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5. THE CIRCULAR ECONOMY APPLIED TO ARCHITECTURAL ELEMENTS IN PUBLIC AREAS

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5.1. Background of the circular economy

From the dawn of humanity up until the onset of the Industrial Revolution, the use of existing natural resources from the surrounding world caused very little environmental impact. Raw materials were extracted and waste returned in quantities that nature itself was capable of absorbing through natural cycles (Vidales Barriguete, 2016).

The problem began to take on an alarming scale in the 20th century, and more specifically from the final quarter of the century onwards, with *"the emergence of an economy based on consumption, a throwaway culture"* (UNED, 2016). Alongside the major changes brought about by technological progress, this has caused a serious environmental impact. *"The use of materials around the world has multiplied tenfold since 1900, and could double again by 2030"* (San juán-Barbudo, 2016).

Following the World Commission on Environment and Development (WCED), which in 1987 presented what is known as the Brundtland Report, "Our Common Future", the EU changed its approach with regard to sustainable development. This idea represents a radical change in the perception of sustainability, understood as a balance between society and its surroundings, providing the initial basis for efforts through a series of programmes, agreements, activities, partnerships, etc., which have arisen in an attempt to provide solutions to existing environmental problems.

Having moved into the 21st century *"we face one of the greatest challenges of humanity: to achieve a truly sustainable global model"* (Barrón Ruiz, 2016). Our environmental awareness is awakening, with constant commitments *"to new ideas, to different formulae which will, when combined with imagination, fairness and resilience, plot courses towards another possible world"* (Novo Villaverde, 2006). This involves a change in attitude with regard to our predominant economic model.

The transition towards the model of a circular economy is a priority in European Union policies. The idea is to make our society efficient in the use of resources, generating less waste, while wherever possible reusing any waste that cannot be avoided as a resource (Secretaría de Estado y Medio Ambiente, 2016). It is here that innovation becomes a key element, not only in the incorporation of new technologies and business models, but also in integrating the circular economy within education, one of the factors responsible for shaping the consciousness of new generations (Espaliat Canu, 2017).

5.1.1. The circular economy model

Right now *the linear system of our economic model (extraction, manufacturing, use and elimination) has reached its limits, or is about to do so, hence the need to find alternatives* (Moraño Rodríguez, 2016). In response to not only environmental but also social and economic problems which have gradually built up over recent years, we are seeing a change in our economic model, giving rise to a circular economy (Fresneda, 2014).

In the 1990s two figures from the USA, the architect McDonough and chemist Braungart, introduced the concept of "cradle to cradle". This involves the materials used in industrial and commercial processes being considered as nutrients, allowing them to be easily regenerated or returned to the earth (Hermida Balboa, Domínguez Somonte, 2014). Such an archetype proposes the foundations for a new paradigm of intelligent design based on closing the product life-cycle, just as we see in nature: the circular economy (Braungart, McDonough, Bollinger, 2007) (Fig. 5.1).

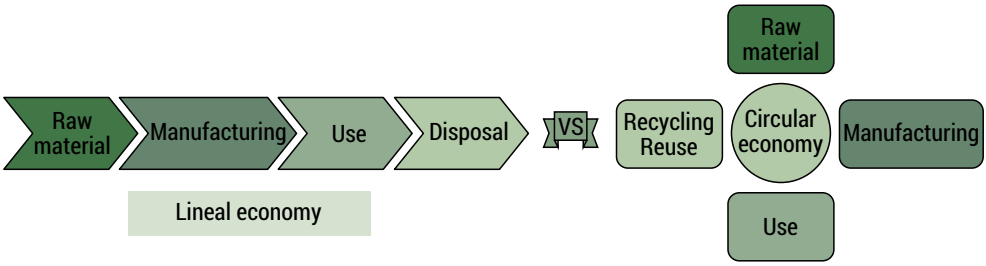

FIG. 5.1. Linear economy versus circular economy (Source: A. Vidales Barriguete, 2020)

The circular economy is a concept which aims to rethink how companies manage the production of their goods and services, while at the same time optimising the use of raw materials, water and energy sources. They are encouraged to achieve not only sustainable benefits for themselves, but also for society as a whole.

The key champions of this approach, such as Ellen MacArthur, a leading figure behind the model, point out that it goes far beyond recycling. The circular economy involves design and innovation, repurposing resources, opening up new markets, value creation, and even to a great extent job opportunities (Fresneda, 2016).

This philosophy emphasises 3 basic principles (Enciclopedia economica, 2018):

1. Preserve and enhance natural capital: the least possible amount of natural resources should be selected, or renewable resources used, in an attempt to manage finite reserves.
2. Optimise resource performance: the need is to achieve the longest possible product life-cycle. Eco-design plays an important role here, with products not simply being manufactured, but also repaired and/or recycled efficiently.
3. Promote the eco-efficacy of systems: negative external factors in the design must be detected and eliminated, in pursuit of harmony among the agents involved.

Many social and business benefits can be obtained by applying the circular economy model in any field. From the preservation of ecosystems in general, to cost-cutting and energy savings in the production of goods in particular.

5.1.2 The circular economy in construction

The construction sector is no exception. José Ignacio Tertre, the President of RCD Asociación (the Spanish Construction & Demolition Waste Recycling Association), points out that *given the considerable volume produced, the environmental impact and ease of recycling, CDW represents one of the five priority sectors for the EU circular economy Action Plan* (Tertre Torán, 2016).

It is a fact that the way we build has slowly adapted to the needs of each era, in response to a social and economic reality, which now also incorporates "ecological" factors as simply a further requirement (Baño Nieva, Vigil-Escalera del Pozo, 2005).

A circular economy focus in construction represents an opportunity for the design and innovation of new materials (Fig. 5.2). Given the need to maintain the added value of products for as long as possible, it is essential to propose long-lasting materials which also avoid waste generation and landfill (Argiz, 2016).

FIG. 5.2. Left: Plasterboard with plastic cable waste additives. Right: Cement mortar with mineral wool waste (Source: photos by A. Vidales Barriguete, 2020)

The circular economy in construction needs to be focused as a new strategy involving all parties:

- Designers: to design projects that extend the useful life of buildings and construction elements as far as possible; incorporate recycled and/or reused materials within such projects; and take into account their maintenance and/or deconstruction.
- Manufacturers: to incorporate recycled materials as a secondary raw material within their products; and provide information about their useful life, and how they can be reused or recycled once this comes to an end.
- Contractors: to play an active part in generating less waste during the construction process; and select suppliers that are committed to sustainability.
- Users: to raise awareness in opting for sustainable solutions.

5.2. Contribution of the circular economy in cities

One effect of following a linear economic model is that cities generate the greatest consumption of natural resources and produce the largest volume of waste and greenhouse gas emissions. The shift in cities to a circular economy awakens and activates the city, contributing not only in environmental terms, but also socially and economically, by making the city:

- Prosperous, with new business opportunities that serve to minimise waste and provide social decongestion.
- Habitable, with a reduction in urban pollution and improvements in the health of the population and their interactions.

FIG. 5.3. **Bus stop in the city of Bialystok, Poland (Source: photos by A. Vidales Barriguete, 2020)**

- Resilient, by extending the useful life of materials and reducing the use of natural resources. There is also a commitment to the production and distribution of local materials, supported by digital technology (Fenollar, 2020).

This is achieved through a radical change in the way we plan, design, use and convert public spaces (Fig. 5.3). Meanwhile, such an operational approach in cities helps to resolve problems connected with mobility and development, and works towards the 2030 Sustainable Development Goals (SDGs).

It is down to public authorities, by applying the policy mechanisms and instruments available to them, to enable this transition towards a circular economy, since they have in their hands the tool of leadership capable of engaging all other public or private sectors (Ellen Macarthur Foundation, 2019).

5.2.1. Cradle to Cradle (C2C) certification

The term C2C (Cradle to Cradle) refers to the certification mark evaluated and issued by the Environmental Protection Encouragement Agency (EPEA), a German scientific institute (Fig. 5.4). It promotes the circular economy or "closed circuit" concept in business, with the aim that everything should be reused. In the case of a product that is a biological nutrient, it returns to the earth, while technical nutrient products are recycled again and again, to be used as a secondary raw material.

FIG. 5.4. C2C (Cradle to Cradle) certification mark (Source: WEB-1)

It all begins with a product (re)design applying the Cradle to Cradle® design protocol, to ensure that products are designed so they can in all cases be recovered through biological or technical cycles. In other words, consideration must be given to the raw materials used in the product manufacturing processes, aiming to select those of a biological nature (nutrients returned to the earth) and optimising these (reducing waste generation); evaluating what can be done with them when they reach the end of their useful life; analysing reduced water and energy usage in manufacturing, and modifying the company's social responsibility strategies. All of which is done without overlooking the conditions that products need to fulfil in terms of usage, health, safety, comfort, appearance, environmental protection, etc. (Tarkett, 2020).

In order to manufacture a product in accordance with the C2C standard, consideration must be given to the three fundamental principles proposed by McDonough and Braungart:

- Waste: the waste obtained when a product has reached the end of its useful life can be converted into a biological nutrient which will again nourish the earth, or be converted into a technical nutrient which is fed back into a new production process.
- Renewable energies: use must be made of the natural energy we have available.
- Diversity: just as the planet has done for millions of years, energy and materials cycles must be closed through interaction among the different agents (industrial operators, consumers and governments), placing value on the diversity of the natural world in order to benefit from it (Prieto-Sandoval, Jaca, Ormazabal, 2017).

C2C certification provides an eco-label demonstrating an organisation's commitment and effort to design eco-products from the perspective of human and environmental health, recyclability or compostability, and manufacturing characteristics (Fig. 5.5).

FIG. 5.5. C2C certification criteria (Source: WEB-2)

C2C certification establishes five levels: Basic, Bronze, Silver, Gold and Platinum, thereby allowing applicants to improve their classification in subsequent evaluations. The evaluation criterion take five factors into account (Estévez, 2014):

- Material Health: assessment of the use of positive chemical components, in other words confirmation of the elimination and/or replacement of any component classified as *high-risk* or *non-classifiable*.
- Material Reutilisation: identification of the flows of material generated when the product has reached the end of its useful life. Materials can be reused as a raw material to be fed back into the manufacturing process (technosphere) or as biological nutrients (biosphere).

- Renewable Energy: confirmation that energy use during the life-cycle is as far as possible renewable.
- Water Stewardship: analysis of responsible and efficient water use, and discharge into drainage networks as cleanly as possible.
- Social Fairness: verification that the staff of the organisation are committed to this philosophy, along with companies in the supply and distribution chain.

The effort required to obtain this certificate for a product involves acknowledging not only its functionality or aesthetic appearance, but also its contribution to planetary sustainability.

5.2.2. Biological cycles and technical cycles

It is not always possible for products to be returned to the earth through biological cycles when they reach the end of their useful life, and on occasions, depending on the nature of the material itself, reuse via a technical cycle might be required (Fig. 5.6).

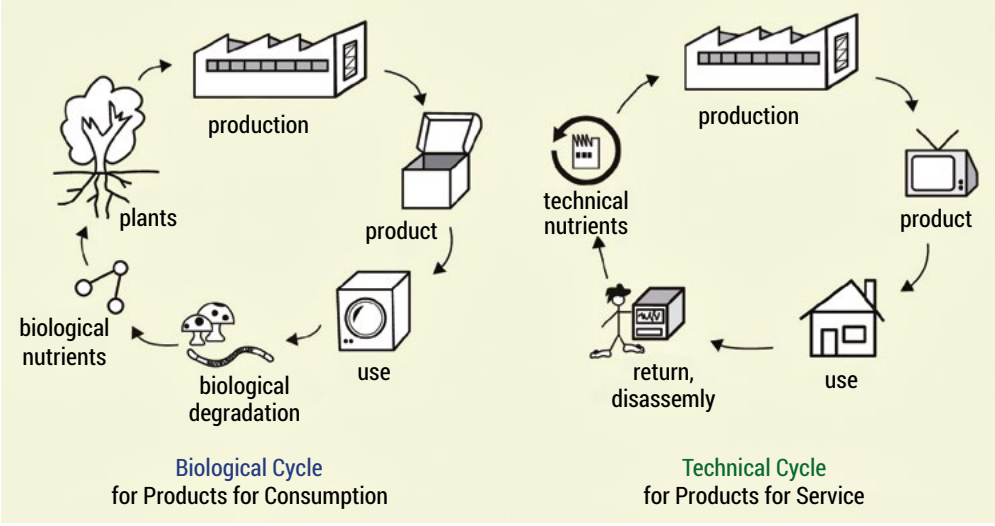

FIG. 5.6. **Biological cycle and Technical cycle (Source: WEB-1)**

In biological cycles, designs are created for biologically based materials such as wood, allowing them to return to the system through processes of composting and/or anaerobic digestion. These cycles regenerate living systems, such as the soil (Ellen Macarthur Foundation, 2017).

In technical cycles, meanwhile, the materials are not suitable to be returned safely to the system, such as plastics or metals, and the design is therefore conducted in order to return them over and over again to the production process for reuse, repair or recycling (Ellen Macarthur Foundation, 2018).

5.3. Circular economy applied to architectural elements in public areas: opportunities

The Urban Agenda of the United Nations, the Urban Agenda for the European Union and the Urban Agendas of each signatory country all aim to achieve the goal of sustainability in urban development policies. Working methods are defined to this end, involving all relevant public and private actors in cities in pursuit of sustainable resource management and support for a circular economy.

The commitment involves fulfilling the 17 Sustainable Development Goals (SDGs) proposed by all the Member States in 2015 in order to achieve a future bringing poverty and inequality to an end, protecting the planet and guaranteeing justice, peace and prosperity by 2030 (ONU, 2020).

The eleventh SDG specifically refers to cities, in pursuit of their sustainability, inclusiveness, safety and resilience.

Public spaces are playing an increasingly important role in society. They serve as a factor identifying a city, and provide platforms for socialisation, gatherings and activity, and so must fulfil suitable conditions for urban living, while successfully maintaining or enhancing the quality of life for their users (Goncalvez, 2011).

On this basis, the urban elements that make up such spaces must also be governed by the same principles as referred to above: resource use and management in selecting these elements, optimal energy efficiency, minimal impact on ecosystems, mobility, accessibility, etc.

FIG. 5.7. Urban elements in the city of Vienna, Austria (Source: photos by A. Vidales Barriguete, 2020)

A wide range of urban elements (rubbish bins, panels, street lamps, bus stops, benches, parking meters, etc.) need to be replaced, and should fulfil not only functional criteria, but also sustainability criteria, so as to be able to achieve the goals which have been set.

Companies, designers and users are increasingly committed to this, to protecting the environment, no longer seeing this as an expense, but viewing it as a strategy for savings and corporate social responsibility (Dirección General de Industria Energía y Minas de la Comunidad de Madrid, 2009). Examples would include the use of photovoltaic or wind energy rather than electrical energy, the use of recycled materials, multifunctional design, rainwater collection, etc. (Fig. 5.7). We must remain committed to this approach, since as Leonardo da Vinci said, *"all those that do not find their model or mentor in the natural world are destined to strive in vain"*.

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