practice between the successful and the beautiful structure?"*.

Observing the share of the structures in two categories of interest for the present study, in the successful and the beautiful ones, it was intended to identify those characteristics that differentiate these categories, to comment on which ones ensures their success and which ones ensures their beauty. This segregation is made by the practice itself. Although the two terms may seem to be confusing, there is still a subtle nuance that makes some structures temporarily successful, because sometimes they are not really beautiful, while beautiful structures will be successful through their beauty. Obviously, the two types of structure did not meet the same sets of conditions.

The eight specialists offered four types of answers regarding the existence or not of a difference between the beautiful structure and the successful one. There were:

- 2 opinions in the favor of overlapping the two concepts: Ionescu, Panțel;
- 2 views that recognized a variable overlap of the two aspects: Bucur, Makay;
- 2 views that were in the favor of the partial overlapping of the concepts, the beauty being included in success: Alexa, Rus;
- 2 opinions that supported the existence of a clear difference between the two concepts: Szabó, Kiss.

Achieving a structure that is both beautiful and successful, according to the perspective of the specialists in the first category, depends on aspects divided into four categories:

- regarding the originality: Panțel, Ionescu;
- concerning the laws of mechanics: Ionescu (2);
- regarding the involved logical reasoning: Ionescu, Panțel (2);
- regarding the architecture-structure report: Panțel.

The segregation of conditions for achieving a beautiful structure from the conditions for achieving a successful structure is visible in the opinions of the specialists whose answers belong to the last three categories from above.

With regards to the conditions for achieving beautiful structures, 20 ideas were highlighted, divided into three thematic categories:

- referring to the impressions or effects that the beautiful structure produces, counted 10: Alexa (3), Rus (5), Makay, Szabó, Kiss;
- referring to the apparent features that a beautiful structure displays, counted 7: Alexa (2), Rus, Makay (3), Kiss;
- referring to the abstract aspects that a beautiful structure embeds or may embed, counted 3: Bucur, Szabó, Makay.

19 ideas have been identified that capture the conditions for a successful structure, many of which refer to a low cost, the optimal investment, economy, low operating costs (4 different ideas). These are divided into three thematic categories:

- regarding the impressions or effects that the successful structure produces, counted 10: Alexa, Rus (2), Makay (3), Szabó, Kiss (3);

- regarding the visual features that the successful structure acquires, counted 2: Rus, Szabó;
- regarding the specialized aspects that the successful structure presents:
 - economic aspects: Rus (2), Makay (2), Kiss;
 - mechanical aspects: Makay, Kiss;
 - technical aspects: Makay (2);
 - abstract aspects: Szabó.

The diagram that captures the essence of the answers to question 5 is visualized in Figure 5.

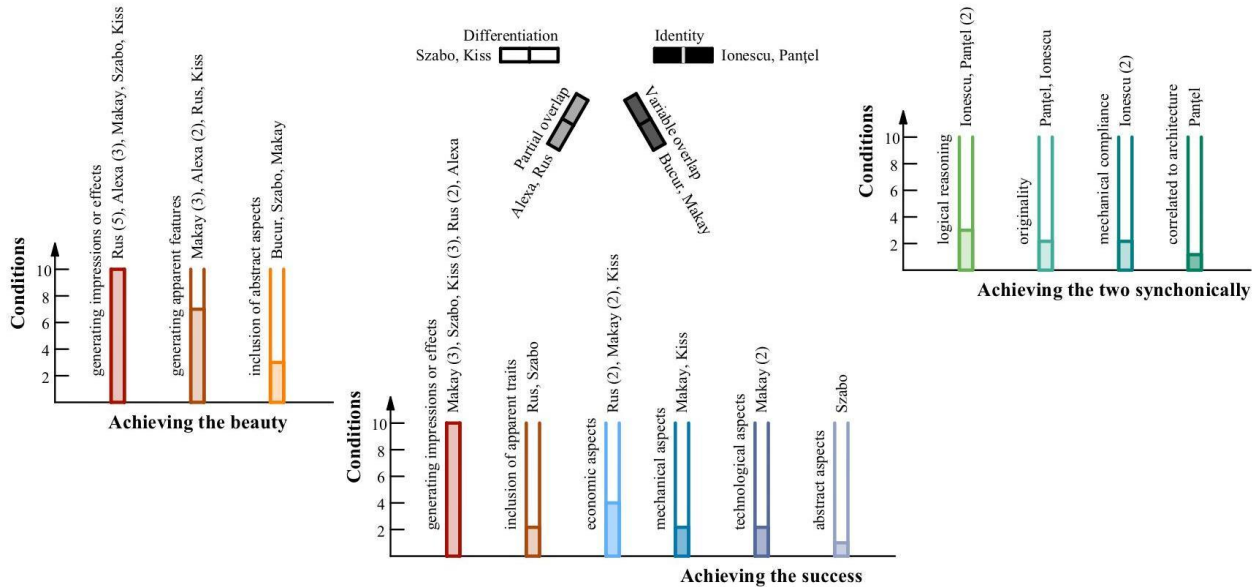


Figure 5. Synthesis diagram of responses on *the identity of beauty with success in a structure and the conditions for achieving the two*

The content of the diagram in Figure 5 shows the four types of attitude on the identity of beauty with the success of a structure and the types of conditions for achieving the two categories of main features:

- identity or differentiation of beauty and success:
 - identity: Ionescu, Panțel;
 - variable overlap: Bucur, Makay;
 - partial overlap: Alexa, Rus;
 - differentiation: Szabó, Kiss.
- beauty conditions:
 - generating impressions or effects: Alexa (3), Rus (5), Makay, Szabó, Kiss;
 - generating apparent features: Alexa (2), Rus, Makay (3), Kiss;
 - inclusion of abstract aspects: Bucur, Szabó, Makay.
- success conditions:
 - generation of impressions or effects: Alexa, Rus (2), Makay (3), Szabó, Kiss (3);
 - inclusion of apparent traits: Rus, Szabó;
 - complying economic aspects: Rus (2), Makay (2), Kiss;
 - complying mechanical aspects: Makay, Kiss;
 - complying technological aspects: Makay (2);
 - including abstract aspects: Szabó.
- conditions for the synchronous achievement of beauty and success:
 - logical reasoning: Ionescu, Panțel (2);
 - originality: Panțel, Ionescu;
 - mechanical compliance: Ionescu (2);

- correlation to architecture: Panțel.

2.6 The essence of the conditions for achieving beautiful and successful structures

The guiding question was "Of these conditions [from question 5] do you consider that a particular one is essential? If yes, which one?" and intended to emphasize an aspect considered essential to ensure a high level of aesthetics and success for a structure. Of course, in real life, all the conditions are important, although one may have a higher potential or may have a greater significance than the rest of them.

The most important aspects, mentioned by the interviewed specialists, in achieving a beautiful structure regard:

- the emphasis on the concept of beauty: the engineer's intention to create beautiful structures (Makay), giving the priority to the beauty against the success in conceiving the structure (Ionescu), the structural concept should pursue the beautiful (Rus);
- the dimensions of the assembly: the structure must have dimensions adapted to the hosted functions (Alexa);
- the effects produced by the structure: it should not disturb (Kiss).

In parallel, the most important aspects that ensure the success of a structure, as proposed, relate to:

- its novelty: the structure must include innovation (Ionescu), originality (Panțel), to denote the constructive and structural creativity of the engineer (Rus);
- spectacularity: the structure must be spectacular (Alexa);
- sustainability and others: *sustainability, energy efficiency, environmental friendliness, safe solutions, resource protection, modern materials, commissioning costs, low maintenance costs* (Kiss, original response);
- the ingenuity of the structural solution: ingeniously solving the problems that are involved by a performing structure (Rus).

The essential general conditions to be met in order to achieve a beautiful and successful structure imply:

- a high quality of the architectural and the structural concepts (Szabó);
- rationality and others: the structure must be rational, minimal and correct, original and must have a minimum crossing index (Panțel).

The diagram that captures the essence of the answers to question 6 is visualized in Figure 6.

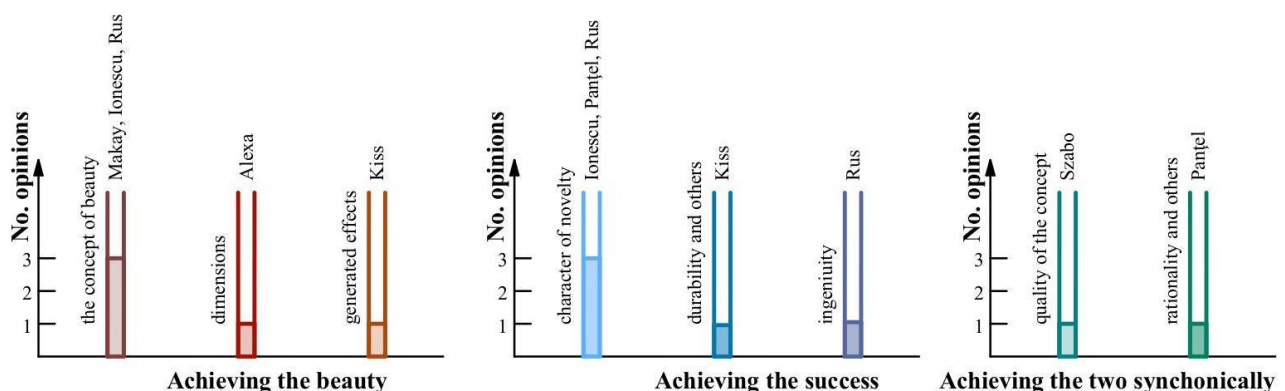


Figure 6. Synthesis diagram of responses on *the essence of the conditions for achieving beautiful and successful structures*

The content of the diagram in Figure 6 shows the most important conditions that can provide

aesthetic value and success to a structure:

- achieving the beauty:
 - (paying attention to) the concept of beauty: Makay, Ionescu, Rus;
 - dimensions: Alexa;
 - generated effects: Kiss.
- achieving the success:
 - the character of novelty: Ionescu, Panțel, Rus;
 - durability and others: Kiss;
 - ingenuity: Rus.
- achieving both beauty and success in a structure:
 - the quality of the concept: Szabó;
 - rationality and others: Panțel.

2.7 Applying the conditions for achieving the beautiful and successful structure

The guiding question was *"How are these conditions implemented?"*. Semantically it resembles to question 4, *"What are the conditions for achieving a successful structure and a beautiful structure?"*, but it is addressed on order to ask for psychological answers, relative to our commentary attached to the other question. That onw included the three types of perspectives in which an open question may be answered, namely in a theoretical, a psychological, and a methodological manner. Obviously, the question that is being discussed now also gives the specialists the freedom to present their point of view in the manner they consider to be suitable.

The theoretical answers describe the steps that the previously discussed conditions are implemented to achieve a beautiful and successful structure. There were identified 17 different steps that build the succession of the implementation of conditions, ideas that were cumulated from 4 respondents: Kiss (7), Ionescu (5), Rus, Szabó (5).

The psychological responses describe how, in what ways, in what manner, in what form, the discussed conditions are being implemented. There were 11 distinct ideas from 5 respondents, which are divided in two main categories: 3 ideas on how not to proceed and 8 on how to proceed in order to achieve the desiderata of the beautiful and successful structure. The first category, how not to, contains an idea for each of these aspects referring to:

- how the financial end of the project is sometimes seen: Kiss, Makay;
- how copying from previous activity sometimes occurs: Kiss;
- how to get to an uncustomized project: Kiss.

The second category of ideas, how to, has 4 subcategories that comment on:

- how to report the engineering field to the architectural one: Alexa (2), Rus;
- how to mentally see the desire to create: Kiss, Rus;
- how the specialist complies to rules and strategies: Kiss, Makay;
- how to run the conditions' application process: Rus.

The methodological answers describe what aspects contribute to the effective implementation of the above discussed conditions. There were 9 ideas divided into 5 aspects that contribute to our topic:

- the professional experience and the maturity: Kiss, Panțel, Makay;
- the selection made in practice: Makay;
- the attention paid to the specialist's and public's education: Kiss, Makay (2);
- the effective collaboration between architect and engineer: Panțel;
- the existence of the desire to create innovations: Kiss.

The diagram that reflects the essence of the answers to question 7 is visualized in Figure 7.

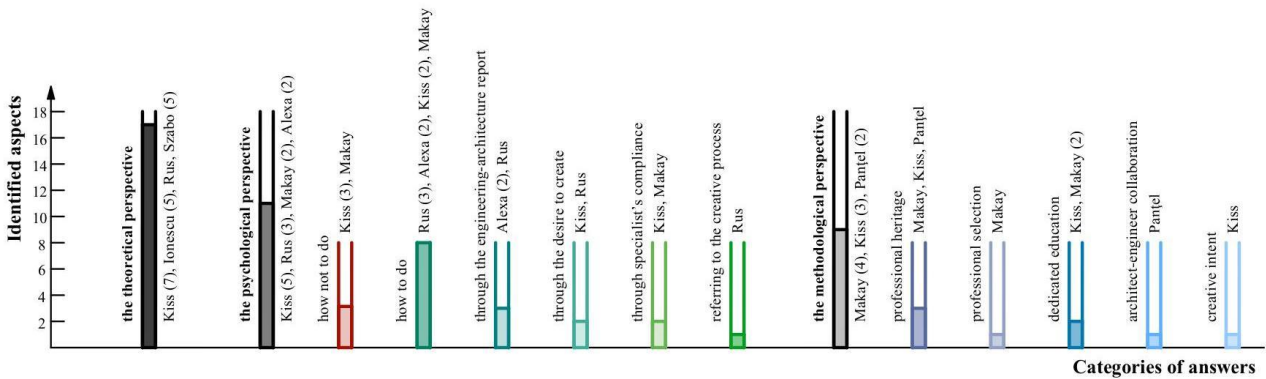


Figure 7. Synthesis diagram of responses on *applying the conditions for achieving the beautiful and successful structures*

The content of the diagram in Figure 7 shows the three types of perspectives in dealing with the application of the previously discussed conditions:

- the theoretical perspective sums up 17 steps to implement the conditions: Kiss (7), Ionescu (5), Rus, Szabó (5);
- the psychological perspective provides 11 ideas divided into two main sections:
 - how not to proceed: Kiss (3), Makay;
 - how to proceed: Alexa (2), Rus (3), Kiss (2), Makay
 - through the engineering-architecture report: Alexa (2), Rus;
 - through the desire to create: Kiss, Rus;
 - through the specialist's compliance: Kiss, Makay;
 - referring to the creative process: Rus.
- the methodological perspective brings 9 ideas divided into 5 categories related to:
 - the professional heritage: Makay, Kiss, Panțel;
 - the professional selection: Makay;
 - the dedicated education: Kiss, Makay (2);
 - the architect-engineer collaboration: Panțel;
 - the creative intent: Kiss.

2.8 The evolution in the structures' aesthetics field

The guiding question was *"Is there an evolution in this field? Either at theoretical level, if an evolution is anticipated – which would be that evolutionary path in the career of a specialist? Or in practice, in today's society of Cluj-Napoca, in comparison with previous periods."* and opened two lines for developing the discussion, namely on the evolution path that the specialist follows during his or her career, in order to acquire those qualities that make him or her design objects with a high aesthetic value, respectively in terms of the evolution observed in practice in our society.

The insights received from the interviewed specialists are thus divided, since they concern:

- the personal evolution of the specialist: Bucur, Rus;
- the evolution and the involution in the constructions field: Alexa, Bucur, Ionescu, Kiss, Makay, Panțel, Szabó.

In the section on the existence of evolution, comprehensive for the personal professional career and the progress in the society, four visions emerged, underlining:

- the evolution: Szabó, Ionescu, Bucur;
- the regression: Makay, Kiss;

- the duality of evolution-involution: Alexa, Panțel;
- the oscillation between the two: Rus.

Regarding the personal evolution of a specialist, 13 ideas were offered by Bucur (8) and Rus (5).

The discussions on the evolution in the constructions field were held both at world wide level (Alexa, Panțel, Ionescu) and at national and local level, referring to Cluj-Napoca (Kiss, Szabó Ionescu, Makay). Since these discussions were conducted on the basis of two criteria, namely the impact area and the evolutionary-involutive character of the course, four subcategories of discussions resulted, summarized below:

- the global developments in terms of:
 - the buildings design: design methods (Ionescu), calculation methods (Ionescu), means of verification and optimization of the projects (Ionescu), developing projects based on performances (Alexa);
 - carrying out the projects: construction materials (Ionescu, Panțel), making-up technologies (Panțel), increasing the feasibility of the projects (Ionescu).
- the evolution at national and local level, argued by:
 - the general evolution of the society: the political and economic progress (Szabó), the raising of beneficiaries' claims (Szabó), the wishes of the beneficiaries (Szabó);
 - liberating the creativity of the architects (Ionescu);
 - promoting of local specialists (Ionescu).
- the global regression – it was mentioned the tendency to make mechanical irrational experiments in constructions (Panțel);
- the national and local regression, which has been taken into account in the following aspects:
 - prioritizing financial interests over the quality and the sustainability (Kiss, Alexa, Makay);
 - the uncontrolled urban tissue exploitation (Alexa, Makay);
 - the preference to demolish historical buildings to replace them with new constructions (Makay);
 - appropriating the role of unique decision-maker in the design process by the developer (Kiss);
 - the unaesthetic consequences that occurred shortly after the completion of the work, as a result of choosing the cheapest constructive variants (Kiss).

The diagram that reflects the essence of the answers to question 8 is visualized in Figure 8.

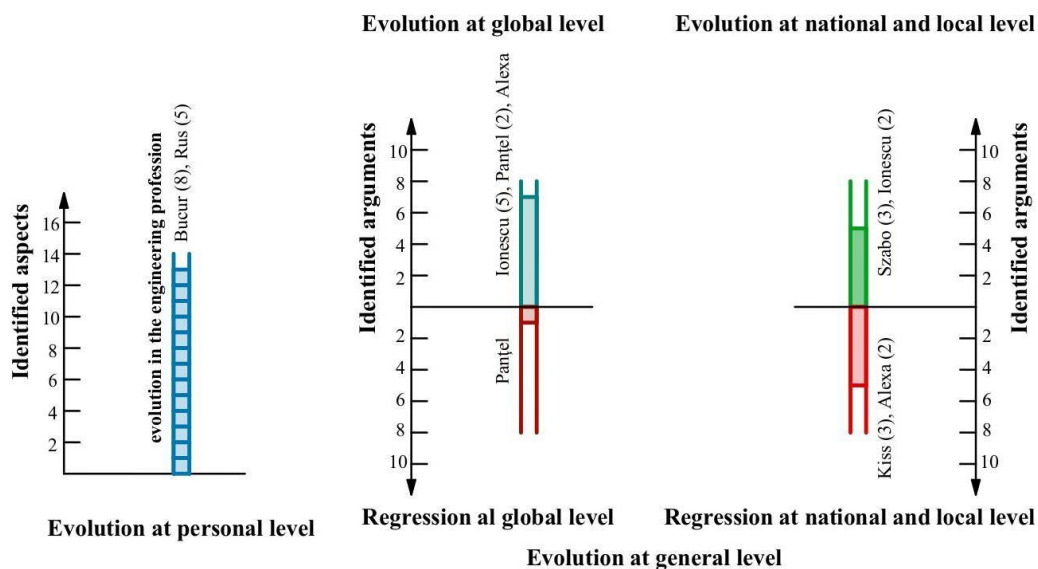


Figure 8. Synthesis diagram of responses on *the evolution in the profession and in the field of the structures' aesthetics*

The content of the diagram in Figure 8 visualizes, in parallel, the identified issues related to:

- the evolution in the engineering profession: Bucur (8), Rus (5);
- the evolutive and involutive character in the construction field:
 - the evolution at global level: Ionescu (5), Panțel (2), Alexa;
 - the evolution at national and local level: Szabó (3), Ionescu (2);
 - the global regression: Panțel;
 - the regression at national and local level: Kiss (3), Alexa (2).

2.9 Reference works and specialists in the field

The guiding question was "*Can you tell me a few works, respectively, a few specialists in whose activity the beauty holds a special place and can be, thus, considered references?*". Some of the reference specialists mentioned by the respondents were presented in a chapter of our PhD thesis. The question offered the freedom of choice on how to mention the references among the specialists, the companies, the works and types of works.

The individual specialists, considered by the respondents as references for the aesthetics of the structures, are listed below:

- Eng. **Mircea Mihailescu** (1920-2006): Bucur, Kiss, Rus, Panțel;
- Eng. and arch. **Pier Luigi Nervi** (1891-1979): Bucur, Kiss, Panțel;
- Eng. and arch. **Santiago Calatrava** (1951- present): Ionescu, Panțel;
- arch. **Zaha Hadid** (1950-2016): Alexa, Panțel;
- Eng. **Gustave Eiffel** (1832-1923): Panțel, Alexa;
- arch. Duiliu Marcu (1885-1966): Alexa;
- Eng. Fritz Leonhardt (1909-1999): Kiss;
- Eng. Jörg Schlaich (1934-present): Kiss;
- Eng. Bálint Szabó (1944-present): Makay;
- Eng. Petru Rus (1947-present): Makay;
- arch. Rudy Ricciotti (1952-present): Kiss;
- Eng. Klaus Bollinger (1952-present): Kiss;
- Eng. and arch. Werner Sobek (1953-present): Kiss;
- arch. Șerban Țigănaș (1963-present) and arch. Claudiu Botea (1971-present): Ionescu.

The companies mentioned as references by the respondent specialists were:

- SC VBS Structure SRL (Cluj-Napoca): Makay;
- Consolidem SRL (Florești): Makay;
- Evergreen Consulting Engineering (USA): Alexa;
- WSP Group (Canada): Alexa.

The most appreciated works of structural aesthetics are listed below:

- **Palazzetto dello Sport** in Rome, Eng. and arch. Pier Luigi Nervi, 1957: Panțel, Bucur, Kiss;
- **Eiffel Tower** in Paris, Eng. Gustave Eiffel, 1887: Panțel, Alexa;
- **Predeal railway station**, Eng. Mircea Mihailescu, 1968: Panțel, Bucur;
- **Box Office of Onești**, Eng. Mircea Mihailescu, 1972: Panțel, Bucur.

The complete list of the reference works for the aesthetics of structures is given below:

- Garabit Viaduct over the Truyère River, Eng. Gustave Eiffel, 1884: Panțel;
- **Eiffel Tower** in Paris, Eng. Gustave Eiffel, 1887: Panțel, Alexa;
- Victoria Palace in Bucharest, arch. Duiliu Marcu, 1952: Alexa;
- **Palazzetto dello Sport** in Rome, Eng. and arch. Pier Luigi Nervi, 1957: Panțel, Bucur, Kiss;

- Pirelli Tower in Milan, Eng. and arch. Pier Luigi Nervi, 1958: Panțel;
- **Predeal railway station**, Eng. Mircea Mihailescu, 1968: Panțel, Bucur;
- Exhibition Hall "Aurel Vlaicu" in Cluj-Napoca, Eng. Mircea Mihailescu, 1971: Bucur;
- **Box Office of Onești**, Eng. Mircea Mihailescu, 1972: Panțel, Bucur;
- TGV train station in Lyon, arch. Santiago Calatrava, 1994: Panțel;
- rehabilitation of the Roman Catholic Church of Mănăstur-Calvaria, SC Utilitas SRL, 1997: Makay;
- Pavilion of Arts and Sciences, Valencia, Eng. and arch. Santiago Calatrava, 1998: Panțel;
- Torre Mayor in Mexico City, WSP Group, 2003: Alexa;
- Taipei 101 Tower, Evergreen Consulting Engineering, 2004: Alexa;
- MAXXI Museum in Rome, arch. Zaha Hadid, 2010: Kiss;
- Cluj Arena Stadium, Cluj-Napoca, arch. Dico & Țigănaș, 2011: Ionescu;
- rehabilitation of the Evangelical Church in Bistrița, Eng. Bálint Szabó, 2013: Makay;
- Museum of European and Mediterranean Civilizations in Marseilles, arch. Rudy Ricciotti, 2013: Kiss;
- Headquarters of the European Central Bank in Frankfurt, Bollinger + Grohmann, 2014: Kiss.

To these are added the mentions made for the historic castles of France and England, the Romanian castles, of which is mentioned the Bánffy Castle from Bonțida dating back to the 17th century, and also the Romanian parks (Szabó).

The diagram that reflects the essence of the answers to question 9 is visualized in Figure 9.

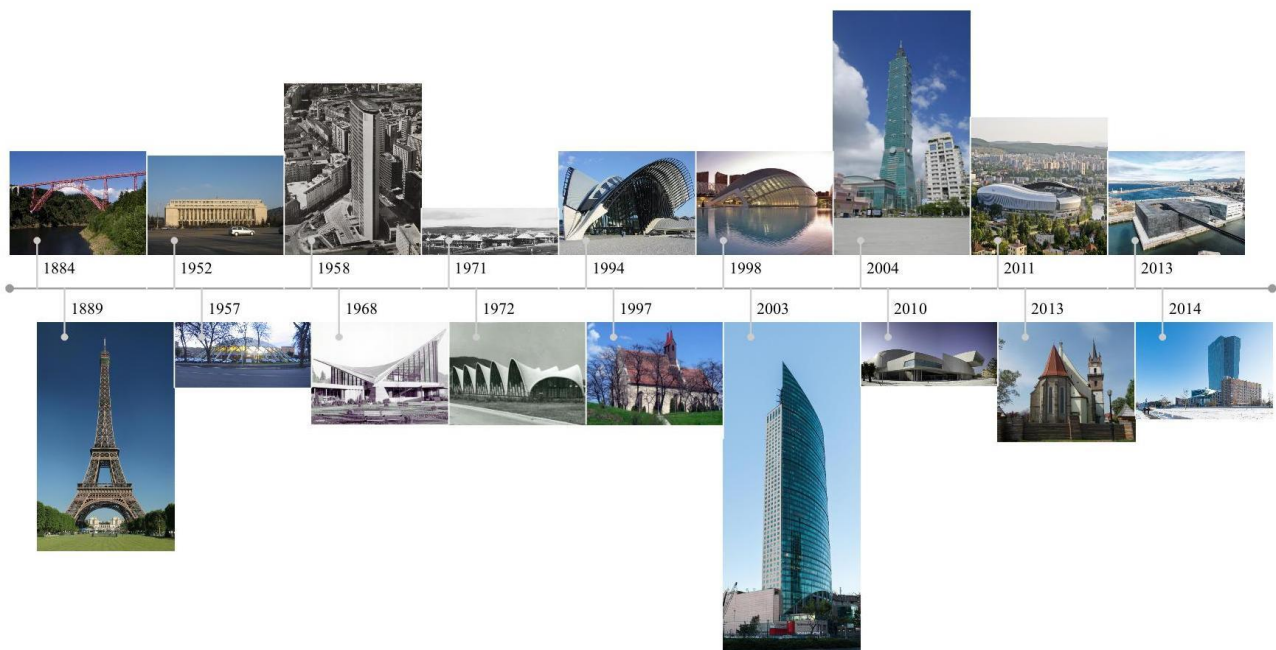


Figure 9. Synthesis diagram of responses on the reference works in the field

A high attention was given to the reference engineers within another work dedicated to the *Contributions of reference structuralists to the structures' aesthetics*. Thus, the synthesis diagram for this question comprises only the list of the reference works as drawn from the opinions of the interviewed specialists, according to the above list, arranged by the year in which their construction was completed.

2.10 Stimulating the design of beautiful structures

The guiding question was "What helps you design a beautiful structure project?" and complements the question 4, "What are the conditions for achieving a successful structure and a beautiful structure?", but is formulated in order to ask for answers from the methodological perspective, relative to our commentary attached to the other question. According to the personality and the formation of each one, the interviewed specialists were invited to contribute to the creation of a richer and more useful image that could guide the young specialists or those who are perfecting themselves, within the path for conceiving beautiful structures.

There were 21 different ideas, shared on the following succinct topics related to those aspects that support, stimulate or improve the professional skills for the design of structures of high aesthetic value:

- intellectual and mental processes: the education (Panțel), the documentation (Panțel, Ionescu), researching and investing resources in research (Kiss), pursuing the evolution of the field (Bucur), the meditation (Kiss), the awareness of the held responsibility (Kiss);
- the interaction of the engineer with the architect, other specialists or other people involved in a project: the engineer-architect collaboration (Panțel, Makay, Ionescu, Alexa), the trust in the architectural concept (Rus), the proposals of beautiful volumetries from the architect (Rus), the beneficiary's trust in the engineer and supporting him or her (Makay), the entourage of specialists (Bucur), the specialists teamwork (Bucur, Kiss);
- the accumulation, the access to and the consultation of several types of specialized knowledge: own experience (Szabó, Panțel, Ionescu, Alexa), knowledge acquisition (Alexa), mathematics and specialty knowledge (Bucur), the consultation with other specialists (Alexa) ;
- the activation of spiritual and artistic components: the specialist spirit (Kiss), the desire to create the beautiful (Rus), appreciating and getting inspired by artistic and technical masterpieces (Kiss).

The diagram that captures the essence of the answers to question 10 is visualized in Figure 10.

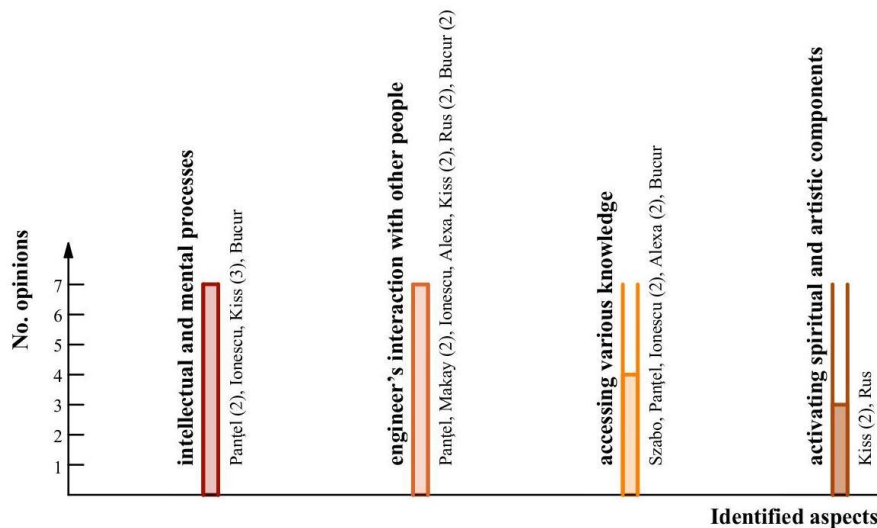


Figure 10. Synthesis diagram of responses on *the design stimuli for beautiful structures*

The content of the diagram in Figure 10 reveals the main categories of stimuli identified by respondents in designing beautiful structures, namely:

- the intellectual and mental processes, 7 ideas: Panțel (2), Ionescu, Kiss (3), Bucur;
- the interaction of the engineer with other people, 7 ideas: Panțel, Makay (2), Ionescu, Alexa, Kiss (2), Rus (2), Bucur (2);
- accessing various knowledge, 4 ideas: Szabó, Panțel, Ionescu (2), Alexa (2), Bucur;

- activating spiritual and artistic components: Kiss (2), Rus.

2.11 The public's response to the specialist's effort

The guiding question was "*How does the public regard at the aesthetic effort of the specialist?*" and it is addressed to the interviewed specialists in order to reveal how they infer the impressions of the public in response to the effort that the specialists make in order to give them an aesthetically valuable built environment.

Seven steps have been identified to reveal the attitude of the public in this regard, summarized below:

- admiring – when the audience sends out their intense positive impressions on a construction, through enthusiasm (Pañtel), admiration (Pañtel, Alexa), excitement (Ionescu);
- appreciative – when it expresses positive feelings about a construction (Kiss, Ionescu, Bucur);
- comforting – when it shows a sense of satisfaction with the aesthetic qualities of the building (Bucur), it feels comfortable or safe by crossing it (Makay);
- heterogeneous reaction – when the public express pros and cons (Kiss), it is not indifferent (Rus), receives what the construction transmits (Rus), changes its opinion by the time passing and by the society's general attitude's change on a building (Alexa);
- uninterested – when it does not understand the architectural value or the aesthetic value of the building, but does not make any effort to change the situation (Makay) or it is sometimes passively deformed by the lower quality of the built-up environment (Kiss);
- disinterested – when the public's interests shift from the quality of aesthetics, functions and structure of the construction to other aspects, such as the financial ones (Kiss) or manifest by a crisis of attitude and behavior towards the built heritage because this trait represents itself very well (Szabó);
- disapproving – when the public releases negative criticism, even if they later change their minds (Alexa).

The diagram that captures the essence of the answers to question 11 is visualized in Figure 11.

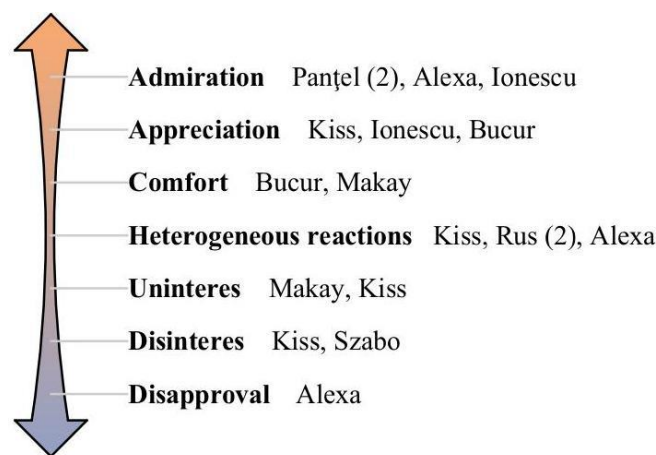


Figure 11. Synthesis diagram of responses on *the public's reaction to the specialist's effort*

The content of the diagram in Figure 11 highlights the main types of the public's reactions identified in relation to the specialist's effort in building a pleasant environment:

- admiration: Pañtel (2), Alexa, Ionescu;
- appreciation: Kiss, Ionescu, Bucur;
- comfort: Bucur, Makay;
- heterogeneous reactions: Kiss, Rus (2), Alexa;

- uninteres: Makay, Kiss;
- disinterest: Kiss, Szabó;
- disapproval: Alexa.

3. Conclusions

The experience of interviewing the specialists in the research presented in this paper was an extraordinary one, as was the following and the synthesis of the contents of the received replies, which have a special professional value.

The discussions were, of course, focused on the topic of the structures' aesthetics, and due to time and space reasoning they were limited to just 11 questions, although many other precious knowledges could have been added. They all enrich the knowledge skills of young specialists and can also be very useful to anyone who wants to deepen the matter of aesthetics of structures.

This paper was intended to synthesize "what" the answers of the interviewed specialists relate to, without actually interpreting or commenting on the answers. They often contain similar, homogeneous answers or a common palette of approaches, as one can observe in the traits identified in the clean structure (question 1), to what connects the beauty to the structures (question 2), which are the essential conditions for achieving beautiful structures (question 6), what helps a specialist in conceiving beautiful structures (question 10). Of course, different responses or approaches have been highlighted in miscellaneous ways, for example on the questions regarding the conceptual approach that is being taken to create a beautiful structure (question 4), what are the conditions for achieving and the differences between a successful structure and a beautiful one (question 5), how do these conditions apply (question 7), if there is an evolution in this field (question 8), how is the perception of the public felt with regards to the specialist's effort to create a pleasant built environment (question 11)). All of them have helped to create a comprehensive and consistent picture of the addressed topics. In our opinion, the various answers from the theoretical, psychological and methodological perspectives were more interesting and valuable, more intensely highlighted in the questions regarding the conceptual approach for a beautiful structure (question 4), the application of the conditions in achieving these ones (question 7) and to the aspects that stimulate their design (question 10).

Prof. Dr. Alexa mentioned in the tenth question, regarding the aspects that help him to conceive projects of beautiful structures, that, among other things, these were the knowledge we can access from the heritage received from previous generations of specialists. Fully endorsing this idea, we emphasize that each generation has the duty, besides to contribute to the evolution of the society it constitutes, also to prepare the next generation in order to properly face the challenges of a certain field. The new generation must be able to quickly and efficiently assume the inheritance it will receive and that is why the latter must contain the knowledge and the scientific progress of the current generation, prepared in an easily accessible, useful and comprehensive shape.

The next generation will, thus, concentrate its interests, resources and effort not on accessing, browsing and assimilating the received heritage, but especially on its own creative and scientific contribution which it is obliged to add to the humanity's progress.

Acknowledgements

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