

**ATINER's Conference Paper Proceedings Series**

ARC2020-0196

Athens, 18 September 2020

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ISSN: 2529-167X

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**Process of Reconstruction of Unused Buildings in Croatia**

**ABSTRACT**

This paper aims to investigate the implementation of 4Rs (Reuse, Reduce, Recycle, Rethink) in process of reconstruction of unused buildings in Croatia. The built environment is one of the largest contributors to global emissions and climate change, thus enhancing the energy efficiency of building leads to the more sustainable development. This especially refers to refurbishment of historical buildings, which were not build according to the demands of substantial reductions in operating energy and carbon footprint in new constructions. Reusing in a sense of refurbishment and/or of reconstruction of existing unused buildings is entailed, reducing in sense of enhancing energy efficiency of building imposes by the law defined maximum energy consumption. Recycle of the material can be observed in sense of using the material from the building site in new purpose, but also in sense of using recycled material for refurbishment of the building. And all above requires rethinking of the approach both in design and in construction with enrolment of all development stakeholders. The in-depth analyses of the projects of reconstruction of unused buildings which authors of the paper were involved as a practicing architects, as well as comparison with best practice contemporary projects, was planned with aim of defining the possibilities of implementation of above mentioned 4Rs. The goal of the paper is to help the transformation of the Croatian construction and real estate markets towards sustainability, by promoting green building programmes and technologies, as well as integrating the available and obtained knowledge, experience and insights into design, construction and management of reconstructed unused buildings in Croatia.

**Keywords:** unused buildings, reconstruction, sustainability, 4Rs (Reuse, Reduce, Recycle, Rethink)

**Acknowledgments:** This research is partially supported through project KK.01.1.1.02.0027, a project co-financed by the Croatian Government and the European Union through the European Regional Development Fund - the Competitiveness and Cohesion Operational Programme.

## Introduction

This paper aims to investigate the state of unused buildings in Croatia and ongoing processes of its reconstructions. The in-depth analyses of the projects of reconstruction of unused buildings which authors of the paper were involved as a practicing architects, as well as comparison with best practice contemporary projects, was planned with aim of defining the possibilities of implementation of above mentioned 4Rs.

Reusing in a sense of refurbishment and/or of reconstruction of existing unused buildings is entailed, reducing in sense of enhancing energy efficiency of building imposes by the law defined maximum energy consumption. Recycle of the material can be observed in sense of using the material from the building site in new purpose, but also in sense of using recycled material for refurbishment of the building. And all above requires rethinking of the approach both in design and in construction with enrolment of all development stakeholders.

The built environment is one of the largest contributors to global emissions and climate change, thus enhancing the energy efficiency of building leads to the more sustainable development. The analyses from BPIE (Building Performance Institute Europe) from 2018 shows that existing building stock and building constructions are responsible for most of the CO<sub>2</sub> emissions, as well as consumption of material resource, produced energy and water supply.<sup>1</sup>

This subject is actual since according to Urban Europe report from 2016 we live in a time where more than 70% of EU population lives in urban agglomerations, rising up to the 75% until 2050. And according to the UN Global status report from 2017 it was projected that by 2060 the amount of square meters of new buildings equal to current area of the entire global building stock will be built in the world. So the need for upgrade of energy efficiency of this sector is imminent!

This urgency is also imposed by a fact that more than 1/3 of waste is produced in the construction sector.<sup>2</sup>

These numbers, of course, refer to projections before COVID pandemic crisis, and downsize of the construction development in the EU from February 2020 was huge, and it has started to recover throughout April and May, so it is too speculative to talk about future situation.<sup>3</sup>

However, this also represents the opportunity to make a new overview of needs for new construction development favouring the reconstruction of the existing buildings!

This especially refers to refurbishment of historical buildings, which were not build according to the demands of substantial reductions in operating energy and carbon footprint in new constructions. And when these elements apply to the abandoned buildings the surpluses are accumulating.

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<sup>1</sup>Source: BPIE Biennial report 2016-2017.

<sup>2</sup>Source: EUROSTAT - Waste generation by economic activities and households, EU-28, 2016.

<sup>3</sup>According to EUROSTAT online publication on Impact of Covid-19 crisis on short-term statistics from August 2020 the construction production for EU-27 has fallen more than 30% in February and March and started recovering in middle of April.

## **Overview of State of Existing Building Stock and Possibilities of its Refurbishment**

The building stock is getting old. The survey from BPIE (Building Performance Institute Europe) in 2011 showed that more than 80% percent of building stock is built before 1990, and more than 1/3 (between 35-40%) are built pre 1960. The numbers are similar and even worse in Croatia due to major structural changes in the last thirty years in our country; which include changes in state structure, war destruction, and re-organization of the defence system, economic transition, economic crisis and the process of depopulation. According to data from Ministry of Construction and Physical Planning of Croatian Republic 78.2% of residential buildings, 79.9% of public buildings, 58% of commercial buildings are built before 1990. So the existing building stock in Croatia can be categorised as significantly old!

As an EU member state, Croatia is obligated to achieve the goals of EU directives about greener, low-carbon Europe, so the government has subsidized programs for energy renewal, both for public and residential buildings. In addition, from 2020, by law, each building (new or reconstructed) needs to be developed by nZEB regulation (nearly ZERO ENERGY BUILDINGS). So, this is ongoing process, which raises a question - how to approach the reconstructions of existing buildings?!

## **Methodology**

Applied methodology in this research is illustrative case studies focused on gaining detailed understanding of a particular event or entity that occurred at a specific time. Case studies presented here are used to describe a phenomenon of reconstruction of existing building stock in Croatia.

The topic of study are examples of reconstructed buildings different typologies, from different historical period, different in scale and functions but with similarities in approach to reconstruction.

The approach to reconstruction in Croatia can be read through historical development of town Split in Croatia, which was used by many architects to study the phenomenon that we are dealing with. Its origin is based in one building, which has become a town for 3,000 people in medieval times. This process was studied in 1962 by Jacob Bakema, from which a theory of reciprocity of form emerged.<sup>4</sup>

He was referring to a process where over the centuries, the inhabitants of the palace, and then the citizens of Split, adapted these spaces to suit their needs by

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<sup>4</sup>Jacob Bakema made a study on the principle "reciprocity of form" and "participation", referring on the Diocletian's Palace in Split which was published in architectural magazine *Forum* No.2 from 1962 by Architectura et Amicitia. And in next years Herman Hertzberger did similar research on the Roman amphitheatres in Arles and Lucca. For further reading see: Hertzberger, H. (1991.): Lessons for students of architecture, 010 Publisher, Rotterdam: 100-103; 146-149.

building inside and on the perimeter walls and towers of the palace, which greatly changed the original appearance, but the outlines of the imperial palace are still very visible and recognizable. And the ruins of the palace still constituted the nucleus of town Split, even today.

The process experienced by Diocletian's Palace has inspired worldwide famous researchers (including Robert Adam, Ernest Hebrard, Aldo Rossi, Aldo van Eyck, Herman Herzberger, etc.) resulting with a number of interesting and often contradictory conclusions. Therefore we can state that the processes of exploiting existing resources are encoded in Croatian architectural design methodology!

*Case Study # 01: Reconstruction of Rural Complex<sup>5</sup>*

Location: Pelješac Peninsula, Dalmatia

Date of origin: unknown

Project: 2014 / Completed: 2017

Architect(s): Davor Bušnja - n`onA d.o.o.

Site area: 3,800 m<sup>2</sup> / Bruto area: 153 m<sup>2</sup>

Old function: Agrarian estate

New function: Leisure country house

First example, smallest in scale, represents a reconstruction of a rural complex located in a small village called KONŠTARI on the Pelješac peninsula.

Croatia has a very specific coastline that is referred in geography as Dalmatian coast, and its characteristics are numerous bays and numerous islands in proximity of the mainland forming the narrow channels between them. This rural complex is located in hinterland of the peninsula where most of first settlements were developed, but due to touristic attraction of the shores, new settlements were developed on the coastline, so most of these original settlements were abandoned or left with only few inhabitants. But now there is demand for this kind "off grid" vacations, and these settlements are in the spotlight of reconstruction processes.

Although the complex is occupying around three thousand and eight hundred square meters, it only has around one hundred and fifty square meters of built area.

By designing outdoor usage of spaces of Mediterranean origin (pergola, outdoor fireplace, garden pavilion, entrance court), open space is treated equal to the closed space which corresponds to our mild and warm climatic conditions thus generating a spatial frame from converging programmatic and ambiance elements.

This project represents the modern version of Dalmatian vernacular architecture, which has the logic of sustainable development due to reaction of given conditions – usage of as few as possible available material for building!

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<sup>5</sup>Data and text description of the project provided by the architects. Source: <http://davorbusnja.com/2017-rural-villa/>; <https://vizkultura.hr/ladanjski-sklop-konstari/>.

**Figure 1.** *Reconstruction of Rural Complex into a Holiday Home*



Source: Davor Bušnja, Marko Ercegović.

#### The 4 Rs

So, the usage of four Rs in this project in:

- reusing the ruinous and abandoned agrarian and housing ensemble. It is transformed into a place of leisure and relaxation accommodating high modern standards of living incorporated in old structure;
- reduce by minimising future energy consumption by implementing in design outdoor usage of spaces of Mediterranean origin (pergola, outdoor fireplace, garden pavilion, entrance court);

- recycle of the stone material from the building site in new ways, but also in sense of adaptation of design solutions that responds and reinvents local architectural expressions and know-how. The whole complex is enclosed by the natural stone wall, thus forming traditional courtyard;
- rethinking the synchronization with the environment was achieved through the passive use of natural resources, as well as through combined use of sturdy authentic and industrial materials, and, moreover, by the use of local crafts.

*Case Study # 02: Reconstruction of Ex Coal Mine Industrial Complex<sup>6</sup>*

Location: Labin, Istria

Date of origin: second half of 19<sup>th</sup> century.

Project: 2007 / Completed: 2013

Author(s): Damir Gamulin, Margita Grubiša, Marin Jelčić, Zvonimir Kralj, Igor Presečan, Ivana Žalac

Site area: - m<sup>2</sup> / Bruto area: 1,200 m<sup>2</sup>

Old function: Administrative and workers buildings of the coalmine complex.

New function: Public library of town Labin

This example analyzes the first phase of reconstruction of an ex Coalmine industrial complex. It is located in hinterlands of Istria peninsula, in north-west end of Croatia.

The complex is located between historical centre of the town Labin and residential settlements developed for the workers of the coalmine.

The complex reached its peak in production volume in 1942 with more than 1 million tonnes of coal produced and approximately ten thousand and five hundred workers were employed. Cheap oil caused the crisis in coalmining industry during 1960-ies, so this complex downsized its production through the rest of the 20th century, and eventually closed down in 1988.

The urban-architectural solution of first-prize awarded competition entry has seen this former industrial complex as new public space and regional cultural hot spot. The spatial solution of the complex presents the idea of redecorating today's inconspicuous and neglected square around entry for the platform for descending into the mine in a representative space of urban characters with entry called Šoht as an iconographic element.

The complex was divided in logical elements and each element was given new function such as coalmine museum, multimedia center, public library, etc., altogether serving as a meeting place and interaction point for cultural workers and citizens of Labin and surroundings.

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<sup>6</sup>Data and text description of the project provided by the architects. Sources: <https://vizkultura.hr/gradska-knjiznica-labin/>; <http://pogledaj.to/arhitektura/knjiznica-u-labinu/>; <https://www.buro247.hr/lifestyle/dizajn-i-arhitektura/rudnik-u-labinu-pretvoren-u-genijalnu-gradsku-knjiznicu.html>.

In the first phase of the renovation, the administrative building with central wardrobe and bathrooms for miners was reconstructed into the Labin City Library and the outdoor areas of Public Square have been refurbished.

The main library room was organized in former Marbel hall, most representative space of the complex, where salaries were received and strikes were organised. Multipurpose room and other utilities were organized in the former bathrooms and wardrobe rooms. The biggest construction intervention is the insertion of a new steel constructed element with put into the former bathrooms and wardrobe rooms. In order not to create confusion about the fact that this is a new intervention, it was treated as an inserted foreign body (steel box) that is clearly legible due to the steel structure, floor and sheet metal ceiling. What is completely new is differentiated from the tissue that had to be replaced by a modern construction (part of the load-bearing structure) due to wear and tear.

As mentioned, this is only the first phase, while others are waiting to be financed. Among them is refurbishment of former coalmine lanes and tunnels to an Underground city. The Underground city will cover around 40,000 m<sup>2</sup> of space and spread the length of 10 km 160 meters below ground surface, forming horizontal lanes and connecting three cities: Labin, Raša and Rabac.

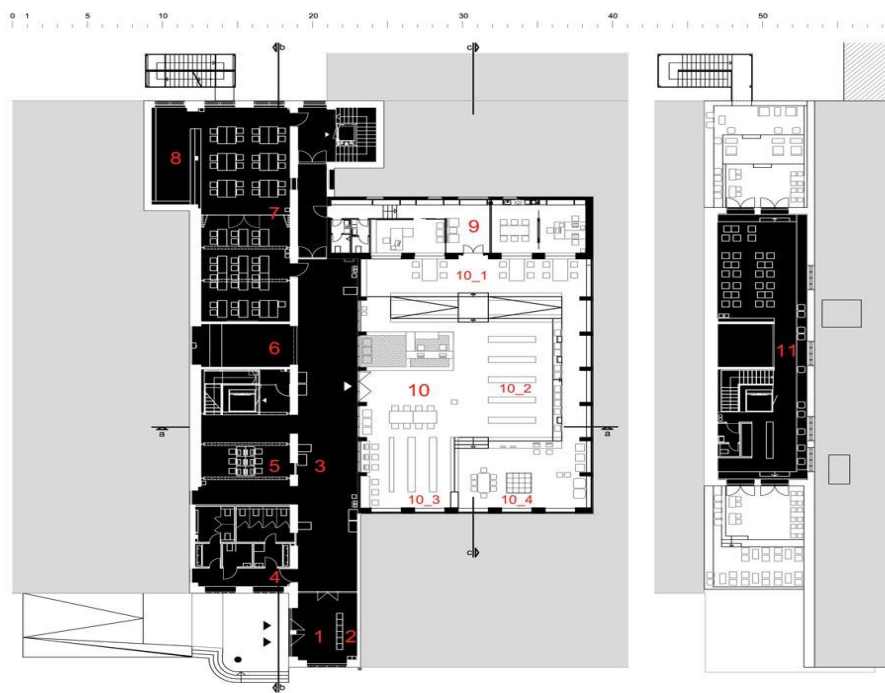
#### The 4 Rs

In this example, four Rs are in:

- reuse of existing space, the hall turned into the main reading room, former utility rooms turned into multipurpose room. With its quality of spatial organization, size and polyvalence, the complex of the former coalmine seems to be extremely suitable for conversion into representative exhibition spaces and cultural centres;
- reducing by "cleaning" the building of inappropriate interventions after closure of the coal mine. In addition, natural light was introduced back to the main library hall through the roof, which reduces the need for artificial illumination;
- recycling the preexisting elements of the buildings. Trough out the building the parts of the old structure is exposed and made visible. For instance, remains of ceramics on the walls were treated in such a way that a polyptych on the walls was obtained from the inconspicuous bathroom ceramics, which connected the former sanitary spaces and the opposite purpose of the polyvalent hall or internet café;
- Rethinking about the infrastructure of the mine complex, which is so imprinted in the collective consciousness of the population of Labin, begins a new path on which it should at least partially remain close to the original mining - industrial identity. Given that there are almost no families in the city in which one of the ancestors or household members did not work in the mine, today's library users - mostly former miners, their children and grandchildren - are often sincerely touched by the new ambience.



**Figure 2.** *Reconstruction of Ex Coal Mine Industrial Complex into a Library*



Source: Ivan Dorotić, Damir Gamulin, Margita Grubišić.

*Case Study # 03: Reconstruction of Ex Cavalry Barracks*<sup>7</sup>

Location: Zagreb, capital of Croatia

Date of origin: 1910.

Project: 2008-2010. Completed: 2011.

Architect(s): Alenka Gačić Pojatina, Branka Petković, Ana Krstulović - AGP dizajn d.o.o.

Interior and system of exhibiton panels and artistic transformation of the facade: Morana Vlahović

Site area: 2,800 m<sup>2</sup>/Bruto area: 2,500 m<sup>2</sup>

Old function: Austrian-hungarian cavalry barracks / cotton industry plant

New function: Lauba - People and Art House

The building was originally part of Austrian-hungarian calvary complex built in 1910 on the west outskirts of town Zagreb. The cavalry barracks was built on an area of almost 21,000 m<sup>2</sup>, and consisted of residential buildings for non-commissioned officers and officers, a swimming pool, a laundry, workshops, warehouses, a series of stables and a large covered manege (riding arena). Today, the manege is the only one left, probably because it was turned into a cotton industry plant soon during the 20<sup>th</sup> century. But as production gradually ceased and relocated, the building served as the factory warehouse until 2008 when the project for reconstruction was done by AGP dizajn (authors Alenka Gačić Pojatina, Branka Petković, Ana Krstulović).

The architects' solution to the client's request of cohabitation of business and artistic operations consisted of an interpolated office cuboid raised on pillars along the southern side. During the reconstruction, the authors and conservators referred to the initial material state of the Austro-Hungarian cavalry barracks. In 2010, when Studio AGP dizajn finished the reconstruction of the building, architect Morana Vlahović took over the interior design, the system of exhibition panels and the artistic transformation of the façade.

The purpose of interior design was to preserve the existing bountiful layers and to expose them to visitors. With the desire to simultaneously exhibit both the art collection and the very architecture, a system of aluminium panels for assembling and disassembling was designed, which enables countless possibilities for organizing space.

Each panel consists of a solid and netted, transparent part. In their starting position, the 22 panels completely cover the north wall of the hall. When they are taken off the wall, a historical brick wall is visible. Each panel that is taken off automatically becomes a part of the spatial constellations on the hall's wooden floor, where the collection is then exhibited.

This way, the house and the art collection exhibit each other, playing spatial games all the time, and thus creating ambiguity of the interior's identity – it

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<sup>7</sup>Data and text description of the project provided by the architects. Sources: <https://divisare.com/projects/316512-morana-vlahovic-lauba-building-for-people-and-art>; <http://www.lauba.hr/en/about/>; [http://www.oris.hr/hr/casopis/clanak/\[19\]laubina-kriska-suvremenosti,340.html#](http://www.oris.hr/hr/casopis/clanak/[19]laubina-kriska-suvremenosti,340.html#).

changes both spatially and in a sense of atmosphere. Lauba transforms its interior like *pleomorphic* organisms capable of shape-shifting during their life spans.

The selection of materials and surfaces was done by “back to basics” principle – with conscious effort to avoid any detailing. The idea of frozen, conserved construction site was executed by frequent and conscious cessations of construction operations, sometimes by the unavoidable, hygienic phases of artisanal activities. Thus, it is possible to read every phase of the building’s life. The memory of the stables is visible in the use of uncommon, almost anachronous materials, such as the wooden floor that recalls sand and hay by its color and smell.

The office cuboid was covered with black reflecting glass. The railing of the main staircase, simulating the climb through the Lauba’s tree crowns, was designed using excess materials from the construction, so-called junk. Lamellas made of glass, steel and wood were arranged in 3D, following the proscribed horizontal and vertical intervals.

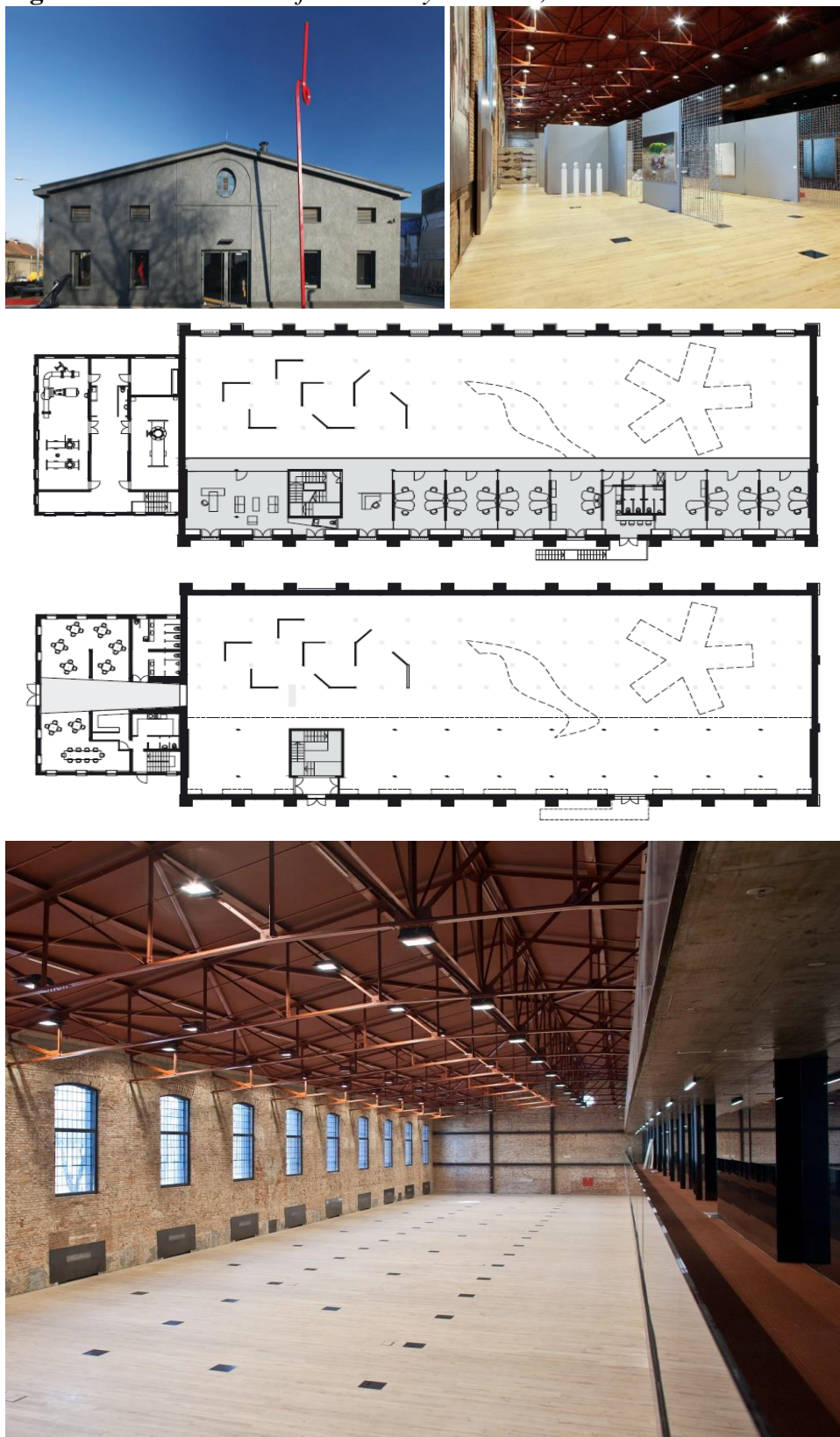
The facade was colored in glossy black, oily and thick as the hot bitumen. The black shine is simultaneously respecting and negating the profiled façade, creating an effect of estrangement. There is no white color in the building.

#### The 4Rs

The 4Rs are in:

- reuse of this building was encoded. The building was originally erected as a *manege* (1910) but turned into a cotton industry plant soon after. As production gradually ceased and relocated, the building served as the factory warehouse until 2008 when the project for reconstruction in to the house for people and art called LAUBA;
- reducing the future redevelopment costs for adaptation work by implementing all the necessary infrastructure in floor and developing disassembling system of exhibition panels;
- recycling to the original material state of the Austro-Hungarian cavalry barracks. The selection of materials and surfaces was done by “back to basics” principle – with conscious effort to avoid any detailing. The idea of frozen, conserved construction site was executed by frequent and conscious cessations of construction operations, sometimes by the unavoidable, hygienic phases of artisanal activities. Thus it is possible to read every phase of the building’s life. Also, the railing of the main staircase, simulating the climb through the Lauba’s tree crowns, was designed using excess materials from the construction, so-called junk. Lamellas made of glass, steel and wood were arranged in 3D, following the proscribed horizontal and vertical intervals;
- rethinking in way of programing the space: LAUBA is a unique hybrid of business and the artistic activities. There is also a meeting place for both activities in the entrance – a restaurant. Lauba combines different forms and dynamics of business and lifestyles earning a name the House for People and Art.

**Figure 3.** *Reconstruction of Ex Cavalry Barracks, Now LAUBA*



Source: Miljenko Bernfest, Morana Vlahović, Damir Žižić.

*Case Study # 04: Reconstruction of Ex Cinema*<sup>8</sup>

Location: Zagreb, capital of Croatia

Date of origin: 1939.

Project: 2018 / Completed: 2019.

Architect(s): Saša Begovića, Marko Dabrovića, Tatjani Grozdanić Begović, Silvije Novak i Paula Kukuljica- 3LHD studio d.o.o.

Site area: 830 m<sup>2</sup> / Bruto area: 1,472 m<sup>2</sup>

Old function: Cinema buliding

New function: URANIA – space for creation  
(architectual office / multipurpose hall, offices)

During the first half of the 20<sup>th</sup> century, numerous cinema buildings were built in the city of Zagreb. Those cinemas were spread within the urban blocks across Zagreb's Downtown. With the opening of new and modern multiplex theatres 20 years ago, the old Zagreb cinemas have gradually started to die out, and the buildings started to deteriorate. One of those buildings was Urania Cinema/Theatre, built in 1939, now being transformed with the project that integrates new office and public space into the existing historic fabric.

The old Urania cinema is a back-building inside courtyard of the typical block structure of historical center of town Zagreb. The building had good predispositions to be adapted, converted and reused into a new office and public space. The entire concrete structure of the building was very well preserved with all the supporting pillars, the main arches in the large hall and all the ceilings. The ceilings are a special example as one of the first concrete structures with longitudinal repetitive narrow structural ribs from that period and represent early concrete engineer technology was worth preserving, restoring and renovating.

Three of the four original building volumes were kept; the three storey entrance foyer and office building, the big lobby and the spectacular main double height cinema hall. The only new addition is the glass pavilion, which originally served as an entrance space of the cinema.

The former cinema hall had a three-nave cross-section with a 9 m high central volume and two 3 m high side aisles. Major challenge was converting this space without any natural light into a functional workspace. The central volume was divided into two floors and natural light was introduced into the ground floor by converting the old cinema halls side aisles into open atriums. On the first floor, the light was provided through the roof – three-meter wide skylights were placed on the roof, through the entire length of the hall. Most of the original structural materials have been retained - original brick walls were cleaned out of old damage plaster, concrete on ceilings and main arches were treated with minimal intervention to satisfy today's demands for fire protection, etc. Three materials define the interior - oak for floors and spruce veneer and raw steel for wall cladding and interior finishing's.

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<sup>8</sup>Data and text description of the project provided by the architects. Source: <https://www.3lhd.com/en/project/urania>.



Transformation of this building was done by through research, excavation, adding, and connecting spaces that will support communication and exchange between its occupants and the neighboring community, so the new Urania houses public spaces for various cultural events and a couple of office spaces. A multipurpose hall equipped with multimedia and stands is connected to a café bar with a patio and a roof terrace. This makes building more part of public realm rather than enclosed office buildings.

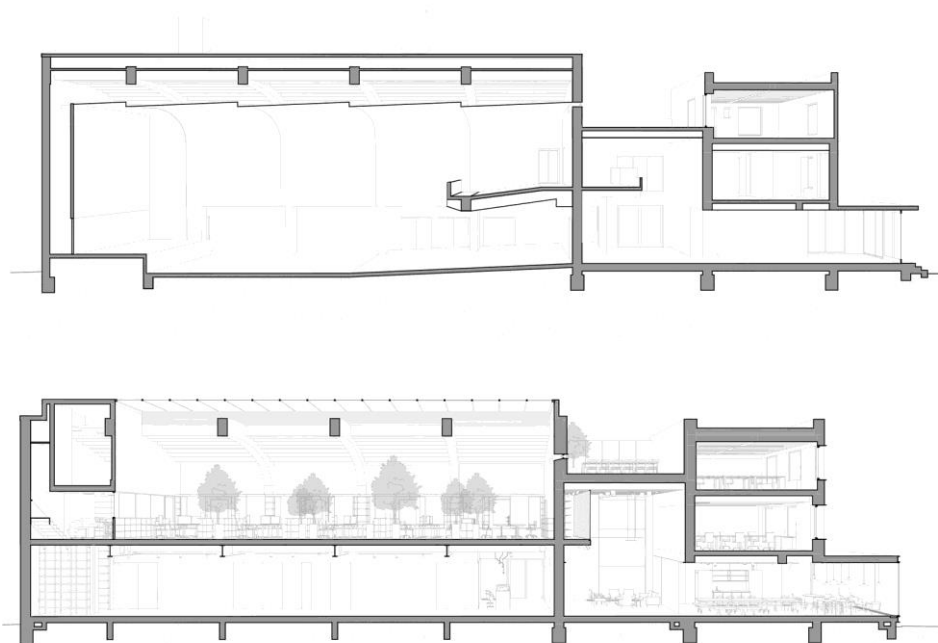
#### The 4Rs

The 4Rs are in:

- reusing one of the old Zagreb cinemas developed in first half of the 20<sup>th</sup> century in downtown and gradually shot down in 21<sup>st</sup> century. The project intervenes into existing historic fabric, integrating a new cultural space;
- recycling three of the four original volumes. The entire concrete structure of the building has been preserved and most of the original structure has been retained with minimal intervention;
- reducing by “filling in” the main cinema hall with additional floor space thus optimizing the usage of space and future energy consumption. Also by “taking off” the ceiling of the cinema halls side aisles and concerting them into open atriums which provide the natural light in ground floor.
- rethinking of the new functions to preserve the public character of the buildings. To do so, the owners developed cohabitation between private office space and open access space in form of multipurpose hall. It is striving to be a focal point of social and public activities, as well as a space for educational workshops, presentations, exhibitions, concerts, screenings and the like.

**Figure 4.** *Reconstruction of Ex Cinema URANIA into Offices*





Source: 3LHD Studio, Jure Živković.

*Case Study # 05: Reconstruction of Ex Student Dormitory<sup>9</sup>*

Location: Split, Dalmatia

Date of origin: 1962

Project: 2016-2018 / Completion: 2020

Architect(s): Hrvoje Bartulović, Dujmo Žižić - FGAG Split.

Site area: 2,750 m<sup>2</sup> / Bruto area: 2,460 m<sup>2</sup>

Old function: Student dormitory with restaurant, commercial spaces

New function: Business incubator

The last example is a project of reconstruction of an unused student dormitory in Split. The building dates from 1960's but several adaptations were done through the decade with partial interventions, and today the parts of the structure, cladding, openings and installation are in a dilapidated condition and in need of comprehensive repair or replacement.

The new function is a business incubator called SPINIT, owned by the University of Split therefore targeting the students and their start-ups as future tenants. New organization consists of modular office spaces and common utility rooms which include meeting rooms, kitchenettes, free-time areas and fitness room, as well as hardware lab, business accelerator office, two different size multifunctional congress halls and co-working space, all available for rent. The building is located close to the north seashore of Marjan hill (green oasis for the whole city), only 15 minutes away from historical center of the city Split, which adds the value of the future usage.

In comparison of the original blueprints and the new ones, the basic structure and layout were kept, with new functions added inside of it forming a symbiotic unity. In total appearance of the building was preserved with minimum intervention. For example, gable walls made of stone blocks are thermally insulated from inside to preserve the original appearance, and places where the originally natural concrete was visible are thermally insulated and covered with metal sheets to respect the original design. Of course, to achieve sustainable design, new layers of thermal insulation were added, new windows and other openings were installed, but always with respect to the origin. Also, functional and safety standards, as well as accessibility elements have been improved throughout the building, and a small solar power plant was designed on the roof terrace. All of this has resulted in a restored building which is ready for the next few decades of safe and sustainable use.

One more interesting point of the project is office modules. Model of the office was derived from the former module of students' dormitory rooms. They are designed to accommodate for up to 3 working places. But new partitioning walls between the offices can be disassembled, thus providing numerous possible organization schemes according to the needs of the tenants. As building was

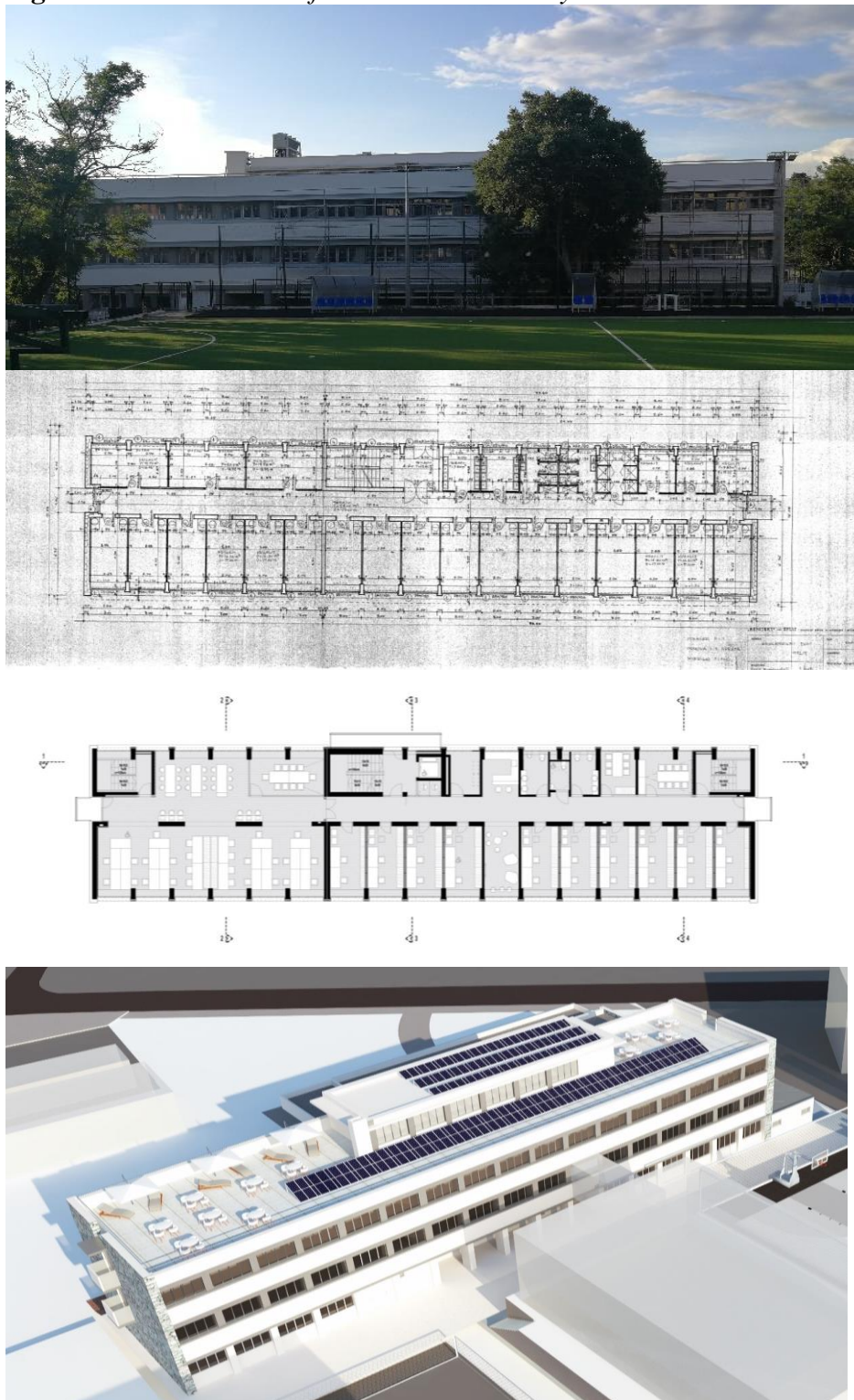
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<sup>9</sup>Data and text description of the project provided by the architects. Sources: Source: authors database; <http://unisthub.com/>.



conceived as an incubator of new firms, this ability to secure growth of employees tries to achieve the much-needed flexibility of the space.

**Figure 5.** *Reconstruction of Ex Student Dormitory into a Business Incubator*



Source: Hrvoje Bartulović, Dujmo Žižić.

### The 4Rs

Therefore, the usage of 4/four Rs in this project can be read through:

- reusing of unused student dormitory which will become a business incubator with all the necessary spaces and infrastructure provided to tenants to ensure sustainability and growth of their start-ups and enable them to create new high-quality jobs;
- reducing the problems of inadequate space for entrepreneurs in Split and the wider surroundings, as well as providing energy sustainable building thus reducing energy consumption;
- recycling the existing footprint and urban morphology, which was not changed with reconstruction. Throughout the building the parts of the old preserved structure were exposed and made visible.
- rethinking the vision of the business and social development of Split and the wider region by connecting talents, knowledge, experts and organizations with the aim of creating innovative solutions in response to future challenges.

### **Discussion**

In closing, the approaches to 4Rs in reconstruction of unused building in Croatia can be described as following:

- a) Reusing of existing unused buildings saves spatial resources, materials and energy. But not only that. Each building has layers of former usage incorporated into its structure. Old buildings also have memories attached to it by local inhabitants or families of former workers, etc. In examined examples, these historical layers and memories are seen as an opportunity to achieve specific atmosphere of the place,
- b) By enhancing energy efficiency of reconstructed building, we are reducing energy consumption thus achieving very crucial point of sustainability issues. Also, by reusing existing building contribution to the reduction of construction waste. In analysed examples new acquired installations, new volumes of space were added, but also adaptable elements were used in design (curtains in Peljašac, disassemble elements in Lauba and SPINIT, multipurpose rooms in Lauba, Labin, Urania and SPINIT) which then minimise (reduce) the need for additional adaptation works in future usage of spaces.
- c) The decay of building, which is not used, is rapid and aggressive, but it should also be looked as a process of purification, where key elements of building emerge, and the expendable ones deteriorate. These key elements are then recycled and incorporated into new structure, as it was seen in the examples. Also, analysed examples find different ways to recycle materials and use it in different function (railing of the staircase in LAUBA, the ceramics tiles in LABIN), or to recycle the technique of

drywall assembly (Pelješac courtyard walls), or just by recycling the volume of existing spaces (seen in LABIN, URANIA, SPINIT).

The analysed examples represent different building categories by type and by period in which they have been built, but have some similarities in approaches to the reconstruction. All projects have sensitive approach to the existing buildings, discovering the potential of existing materials and construction. They all respect the original design, but also innovate the way building will be used. New functions are a combination of public and commercial use, which provides hybrid typologies that are answering to all three fields of sustainability: environmental, social and economic. And, when these elements apply to unused buildings, the surpluses are accumulating.

## Summary

Instead of conclusion, we will summarise with some additional data analysis. If we look at the statistic on building permits issued in last three years, we can see that ratio between permits for new construction and reconstruction is not changing. Less than 1/3 of all permits issued are for reconstruction of the buildings. This is not a good ratio, considering that

By data received from Ministry of Construction and Physical Planning of the Republic of Croatia the overall surface (in total almost 4,200,000/four hundred and twenty thousand m<sup>2</sup>) of deserted and unused spaces and buildings is owned by the state and local or regional self-government units, this exceeds current needs for new public facilities planned to be developed in period of next decades!

According to building permits issued in

2017:

- 70.2% of building permits were issued for new construction
- 29.8% of building permits were issued for reconstruction of existing buildings

2018:

- 71.9% of building permits were issued for new construction
- 28.1% of building permits were issued for reconstruction of existing buildings

2019:

- 73.7% of building permits were issued for new construction
- 26.3% of building permits were issued for reconstruction of existing buildings<sup>10</sup>

So, opportunities for progress in this area are huge. The implementation of 4Rs (Reuse, Reduce, Recycle, Rethink) of reconstruction of unused buildings in Croatia is ongoing process and the goal of this paper is to help the transformation

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<sup>10</sup>Source: Official data from Croatian Bureau of Statistics.

of the Croatian construction and real estate markets towards sustainability, by promoting green building programmes and technologies which are incorporated in process of reconstruction of unused buildings.

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