MATERIALS AND TECHNOLOGIES IN RESTORATION

Memorandum on Knowledge Needed for a Common Ground in National Heritage Restoration Practice

URHERIT

Royal Danish Academy
Architecture Design Conservation

HCAY

LEGEND

INTRODUCTION

Acknowledgments

This memorandum is a part of the Ukrainian and pan-European project UREHERIT (2023-2026) funded by Creative Europe. It aims to support Ukrainian architect with knowledge, methods and strategies for restoring and rebuilding Ukrainian cultural heritage. Furthermore, the project strives to knowledge share between European and Ukrainian architects. The memorandum is produced by The Royal Danish Academy, Henriette Ejstrup, Ulrik Stylsvig Madsen together with National Union of Architects of Ukraine (NUAU), Olena Oliynyk, Mariana Kaplinska in the spring of 2024.

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Ihor Bokalo and Mariana Kaplinska, PhD, work at the Department of Architecture and Conservation, Lviv Polytechnic National University, Lviv, Ukraine. They have an extensive experience in conservation of wooden architecture

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Henriette Ejstrup is Assistant Professor at Institute of Architecture and Technology. She has background in cultural heritage from Aarhus School of Architecture and a Ph.D. from The Royal Danish Academy, Center for Industrialised Architecture (CINARK). Her field of research is centred around, how vernacular architecture, materials and crafts can be reinterpreted into modern building culture and – practice.

Scope of the memorandum

This memorandum serves as inspiration for further development of Ukrainian national strategies for preserving architectural heritage. It points to experiences and prioritize interventions either within a monument or between monuments. This way, it becomes clear, where to put efforts politically, economically and professionally. Moreover, the memorandum will feed directly into The Royal Danish Academys next work package, work package D3.5, which is a workshop on practical knowledge set to be held in May 2025 resulting in a report on the same theme to be delivered in July '25.

Approach of the memorandum

The first part of the memorandum is an article by Olena Oliynyk scoping recent trends in restoration and architectural heritage in an Ukrainian context. A supplement to this study is a short review by Maryana Kaplinska and Ihor Bokalo on the influence of modern materials on historical architecture with an emphasis on wooden architecture.

The second part is a analytic discussion based on observations done from an theoretical architectural heritage perspective during the first project period of UREHERIT (2023-2024, June) as well as the first conference in Lviv (October 13th, 2023 – see appendix 1) and especially at the second conference in Stockholm (May 14th 2024 – see appendix 2) by Ulrik Stylsvig Madsen and Henriette Ejstrup.

Each part is followed by relevant references or bibliography related to the particular section.

Lastly follows an appendix including the programs of the two conferences.

THE LATEST TRENDS IN THE RESTORATION AND RECONSTRUCTION OF CULTURAL HERITAGE OBJECTS BASED ON THE PRINCIPLES OF SUSTAINABLE DEVELOPMENT

Article by Olena Oliynyk

Introduction

Historical and cultural heritage is a set of aesthetic and spiritual values accumulated in a certain region throughout history, which we must pass on to future generations. They are part of our civilization and the property of every country. In addition, it is a powerful economic engine in terms of tourism.
In seeking to preserve heritage on the basis of sustainable development, it is important to draw on the UN Sustainable Development Goals by 2030 (Resolution 70/1, 2015; ICOMOS, 2021). This UN document indicates that, as a result of increasing urbanization, cities now generate 70% of global carbon emissions and are responsible for more than 60% of resource use. The decarbonisation policy developed by the European Union (EU) in the road map for reducing emissions covers all economic sectors, including construction, which includes the heritage fund (European Commission, 2011). The need to reduce emissions in this sector has prompted European legislators and international research centers to reduce energy needs by using solutions with almost zero energy consumption (International Law And The Protection Of Cultural Heritage 2011, European Union 2018).

The European Union (EU) has also developed its framework for safeguarding cultural heritage, which covers the tangible, intangible and digital aspects of heritage, including memory, understanding, identity, dialogue, cohesion and creativity (European Parliament, 2018). The European framework for Action on Cultural Heritage, announced in the new European Agenda for Culture, is aligned with the Council of Europe's European Heritage Strategy and based on five pillars:

- Cultural heritage for an inclusive Europe: participation and access for all;
- Cultural heritage for a sustainable Europe: smart solutions for a cohesive and sustainable future;
- Cultural heritage for a resilient Europe: safeguarding endangered heritage;
- Cultural heritage for an innovative Europe: mobilising knowledge and research;

- Cultural heritage for stronger global partnerships: reinforcing international cooperation. (Strategic framework for the EU's cultural policy, no date)
- Cultural heritage conservation is a complex topic that requires a vision that embraces both the past and the future, integrating technological advances with a significant commitment to preserving the architectural treasures of the past. (Cinquepalmi & Tiburcio, 2023)

For this reason, heritage requires significant efforts to record, maintain, preserve and ensure its sustainable development. The use of new technologies to protect and quickly restore these unique works is especially important when they become a target for terrorists or when an armed conflict breaks out.
The policies of most post-Soviet countries did not favor the priority preservation of authentic architectural monuments, moreover, objects of cultural heritage were consistently and relentlessly destroyed, gradually being replaced by fakes, kitsch innovations or commercial new buildings. Thus, ten years ago in Ukraine, 50-70% of objects of historical and cultural heritage were in an unsatisfactory technical condition, up to 10% were in emergency condition. (Concept of National Policy, 2014, p.14)

This number grew tens or hundreds of times after the beginning of the full-scale invasion of Russia into Ukraine, which became a direct threat both to the lives of the people and to the historical and cultural heritage of Ukraine. (Nazarenko, 2023).

The Hague Convention of 1954 obliged the countries participating in the armed conflict to protect cultural heritage with the so-called "Blue Shield". This convention stipulates that in the event of hostilities, objects of cultural heritage cannot be either intentional targets or collateral victims of hostilities or bombings. According to the Hague Convention, "damage to cultural property belonging to any people means damage to the cultural heritage of all mankind, since each person contributes to the culture of the world." [Mizhnarodni zasady, 2008) However, during the last 50 years of war in Bosnia, Sarajevo, Serbia, Macedonia, Syria, Ukraine, Israel, ignoring the Hague Convention, caused and continues to cause irreparable damage to the state of cultural heritage. (Sällström at al., 2023).

At the same time, the loss of cultural values is irreversible and irreparable, they inevitably reflect on current and future generations, leading to spiritual begging, falsification of history, loss of historical memory, destruction of the intellectual and creative potential of society as a whole. They cannot be compensated either by the creation of new significant works or by the development of culture as a whole. (Concept of National Policy. p.14)

Thus, today the question arises not only about the preservation and adaptation of cultural heritage, but also about measures for its mass restoration, inventory and documentation of losses. This requires the involvement of the latest survey and research technologies, especially in the conditions of destroyed or damaged monuments.

The latest technologies in restoration, construction and surveying methods are considered today mainly from the angle of sustainable development. These are energy-saving, recycling technologies, or those that use natural and local materials, involving local industry and existing traditions. These are also the latest methods of examination, 3D scanning, digitization and determination of damage.
The connection of the technological industry with the principles of sustainable development is particularly relevant today when the construction industry has become one of the most expensive of all

production industries. Therefore, there is a trend in the world to reduce energy consumption and build facilities that provide themselves with renewable energy.

Requirements for improving energy efficiency in cultural heritage buildings establish the use of general principles of restoration, including reversibility and non-invasive interventions in historic buildingsThe ultimate goal of these conservation efforts is to promote the development of more ecologically sustainable and livable urban settlements while ensuring the preservation of the historical and cultural context (Chen at al., 2022; Cinquepalmi & Tiburcio, 2023).

Analysis of previous studies and existing methods of restoration

In the 1980s, the concept of the historical city as a cultural landscape was finally established. In particular, cultural heritage is considered now as an integral part of the city as a whole. Thus, more and more attention is paid to the comprehensive study of the structure of historical cities, including unrecognized heritage, public spaces, preservation of identity, etc. (Oliynyk, 2018; Sällström at al., 2024).

The works (Elabd at al., 2021; ICOMOS, 2011; Pezzotti, 2022; Rosa at al., 2012;) are devoted to the analysis of the introduction of the latest materials and technologies into traditional restoration methods. At the same time, methods of research and preservation of individual objects, including damaged or destroyed ones, are being deepened and improved. The studies are devoted to 3D technologies of scanning and surveying monuments (Saygi, 2013).

Methods of assessment of destroyed and damaged heritage

During destructive wars, when unique and unique historical buildings are turned into ruins every day, a preventive policy of surveying the historical and cultural heritage and using various technologies for its preservation is necessary, which will help preserve the history of each country.

3D scanning and examination technologies

The development of certain technologies is a powerful tool in the fight against the disappearance of cultural heritage. Virtual reality (VR) allows the creation of interactive digital models of buildings, monuments and other heritage sites. Laser scanners are sometimes used to create highly accurate 3D digital models of buildings, monuments and other surviving heritage sites,

In Ukraine, laser scanners are used to create digital models of monuments that are under threat of destruction, dilapidated or inaccessible. (Fig. 1)

Terrestrial laser scanning is currently the only method that allows at high speed (hundreds of thousands of points per second) to determine the coordinates of a significant number of points on the object's surface with an accuracy from a few millimeters to 4 cm without significant surface distortions. The data obtained as a result of laser scanning allows you to fully reproduce any object in the form of a point 3D model.

Drones that take aerial photos of monuments and archaeological sites are also used to create 3D models and topographic maps. Using ultra-high-resolution aerial imagery, photogrammetry combines information obtained from UAVs with powerful GIS mapping systems to create dynamic, measurable documents for a range of real-world situations and purposes.

Fig. 1. Digitalization of cultural heritage objects in Ukraine: The Church of St. Lawrence in Zhovkva (1618) and the Church of St. Archangel Michael in Pidberiztsi (1891-1910). Digitalizing: Lviv company "Skeiron", 2022. Source: Salstrom at al., 2024.

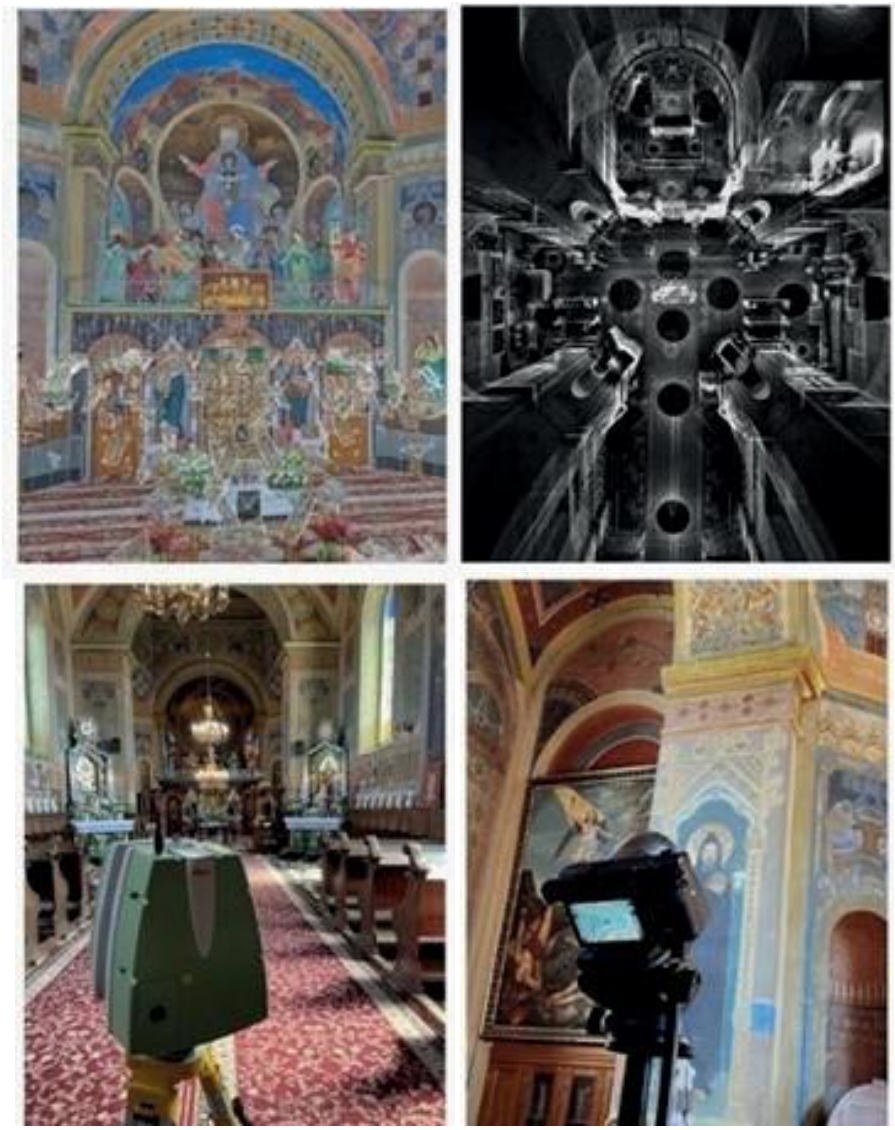

Fig. 2. The scanning materials also helped the Department of Architecture and Urban Planning at the Lviv regional state administration to add the church of Saint Archangel Michael with its sacred paintings by Modest Sosenko to the List of newly discovered objects of the cultural heritage of the Lviv region. Source: Salstrom at al., 2024.

In 2018, the National Union of Architects of Ukraine developed “Svirzh Castle: Genesis. Development of the concept of revitalization and adaptation of the Castle in the village Svirzh of the Peremyshlyan district of the Lviv region” (scientific manager O. Oliynyk), within the framework of which work was carried out on the creation of a detailed digital orthophoto plan of the roof of the Svirzh castle. A digital orthophoto plan of the roof and sections of the 3D model of the castle in planes under different azimuths were created. The works were carried out using geodetic determination methods using the latest technologies and modern equipment. (Svirzh Castle, 2018; Olijnyk at al., 2022)

Fig. 3. Works on creating a detailed digital orthophoto plan of the roof of the Svirzh Castle. Scientific management Oliynyk O., Geodetic engineer D. V. Khomushko.

3D technologies are also used in Ukraine by the companies HeMo and Backup Ukraine, which document and digitize damaged objects with absolute accuracy immediately after the destruction, while they still exist. This methodology is somewhat unique, because never before was the documentation of losses carried out during a war, only a year and a half after its end, as in Sarajevo (Heritage monitoring for recovery, 2024)

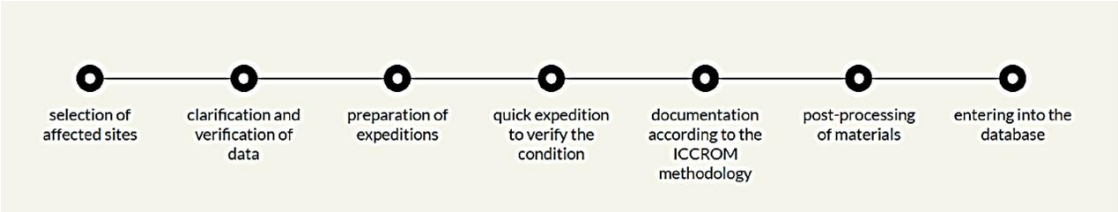

Fig.4. The documentation process. Hemo. Source: https://www.heritage.in.ua/en

The availability of digital cultural heritage will help record history, create a digital library for researchers and public education, and enrich social and cultural experiences (Fig.6).

Research and preservation of wooden churches is also carried out in Ukraine with the involvement of modern technologies. On the territory of the Lviv region there are more than four hundred sacred wooden monuments that need special protection. In addition to ongoing preservation measures, updating existing and creating new graphic materials is a particularly pressing issue. Today, ground-based laser 3D scanning is considered the most advanced digitization method with high accuracy.

Fig.5. Church of the Nativity of the Holy Mother of God, Viazivka village, Zhytomyr region: general view, photogrammetry (May 2023), Laser scanning (October 2023). Vasyl Rozhko, Hemo Source: https://www.heritage.in.ua/en

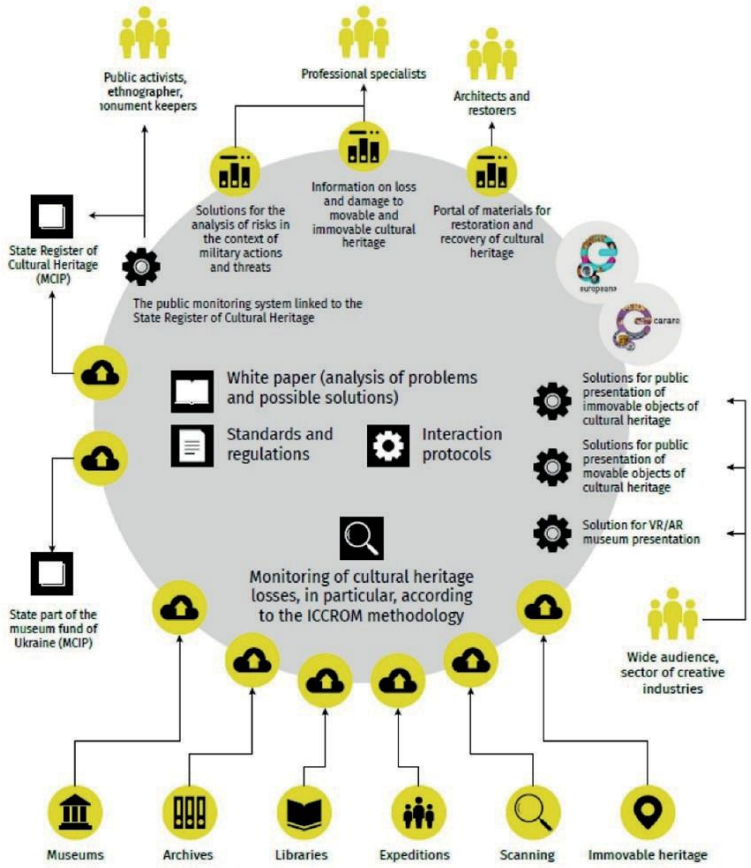

Fig.6. Data infrastructure Source: https://www.heritage.in.ua/en

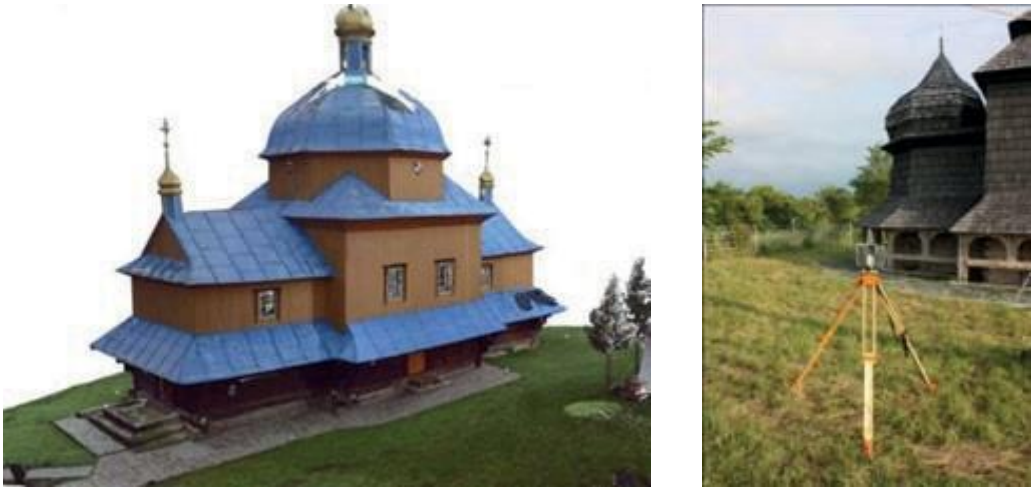

Fig. 7. Digital model of the wooden church Pr. Mother of God in the village Velikopole of Yavoriv district. Church scanning process. Source: https://geoterrace.lpnu.ua/

During 2012-2015, a project was conducted on the territory of the Lviv region to scan wooden churches of the Lviv region. The project was carried out in accordance with the Regional Program for the Preservation of Monuments of Wooden Sacred Architecture of the Lviv Region. The project was implemented by the Institute of Geodesy of Lviv Polytechnic University. (Geo Terrace Network, no date). (Fig. 7)

New methods of restoration. Materials and technologies

The latest technologies penetrate even into traditional methods of restoration. By definition, the main requirements for materials used during restoration work on cultural heritage sites are as follows: restoration materials must be close in physical, chemical, technical, and optical characteristics to the authentic materials of the monument;

- not to contribute to the destruction of the authentic existing decoration of the planes, especially painting;
- do not change the steam, moisture permeability and temperature regime of the premises;
- the strength of the restoration systems must be lower than the strength of the front surface of the authentic masonry (solutions). (Mizhnarodni zasady, 2008).

From the updated list of materials that are used in practice today, and differ from the list of those that were used in the middle of the 20th century. could be used by restorers at cultural heritage sites, can be attributed to:

- water-based bituminous waterproofing;
- system of sanitizing plasters;
- thixotropic cleaners that work on vertical planes (do not slide);
- ready solutions for reprofiling stone and brick masonry (but their main drawback is high strength);
- paint systems with a bionic principle of action (self-cleaning ability);
- a wide range of pigments for painting restoration.

Materials such as tow, olifa, clay lock arrangement are almost no longer found in technologies (UREHERIT, 2023)

True sustainable architecture requires the use of building materials that consume minimal energy and do not pollute the environment, such as bamboo, raw earth, stone and wood in regions without deforestation. Considering the state of the global environment, modern architects must abandon building materials such as metal and concrete, as well as large windows in cold climates, while using eco-technologies and design adapted to the local climate.

Adaptive reuse

An important place in the implementation of the latest technologies based on the principles of sustainable development in heritage preservation is occupied by adaptive reuse. The question of the possibility and expediency of reproductions of historical and cultural heritage everywhere in the world is the most difficult ethical problem. The question of what is more important — the authentic appearance or the authentic remains — remains, as a rule, at the discretion of restorers. (Concept on National Policy, 2014, p. 45)

But in Ukraine, the trends of destruction of authentic immovable heritage have reached such a critical level, which will be followed by the irreversible destruction of the traditional nature of the environment of historical cities, the loss of self-identification of the multinational culture of Ukraine, as well as a sharp decrease in the attractiveness of the state at the international level. (Concept on National Policy, 2014, p.46)

The way to find a certain compromise can be the method of adaptive transformation, which can be used in the case of restoration of damaged objects that are not the most valuable or objects that require re-interpretation and change of identification, as with the buildings of the Soviet period.

Adaptive reuse can be defined as the process by which an unused or inefficient element is transformed into a new element that can be used for another purpose. This architectural redesign is a consequence of the need to save energy in the production of building materials — one of the most energy-intensive and polluting industries (Cedeño Valdiviezo, 2023)

This trend is consistent with three goals of sustainable development: responsible consumption, energy efficiency and urban development

In Ukraine, to assess the losses and determine the value of buildings that are not recognized heritage sites for the purpose of their further adaptive transformation, within the framework of the EU UREHERIT grant program, Danish and Italian technologies based on the principles of sustainable development are involved. (UREHERIT, 2023; Sällström and Oliynyk, 2024)

This concept resonates with Bandarín & Van Oers' research on "urban preservation", which corresponds to the important goals of preserving historic cities, namely preserving the authenticity or integrity of their physical and social structures, which is possible only as long as the historic city lasts. These values

act as guardians of identity and collective memory, helping to maintain a sense of continuity, continuity, and patriotism (Bandarín & Van Oers, 2012). Issues of national identity, as a guarantee of continuous and subsequent development, are closely related to the Sustainable Development Goals, as defined in (Sallstrom at al., 2023).

Modern trends, such as eco-urbanism, green planning, ecological planning, bioclimatic urbanism, which indicate the need to radically change urban life in accordance with the sustainable city model, also directly affect historical cities.

Circular economy. Recycling

The circular economy considers materials as assets that need to be stored rather than constantly consumed, thus contributing to sustainable development (Mossin at al., 2020).

As an alternative to the linear economy, the circular economy represents a development strategy in the direction of sustainable growth, which is based on reducing the consumption of resources, increasing the useful life of products and using over consumption.

In 2020, the European Union published the Circular Economy Action Plan, which proposed requirements for the content of recycled waste in construction projects. This became a significant change in the paradigm of building regulations (Cedeño Valdiviezo, 2023). Currently, efforts to introduce recycled building materials are underway in Prague, where the municipal government has established “Reuse Centers” to collect and recycle old furniture and appliances, as well as household food waste for conversion into biogas.

One of the recent applications of the circular economy in construction is sustainable construction, which involves the use of environmentally friendly building materials. A product is environmentally compatible if it can be recycled at the end of its life (Cedeño Valdiviezo, 2023). For example, after the end of the life cycle of historical buildings, materials from them can be reused or recycled.

Another fundamental aspect of architectural decay restoration is the use of materials with low primary energy content, which do not pollute the environment and can be reused in the future or re-incorporated into the environment after decay. However, the use phase is the most significant in terms of energy consumption.

LCA (Life Cycle Analysis) allows for the selection of materials that can be easily separated at the end of the building’s life, so that waste can be properly managed, in particular through recycling. Unlike recent buildings assembled using dry construction technology, which makes it relatively easy to reuse their parts, buildings built during previous centuries used glues and mortars to join materials together, making it extremely difficult to separate them later. (Cedeño Valdiviezo, 2023). However, recycling most materials in historic buildings can be difficult.

Since historic architecture is generally built to last for centuries, it is sustainable architecture by definition sine qua non. The challenge is to achieve appropriate comfort conditions and reduce energy consumption in historic buildings.

Features of thermal insulation of historical buildings.

The International Energy Agency (IEA) attributes more than 40% of heating and cooling energy savings under the low-carbon scenario to improved envelope structures (International Energy Agency, 2014). When insulating enclosing structures, the outer location of the insulation layer is predominant. For historical buildings, the main and important disadvantage of such insulation is the loss of the historical appearance of the buildings.

Therefore, it is better to abandon the insulation of the facades of historical buildings in favor of engineering re-equipment of the building. The threat of losing the authenticity of the historical environment (even of the usual background buildings) is incomparable in significance with insignificant energy savings. If the decision to insulate the facades is made, then a reasonable scheme can be the external insulation of the courtyard facades and the internal insulation of the front facades. (Murgul & Pukhkal, 2015; Gorshkov at al., 2016) Current regimes of cultural heritage sites protection zones in most post-Soviet countries do not allow changes to the front facades of buildings, while courtyard facades can be changed. Penića, M. & Murgul V. propose the construction of internal insulation with the expectation of condensation. However, such a scheme is possible only in the absence of protected interiors (Penića at al., 2015) (Fig. 10).

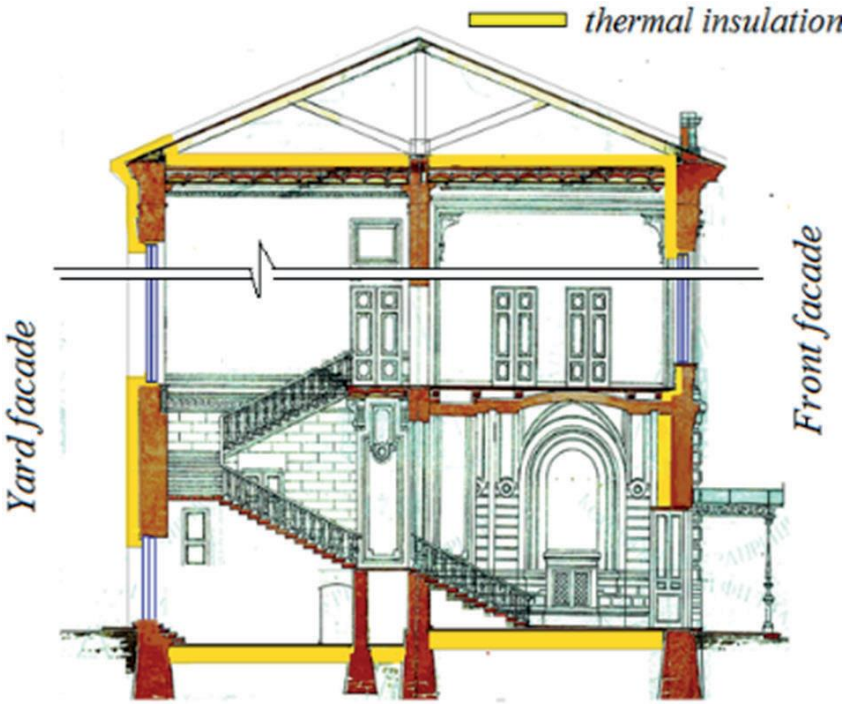

Fig. 10. Scheme of insulation placement in a historic building Source: Murgul & Pukhkal, 2015

Use of solar energy for the purpose of energy modernization

Available today methods of increasing energy efficiency allow to reduce heat energy costs without harming the historical authenticity of residential buildings, this applies not only to facades, but also to the historical construction system of buildings. First of all, this is the technical re-equipment of the building (installation of energy-efficient devices and equipment)

The evolution of architecture can be considered as a process of aesthetic mastering of new technical means, i.e. “transformation of the useful into the aesthetic.” One of the important factors affecting the appearance of a modern building are elements related to the use of solar energy. (Baiani at al., 2023)

The study of the global experience of using solar energy for the purpose of energy modernization of buildings - monuments of history and culture made it possible to draw the following conclusions:

1. Making decisions about changing the appearance of historical buildings is based on an individual approach in each specific case and is coordinated with the authorities for the protection of historical and cultural monuments of this country.
2. Despite the fact that the states stand to protect historical buildings, it is the monuments of world importance that are often the bearers of the ideology of sustainable development. Modern energy modernization of unique buildings - monuments often has as its goal not only and not so much the transition to energy supply based on renewable sources, but the idea of declaring the principles of a new energy policy, a new look at the processes of energy production and consumption.
3. Summarizing the existing global experience of energy modernization of historical buildings based on the use of solar energy, two main approaches can be distinguished:
   - form-forming techniques, that is, visible and active methods of reconstruction: elements of solar energy supply are actively brought to the facade and dominate the updated form of the building
   - methods of inconspicuous modernization, which mask the methods of including solar energy supply systems in the exterior of the building, the principle of minimal intervention in the original appearance of the building is used.
4. Current regimes of protection zones of cultural heritage objects impose significant restrictions on the location of technological equipment directly on building structures. However, the level of development of PV-technologies today allows to make technological upgrading completely imperceptible. The conflict situation between the need to preserve the appearance of buildings and the use of solar energy can be avoided by using BIPV class solar elements integrated into the enclosing structures and window fillings, which provide masking techniques for technological retrofitting of the enclosing structures of buildings. (Rosa, 2020)

V. Murgul proposes to introduce the concept of temporary energy supply systems for additional energy supply systems based on solar energy. Building-independent temporary photovoltaics constructions (BITPVC), which can potentially be separated from the capital backbone of the building. The use of temporary energy supply systems allows to take into account the seasonality of fluctuations in the arrival of solar radiation, which is especially relevant in the climatic conditions of Ukraine and Kazakhstan, as well as to return to the original appearance of the historical building at any time (Murgul, 2014).

Based on the study of the global experience of energy-efficient modernization of historical buildings of monuments of history and culture using solar energy, the main methods of integrating solar power systems into the enclosing structures of historical buildings were revealed, which can be combined into two groups: “masking ” and “style-forming”.

The first group includes solar power supply systems inconspicuously included in the enclosing construc-

tions of buildings (for example, the BIPV class (Building-independent temporary photovoltaics constructions)) or the placement of solar equipment on invisible roof surfaces). The second group includes ideologically active methods of reconstruction, when solar equipment is openly placed on the facade of buildings, and is actually a new architectural dominant (solar systems of the BAPV class (Building attached photovoltaics systems) and methods of passive solar design. (Rosa, 2020)

BIPV solutions should be evaluated as opportunities in the energy efficiency processes of historic buildings. At the same time, it is necessary to assess the restrictions to mitigate the risks of impact on the architectural and landscape heritage, which is worthy and valuable.

Conclusion

Advanced technologies can help in the restoration and digitization of tangible cultural heritage.

This report presents projects and examples that have demonstrated significant progress in cultural heritage conservation. As these technologies continue to develop and experts in the field become more knowledgeable and skilled in the use of these technologies, there is a positive prospect that the continued improvement of technologies will provide further advances in cultural heritage preservation and digitization.

The report examines the close historical connection between architectural restoration and the principles of sustainable development. Following the principles of environmental compatibility, new structures should be built in such a way that, when they are no longer needed, they can be disassembled and reused to avoid waste. However, achieving architectural sustainability in practice is still challenging, and architects and others involved in restoration must strive to balance historic authenticity with environmentally sustainable building and renovation practices.

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MODERN MATERIALS
AFFECTING HISTORIC ARCHITECTURE

by Ihor Bokalo, Mariana Kaplinska

One of the challenges we face due to the use of modern building materials, despite all their benefits and perspectives, is the transformation of historic architecture in a way that leads to the loss of the local features of the built environment as well as its ability to embody certain cultural identity. Generally speaking we face a potential loss of architectural heritage. Materials are one of the factors determining architectural form, which changes drastically with the transition from traditional to modern construction methods.

Ukrainian traditional wooden vernacular architecture may serve as an illustrative example, when once very tall four-pitched thatched roofs became shorter with the use of wooden shingle and ceramic tiles, then even shorter with the use of metal roofing. Today the tradition to build such wooden architecture as well as the professional knowledge and craftsmanship are almost lost, while roofs in general may remain pitched in individual residential architecture, in most cases of modern development they became flat. Modern materials are able to prevent water penetration and protect the building from precipitation at any angle of the roof. So that traditional materials that affected the characteristic image of historic buildings and of the whole inherited environment for centuries, today recede into the background. Necessity does not dictate slopes have to be done anymore, so it's just an architectural caprice or a matter of taste they are still in use. Together with the increase of the size of buildings, this completely changes a traditional ruralscape.

Leaving aside the roofs, transformation of a building structure components occurs in two main directions: the increase of the building skeleton weight, due to the use of heavy concrete and iron, and the reduction of the building shell weight, when the walls are made as light and thermally efficient infill of the skeleton.

It seems that modern materials allow to create architecture of any conceivable form, and this form can be easily generated with the help of architectural design software. In practice such morphogenesis remains limited to software features and skills of a particular designer, as a result a form often appears simplified, even rough, and lacks finesse and detailing. Serial manufacturing is another reason to reduce the prices, simplify architectural details and construction nodes.

Modern materials require high-tech modern tools and construction skills and methods that are different from traditional ones and displace them. Since the demand for traditional architecture and building craftsmanship decreases at some point, construction crews lose their skills. Traditional

methods become forgotten. The trend of architectural globalization and industrial optimization makes once familiar and affordable traditional methods and the use of sustainable, reusable and safe materials, such as wood or ceramics, exclusive, expensive and elitist.

It is difficult to predict the behavior of new building materials for decades ahead in terms of their durability, safety for human health and environmental effect. What we can be sure of is that they are not always easily compatible with traditional ones, and while using in valuable historic architecture attention needs to be paid to preserve its authenticity and assure reversibility.

We all are fascinated with the novelty, flexibility and freedom of expression modern materials allow. Nevertheless, they have to be considered carefully for traditional materials and construction methods to be preserved for future generations.

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NEEDS OF KNOWLEDGE ON MATERIAL AND TECHNOLOGIES

by Ulrik Stylsvig Madsen and Henriette Ejstrup

Introduction

In Stockholm the progress and insights from the first work packages were presented and discussed amongst peers. The peers consisted of the UREHERIT partners, participants of the CPD programme, and other stakeholders and interested professionals. The academic articles by Olena Olyinyk summarizing latest trends in restoration in Ukraine and The presentations and discussions at conferences have highlighted various issues. These perspectives forms the ground for the meta-analysis of the knowledge needed regarding materials and techniques.

Since the 1950ies international heritage institutions like ICOMOS, UNESCO, DOCOMOMO have facilitated the European discussions on architectural heritage. Chartres and directives like the International Charter for the Conservation and Restoration of Monuments and Sites[1] (1964) Convention for the Protection of the Architectural Heritage of Europe[2] (1985) have been central to pan-European discussions and directions regarding heritage restoration which have pointed to general international principles for restorations. Although each nation has interpreted the directives differently in their national legislations, common aspects on antiquary value of original material, use and preservational approach are influenced by this. Therefor common aspects on how to handle specific heritage monuments regarding new and old materials and technologies will be found across Europe.

Theories and methods in conservational practice

At the Stockholm Conference roughly two typologies of architectural heritage were represented in the discussions: Ukrainian historic/vernacular architecture and Soviet modernistic heritage. The two types represent two very much different periods of technology and production. To restore the different typologies, it is important to make a system of assessment methodologies, that prioritizes the areas of action. This could point to, where heritage can be restores in accordance with historic materials and crafts, where heritage can be further developed and interpreted, and where refurbisment/deconstruction/ damages have been too grand to still hold meaning in a conservational practice, although restorative interventions can hold other aspects than antiquarian interest.

1 Popularly called The Venice Charter due to its origin
2 Popularly called The Granada Convention due to its origin.

It is suggested, that a national standard for assessment and prioritizing between the monuments are developed, to align and prioritize area of actions and conservational approaches. Furthermore, methods for formulating conservational approaches on the basis of the assessments could be relevant, to guide and make transparent argumentation for different interventions in a monument weather it is conserving, restoring or transforming. Directives from relevant European and international heritage organizations could be relevant guides as well as experiences (both good and bad) with methodologies and practises in other countries with heritage of similar materials, technologies, social contexts, etc. (see WP D3.2 report on Assessment Methods of Architectural Heritage).

Historic and modern technologies and materials

As of now, no up-scale production lines of sustainable materials are well established in Europe. The modernistic heritage was born out of mass production and industrialization, which differs radically from the tectonics in vernacular and historic heritage. It might be easier to suggest and align prefabricated products in a restoration in the modernistic heritage, than in the traditional and vernacular heritage. It can be argued, that modern production lines and materials are easier to integrate with the modernistic heritage, as it logics derives from the same tectonics, whereas traditional or vernacular heritages rest on another tectonic tradition. On the other hand, emerging discussion of sustainable materials, which at the moment are heavily centred around biogenic materials, has not yet been well tested when refurbishing or transforming the modernistic heritage. This could be an area of common ground for further development.

When it comes to the vernacular and historic architecture, another category of problems arises, as the knowledge on historic materials and traditional crafts are endangered. Few craftsmen are educated or possesses knowledge on traditional materials and technologies, which represents a problem, when maintaining or restoring historic buildings. Wrong materials or technologies used in these buildings will endanger the heritage further with loss of original material, traces of historic production techniques and crafts. The historic and vernacular remains are the best sources of documentation on how to reinvent these crafts. The remains should be studied thoroughly rediscover and revitalise historic crafts and traditions. In addition other regions with similar building culture can be a supplementary to retrieve knowledge on historic materials an techniques.

Restoration and rebuilding based on sustainable principles

As discussed in the chapter by Olena Oliynyk the future restoration and rebuilding of the cultural heritage in Ukraine must be based on sustainable principles. This points to a wide range of actions involving a variety of disciplines like architecture, engineering, manufacturing, craftsmanship and facility management. The development of new interdisciplinary collaborations must be established to create innovative solutions with a holistic approach to the problems.

Circular principles for working with the recycling of materials from destroyed buildings can ensure a sustainable use of resources while maintaining the building-cultural values embedded in the materials. To ensure that materials can be part of a circular flow of materials in the future, the joints in the construction can be developed based on design for disassembly principles. This must of course be done without changing the special character of the construction. Traditional structures are often designed based on the principle of disassembly, which makes it possible to replace individual elements of the structure or

disassemble it completely. Revitalizing traditional methods and craftsmanship can in this way be the key to the development of future solutions.

To ensure good comfort in buildings, retrofitting insulation may be necessary. Of course, this must take into account the architectural character of the building, both inside and out. Choosing insulation materials with a low carbon footprint is also important in terms of sustainability. This calls for the development of new principles for both exterior and interior insulation. The use of renewable energy forms such as solar panels can also contribute to a more sustainable operation of a listed building. However, this requires an in-depth analysis of how the placement of solar panels will affect the appearance of the building. In many cases, this will not be possible without degrading the building's architectural expression.

Recommendations

On the basis of the three themes, *Theory and methods in conservational practice*, *Historic and modern technologies and materials* and *Restoring and rebuilding based on sustainable principles*, and the discussions within three principles for recommendations have been identified:

- Educational alignment of theories and methods in conservational practice
- Recovery and revitalization of historic crafts and technologies
- Developing sustainable strategies based on a holistic approach

The specific recommendations underneath each principle must be unfolded in close corporation between relevant national, regional and local stakeholders.

The Royal Danish Academy's next work package, work package D3.5, is a workshop on practical knowledge set to be held in May 2025. The workshop will take point of departure in the three principles with the intention of sparking discussions and establishing a framework for futher development.

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APPENDIX

1 Lviv Conference Program

CONFERENCE IN LVIV, OCTOBER 13" 2023

Bank hotel

Lystopadovogo chynu str, 8, Lviv

PROGRAM

9:00-9:30 Press conference

9:00-10:00 Registration, coffee

10:00 - 10:05 Welcoming speech: Oleksandr Chyzhevsky, President of NUAU

10:05 - 10:10 Welcoming speech, explanation of the conference program: Ruta Leitanaite, Coordinator of UREHERIT, Architects Association of Lithuania

10:10 - 11:10 Discussion "Coordination of the efforts of the key stakeholders in the post-war heritage recovery": Anna Bondar (member of Verkhovna Rada, Ukraine), Vasyl Petryk (Head of department of the urban planning of Ministry of Culture of Ukraine), Ministry of Infrastructure of Ukraine (TBC-Ro3kvit!), Ministry of Education Ukraine (TBC), Mariana Oleskiv (Head of State Agency for Tourism Development of Ukraine), Chiara Dezzi Bardeschi (Head of UNESCO desk in Ukraine), Mykola Bevz (ICOMOS Vice-President, Ukraine), Oleksandr Chyzhevsky (President of NSAU), Ruth Schagemann (President of Architects Council of Europe, ACE), Maryna Solovjova (Director of the Department of Cultural Heritage Protection of the KMDA), Roksolana Yasynska (Chief of the Culture Heritage Assessment and Preservation Subdivision, Department of Architecture and Urban Development of the LODA, chief architect of the Lviv region)

Moderator: Ruta Leitanaité, UREHERIT coordinator

11:10 - 11:20 General presentation of UREHERIT project: Ruta Leitanaite, Coordinator of UREHERIT, Architects Association of Lithuania

Presentations of each of the topics and activities inside the project UREHERIT.

Assessing value and damage to the cultural heritage in Ukraine.

11:20—11:35 Damage, done to cultural heritage by war assessment. Olena Oliynyk (NSAU, Ukraine) + Lilia Canarella (CNAPPC, Italy)

11:35—11:50 Heritage value assessment Olena Oliynyk (NSAU, Ukraine), Henriette Ejstrup/ Ulrik Stylsvig Madsen (KADK, Denmark - online)

11:50 — 12:20 Discussion on monitoring and evaluating the value of heritage and damage in Ukraine. Participants: Vasyl Rozhko (team leader of Ukrainian Heritage Monitoring Lab??), Kateryna Honcharova (Ukrainian Heritage Crisis Specialist, World Monuments Fund), Vasyl Petryk (Head of department of the urban planning of Ministry of Culture of Ukraine, Maryna Solovyova.

Moderator: Olena Oliynyk, NSAU, Ukraine

12:20-13:40 Lunch break

Ensuring Participatory Approach in heritage reconstruction.

13:40 — 13:50 Ukrainian context of heritage participatory actions. Tetyana Oliynyk (Ro3kvit Urban Coalition for Ukraine)
13:50 — 14:00 Urban Forums for inclusive decision on rebuilding with heritage. Aet Ader (Estonian Association of Architects, EAL)
14:00 — 14:10 Method for inclusive heritage recovery. Stefan Balici (Romanian Order of Architects, OAR)
14:10 — 14:25 Architecture design competitions guideline, network and potential projects. Daniel Fiigenschuh (BKZT, Austria), Anna Bondar (member of Verkhovna Rada, Ukraine)
14:25 — 15:10 Discussion on inclusive and transparent, quality-oriented processes of heritage restoration in Ukraine. Participants: Volodymyr Gaidar (Architect, NUAU, ICOMOS)
Nechyporchuk, Anna Bondar, Andriy Kotlyarchuk (State Historical and Cultural Reserve Tustan).
Moderator: Olga Neshta (PhD in Architecture)

Recommendations on holistic reconstruction of heritage in Ukraine.

15:10 — 15:25 Planning methods for holistic renovation of Soviet housing (AAL, NSAU). Ruta Leitanaite/Martynas Marozas (Architects Association of Lithuania), Svitlana Biriuk (NUAU) Candidate of technical sciences . Atlas of Modernist heritage of Ukraine. Iryna Matsevko (KhSA).
15:25 — 15:40 Technologies and heritage: Practical knowledge on sustainable materials and techniques in large scale reconstruction of heritage. A new production line for large scale reconstruction of heritage. Henriette Ejstrup/ Ulrik Stylsvig Madsen (KADK, online), Alica Sviatyna (Director of Restoration and Technological center, Ukraine), Gennadiy Fareniuk (Doctor of Technical Sciences, Professor. Laureate of the State Prize of Ukraine in Science and Technology, Academician of the Academy of Civil Engineering of Ukraine).;
15:40 — 16:10 Discussion on re-using and reconstructing heritage as a resource for sustainable and socially just rebuilding of Ukraine. Participants: Svitlana Biriuk (NUAU) Candidate of technical sciences , Ihor Hnes PhD in Architecture (NUAU), Gleb Ushakov, PhD in Architecture, (Save Kyiv Modernism) (online), Alisa Svyatyna, Director of Restoration and Technological center, Ukraine (online), Iryna Matsevko (KhSA), Hanna Havryliv (Heritage.ua). Moderator: Olga Terefeyeva (NUAU)

16:10-16:30 Coffee break

Education, capacity building

16:30 — 16:45 Education in critical reconstruction. Daria Ozhyhanova (KhSA).
16:45 — 17:00 CPD program on integrated heritage recovery. Olena Oliynyk (NUAU), Pehr Mikael Sallstrom (Swedish architects).
17:00 — 17:30 Discussion on heritage as a topic in professional education and demand of specific knowledge of Ukrainian professionals) experts. Mykola Bevz (Lviv Polytechnic), Oleksandr Kashchenko, Doctor of Technical Sciences, Professor, (NUAU), Oleh Drozdov, architect, founder of Kharkiv School of Architecture (KhS
Moderators: Anna Pomazanna (KhSA), Olena Oliynyk (NUAU).

17:30 — 17:45 Investment plan for heritage protection and restoration. Oleksandr Chyzhevskiy (NUAU).
17:45 - 18:00 Resume of the conference

2 Stockholm Conference Program

UREHERIT ARCHITECTS FOR HERITAGE IN UKRAINE. RECREATING IDENTITY AND MEMORY

DRAFT STOCKHOLM CONFERENCE PROGRAM

May 12 Arrivals and check in to hotels mainly in Älvsjö

May 13 9.00 -12.00 Visiting downtown

12.00 -14.00 Lunch

14.00 - 17.00 Summit 2.0 at Architects Sweden

18. 00 Dinner with partnership

18.00 - 22.00 Check- in with CPD participants in Älvsjö

May 14 9.00 - 16.00 Stockholm conference at Royal Academy of Art

09.00 Press conference

09.00 Registration, coffee, mingle

10.00 Opening by Sr Johan Forsell (tbc), minister of export and aid

10.15 Welcome by Emina Kovacic, president AS tbc

10.30 UREHERIT update by Ruta Leitanaite

10.45 Needs report by Pehr Mikael and Olena Oliynyk

1l .00 Assessing value and damage to the cultural heritage in Ukraine

progress report by Olena Oliynyk (coordinating), Lifts Ganareffa, Henriette Ejslrup and Urik Slylsvip Madsen.

Panel discussion including experts and CPD participants.

I 2.00 Lunch

13.00 Ensuring Participatory Approach in heritage reconstruction.

progress report by Telyana Oliynyk(coordinating), Aet Eder and Slefan Balici, Danie/ Fäpenschuh.

Pane/ discussion

14.00 Recommendations on holistic recon9truction of heritage in Ukraine.

progress report by Rätt Leitenaite (coordinating) , Marlynas Maroz ms, Svitfana Biriuk, liyna Matsezo andAnna Kyrii'.

Pane/ discussion

15.00 Fika

15.30 Education and capacity building

reports by Pehr Mïkael Säl/slröm, Daria Ozhyhanova (coordinatinp), Eupenïa Bevz, and Oleksandr Ghyzhevsky.

Pane/ discussion

16.30 Sum mary by organizers

Ruta, Tetyana, Chyzh evskyi, Pehr Mikae l tbc

16.00 End

18.00 Re ce ption by the City Mayor - tbc

May 15 8.00 -14.00 Visits in Stockho lm (with CPD)

Re storation of the Cu lture House, Per Ahrb om - tbc

Heritage in the Me atp ackin g District plan, Nyré n s - tbc

Färgfabriken/Lövho lm en

14.00 - 17.00 Pecha Kucha Ureherit CPD projects

Venue Färgfabrike n - tbc

14.00 Intro by Tina Wik, ENS

14.30 12 projects from Ukraine 5 m in each

Presented by lhe jury

15.30 Fika

16.00 12 projects from Europe 5 min each

Presented by Pehr Mikae/

17.00 End

Themes: reuse, carbon load, public space, participation, value assessment