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INTEGRITY AND LIFE IN THE PROCESS OF DESIGN AND REALIZATION IN EMERGING ARCHITECTURE - DIGITAL CHAIN CASE

INTEGRITET I VEK U PROCESU PROJEKTOVANJA I REALIZACIJE NOVONASTAJUĆE ARHITEKTURE - DIGITALNI LANAC

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- integrity and life of architectural object
- positioning of the architect

Abstract

Considering the complexity of architectural requirements and general issues of design and realization, sustainability, maintenance, durability and recycling in emerging architecture, the topic of the integrity and life of architectural objects is highly actual. Architectural spaciousness as a creative activity and durability of construction in terms of careful and complex designing of the structure, has a multi-layered networked - common effect. This paper is a study - simulation of possible results during digital data driven design and realization in architecture and integrity of architectural objects in terms of improvement of architectural profession and architecture as a science.

Ključne reči

- novonastajuća arhitektura
- proces projektovanja i realizacije
- Digitalni Lanac
- integritet i vek arhitektonskog objekta
- pozicioniranje arhitekte

Izvod

Posmatrajući kompleksnost arhitektonskih zahteva i opštih pitanja projektovanja i realizacije, održivosti, održavanja, trajnosti i recikliranja u novonastajućoj arhitekturi (engl. emerging architecture), tema integriteta arhitektonskih objekata je vrlo aktuelna. Arhitektonska prostornost kao delatnost stvaralaštva i trajnost konstrukcije u smislu pažljivog i kompleksnog projektovanja konstrukcije, imaju višeslojno umreženo - zajedničko dejstvo. Ovaj rad je simulacija mogućih rezultata pri digitalnom kodiranom projektovanju i realizaciji arhitekture i integriteta arhitektonskih objekata u smislu unapređenja arhitektonske profesije i arhitekture kao nauke.

INTRODUCTION

The durability of architectural objects is a current topic in emerging architecture in terms of sustainability and recycling of building materials, but also in terms of designing and adapting the architectural organisation of the space and structure. Emerging architecture is the newly created architecture with complex architectural requirements and with an innovative way of design and realization.

Considering the complexity of architectural requirements and general issues of design and realization, sustainability, maintenance, durability and recycling in emerging architecture, the topic of integrity and life of architectural objects is highly actual. Architectural spaciousness as a creative activity and durability of construction in terms of careful and complex design of structure, has a multi-layered networked - common effect.

This research is a continuity to already started research and gained results. The term *integrity of architectural objects* may be understood as the function and construction of objects designed to prevent possible failure, that all elements, requiring special control in exploitation, are defined in the design phase and that the design documentation includes all necessary data for object realization, management over predicted exploitation life and life assessment, /1/. New technical development, whether tall or nano-sized, requires that functionality and reliability be considered in addition to safety, /2/. Functional service life is also considered - the time during which a structure is in use until it becomes functionally obsolete due to changes in requirements (changing the use of space, the need for different access, etc.), /3/.

The settings of design and architectural realization today cannot be considered separate from emerging architecture based on digital technology. Digital technology has primarily affected the architectural presentation, and eventually began to represent a design tool directly connected with the realization that, across various digital techniques, is establishing a continuity of a 'digital gap' between the design and architectural realization. With characteristics of continuous connection, this relation design-realization is increasingly manifested as a CAD/CAM technology and most commonly researched as a Digital Chain principle, /4/. Primarily, the term *Digital Chain* is defined and investigated at the CAAD department of ETH Zürich, within research projects in this institute, /5/.

Emerging architecture sets in front of architects a large number of requirements that are now digital, interrelated and conditioned by varying, more or less acceptable results. Architecture as a science and art of design and forming the space, setting on usual starting points, is determined by the context and space, /6/. Emerging architecture, along with digital technology, is pushing the boundaries of future

architectural activity, but also sets high standards for future treatment of existing architectural objects - structures and buildings.

The whole package of requests needs experienced and expert decisions that cannot always be totally coded and belong to the architect as a carrier of personal and non-coded data.

EMERGING ARCHITECTURE AND INTEGRITY AND LIFE OF ARCHITECTURAL OBJECTS

The context of emerging architecture is itself complex, composed of several layers - different interlocked disciplines, and is multidisciplinary. In contemporary terms, the architecture is closely related to urban planning, and in explaining of the treated topics corresponding to engineering sciences: civil engineering, electrical engineering, programming and mechanical engineering. The wideness of the architecture is also reflected in the interdisciplinary work, and by definition is a social and technical science on one hand, and artistic on the other hand, with a substantial admixture of psychology - cognitive science, as well as aesthetics and mathematics.

If we define the context by basic linguistic meaning of this word which represents a connection of thought in speech, it is associated to the essence of architecture by its nature, appearance and expression. This definition links architecture directly with the idea and approach to the process of design and realization.

If we define the context by architectural meaning of the word that represents external physical and non-physical elements that affect architecture (the house), then we connect it to the requirements of design and realization of architecture. In this case we are talking about the determinants of architecture as specific target, i.e. about the design assignment.

If we consider the context in digital architectural terms, it represents an artificial environment, i.e. environment of digital design - coding, where the selected parameters have the role of factors and are determined in the form of an artificial environment, /7/.

In all three cases, the presence of the architect is inevitable in the process of creation of architecture in terms of setting up, managing and dictating architectural trial. Positioning of the architect in the digital approach to architecture with parameter settings of new context, recently becomes more and more provocative in terms of simultaneous occurrence of his reduced need and necessity, /8/.

Therefore, the new architectural context is the gathering of all standard architectural parameters and practical experience with a step further, predictions about future human needs - microscale and city development and economy - macroscale with included interdisciplinary thinking.

The macroscale should be considered as a flexible urban context. Design architecture is part of nature or cooperation with landscape and urban concept as fragments of nature incorporated into the abandoned artificial environment, /9/.

Microscale should be reconsidered as the connection between urban and human and everyday culture of living, /10/, in sense of quality of life - comfortability.

Spatial architectural solutions of structure and function require a common approach with consideration of future aspects as well as experience of existing practice. Functionality includes compliance of architecture with the requirements of purposes, as well with the standards of design and dimensions corresponding to the user - human. On the other hand, the economic unsustainability of a single function, and the complex activities of a human, introduce, as basic requirements, multi-functionality, i.e. flexibility of space particularly reflected through the utility parameter as major project of predicting and understanding different functional programs which support the sustainability of architecture (house), /8/.

There are a lot of examples where the needed change is not just in construction. Good practice examples of spatial - functional approach with change of architectural functions in re-used specific or industrial buildings are based on combined usage of existing buildings in the central city structure or outside of the city, Fig. 1.

As a specific architectural building, e.g. the All Saints Church in Hereford stands out in the United Kingdom, Figs. 1a and 1b. In the city structure of Hereford centre, it is being partly reconstructed with the addition of commercial content, to café shop, unusual to other function. It has been preserved in its original form, maintained by city regulation and set in the city's extraordinary motive. Industrial buildings are largely amenable for changing functions and adaptation. Sargfabrik in Vienna, Austria (Fig. 1c) is an excellent example of factory reconstruction to an open type of private housing along with smaller commercial and cultural facilities. The factory has grown into an artistic contemporary community of housing, cultural centre, gallery and restaurants. Gasometers in Vienna, Austria (Fig. 1d) are 4 industrial buildings raised to the form of attraction with an inviting project for architects Jean Nouvel (Gasometer A), Coop Himmelblau (Gasometer B), Manfred Vehdorn (Gasometer C) and Vilhelm Holzbauer (Gasometer D). The renovation and revitalization for the new use of these buildings support solutions of separation of private and public buildings, but with mixtures of functions inside every building, producing the high level of urbanity. Public content combined at the building are visible in adaptation of the Schiffbau building in Zurich, Switzerland (Fig. 1e). The shipyard is reconstructed into a cultural function of a theater and a commercial function of the restaurant. A similar concept with a larger number of functions inside one urban block is the Korjaamo in Helsinki, Finland (Fig. 1f). The tram factory is transferred into a cultural factory, an alternative place of multifunctional public facilities as the tram museum, cinema, restaurants with permanent commercial themed organisation of cultural events.

In these examples, architectural experience is used for future projects. The freedom of architectural expression in terms of function and structure is important to be previously set, making possible after future changes and adaptation to the next conditions. Resulting professional knowledge is the basis for future experiential and expertising data as the base for needed architect decision in terms to actual space request. The architectural process in emerging architecture

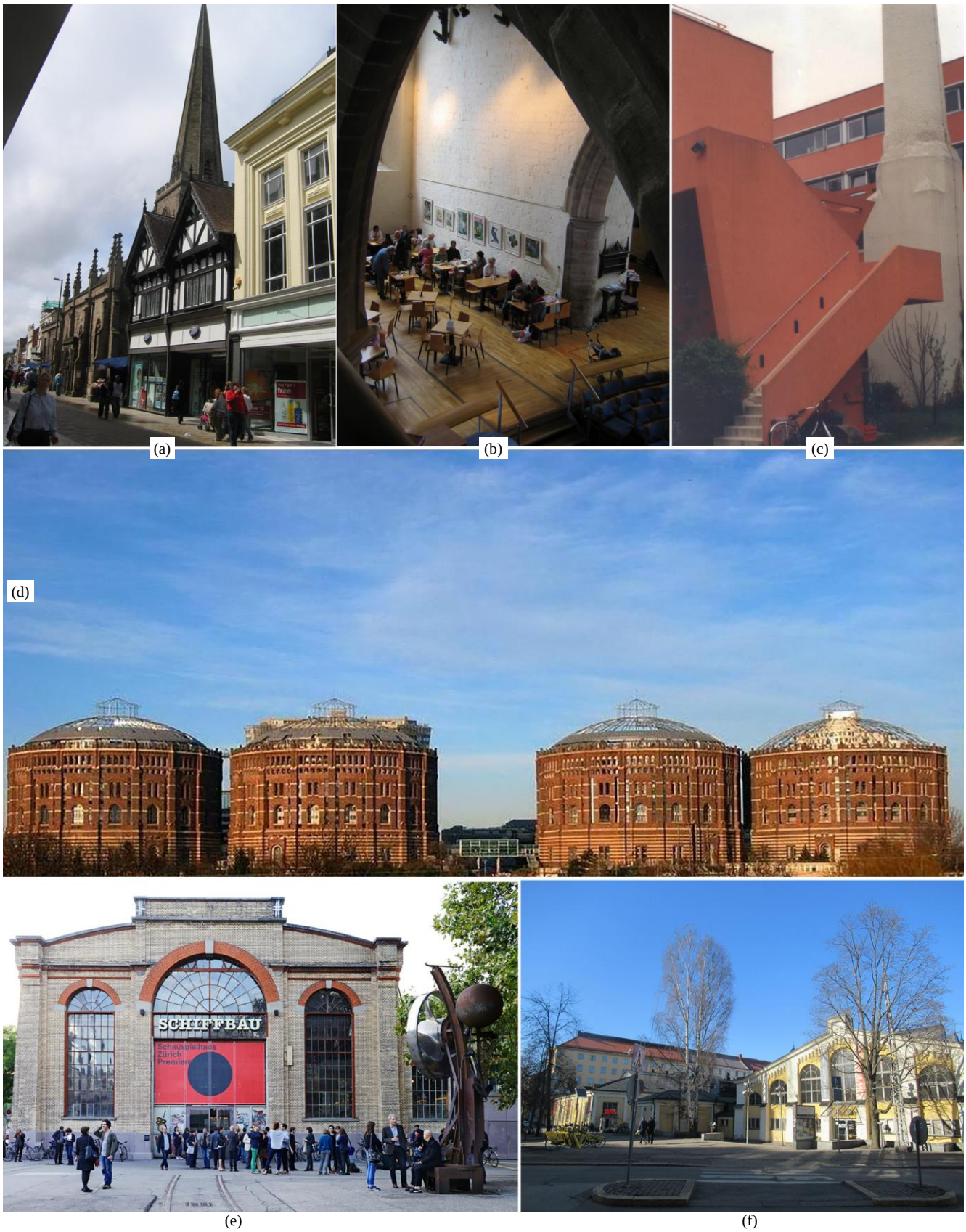

Figure 1. Spatial functional approach: (a) and (b) All Saints Church, Caffe@All Saints, Hereford; (c) SargFabrik, Vienna; (d) Gasometers, Vienna (source: https://en.wikipedia.org/wiki/Gasometer, Vienna); (e) Schiffbau Spielhaus, Zurich (source: https://zero.eu/en/luoghi/83333-schauspielhaus,zurich); (f) Korijaamo, Helsinki.

is not interactive only in technological sense, but also in social, meaning that the process is explained through the idea, internal and external influences, modelling and carrying the prototype to the final product - building. The emerged digital design presents the transformation of traditional design activity, while digital architecture is the whole combined group of constructive engineering technologies, new materials, production and constructive processes, allowed by computer, conditioning and discovering.

Today, the context includes communication with the present moment in terms of technological advancement. Further speaking, the new context is the communication of programming parameters, i.e. coding. Emerging architecture is an overlapping product of technological tools and context with their connections to various complex requirements, approaches and action by the expert, who has the skills of a meaningful connection to the product, i.e. space. Architectural spaciousness is basically defined by the architect's parameters of functionality and form. The emerging architecture of today's architectural reality includes a wide range of different types of architectural products, created in parallel processes of design and realization of conventional, digital or combined tools. In response to a complex context and requirements of today, emerging architecture itself is the experimental process, based on a digital approach to constant rehearsals and changes which is a necessary passing phase of the prototype, but in most cases also testing the process of design and realization, materials and machines.

EMERGING ARCHITECTURE VS. INTEGRITY AND LIFE OF BUILDINGS - DIGITAL CHAIN PRINCIPLE WITH THE POSITIONING OF ARCHITECTS

Digital phenomenology in emerging architecture is a driver of idea of digital approach in architecture, not just an organized process, but also an effective way of solving the permanent architectural long path problem and separation between design and realization.

The demystification of the Digital Chain /8/ is done by explaining the components in this process, their overlapping or discrepancies in relation to conventional design and realization in architecture, as well as their manifestation through practical use in architecture.

The whole digital process is explained by a chain of links, organised in different ways and represents an organised subprocess in the Digital Chain, Fig. 2. The links are:

1. Approach to design assignment
2. Digital design - coding
3. Production 1 - prototype
4. Production 2 - production of structure

They are individual and as part of the chain under the influence of a number of connectors. Connectors are based on interactivity of the complex design process and realization in architecture and represent disruptions in chain linearity:

(a) Internal and external influences on the approach to design assignment and on digital design - coding
(b) Influences of machine and material parameter
(c) Fabrication - influence of transport tools and assembling

The end of the chain is related to the post-production period and is linked to the presentation and confirmation of structures.

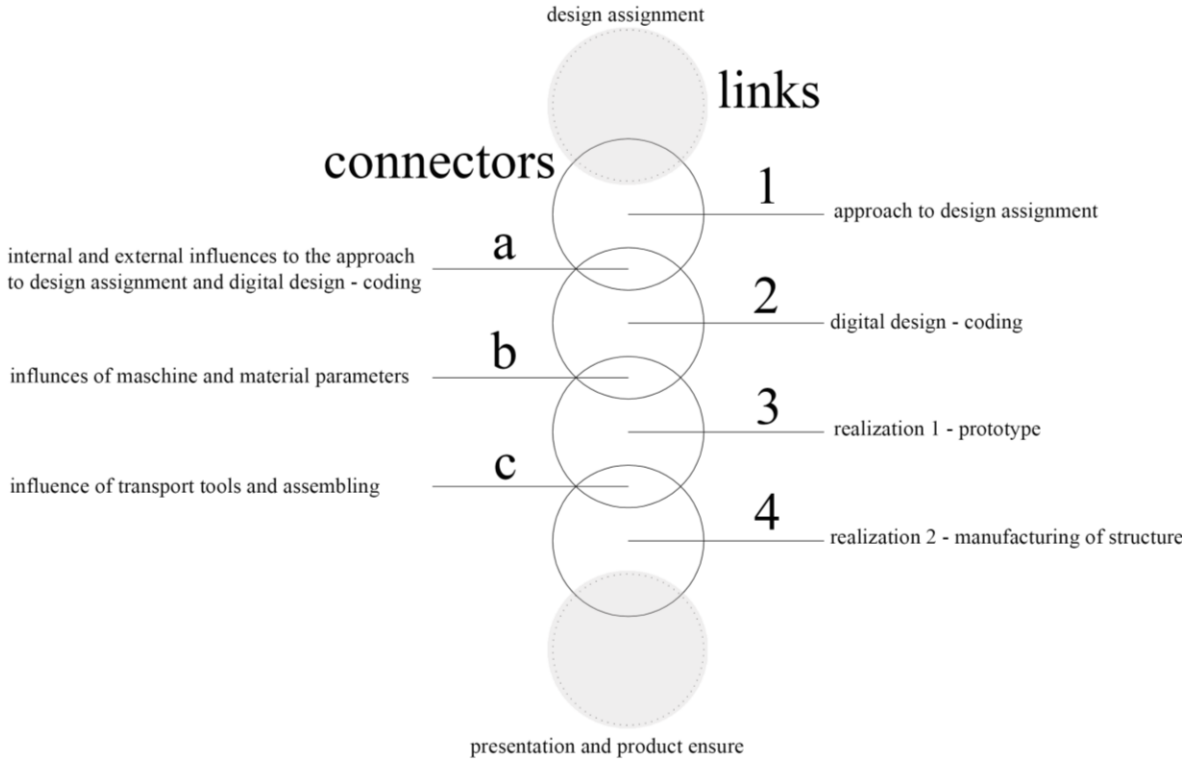

Figure 2. Digital Chain - scheme with elements of the Digital Chain *links* and *connectors*.

First ideas of connecting the design and realization are going actually in a direction of solving the object following the defined form through structure. Later this process further develops in the direction of developing the structure based on function and even further to interlocked relationship between them.

Today, there are added side effects to the forming which are the result of technical requirements and contemporary trend. Efficiency and sustainability are demands of speed, quality and preserving the design and construction of architecture. Prior requirements include digital tools as a deduction in solving tasks and problems, as well as the inevitability of today. Not only geometry is commemorative to the program of structure, but with software the structure creates a new context of parameters with implementation as a decision problem. The complexity of the request causes the creation of digital technology, but it also increases the demands causing further development of digital technology in the required direction. Determination of needs and problems of requests, as well as complex research at the beginning of each design, requires a person who stands in front of and behind the holistic approach and process.

The architectural context is, basically, the connection of thoughts and different communication levels. Urban and environmental conditions include communication of architecture with regulatory norms, standards and planning solutions, more represented also on a global level of the digital system. The context is previously included in communication with the environment and neighbours, i.e. a genius loci.

Architectural parameters, as well as those in terms of architectural functionality as a user needs, have an impact on the durability of the structure in a networked joint effect. The Digital Chain, as an unbreakable link between design and realization, is the strategy of linear connection space-material and machine, and also includes parameters of the relationship between functionality and construction as a necessary architectural part of the code, Fig. 3.

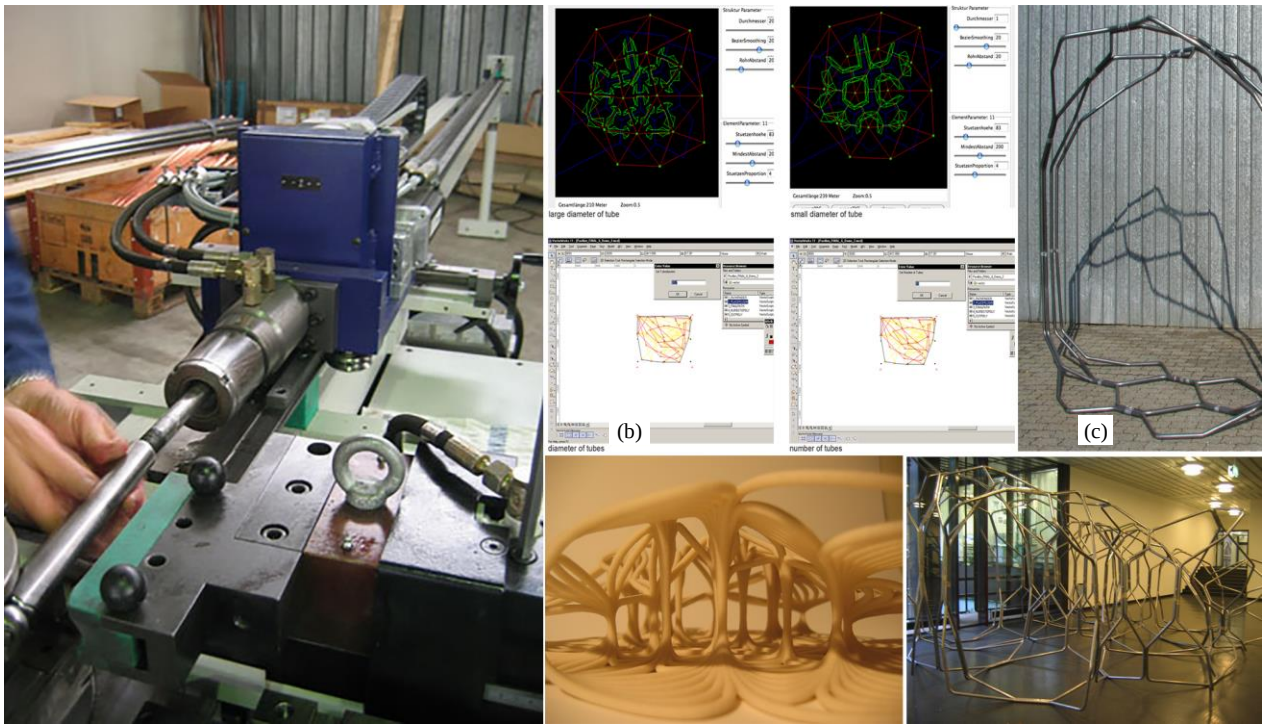

Figure 3. Digital Chain: (a) machine; (b) coding; (c) 3D printed prototype, (d) real life prototype, (e) architectural structure - space (source: MAS CAAD ETHZ 2003/2004 Group Archive).

In response to the many complex demands of architectural design and realization relating not just to global environmental and economic, almost daily changes, it is almost impossible to find out and harmonize to standard paths, and even harder to design and to implement. Data networking for the purpose of integrity and life of buildings, and in terms of networking knowledge, is possible through a digital approach in the form of a coded architectural process, which enables and implies complexity of parameters such as architectural influences, but as well as the effects of machines and materials. The relationship of flexible function and free structure are the basis for uncomplicated changes.

Architectural code as the connection of design and production can include parameters of flexible function and existing structure that support architectural integrity and life requests as a possible solution for old buildings. Space improvement and innovative concept open more reason for reconstruction of structures and infrastructures of existing buildings.

The main characteristic of data driven design is actually the possibility of flexibility and as well the advanced model and prototype control through iteration of parameter change - form, functions, aesthetic parameters. Considering these statements related to new tool-based on connected requests,

the settings of architecture could be treated in the same way as the structure and the material.

In addition, the code is formed by developing the information system knowledge database. This database could be added with new cases in the term of defining general principles and relationships between them, as intelligent services /11/, with subprograms.

In comparison with physical modelling, digital modelling is actually prototyping of outputs - results with realistic scale of building characteristics and their relationships with possible iterative changes related to inputs, /12/.

But sometimes, the settings of architecture in terms of integrity of architectural objects could be more than structure and material. The settings of architecture could be done in terms of usable value with the ability to be held within the urban frame as a purpose of the urban highlights of the city. The design is the process of harmonization of context and function as a three-dimensional geometrical result - architecture, which passes all aesthetic criteria (Fig. 4) /13/, and involves unpredictable elements with the need of expertise on a human, non-coding level.

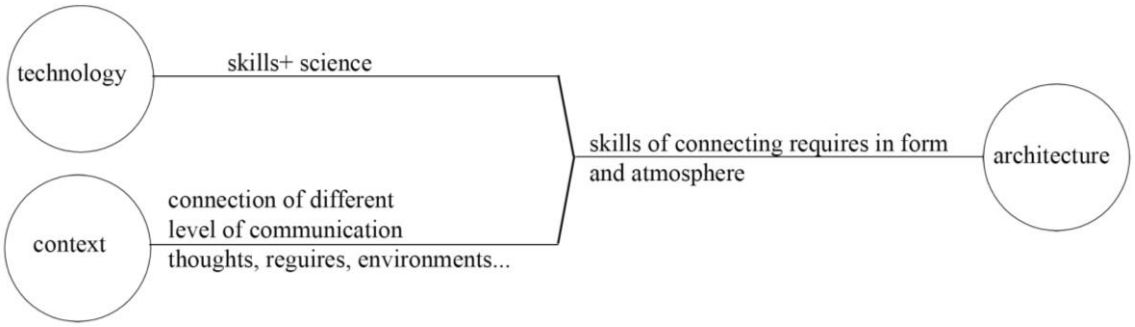

Figure 4. Connections of the requirement complexity of emerging architecture.

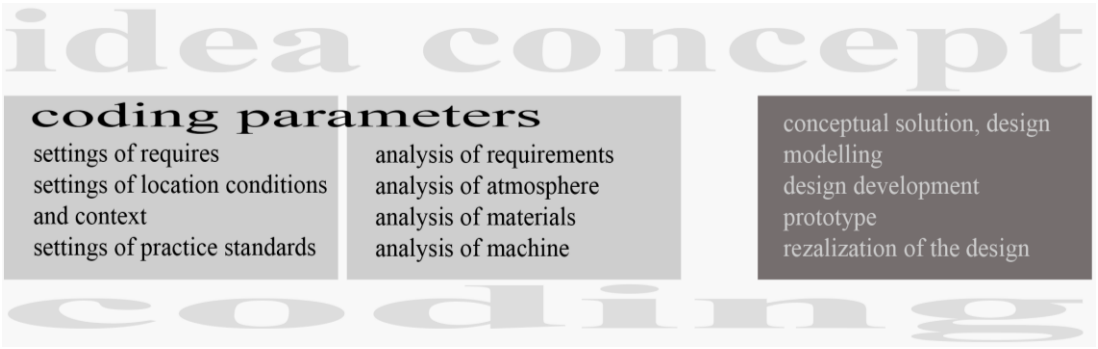

Figure 5. Parameters of coding: analysis of concept - idea of design in the Digital Chain.

Types of requirements in digital techniques are taken from primarily architectural standard design requirements. The architect, by his skills, knowledge, understanding of problems and acceptance of challenges, forms criteria of the process by encoding the idea of the concept, based on main determinants of his sense and ability. The criteria are guidelines that shape the product with the possibility of permanent changes of certain parameters and it is always better to have more of them, Fig. 5.

Results of the work are interwoven by designing thought as a guiding principle and characterized as:

– redefinition of a Digital Chain overlapped with conventional principle, move of change of control, but also an increase of the influence of realization to the idea;
– architect dictates creativity and process control;
– direct participation of the architect in the realization - determines the machine parameters and participates in an interdisciplinary process as the creator of the application;
– digital coding - selection of parameters, new, artificial context;
– continuity of the in realization achieved influence of architects - fluid, energy.

Considering that, the role of the architect is still experiential and expertised, both in terms of analysing the reality and designing the future, with creating a database and verifying it, setting the parameters for asked requests, controlling the process and results, and all by improving the tool. Architects' feeling is still a non-code level for assuming and presenting the code, as well as the solution that satisfies requests beyond the choice of the machine. The overview of the whole process is based unconditionally on freedom in decision making and knowledge of the complex collection of skills, /14/.

The position of architects in certain links of various CNC fabrication is vague and limited, primarily in the change related to overlapping to the conventional chain. These are positions of the introduction of machinery and materials, i.e. connection with tools, where the role of the designer expands as well as in the redefinition of design to the coding.

Parameters of machines are at the beginning support and restraint, while for the art of setting parameters that are not a limitation, it is necessary that the architect is a great master of improvisation and the magician of creation. This

part shows important characteristics and tasks of architects in digital architecture, /8/.

Instead of thinking of a digital only means the organising of standardized practice, there is a possibility to re-examine how materials are used, details are done and produced for the built environment. Our use of the term digital production proposes a new engagement in small-scale material specifications, which lead to new practice where architects and designers become creators of materials as finalized products. Our manufacturing industry is entering a new era dominated by engineering materials and it becomes possible to wonder how architecture can be built from the location or use of specific materials, made directly in response to the locally-defined design criteria, /8/.

The strategy of digital design and realization and the achievement of target architecture by fabrication, as a combination of old, reconstructed and emerged, is shown in the example of Sagrada Familia in Barcelona, Spain, Fig. 6. The famous Gaudi's cathedral was started manually but completed digitally and upgraded by great architectural experience in observing the life of an object in terms of duration.

Figure 6. Sagrada Familia (source: https://www.blic.rs/kultura/vesti/zapoceti-radovi-na-kulama-cuvene-crkve-sagrada-familia/yxsdqem)

Mark Burry is following Gaudi's idea and enhancing it by new tools and material. He was working on the architecture of Sagrada Familia design since 1979, using his associated standard and digital education as an example of good practice and tools in architecture, but also brought himself personally into the real-virtual environment of Gaudi's architecture. Free Gaudi's natural forms are designed by analysing existing parameters and realized by robots - 3D printers. Facilitating today's execution gives importance to the already existing idea and design method.

Gaudi's architectural principle has also ensured its usefulness as a functional object in every moment, from the exhibition of the design and execution of architecture till the ultimate function - the cathedral. The digital approach made it possible to decode the standard code and the current finalizing of the architecture. Its continued existence and maintenance is part of the digital code as well.

When the attitude and influence of the architect's idea is huge and special, with trend- and style-independence, then it is tool-independent, and the digital tool is just a help.

The relationship of digital technology and the design process in architecture in sense of solutions of problems of feasibility and implementation, caused by complex conditions, needs ideas and digital techniques, and is still under development. This complex information-requests in a Digital Chain as an interruptible process are interlinked by digital design-coding, which makes the most intense impact on standard design process and turns realization-manufacture in continuous extension. Coding is a synthesis of data derived from a detailed analysis of idea and design requirements with obtaining one or more solutions through a set of parameters which are then checked through a prototype realization.

Setting up and controlling all parameters of design, as well as the completed connected process of design and realization of the architectural product, through realization of prototype, are performed by the architect. Integration of the concept design translated digitally and various scales mocked up with consulting and reviewing feedback are parts of successful project results, /15/. By Digital Chain the architect creates both a process and a product. At the same time architecture is a changing trajectory with a return to origins and sources but having the possibility of expansion and definition by new architectural activity in the future, /16/.

Today it looks as the tool has become indispensable, inevitable and active, and the architect seemingly passive and in an unclear position in the whole process and offered solution space and architecture. This work proves that the creation of the design process in new architecture and control of each unit is impossible without a clear positioned architectural influence, /8/. Encouraging architects to meet and know design coding can be helped by Mark Burry's words /17/: *'I was also curious to learn the motivation of the designers I approached - what attracted them to scripting?*

The responses were satisfyingly varied:
- *reaching beyond analogue processes;*
- *capturing material logic and computing performance;*
- *being playful;*
- *exploiting generative processes;*
- *seeking deeper access to the imagination;*
- *engaging with complexity;*
- *inducing rapid iteration and variation;*
- *grappling with the performative;*
- *toying with unexpected and delving into unknown;*
- *being forced to be explicit;*
- *discovering novelty;*
- *localizing intelligence;*
- *investigating self-organization principles;*
- *studying phenomena;*

… and of course, going for good old task automation.'

CONCLUSION

The aim of the research is to show one more reason for establishing an efficient, complex, specific and defined design based on characteristics of different requirements and materials, which continually leads to the limited series of an automated realization of architecture in a creative and controlled contribution of architectural profession in every part of the architectural chain.

In the sense of following integrity and life of the architectural object, we also meet the architectural experience of good practice for future projects. Freedom of architectural expression in terms of function and structure is important to be previously set making possible after future changes and adaptation to succeeding conditions.

The main idea is adopting and following experimental research in the advancement of the technological process and tools with a presence of experience based on the expert approach to architecture and civil engineering. Improvement of the technological tool is caused by constant theoretical and practical learning.

The emerging architecture, along with digital technology, sets high standards for future treatment of existing architectural structures-buildings. Existing buildings are either avoided or denied in the development.

Today's aspiration of life cycling in architecture offers the demolition as the cost-effective solution. If we return to the idea of architecture as a witness of culture, one question also arises - who will testify tomorrow about the way we are living today or have lived yesterday?

The realization of the creativity is a prime architectural principle by which architecture lasts longer than humans. Extending the life of architectural objects and revitalization of architecture is also the inclusion of humans into different generations of architects as well of users.

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