A RETURN TO LOW-TECH: A SOLUTION FOR A MORE SUSTAINABLE FUTURE

Contents

INTRO-DUCTION

Introduction

The carbon-rich technologies that launched modernism and subsequently high-tech design now fuel climate change; a reset to sustainable, low-tech design is now imperative. Through reflecting on historic construction methods and philosophies, such as thermal comfort and the use of natural materials, this essay will challenge the notion that contemporary design is founded in boundless technological capability, eclipsing rationalism, in an age of depleting resources and increased carbon emissions.

The roles and responsibilities of an architect have changed. The desire to design beautiful, functional buildings has been unfaltering over time, however now it is ethically unacceptable for designers and architects to ignore the challenges of global warming (Edwards, 2014). With two thirds of the UK's waste and 10% of its carbon emissions being from the construction industry, today's architects are active players in shaping the future of our planet (Hurst, 2019). There are a number of initiatives that have been introduced in the past decade, 'Retrofirst', a campaign introduced by the Architect's Journal to prioritise retrofit over demolition and rebuild (Hurst, 2019), perhaps being the most relevant to this topic. However, we continue to lose on average 50,000 buildings each year to demolition in the UK alone, resulting in catastrophic damage to our natural environment.

With these figures in mind, I will begin to explore the various emerging and historic strategies that will help us to achieve sustainable design, with a focus on adaptive reuse. For the purpose of this essay, 'sustainable design' is defined by the intent to reduce the building's negative impacts on the environment, using natural resources, in order to ensure that future generations can enjoy a satisfactory quality of life. The application of this idea to architecture requires us to first look at the existing built environment. With more than a third of the lifetime carbon emissions in a typical building already emitted upon completion (Hurst, 2019), it is vital that we value this embodied energy through taking a repair and reuse approach. Where new interventions are required, however, we must then look to using natural resources. Vernacular architecture has taught us that using local, renewable materials to respond to specific site conditions, despite being the most 'obvious' option, is perhaps the most responsible and appropriate technological approach an architect can take. Yet working within an existing fabric, with all of its imposed constraints, is arguably the most creative task in architecture.

(previous spread)
Schuurkensstraat by Abscis Architecten, Ghent, Belgium.
Source: Dennis De Smet Photographs for Architizer

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The Pantheon, Rome
Source: Getty images via The Independent

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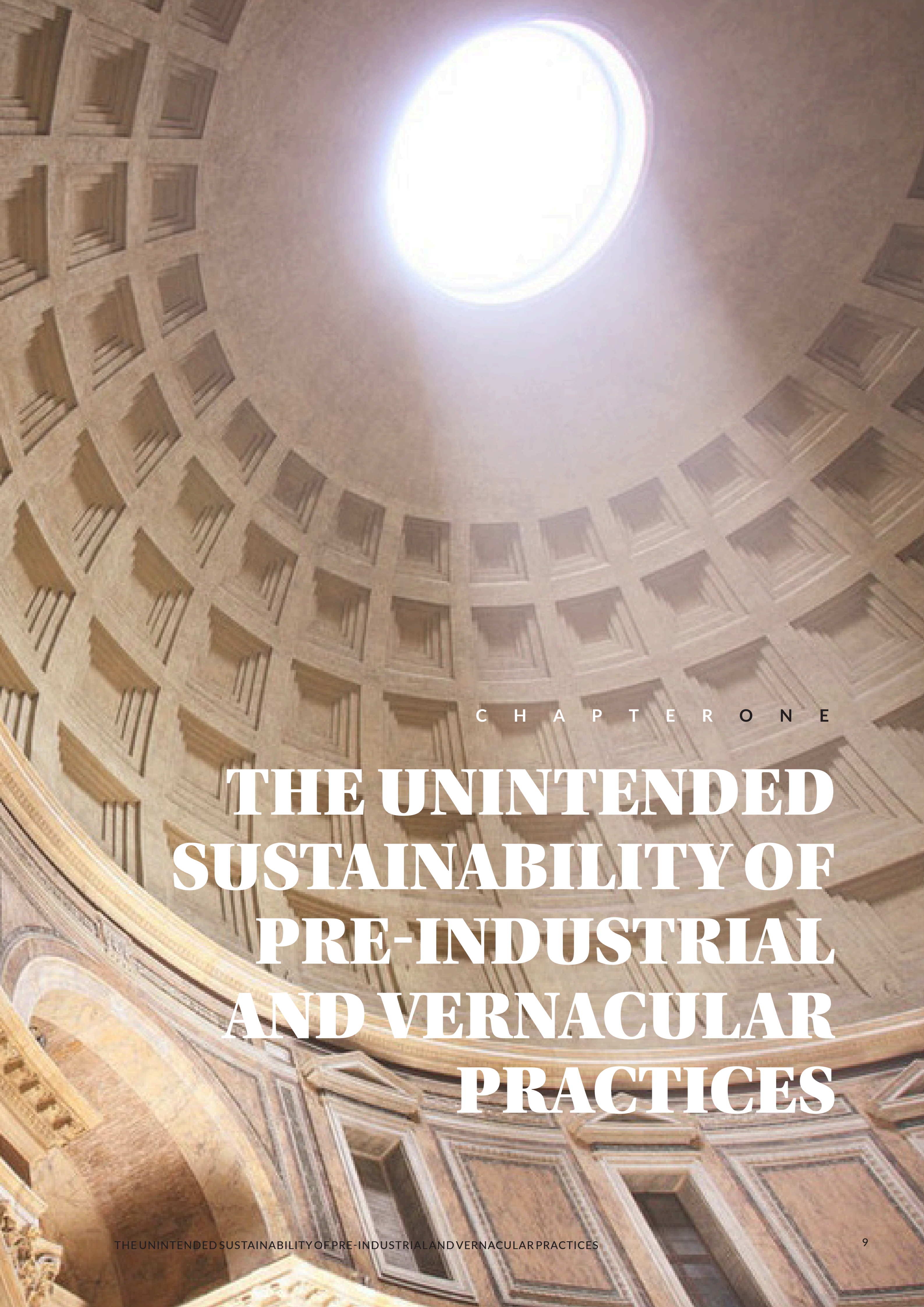

C H A P T E R O N E

THE UNINTENDED SUSTAINABILITY OF PRE-INDUSTRIAL AND VERNACULAR PRACTICES

The unintended sustainability of pre-industrial and vernacular practices

In order to understand the fundamentals of sustainable design, we must first begin at the origin of our built environment and examine its historical management. In doing so, we are able to see how many historic buildings can serve as a precedent for sustainable building practices.

Historically, buildings were designed with durability and function at the forefront, with sustainability becoming an unintended by-product of this. Today, however, focus has shifted. There is now an urgent call for more environmentally articulate, climate-responsive, 'green' design, where sustainability factors are an inherent part of the planning process. However, the approach, once instinctive for the earliest builders, has been repeatedly forgotten and repeatedly rediscovered overtime (Simmonds, 1994).

Today, it would be considered absurdity to put forward a brief for a building that should have no mechanical or electrical means of lighting, heating or ventilation, be built solely from local materials, emits zero VOCs (volatile organic compounds), is easily accessible and should last a minimum of 500 years. Yet, these requirements exist in numerous historic buildings across the world; the Pantheon in Rome (circa 118-128 CE), Hagia Sofia in Constantinople (532-537) and Fogong Temple in Yingxian, China (1056), to name a few. These historic buildings stand as proof that structures, finishes and furnishings can be built to last, and subsequently become excellent examples of sustainable design. For example, the permanent bricks used at the Ishtar Gate in Babylon, Mesopotamia (Iraq, circa 612-539 BCE) (figure 1) serve as decoration whilst their weather-resistant properties also protect the building's structure (Winchip, 2011); a great lesson in designing self-preserving and enduring environments.

During the pre-industrial era, a lack of vehicular transportation meant that previous civilisations were reliant on local skills and materials. These particular set of circumstances helped to conserve resources and later became recognised as vernacular architecture; an ideology with its principles set in inherently durable materials, structural integrity, climate-responsive design and excellent craftsmanship. For example, wood – a largely non-permeable, renewable material – was used to form a very steep roof in the oldest stave church in Norway (figure 2), to prevent snow and ice form accumulating on the structure (Winchip, 2011). Other durable materials common in vernacular architecture include stone, earth, brick (sometimes glazed), and ceramics.

The climate-responsive aspect of vernacular settlements is also an issue that has been highlighted by many scholars in the past. For example, Morris

(*previous page*)
Fogong Temple, 1056, Song dynasty; at Yingxian, Shanxi province, China.
Source: Christopher Liu/ ChinaStock Photo Library

Figure 1
Permanent bricks used for the Ishtar Gate in Babylon

Figure 2
Timber roof of a Norwegian stave church

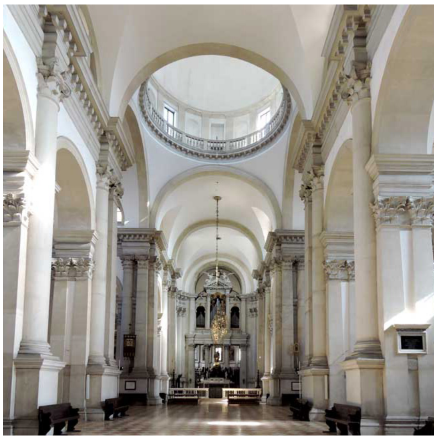
Figure 3 San Giorgio Maggiore (1566) in Venice by Andrea Palladio has existed for more than 400 years


Figure 4 Villa Rotunda (1566-1580) near Venice by Andrea Palladio

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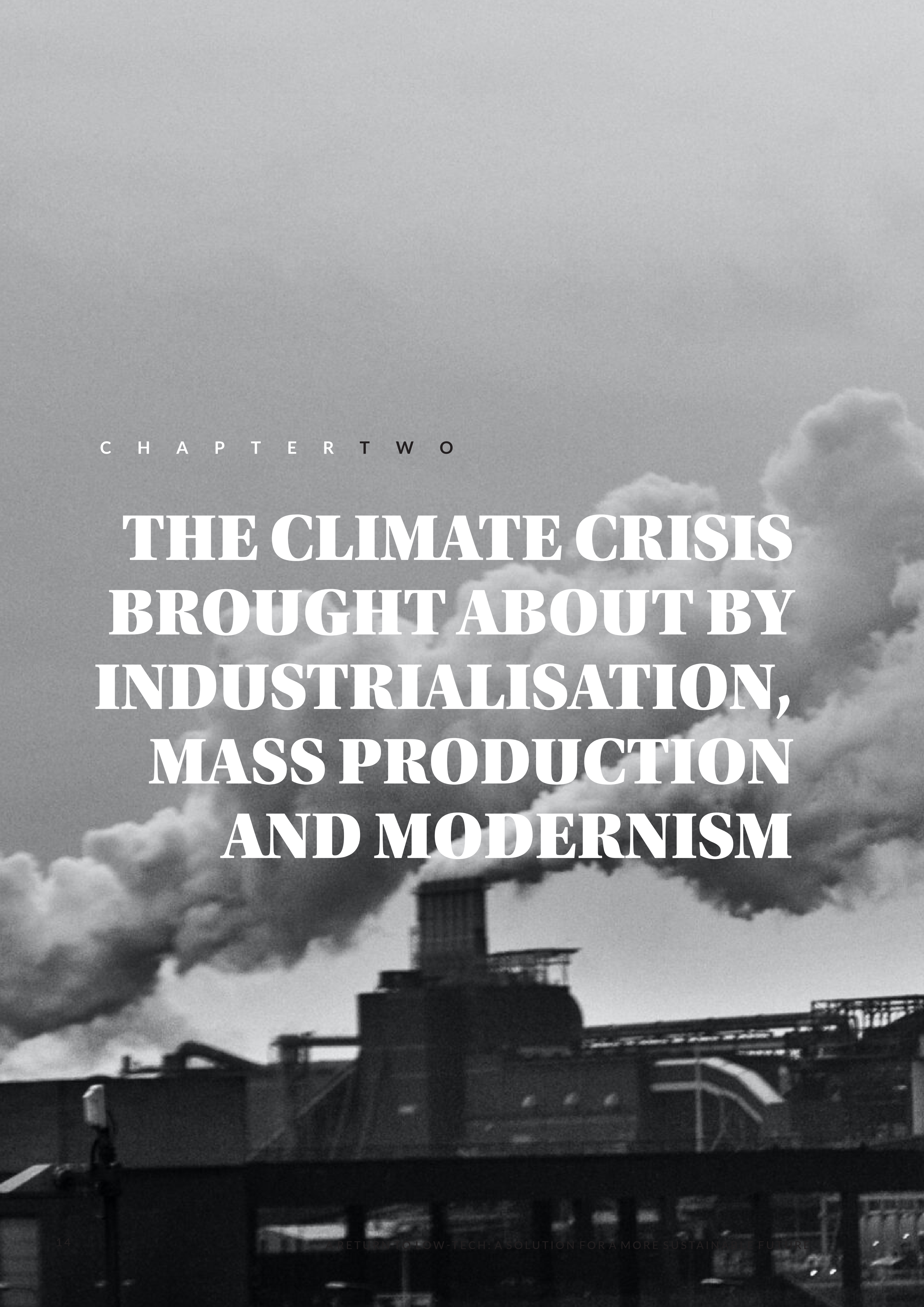
Ancient Roman architecture
Source: Pixnio

(1994) looks at the prevalence of courtyard planning in hot-arid climates. This particular low-tech strategy is a great example of how architects would maximise daylight prior to the twentieth century (and consequently prior to electricity). Through strategic spatial planning alone, they would increase daylight, enhance natural ventilation, conserve heat, maximise space and create views (Santamouris, 2006); all of which are desirable characteristics recognised today by associations such as LEED, however were achieved entirely, although unintentionally, using sustainable techniques. These solutions were often reached simply by selecting the most 'obvious', least resource-intensive scenario; however, this doesn't mean that the result has to lack in any exuberance or expression. Proof of this is the San Giorgio Maggiore in Venice by Andrea Palladio (figure 3). This particular design, built in 1566, utilizes deep window recesses, white reflective surfaces, a large reflective dome and strategic spatial planning in order to maximise natural light, completely eradicating the need for artificial lighting and electricity (Friedman, 2010).

The historic practice of maximising nature is also apparent in Andrea Palladio's Villa Rotunda in Italy (1566-1580) (figure 4). Here Palladio cleverly utilizes the topography of the site, locating the residence at the top of a hill and enveloping it with numerous openings in all directions, encouraging cross-ventilation and maximising daylight whilst also creating spectacular views which affirm the building's connection to nature (Winchip, 2011). Both of these examples by Palladio are excellent precedents of sustainably designing the built environment to optimize the interaction with warm climatic conditions.

Another key historic advocate for sustainable design was the Roman architect and engineer, Vitruvius. This is perhaps most notable in his writings within 'The Ten Books on Architecture', in which he provides examples of how to create 'permanent durability' and has several chapters addressing the impact of weather and the climate on buildings (Morgan, 1960). This philosophical perspective undoubtably contributed to the permeance and longevity of Roman buildings. The intent was to repair and replace components that were assumed to depreciate, never to demolish – a practice still used today, but arguably with less vehemence.

In looking into the many historic buildings we still have present today, it is clear that there is a strong relationship between permanence, durability and the ability to be adapted. Perhaps this goes some way to supporting the argument that the most sustainable building is the one that already exists, hence the one that has the most longevity and can withstand the test of time.



C H A P T E R **T W O**

THE CLIMATE CRISIS BROUGHT ABOUT BY INDUSTRIALISATION, MASS PRODUCTION AND MODERNISM

The climate crisis brought about by industrialisation, mass production and modernism

"One might say that the infrastructure created by the industrial revolution of the nineteenth century... is powered by fossil fuels, nuclear reactors and chemicals. It is pouring waste into the water and smoke into the sky. It is attempting to work by its own rules, contrary to those of the natural world."
– 'The Next Industrial Revolution,' William McDonough and Michael Braungart, Atlantic, October 1998

(previous spread)
The Industrial Revolution
Source: Cabral, C. on Shortform

By the mid 1800s, the industrial revolution, in all its phases and regional incarnations, had changed the relationship between the natural and human environments. Machines were developed that used natural resources to create an economy based on acquisition of the symbols of wealth (Jones, 2008), causing an international transition from an agricultural, land-based society to an industrial-based, fast-paced society (Keeler & Burke, 2009). Land economist Richard T.Ely noted that the early concept of 'land' had become devoid of any association to nature, but instead primarily referred to property or possession (Daly & Cobb, 1994). It is from this transition that the built environment lost it's vital connection to nature, and the climate crisis was born.

With the revolution's contribution to the growth of the economy and new technologies, also came the rise of Modernism. Although much of modernity was in principle about clean, healthy, prosperous lives brought about by good, modern design – we can see now that from an environmental perspective, the result was quite the opposite. This narrative is now beginning to unravel into the need to change habitual design practices, back to those akin to pre industrialisation.

One of the key downfalls of modernism from an environmental perspective was in its rejection of the built environment, enshrined in the ideology of functionalism. It was believed that true modernity was only possible out in the open, away from the 'old'. Bizarrely, the result was a decreasing population continuing to 'need' new-builds in the last remaining landscape, instead of functioning sensibly in the existing building environment. What started as division of labour and separation of functions, resulted in a neglect of any existing building fabric. In fact, increasingly, new buildings were not built to satisfy a real demand but instead to counteract unemployment (Schittich, 2003).

At building scale, a century ago in 'Vers une Architecture', Le Corbusier dismissed over-stylistic trends, rejoicing in the possibilities of mass production and materials such as reinforced concrete, which facilitated

Figure 5 (left)
Villa Savoye (1928-1931) by Le Corbusier

Figure 6 (right)
Farnsworth House by Ludwig Mies van der Rohe is seriously threatened by flood waters every year

his use of pilotis and ribbon windows to enable the free plan (Fowles, 2021). To him, having an open plan and free façade represented freedom achieved by modern technology. Of course, intent and execution aren't always synchronous. While a renowned example of The International Style, Le Corbusier's the Villa Savoye (figure 5) leaked badly each winter (in June 1930 Madame Savoye wrote to Le Corbusier saying "It is still raining in our garage") and was largely uninhabitable due to excessive damp and cold (Thoo, 2014). This is a complete reversal from the historic tradition of durability and impermeability as mentioned previously and has had, and continues to have, detrimental effects on the longevity and therefore sustainability of the modern built environment.

The Farnsworth House, another celebrated example of modernism, was commissioned by Dr Edith Farnsworth to be designed and constructed by Ludwig Mies van der Rohe between 1945 and 1951 (figure 6). However, she later went on to sue the architect over claims of malpractice; the residence was expensive to heat, had poor ventilation, the steel was rusting, and at night when illuminated became a beacon that attracted swarms of insects and lacked privacy (Thoo, 2014). Unfortunately, once again the advancement of technology sparked a design that, although beautiful, put form over function, using non-renewable materials and environmentally destructive methods of construction with little environmental or functional success.

Ultimately, Modernism was a celebration of our industrial capacity and mechanical prowess, of our ability to overcome prevailing conditions, rather than have to work with them. Subsequently, man's interference with nature was becoming increasingly clear; for example by the 1980s, we had destroyed two thirds of the rainforest that existed in the 1950s, and were beginning to impact on fragile ecosystems such as Antarctica (Meadows, et al., 1972). Since then, experts have been warning of irreversible damage to our planet. This is further linked to the major issues of depleting natural resources and fossil fuels, decline in air, water and soil quality, and an increased volume of waste; all of which the built environment is a major contributing factor towards (Gauzin-Müller, 2002). However, unfortunately spatial and material ideals instilled by the modern movement still define mainstream attitudes to building today; hence, in order to heal the climate crisis, a reset to sustainable, low-tech design is now imperative.

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MuseumLab opens in ruins of lightning-struck Pittsburgh library
Source: Dezeen


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CHAPTER THREE

ADAPTIVE REUSE AS THE ULTIMATE SUSTAINABLE BUILDING SOLUTION

Adaptive reuse as the ultimate sustainable building solution

Especially true during the classic modern era, when the avant-garde focused all its energies on innovation, architects have viewed building reuse as a necessary evil for some time, preferring to form a reputation based on spectacular new builds instead. However, things have changed. It is now imperative, in both an economic and an environmental sense, that we focus our energies on repairing and restoring our existing built environment, as opposed to destroying more green space and exploiting more resources.

Vitruvius once said, "When gold has been woven into a garment, and the garment becomes worn out with age so that it is no longer respectable to use, the pieces of cloth are put into earthen pots, and burned up over a fire" (Morgan, 1960, pp. 215-216). To encourage building reuse, Vitruvius is suggesting that the gold which remains in the ashes can be used again for other functions. Today, conversions account for nearly 40 percent of construction in central Europe (Schittich, 2003); a promising figure yet there is still some way to go.

For some time, Carlo Scarpa's refurbishment of the medieval Castelvecchio in Verona (1956 –1964) has been considered the benchmark for all creative conversions (figure 7). The distinct separation between the old and the new achieved through a contrasting use of materials is a highly thought-of approach and one that has been applied to numerous historic adaptive reuse projects since; Alvaro Siza's urban renewal in the Sicilian Saleme for example (Schittich, 2003). However, regenerating the built environment not only means working with structures of historic significance, but increasingly includes the refurbishment of modern architecture too - industrial structures or mass housing schemes from the postwar era for example. In theory, there is not a single building not available for conversion; and with such a wide range of canvases, the spectrum of tasks is correspondingly varied. Techniques for reuse include, but are not limited to:

- Preserving the Old in its entirety – finding inspiration in the original
- Contrasting layers and fragments - the portrayal of narrative
- The existing fabric as material for the "new entity"

Where originally, in pre-industrial times, reusing buildings was a logistic and economic necessity due to the limited availability of resources and methods of transportation – today, working with the existing building fabric, with all of its imposed constraints, is arguably the most interesting thing an architect can do.

(previous page)
Carlo Scarpa's Castelvecchio
Source: Guthrie, P. for Building on the Built

An excellent example of this is Granby Four Streets by Assemble (figure 8). This was a community-led project to rebuild Granby, a Liverpool neighbourhood that was nearly made derelict by decades of poorly planned regeneration initiatives that lead to the demolition of all but four of Granby's streets of Victorian terrace houses (Assemble, 2013). Assemble worked in collaboration with the local residents to create a sustainable solution that would breathe life back into the community, creating new opportunities for both housing and employment. The approach was characterised by celebrating the area's architectural and cultural heritage, building on the local craft and 'DIY spirit' that defines the four streets (Assemble, 2013).

In addition to the renovation of 10 houses and a series of empty shops and ceramic studio, the scheme involved creating a community winter garden within the empty shells of two of the houses. Here, Assemble retained the aesthetic of the exposed raw masonry construction within the triple height interior, transforming one of the terraces into a large indoor garden, topped by a glass pitched roof, resembling a Victorian palm house - a nod to the site's Victorian heritage. To achieve this, the studio reached out to a local structure workshop, who developed two bright blue steel rings that would brace the walls (Crook, 2019). The indoor garden is also complete with hand-dipped marbled and a custom range of double fired blue gradient tiles, all made on site using a technique not too dissimilar to the permanent bricks used at the Ishtar Gate in Babylon, as mentioned previously.

In examining this case study, it becomes clear that responding to the existing building fabric can not only reduce waste and carbon emissions, but it can also build on the dialectical discourse and thus the cultural value of the site. Reusing buildings from the modern era requires, arguably, a much more comprehensive understanding of the existing interaction between architecture, function, structure and building climate prior to renovation. Thus, historic techniques and technologies that are often forgotten, such as the use of the hand-made ceramic tiles, can provide invaluable insights for contemporary design and user experience.

However, Granby is not alone in its poorly managed decline and failed regeneration schemes. Each year, we loose on average 50,000 buildings to demolition, contributing towards two thirds of Britain's total waste (Hurst, 2019). Reusing existing buildings has become about much more than preserving cultural and historic significance, it is now imperative in order to conserve resources and tackle the climate crisis. After all, "the greenest building is one that already exists" (Hurst, 2019).

Figure 7 (left)
Carlo Scarpa's Castelvecchio

Figure 8 (right) →
Granby Four Streets by Assemble

(next spread)
Bamboo is the most widely used building material in the world
Source: Elemental Green

CHAPTER FOUR

USING NATURAL MATERIALS IN CONTEMPORARY LOW-TECH ARCHITECTURE

4


SEARCH ENGINE
GREAT HALL
RAILWAY
MUSEUM

Using natural materials in contemporary low-tech architecture

Where full building reuse isn't entirely possible and a new intervention needs to be introduced, we must rethink conventional design solutions by adopting vernacular principles and implementing the use of natural materials. These ideologies can be characterised using the term 'low-tech architecture'; a method of construction which seeks to re-balance the relationship between buildings and technology (Fowles, 2021). It is about faster, less complex and inexpensive construction, a preference for natural, low-embodied carbon materials, and a reduced reliance on technology and mechanical servicing (Salihbegovic, 2020). In essence, low-tech approaches are often seeking the simplest solution to the problem; they look back to historic precedents and combine these vernacular principles with contemporary application to form intuitive design solutions.

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3500m² timber frame at Feilden Fowles' National Railway Museum York Central Hall
Source: Feilden Fowles

There are also a number of broader social, wellbeing and ethical factors that's these practical tenets address, ranging from enhanced occupant comfort and health due to access to greenspace and improved air quality, to the responsible sourcing of materials, to supporting and stimulating local craftsmanship. In this sense, low-tech architecture shares many of it's social intents with the Arts & Crafts movement, echoing Ruskin's core values of handcrafted, honest materials and a respect for the culture from which they have been developed (Fowles, 2021).

One practice which shares similar values is Superuse Studios, a Netherlands based architecture practice who "view design and construction as a circular process of creation and recreation, use and reuse" (Superuse Studios, 2020). They apply several strategies - including material harvesting, using recycled or biobased materials and demountable construction - to make sustainable architecture with reclaimed materials. The result is a unique quality of adopting site-specific techniques and unifying different architectural elements into a homogeneous enclosure that envelopes the building volume seamlessly via its materiality.

These principles of material-driven design are some which are capable of transcending all areas of the built environment, in both adaptive reuse projects and new builds. Examples of said low-tech, renewable materials, evident in both vernacular and contemporary architecture, include:

1) Wood (figure 9)

Wood as a natural "living" material is perhaps the epitome of low-tech, sustainable design. It is renewable, has good thermal properties

Figure 9 Feilden Fowles' studio in south London uses lengths of UK-grown Douglas fir in a simple pitched extrusion

Figure 10 Dake Architectural Design use recyled stone from the local river banks to build 'Stone House' in the ancient village of Rizhao

Figure 11 Tatiana Bilbao architects use rammed earth to construct an adaptable, vernacular house in Jalisco

and a high thermal capacity, but above all it is extremely durable. Based on a long tradition of timber structures, buildings made out of wood are continuously reproduced to an increasingly high level and have a very strong presence in today's construction industry. The transportation and fabrication of timber elements also requires minimal embodied energy in comparison to other building materials such as steel, hence more and more architects are opting to use wood for their long-span and even multi-story structures (Innovative Wood Products Collaborative, 2020).

2) Stone (figure 10)

A substantial natural resource, stone as a building material continues to withstand the test of time. Dating back to the early middle ages with the emergence of the dry stone wall, the exploitation of quarries has become an unlimited resource of the durable and recyclable material. A symbol of strength, stone was historically used for load-bearing structural elements of buildings or in the foundations; nowadays, it is often used as a cladding due to its high thermal capacity (Berge, et al., 2009). However, despite its change in application, stone remains an excellent option for a sustainable, long-lasting piece of architecture.

3) Soil (rammed earth, loam or clay) (figure 11)

Due to its versatility and energy storage capacity, soil is often used in passive design strategies and has become the second most widely used building material in the world behind bamboo (Salihbegovic, 2020). Since its application of rammed earth walls in ancient times, soil materials have been used for a range of different purposes, including: sand and gravel as aggregate in concrete, clay mixed with earth and formed into solid walls, and clay for the production of bricks and ceramic tiles (Berge, et al., 2009).

A self-proclaimed low-tech building that encapsulates all of these sustainable materials is Sands End Community Centre by Mae (figure 12), which combines the use of recycled materials with an intelligent and restrained approach. In addition to the use of 'StoneCycling' bricks, which has allowed Mæ's design to effectively upcycle over 28 tonnes of potential construction landfill material, the centre's placement, orientation and massing reduces overheating, maximises natural daylight, and promotes passive ventilation (Pintos, 2020). This makes Sands End Community Centre an excellent example of how we can adopt vernacular techniques in the application of natural building materials to form a sustainable, energy-efficient building design.

Natural materials	Density ρ [kg/m3]	Thermal conductivity λ [W/(mK)]	Embodied energy [4] [MJ/(kg)]	Usage
Wood	400 - 1000	0.075 - 0.25	1.19 – 9.19	Elements of load-bearing structure (wall, roof, ceiling, floor), infill, cladding, roofing
Stone	1500 - 2000	1.16 - 1.4	0.5	Elements of load-bearing structure (walls), cladding, roofing
Gabions				Elements of structure, infill, cladding, roofing
Loam	1000 - 2200	0.20 - 0.95	0.5 - 1.2	Elements of load-bearing structure (walls), infill
Rammed earth				Cladding - green envelope

Table 1
A comparison of the aforementioned natural materials and their characteristics
Credit: Salihbegovic, 2020

Figure 12 (right)
Mae Architects' Sands End Arts and Community Centre

(next spread)
Jingdezhen Imperial Kiln Museum / Studio Zhu-Pei; an example of local Materials and Methods in Contemporary Chinese Architecture
Source: Studio Zhu-Pei

CONCLU-SION

Conclusion

Current construction trends based on high-tech design, fuelled by the technological advancements brought about by the Modern Movement, are under review due to their disregard for the natural environment. It has become imperative that we shift focus onto reusing the existing built environment, supplementing this with the application of natural materials where necessary. This use of passive design strategies is one that should be instilled within future generations of architects and designers; the research into renewable materials and sustainable methods of construction is all there, we only need to use it. But above all, we must rebalance the relationship between the natural and the built environment through studying vernacular architecture and traditional methods of construction – in essence, we must strive for simplicity. Of course, this should rely on the foundations of science and experience, however destructive technologies based on chaotic systems and boundless capability tend to favour profit and are short-term solutions that endanger the natural environment. Therefore, the technological approach should be grounded in ethical, social and environmental objectives; we must use technology responsibly to form appropriate low-tech design solutions.

The examples of case studies addressed in this paper, such as Granby Four Streets and Sands End Community Centre, are excellent examples of low-tech architecture. They are environmentally conscious, making use of natural materials and vernacular principles, without lacking in any visual excitement or exuberance. They also connect with the community in a way that high-tech design often doesn't, using local craftsmanship and resident involvement to create a holistic design that beautifully intertwines people, nature and buildings. This homogeneous unity is also achieved in a physical sense through each building's seamless use of natural materials, creating a sense of harmony that can only be accomplished by adopting site-specific techniques (Salihbegovic, 2020).

However, although becoming more frequent, these types of precedents are few and far between. Modernist ideologies still penetrate much of today's designs, however we can no longer afford to operate on the philosophy that "form follows function", and instead should formulate design solutions that respond to the "giftedness of [existing] space", as well as to site specific conditions (Schittich, 2003). Architects must seize this opportunity to define a new language of architecture for our time.

"A century ago the modern movement provided a radical shift in our social and technological approach to architecture: it will require no less a radical shift in our environmental approach if we are to meet the threat of climate change" (Feilden Clegg Bradley, 2007).

(***previous page***)
Casa Collage by S+PS Architects, illustrating the practice of deconstructing and reusing rather than demolising.
Source: S+PS Architect

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Figure 1: Permanent bricks at the Ishtar Gate in Babylon

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Figure 4: Palladio's Villa Rotunda

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