About the resilience of architectural heritage

Friedrich Idam and Günther Kain

Efforts to cushion global climate change are also calling into question the characteristics of current *Baukultur.* Unbridled consumption of resources for the production of short-lived buildings will already cost us dearly in the near future. A promising, successful solution strategy for this issue seems to lie in technical innovations, all the way up to fully automated 'intelligent' buildings – so-called 'smart buildings'. However, owing to inadequate technology impact assessments, the fact that it is precisely technical innovation that may increase the overall consumption of resources is being overlooked. As early as the second half of the nineteenth century, the 'Jevons paradox' was formulated, according to which technical innovations that allow more efficient use of resources will lead to an increased use of these resources instead of reducing consumption.[1] This is also known as the 'rebound effect'. Thus, societies in the developed world have been practicing energy saving since the oil price crises of the 1970s; yet, year after year, their consumption increased. Hence if innovations in connection with inadequate technology assessments do not constitute a promising solution, targeted exnovation – in the form of re-implementation of long-established proven technologies, the long-term consequences of which actually lay before us – may prove to be successful.

For there is a treasure trove of empirical knowledge in our architectural heritage that is currently mostly lying idle. For previous generations, it was a matter of course to create durable buildings with simple means. This type of construction has often stood the test of time over centuries and we can learn from it. The building fabric that has been preserved and is still occupied is first-rate: these are the best houses, these are the structures that survived a tough evolutionary process. Quite simply, these superb houses have worked well for a long time. In various regions, resilient buildings and building types have developed out of locally available construction materials, withstanding the centuries and, precisely for this reason, still offering a high quality of use. In order to successfully revive a proven *Baukultur,* practical and artisanal experience will have to be combined with the findings of building research. Within the framework of ICOMOS Austria's research network, future strategies applying this approach are currently being developed, which will contribute to the sustainable implementation of globally-needed energy-saving goals.

The pilot projects presented below were funded by Unit 4 in Division IV of the Austrian Federal Ministry for Arts, Culture, the Civil Service and Sport (please see article by Elsa Brunner).

Heritage window designs

Period double windows are still in use, but since the 1980s have increasingly been replaced by so-called thermal windows made of wood, metal or plastic. In addition to the durability of new surface coatings, the main argument in favour of window replacement is the high level of heat transfer through double windows. As regards these period windows, however, measurement results did not originate in the real building stock, but from fictitious substitute values specified in a standard; these, admittedly, were three to four times higher as laboratory values for industrially manufactured thermal windows. In order to be able to determine actual heat transfer through windows *in situ*, the development of a measurement method has been undertaken that can be used on actualproperty premises.[2]

In regions with pronounced winter and summer climates, very different challenges to building envelopes arise over the course of the year. At the moment, technical air conditioning solutions try to offset this. Alternatively, an adaptation of the building envelope that would vary according to the seasons could also serve as a counterbalance. Up to the middle of the twentieth century, window constructions were equipped with an additional casement to prevent energy loss during the cold season, whereas during the warm season shutters prevented excessive solar radiation and improved ventilation (see Fig. 1). The transformation of this approach for modern buildings offers an interesting field of research with a good potential for the future.

Peat moss (sphagnum) in the construction sector

Nowadays, when windows are installed within wall constructions, polyurethane foam is primarily used. The manufacture and, above all, disposal of this product are problematic from an environmental point of view. In order to develop an environmentally acceptable alternative, the historical use of moss in ancient designs has been investigated. In the building materials laboratory, valid technical peat moss parameters were determined; these are at least as good as those of common synthetic products. Peat moss seals from the middle of the eighteenth century that are just as functional as they ever were have been documented. Large quantities of peat moss, a tried-and-tested sealing material, are widely available today in 'paludiculture' areas. In such places, peat moss is cultivated in order to make ecological use of wet meadows and achieve long-term storage of CO_2; currently it is only used as a mulch. By treating peat moss as a sealant, a higher-quality use as a material is made possible.[3]

Solid masonry

Solid masonry made of stone or brick has been the universal wall solution for millennia. Depending on the type of masonry, it combines the advantages of using locally occurring raw materials, a quasi-ductile behaviour and a high thermal mass. By combining locally available stone material and lime (the traditional binding agent), durable walls with a moderate environmental footprint can be erected (see Fig. 2).[4] Contrary to cement, lime permanently binds atmospheric CO_2 during hardening. Up until a few years ago, stone walls were perceived as too cold, above all in winter; but with summers becoming ever hotter, they now offer a pleasantly cool indoor climate without any energy-intensive cooling technology whatsoever. Thereby, daytime temperature peaks simply shift into the cool night-time hours thanks to the inertia of the thermal mass without any need for further action.

Air-well systems

A deep geothermal mass with air throughflow is referred to as a *Luftbrunnen* ('air-well system'). The ventilation system of the Vienna Burgtheater demonstrates that building air conditioning can be achieved in an energy-efficient way for the long term. The air supply sinks down a deep shaft and through a tunnel about one hundred metres long before reaching the ventilation control room in the third basement. In winter, the geothermal mass preheats the cold outside air, while in summer hot outside air is cooled down. Similar processes take place to offset air humidity, with the porous lining of the supply air duct serving as a moisture buffer. The air intake is then distributed throughout the entire building via the ventilation control room, using a highly complex system of corridors, shafts and chambers. The highest point on the roof is occupied by the outlet opening of this ancient ventilation system, the so-called blowing angel (see Fig. 3). This figural sheet-metal *repoussé* work serves as a weathervane that has autonomously been rotating the exhaust air duct's outlet opening leeward for over 130 years.

The topic of a ventilation method, which was necessary for the purposes of hygiene and disease prevention, had its starting point in the military hospital sector in the nineteenth century. The 'air fountain' of the Vienna Burgtheater was built in the late nineteenth century, its design features following the principles of hygiene and disease prevention. One of the advantages of this ventilation system is that the supply air flows in over a large surface down through the ground and is discharged vertically upwards through the ceiling of the auditorium. Thereby, no lateral distribution of potentially contaminated air can take place, which minimizes the risk of infection.[5] In conjunction with the *Restart-19* research project at the Martin Luther University Halle-Wittenberg, it has become clear that some of the potential that lies in our architectural heritage can suddenly become relevant for coping with a current pandemic.

Simple Smart Buildings

Even in times of crisis, we have to build, but unlike in periods of abundance, it is important to use our resources sparingly. The ongoing global climatic changes and the economic consequences of the COVID-19 crisis require the development of simple, resilient and, above all, more cost-effective construction technologies, building types and building services management systems. Such simple yet intelligent technologies and systems are accessible to broad groups of the world's population, whereas short-lived, expensive high-tech systems do not meet this requirement.

This *Simple Smart* Buildings approach was presented at the Vienna University of Technology as part of the *historic smart* series of lectures; it has also been incorporated into the teaching of the restoration class at the HTBLA advanced technical college *(Höheren Technischen Bundeslehranstalt)* in Hallstatt. A specific podcast format has also been developed in order to appeal to wider sections of the general public in an effortless way; a new facet of the *Simple Smart Buildings* topic is presented there on a weekly basis.[6] The future belongs to a high-quality *Baukultur,* as stated in the *Davos Declaration*[7] – a *Baukultur* that is based on a cautious, knowledge-based handling of locally available building materials and the empirical knowledge associated with our architectural heritage.

1 William Stanley Jevons, *The Coal Question; An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal Mines,* London: Macmillan and Co. 1866.
2 Günther Kain, Florian Gschwandtner and Friedrich Idam, 'Der Wärmedurchgang bei Doppelfenstern — Konzept zur In-situ-Bewertung historischer Konstruktionen', in: *Bauphysik* 39, 2.2017, pp. 144–147.
3 Günther Kain, Friedrich Idam, Sarah Tonini and Angelika Wimmer, 'Torfmoos (Sphagnum) — historisches Erfahrungswissen und neue Einsatzmöglichkeiten für ein Naturprodukt', in: *Bauphysik* 41, 4.2019, pp. 199–204.
4 Günther Kain and Friedrich Idam, *Historische Bautechniken für Wildbachverbauten im Salzkammergut*, Göttingen: Cuvillier Verlag 2020.
5 Günther Kain, Friedrich Idam, Alfons Huber and Markus Goldsteiner, 'Luftbrunnenanlage des Burgtheaters Wien: Nachhaltige Klimatisierungsstrategien', in: *Bauphysik* 43, 1.2021, pp. 1–11. www.doi.org/10.1002/bapi.202000021, accessed 13.03.2022.
6 Simple Smart Buildings, podcasted3e6b.podigee.io.
7 *Davos Declaration* 2018, p. 11, Article 13.

Abstract

À propos de la résilience du patrimoine culturel bâti

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Les besoins en ressources et en énergies exigés par la réalisation et l'exploitation de bâtiments accélèrent le changement climatique. Une solution réside dans le développement de systèmes de gestions des bâtiments complexes, pilotés par électronique, qui font d'un bâtiment un *Smart Building.* En raison de l'absence d'évaluation des conséquences techniques, les cycles de vie brefs de tels systèmes sont négligés en lien avec l'évolution technologique rapide. Le fait que les innovations techniques augmentent considérablement la consommation de ressources nie profondément la vision de la foi dans le progrès. Dès la seconde moitié du XIX[e] siècle, il apparut que les innovations techniques, qui permettent une utilisation efficace des ressources, finissent par entraîner de manière paradoxale une consommation plus importante de ces ressources. Ainsi, depuis la crise du pétrole des années 1970, les sociétés évoluées s'investissent dans les économies d'énergie, alors que leur consommation augmente sans cesse.

Or, si les innovations ne fournissent plus de solutions prometteuses, des « exnovations », sous forme d'une réimplémentation de technologies éprouvées, dont les conséquences à long terme sont connues, peuvent s'avérer fécondes. Une approche prometteuse du développement de techniques constructives simples et résilientes, ainsi que de types constructifs et de systèmes d'exploitations durables réside dans le concept de *Simple Smart Buildings,* qui s'inspire du potentiel de notre patrimoine culturel bâti. La relance couronnée de succès d'une culture du bâti éprouvée exige la combinaison de savoirs pratiques et artisanaux avec les résultats des sondages et de l'analyse du bâtiment. Dans le cadre du réseau de recherche d'ICOMOS Autriche, un certain nombre de tels projets d'études sont actuellement en cours. Il s'agit notamment de l'évaluation de la mesure de la transmission thermique de fenêtres historiques, du potentiel de la mise en œuvre de mousse de tourbe (sphaigne) en tant qu'étanchéité et isolant, de la réévaluation des qualités thermiques de maçonneries massives dans le cadre des nouvelles conditions climatiques, ainsi que de l'analyse du potentiel climatique et hygiénique d'un puits canadien historique. La *Déclaration de Davos* esquisse le concept d'une telle culture du bâti de qualité, qui repose sur une approche prudente, fondée sur la connaissance de notre patrimoine culturel bâti et l'expérience pratique qui en découle.