

Article

A New European Bauhaus for a Culture of Transversality and Sustainability

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Abstract: This article provides a critical study of a New European Bauhaus initiative in the context of transversality, relational nature and sustainability of construction, architecture and civil engineering. Social and environmental factors in this ecosystem of innovation are highlighted, as well as the perspectives of actors within it. The relationships between art, technology and science of historical Bauhaus are assessed. The investigation of transversality was carried out using a visual tool developed by the authors, CATI, considering sustainability as the backbone. The New European Bauhaus is a pool of innovation that is supported by governments, academia, industry, society and the (natural) environment. It aims at social, environmental and cultural sustainability and includes ideas of social transformation. It is necessary to absorb the impact and overwhelming cultural consequences of previous and current Industrial Revolutions, principally relying on cyber-physical systems to generate spaces and collective intelligence. The climate crisis and the COVID-19 pandemic have increased the need for new approaches, expanding the concept of smart cities to smart territories, taking into account participation in society and general inclusivity.

Keywords: New European Bauhaus; innovation ecosystems; sustainable engineering; smart territory; sustainability



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1. Introduction

The purpose of this study is to carry out research on the New European Bauhaus as an ecosystem of innovation, as well as the perspectives of the actors within it. The key characteristics of each of the actors are outlined, with reference to the premises of historical Bauhaus. This helps to ground the analysis, even if new proposals by the European Union might take different paths in response to the requirements of new conditions and challenges. Collective intelligence, which refers to a deepening of the collaboration between humans and machines, is regarded as a crucial aspect for the vision of the New European Bauhaus as a pool of innovation.

This subject matter has achieved heightened relevance due to the unique current situation regarding the climate and COVID-19 crises, thus necessitating comprehensive study. It is necessary for the New European Bauhaus to absorb the impact and overwhelming cultural consequences of Industrial Revolutions 4.0 and 5.0, aiming towards environmental, social and cultural sustainability. Art and aesthetics cannot be forgotten or played down in this process.

The New European Bauhaus is hereby understood as a pool of innovative experimentation, with a shared idea of transversality among disciplines, beyond what was supposed by historical Bauhaus. Examples include Ectopia, an experimental art/science laboratory [1], as well as the *White Paper on the Interrelation of Art, Science and Technology in Spain* [2]. The New European Bauhaus transcends its origins as a school for education

reform in the evolution of artistic and (construction) industry practices, while sharing its ideas of societal transformation.

From an industrial perspective, it is time to move forward with the development and implementation of collective methodologies, such as BIM (Building Information Modeling) in construction engineering. Collaborative methodologies should be a vehicle for the design and management of full circular (construction) life cycles, as well as intelligent territories. They have immense future potential in the renovation sector, fostering sustainability through the introduction of complementary systems, such as laser scanning and rapid energy efficiency analysis.

This ecosystem vision promotes the idea of a networked ‘place for life’, as well as the creation of public space; therefore, the smart city [3] idea needs to evolve into the concept of smart territories, revolving around the cohabitation of humans and nature on planet Earth [4]. Only in this way can the compelling ideas of the New Bauhaus impact and transform current socioeconomic conditions and create a New Sustainability Culture.

The organization of the present study is as follows. First, a general framework is provided, describing historical Bauhaus, the Industrial Revolutions, and proposals of the New European Bauhaus. Next, the concepts of transversality and innovation ecosystems that serve as the methodological underpinnings of the study are presented. Subsequently, an in-depth analysis of the actors in this innovation ecosystem—government, industry, academia, society and the natural environment—is carried out, on the basis of which the different possibilities and alternatives for the NEB are discussed.

2. Theoretical Framework

As background to the New European Bauhaus proposed by the European Union, this section describes historical Bauhaus and the Industrial Revolutions that served as its foundations.

2.1. Historical Background of Bauhaus

The beginnings of historical Bauhaus were strongly influenced by the trauma of the First World War, and by the need to absorb the shocks of the first two Industrial Revolutions.

In the aftermath of the First World War, there was a pressing need for housing. It is therefore no coincidence that ‘form follows function’ was the main principle of the Bauhaus philosophy. This, however, did not mean just any form, but rather a ‘true form’ that was a response to functional requirements [5].

Moreover, industrialised products and houses were to be made culturally (i.e., socially, economically, symbolically and practically) acceptable [6]. This assumption holds in the present day, when environmental sustainability is considered.

From an artistic perspective, other recognised contemporary movements focused on the concept of sociocultural transcendence and the transversality of science, arts and technology [7]. These movements were the root of recent efforts to bring artists and engineers together [8]. De Stijl’s movement in particular manifested a strong sensitivity towards the social function of art and exerted a decisive influence on Bauhaus. From De Stijl’s perspective, art was for everyone, and architecture, as the mother of all arts, had a sacred, almost religious mission to shape life itself.

In this context, the historical Bauhaus school was founded by Walter Gropius in 1919 in Weimar, Germany. The school had three distinctive stages, which are summarised in Figure 1.

The first stage can be described as focusing on experimentation with ideas, forms and products. At that time, Bauhaus was considered to be the first school of design to have been strongly influenced by the expressionist movement [9].

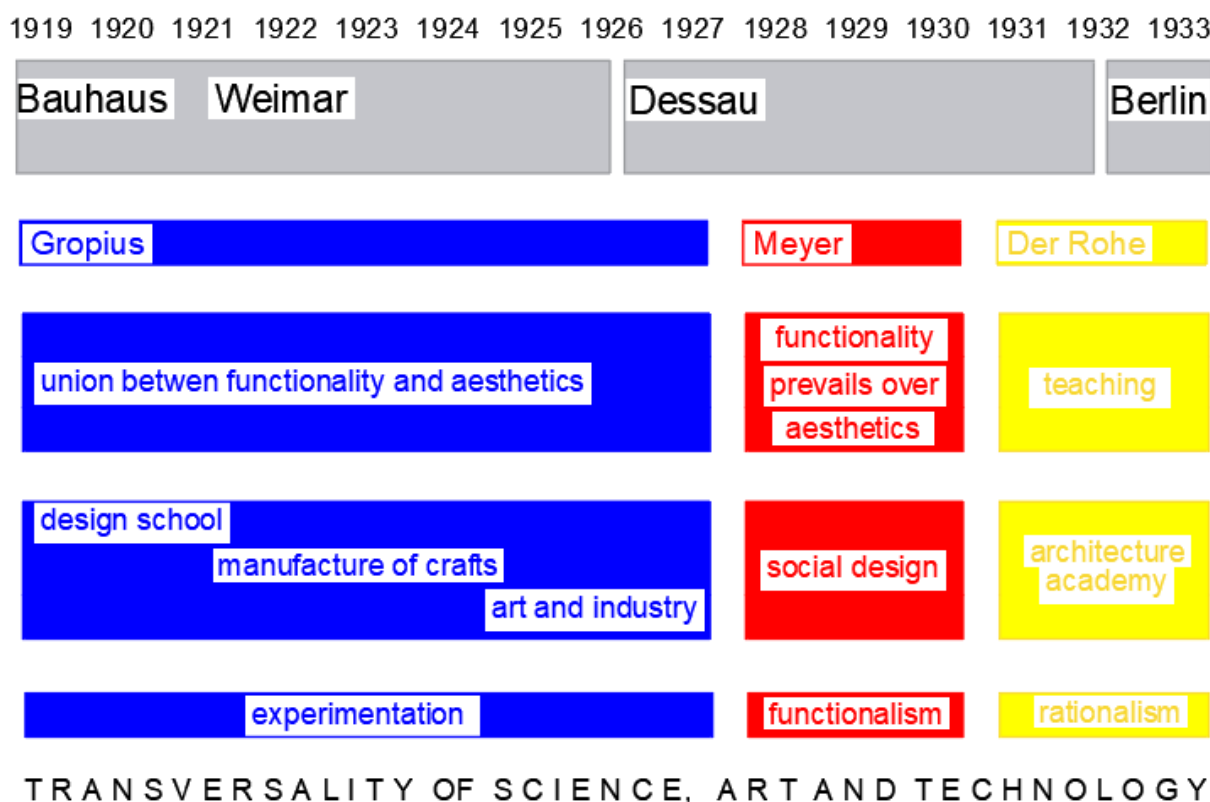


Figure 1. Bauhaus timeline. Source: authors.

In the second period, the school was under the direction of Hannes Meyer, who also strongly promoted the Bauhaus trademark and was more engaged in the social dimensions of architecture. He turned towards a more collective and interdisciplinary endeavour, which included a division of labour. Meyer openly denied the aesthetic concept of architecture introduced by Gropius, and the primacy of artistic design and expression in building. This stage was focused on functionality, and its ideas were to be manifested through construction and engineering.

The third director was Ludwig Mies van der Rohe, a cool pragmatist and thus the opposite of Meyer. This last phase was characterised by the intellectual educative component, and during this period, Bauhaus mainly functioned as a school of architecture [10].

During its three phases—from Weimar to Dessau to Berlin, and from de Gropius to Mies to van der Rohe—Bauhaus transformed outlooks on innovation by introducing transversality in science, art, design and architecture. Clear typography was understood as a means of communication and artistic expression at the same time, which prepared the way for the construction of corporate identities and marketable images.

Although it was short-lived—it was closed by the Nazis in 1933—Bauhaus was the most influential design institution of the 20th century. Great artists participated in this experiment in education and, moreover, life. The Bauhaus sites in Dessau and Weimar now enjoy the status of UNESCO World Heritage sites [11], and Tel-Aviv, with its White City and four thousand Bauhaus buildings, is known as the ‘Bauhaus capital’.

After the closing of the school, there were several attempts to revive the Bauhaus concept. In 1933, John A. Rice founded the Black Mountain College in North Carolina, and in 1937 Moholy-Nagy founded the New Bauhaus in Chicago. Gropius himself moved to the influential Harvard School of Architecture, whereas Mies van der Rohe and Moholy-Nagy helped to transform the Illinois Institute of Technology. In the 1950s, Max Bill created the Hochschule für Gestaltung (‘Design High School’) in Ulm, Germany, which was also intended as a new Bauhaus. These new impulses were categorised as the so-called

‘International Style’, which was marked by the absence of ornamentation and by strict correlation between function and design.

With a historical perspective, it can be seen that Bauhaus was fragmented and harboured many opposing ideas. What is now understood and celebrated as ‘Bauhaus’ is not historical Bauhaus per se, but a well-known and popular conception and idea of modern architecture that has remained true to an idealistic functionalism [12].

2.2. Current Background—Industrial Revolutions

Historical Bauhaus was a response to changing conditions, and the same is true for New European Bauhaus. These new circumstances are studied here by examining Industrial Revolutions as marked shifts in social and scientific paradigms [13].

Each Industrial Revolution has had an influence on engineering and construction (Figure 2). Before the first Industrial Revolution, there was no drastic division between the competencies of architects and engineers, and both professions dealt with both the technical and aesthetic aspects of their work [14]. Professional specialisation came with industrial development.

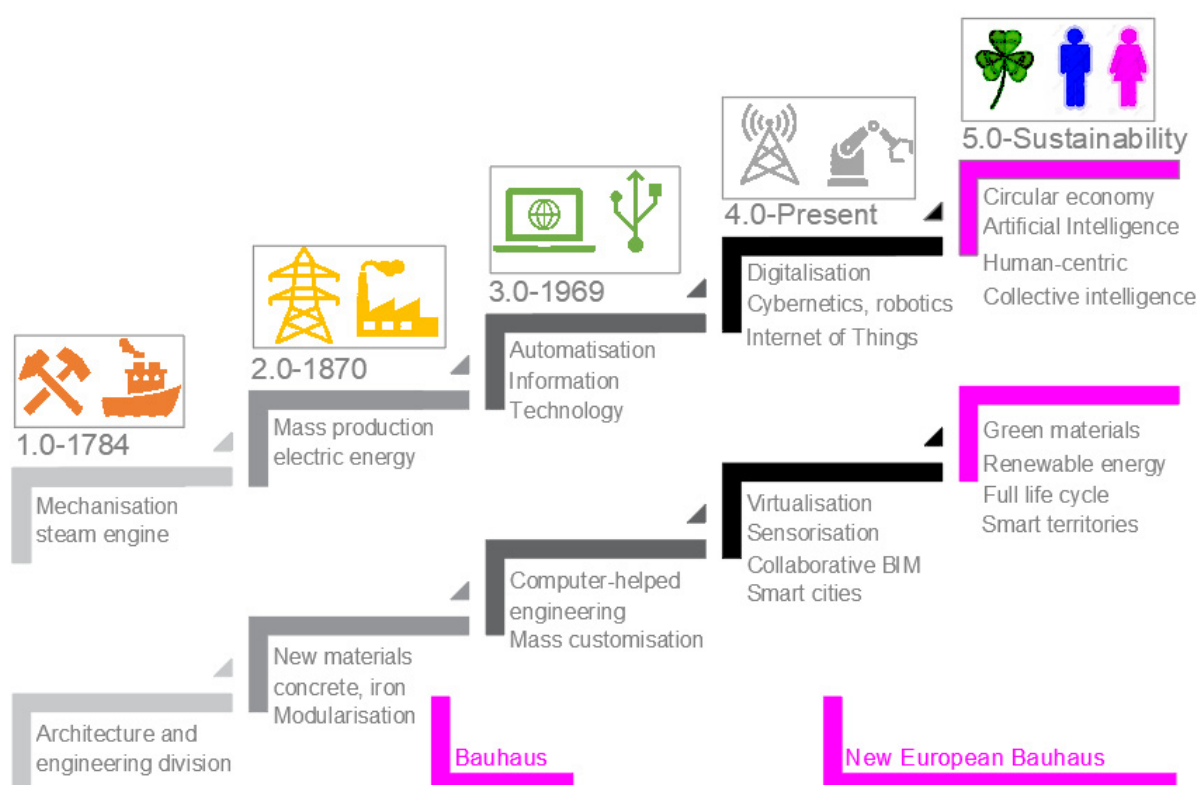


Figure 2. Industrial Revolutions and their transposition into architecture and civil engineering. Source: authors.

The first Industrial Revolution began the transition from artisanal to industrial socioeconomy by introducing mechanisation. In general terms, it was marked by the use of steam engines, coal and iron. In engineering, cast and wrought iron were the key materials in large-scale construction, and these materials changed design and construction methods.

The second Industrial Revolution brought electric energy, oil and steel, and thus, mass production. Steel and reinforced concrete were important new materials in architecture and engineering. Mass production was enhanced by modularisation and standardisation.

In the Third Industrial Revolution, the use of electronics and information and communication technologies allowed for automatisation. Computers began to be used in the design phases of architecture and engineering, and became a part of their creative processes. The computerisation of calculations, together with the development of new materials such

as pre-stressed concrete and composites, led to a leap in the scale of projects—the design of large-span bridges, for example—and to mass customisation.

The ongoing Fourth Industrial Revolution [15] is principally based on cyber–physical systems [16]. The spread of internet use, digitisation and sensorisation (i.e., the Internet of Things, or IoT) brings new opportunities for optimisation, in which artificial intelligence and deep learning are used to manage the data generated. Three-dimensional printing and augmented virtual reality allow for rapid and efficient prototyping, with virtual models that can be used in different architectural and engineering design phases. These technologies can be useful in understanding the relationships between a building and the environment. Creative and innovative proposals can be tested and simulated with prototypes, and general constructability can be guaranteed at any phase; this enables personalised production.

A Fifth Industrial Revolution is currently developing—the concept was first presented in Japan in 2016 [17]. Unlike ‘Industry 4.0’, which centred mainly on economic and technological aspects of industry, the Fifth Industrial Revolution also takes environmental and social sustainability into account. The United Nations Sustainable Development Goals can be addressed in this way, and must also be addressed in culture [18]. The evolution of the cultural paradigms of society relies on, but does not exactly follow, historic revolutions. The very first of these revolutions brought about first the hunter–gatherer and then the agricultural pre-industrial societies, and were followed by the Industrial Revolutions, which include the information society (Industry 4.0) and the sustainability society, which is accompanied by the greening of the socio-economy (Industry 5.0). As with every paradigm shift, these transitions are gradual in nature [13].

Industry 5.0 is centred on sustainability because of the threat of climate change. Other drivers for Industry 5.0 include increasing digitalisation, networking and a globalised world. These all bring new challenges for households, neighbourhoods, cities and territories. The COVID-19 pandemic has also brought into focus the need for a different approach. The configurations of open, socially oriented and private spaces need to be re-defined, as does their relation to the (natural) environment.

According to Eurostat [19], in 2019, more than 12.3% of total EU GDP was spent on housing, water, electricity, gas and other fuels. In the same context, empty houses co-exist with housing shortages. Whatever one’s views, these realities demonstrate the huge importance of housing and living space policy for the wellbeing of society [20,21].

From a sustainability perspective, buildings utilise more than 40% of the total EU’s energy consumption and are responsible for 36% of greenhouse gas emissions [22]. Currently, however, only 1% of buildings are undergoing renovations to improve efficiency every year. Increasing the sustainability of the building sector is key to achieving net-zero in the EU by 2050 [23].

In addition, the COVID-19 crisis has made a re-assessment of the energy and resource profiles of homes essential, due to major increases in time spent at home by populations under social distancing and the associated digitalisation requirements [24].

2.3. The New European Bauhaus Proposal

The Davos Declaration [25] of 2018, signed by culture ministers from EU member states, can be seen as a precursor to the New European Bauhaus concept’s focus on social and environmental sustainability.

This study is centred around the conception of the New European Bauhaus presented by Ursula van der Leyen [26]—an innovation pool, which creates an innovation ecosystem with actors working on different stages of the innovation process. According to this perspective, it is intended to be a bridge between two worlds: first, that of science and technology, and the other of art and culture, and in this way, bring the historical Bauhaus ideal of transversality into the current era. This historical tendency has been and is supported by many individuals, from Goethe to Einstein [27–29].

As an extension of the premises of the European Green Deal [23], the New European Bauhaus is intended to address climate change, pollution and biodiversity loss, and to make sustainability more tangible, by taking these realities into account when designing good living spaces for European citizens [30].

In essence, a more humane and more beautiful 21st century is the objective [26]. Healthy, accessible and affordable housing, on a more detailed level, involves “energy, material and water use, quality and value of buildings, health, comfort, resilience to climate change and life-cycle cost” [24]. However, a fundamentally buildings-oriented approach is concerning. Efforts which are not currently contemplated in the Green Pact are also necessary, such as the work of the Infrastructure & Ecology Network Europe [31], aimed at the development and sustainability of the civil engineering sector, and planning in direct relation with nature as practised by some H2020 research projects [32].

Other relevant milestones to consider include social sustainability upskilling, occupational health and safety, and the inclusion of women and youth. Achieving gender equality will be one of the pillars of the Fifth Industrial Revolution. Encouraging the mass participation of women in technological professions will ensure that their voice is heard in economic and political sectors.

The New European Bauhaus is to be staged in three phases [30]: ‘Design, Deliver and Diffuse’. It is intended to follow the innovation ecosystem process, with actors circulating through intermediary and hybrid innovation entities. In the ‘design’ phase, as an ‘incubator’, it will be a forum for discussion and experimentation at the ‘niche’ level. In the ‘deliver’ phase, it will be an ‘accelerator’, scaling up solutions for sustainable and attractive living. In the ‘diffuse’ phase, it will be a hub for global networks and specialists, and also for citizens.

Five European Bauhaus projects are to be initiated between 2021 and 2025 in five different EU countries [26]. These projects will each focus on natural building materials, energy efficiency, demographics, future-oriented mobility or resource-efficient digital innovation. In January 2021, the European Commission began the consultation phase with a call for ideas from incumbent actors, and in spring, the first edition of the New European Bauhaus prize was promoted. The first call for projects is to be launched in the autumn of 2021 [33], and the first European Bauhaus construction is to start thereafter in late 2021.

The document ‘Renovation Wave’ [24] strongly centres on the renovation of European housing stock, mainly from an environmental and social sustainability perspective. Social sustainability is probably well-expressed by a commitment to inclusivity. A brief section of the document is dedicated to the New European Bauhaus and its two dimensions [24] as a network of different actors and as a series of innovative projects demonstrating sustainability potential.

The plan for post-COVID-19 recovery, NextGenerationEU [34], is considered to be the foundation of the development of the Bauhaus and circular economy approach. It includes a list of several research avenues related to construction, as well as the Built4People partnership proposal which hopes to develop “a truly holistic, integrated and people-centric approach to the design, construction, operation, maintenance, rehabilitation and recyclability of buildings and the built environment that will drive the sustainable transition in the society and economy” [35]. The engagement of citizens with sustainability is one of its pillars.

3. Materials and Methods

This study builds on the theoretical perspective of critical qualitative enquiry, and its epistemological stance is grounded in the interpretative conceptual framework of innovation ecosystems. The case study analysed from this standpoint is the New European Bauhaus. The study is also based on historical predecessor premises such as transversality, inter-relationality and transdisciplinarity of disciplines [36–38]. It also takes account of the social evolution caused by different socioeconomical and paradigmatic [13] backgrounds and challenges, which are referred to here in terms of Industrial Revolutions.

A visual tool called CATI (see Figure 3) is applied for the analysis of the positioning of New European Bauhaus as an approach to transversality. The abbreviation CATI is Spanish, and stands for: *ciencia* (science), *arte* (art), *tecnología* (technology), and *innovación* (innovation); these concepts are considered to be the backbones of sustainable engineering and industry. The terms used in the tool are in English, where 'C' stands for science and 'I' stands for sustainability and also innovation, which is located at the hidden vertex of the other plane. The CATI tool situates sustainability in the centre, as a new vertex which allows a third dimension and opens the plane to social, environmental and cultural concepts.

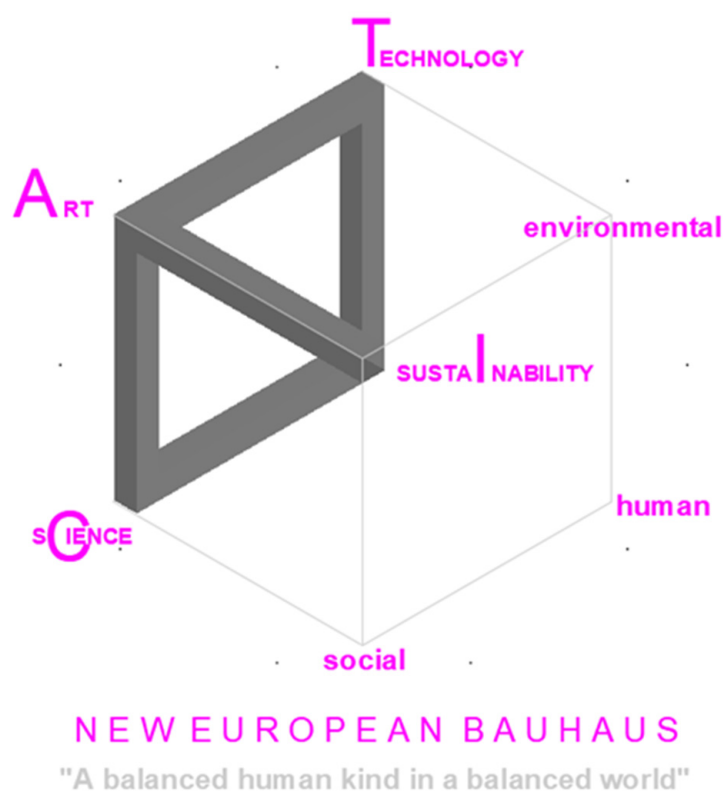


Figure 3. CATI: a new sustainability culture. Source: authors. The theory underlying this research is likewise based on transversality and the innovation ecosystems outlook.

This study is also developed around the actors of the innovation ecosystem: government, industry, academia, society, and environment, and always takes transversality and sustainability into account as the basic approach of the CATI perspective.

3.1. Transversality

The main objective of the founder of historical Bauhaus was to reimagine the physical world through the unity of all arts, with architecture as the *summum bonum* of all efforts. Indeed, industrialisation, together with the inclusion of crafts into it, were the main pivotal points of the Bauhaus concept, and 'Art into Industry' became a Bauhaus slogan—this represented a confrontation with the belief that industry was of a manual and technical nature, but never of an intellectual or artistic nature [39]. In a sense, conventional forms were dematerialized to their minimal function- and use-centred existence.

The Bauhaus concept of *Gesamtkunstwerk*—'total or joint work of art'—expresses this idea of transversality and togetherness in the development of a holistic work of art. In this same sense, boundaries between life and these disciplines become blurred. This multidisciplinary is especially relevant in an era of hyper-specialization and the commodification of art and culture.

The concept of transversality is identified with the intersection between different universes, whereas multidisciplinary, interdisciplinarity or inter-relationality, and trans-

disciplinarity entail the ‘excesses’ of the discipline. The transversal occurs in the specialist but also in the everyday real; in academic culture, but also in popular culture. That is to say, the transversality with which we address in this study can also occur outside the academic sphere, without starting from circumscribed, established, disciplinary knowledge [29].

The first antecedent of transversality can be found in the culture of ancient Greece: at the same time as refined works of art were being created and great buildings were being built, music was studied and plays were written, the mind was exercised with mathematics and medicine, and politics were discussed [40].

Transversality is not so much a transmission of knowledge between disciplines, but a disposition for joint action. In this interface of difficult delimitation and definition of terms can be found works which feed the transdisciplinary dialogue between scientists and artists [41].

A similar to transversality is interdisciplinarity. This term refers to that which is related to more than one branch of knowledge, be it a product or result, a methodology or a procedure. An interdisciplinary result can combine different disciplines or professional specialties, and above all, belongs to all of them and is difficult to associate with just one [42].

Previous examples of interdisciplinary art include Florence of the 16th century, or the Black Mountain College in the United States, an openly multidisciplinary educational institution in which the study of art was the nucleus of education. The Knowbotic Research collective also stands out: a German–Austrian interdisciplinary group recognised for its work with knowledge systems and information visualisation. Its environment facilitates reflections on urban planning and construction [43]. It is also worth mentioning those works dedicated to the creation of environments for collaboration and experimentation, such as those of Christa Sommerer’s group and Laurent Mignonneau [44]. These artists created ‘Life Spaces’ [41] so that remote visitors could interact in a virtual world. Similarly, so-called ‘transarchitecture’ tries to create physical places as portals to virtual spaces with new informational spaces [45].

When the different fields of knowledge and arts are overprotected and isolated from each other, this leads to a lack of global perspective and the exhaustion of new ideas and visions; the cross-pollination of knowledge is required [46]. Creative processes are parallel in all disciplines, including science and arts, and the procedures in many cases can be transferred and extrapolated into new areas. In interdisciplinary work, the conflicts among disciplines [47] can be overcome and the individual elements that converge mutually reinforce innovation [48].

Today, architecture seems to be situated within the field of creativity and aesthetics, whereas engineering is restricted to technology and science. Nonetheless, engineering is understood here not only as a science, but as an expression of the necessary synthesis of art and technology. It is the germ of a modern renaissance of consciousness, which is defined as transversal and reborn into the future from the past [49].

The hybridisation of art and engineering as a common engine of innovation is required. It is important that errors made by the original Bauhaus are not repeated—for instance, civil engineering, structural art and new technological advancements such as concrete and steel were not recognised by the Bauhaus founder and promoters.

Designing a new system of living was, in a sense, the ethics of aesthetics in historical Bauhaus, and it is also raised in the idea of New European Bauhaus [26]. As society, and reality itself, becomes more liquid [50], risky [51] and uncertain [52], the modern exclusively rational vision of the world will be overcome, even if it is still persisting today. With the theory of relativity, traditional concepts of time and space have become interrelated with each other; thus, their relative character has been discovered. The dissolution of matter into energy brings us to another approach to objects [53].

This scientific paradigm change embraces the experiential relation and socialisation as cultural production in the context of relational society [54], or at least a society where

‘relations’ are known as a key element defining it. This focus on ‘relational reality’ makes the approach more comprehensive.

3.2. Innovation Ecosystems

This analysis follows the conception of different innovation ecosystem actors within the innovation helix framework shown in Figure 4 [55]. This is a more structural and collective intelligence-oriented approach to innovation than the romantic vision of an innovative entrepreneur or enterprise which stems from the more reduced vision of relation dynamics [56].

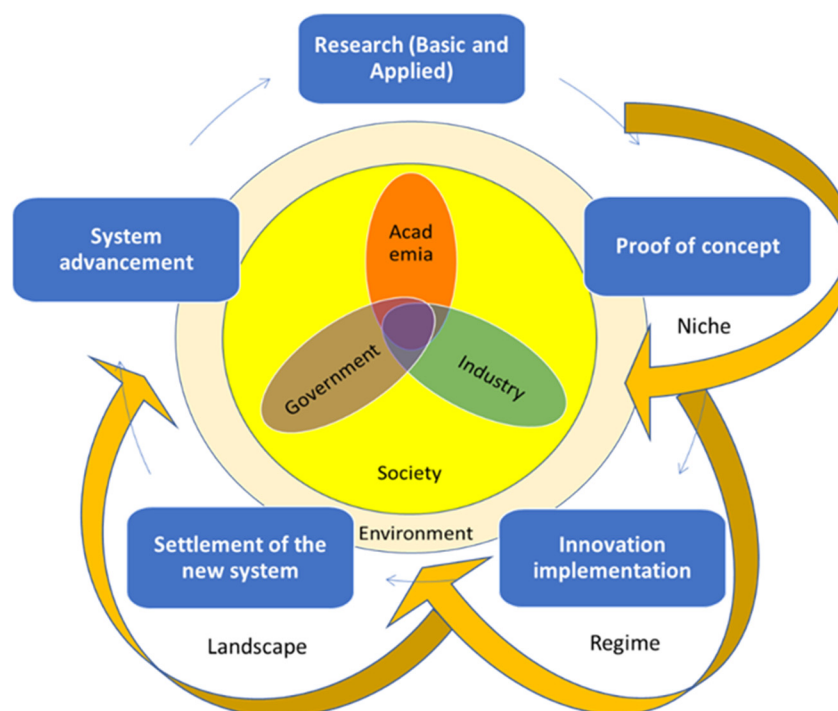


Figure 4. Innovation Helix—ecosystem actors and multilevel process. Source: Reprinted with permission from ref. [55], 2020, Renata Kubus.

The triple helix [57] is derived from Sabato’s triangle of knowledge [58], and is the approach currently used by its innovation and development programs of the European Union [59]. According to this conceptual framework, there are three principal actors which articulate the flow of relations in the innovation ecosystem. ‘Government’ is understood as a provider of physical and legislative infrastructure for the activity of other actors. ‘Academia’ is centred on the generation and diffusion of knowledge through its research and education functions. ‘Industry’, in turn, is focused on the productive exercise. ‘Society’ and ‘(Natural) Environment’ were added to this basic vision in order to envisage long-term social and environmental sustainability [55].

This corresponds with the underlying process of innovation developed in accordance with the multilevel perspective [60], with the phases of innovation being emergence in diverse niches, incubation, diffusion towards the sociotechnical regime of socioeconomic reality functioning, and transposition towards the societal mindset at the sociotechnical landscape level. It is a never-ending spinning process, pushed forward by different challenges acknowledged at different levels, but mainly by the mindset of an evolving society. The striving towards sustainability is endorsed in this sense as the main underlying drive for current evolutions and the overcoming of sub-optimal innovation ecosystems.

The development of the innovation ecosystem can be seen at each actor or vertices’ intra-relational or vertical level, among them in the inter-relational dimension, as well

as the extra-relational dimension, where the relationships with other ecosystems are an important force [58].

Following the relational and transversal conception of the innovation process, it is upheld as a socially constructed and shaped endeavour [61–63]. Moreover, diversity and inclusiveness should start from the very beginning of innovation ideation, and not only be staged for its reception and accessibility. How to enable and orchestrate this participation is a key question, which can be answered with the help of collective intelligence frameworks for intelligent learning [64], deliberation and action.

There are several levels of an innovation ecosystem configuration, depending on the different actors' pre-eminence in the process [65]. In the statist model, the government is pre-eminent; in the laissez-faire model, industry (more imaginative than real) is; and in the balanced model, these relationships include provisions for the knowledge society, with overlapping relations stressing the importance of academia. This balanced model is a base for a reframed innovation helix. It represents several developmental stages [66], starting from the innovation helix impetus and the flourishing of collaboration among different actors, that furthermore commence taking on the role of the other and progress from bilateral to multilateral relations. At the end is the conception of institutionalisation [67], where it is generally considered as a norm which guides action.

A meta-innovation ecosystem [66,67] evolves at the third stage, and this is when hybrid, intermediary entities such as innovation hubs, incubators, accelerators (depending on the innovation stage), joint research centres, or more traditionally science and technology parks, play an important role. In this context, the New European Bauhaus initiative is conceived as a potential intermediary innovation catalyst. Open, collaborative and participative processes at the deliberation stage are critical for a proper innovation forum or laboratory. A renewed commitment to creativity and experimentation echoes the ethos of historical Bauhaus: Bauhaus literally means 'house of construction'.

4. Results

New European Bauhaus is considered to be an innovation pool, sharing the idea of transversality between disciplines beyond what historical Bauhaus was. Different results of the study are pointed out according to the actors of the innovation ecosystem.

Science, art and technology have historically intersected in the different stages of and its 'reincarnations'. At this time, as already mentioned in the section on Industrial Revolutions, the concept of sustainability needs to be stressed and juxtaposed with other concepts within the CATI perspective, as shown in Figures 4 and 5.

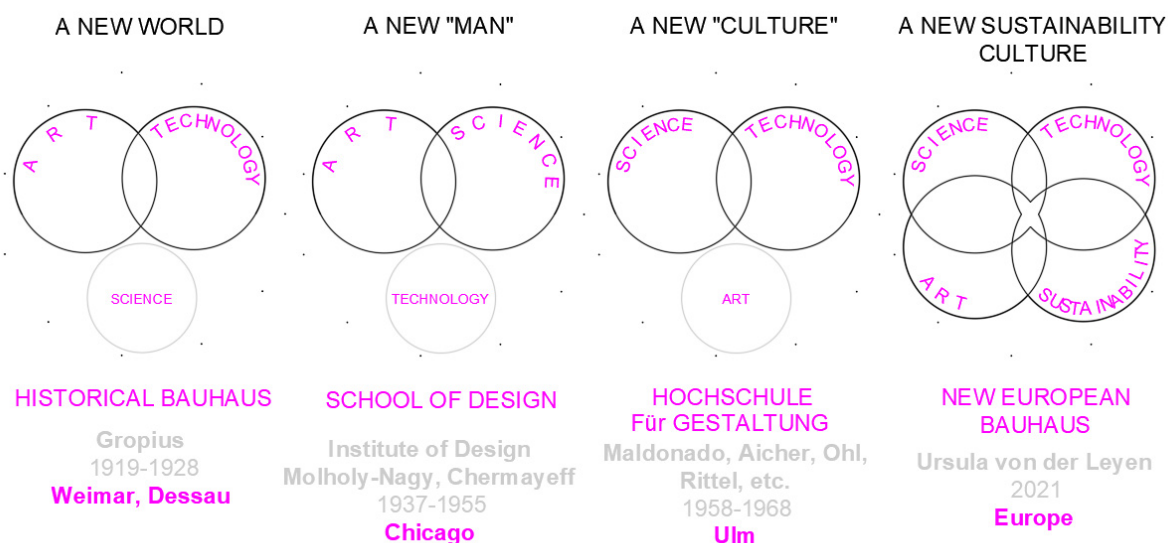


Figure 5. A new sustainability culture. Source: authors, following [2], adding New European Bauhaus-Sustainability.

This new conception of the New European Bauhaus is to have its roots in the action fields of different actors [68] within the meta-innovation ecosystem.

4.1. Government

The role of government is to provide not only physical (or virtual) infrastructure but also legislative and financial frameworks.

Thus, government should play an active role, not only in the top-down conception of the New European Bauhaus as a pool of innovation, but especially in its workings, by providing financing, in particular during the first stages of innovation and the overcoming of the ‘valley of death’ where it is proven that private financial investment is generally unreliable [66]. Private financing is the Achilles heel of the EU, especially in comparison to the United States; it can be attracted and mobilised through different new or previously conceived forms of collaboration such as blended finance [69].

New European Bauhaus brings together a necessary innovative impulse for recovery from the pandemic. The budget, and even general financial figures, are still to be defined. The initiative should reinforce the cultural and creative ecosystems which were hit especially hard by the pandemic. Culture and creativity provide a space where outdated conceptions and powerplays can be challenged.

In principle, the financing of the New European Bauhaus initiative should be sourced from European Funding, New Research and Innovation Program Horizon Europe [69], Recovery Fund under Regeneration Wave [24] or NextEurope [34], probably together with structural and regional funds, which, among others, provide finance aimed at artists as well as networking engineering innovators. Horizon Europe includes the ‘smart cities’ mission, the purpose of which is the creation of 100 climate-neutral cities in Europe by 2030 [69]. Sustainability is its main objective; therefore, the Green Deal [23] financial envelope should also be considered.

In terms of physical infrastructure, there are five centres to be developed in Europe. However, the actors’ inclusion in the process should be enabled through the careful action of government as a catalyst. Different actors have different interests, but also different capacities for participation and action with regard to the innovation powerplay in the social shaping of technology [63] and innovation.

With regard to the innovation ecosystem actors’, it is of paramount importance from an inclusiveness point of view to involve regulators from the EU and EU member states, city mayors, as well as social enterprises, environmentalists, districts and communities, which are supposed to be at the core of the unfolding approach, and evolving from purely consumers to prosumers. Technological advancements will be key for specialists and designers in the construction sector, but their implementation may be hampered without the participation of authorities. The New European Bauhaus initiative must bet on open innovation and Living Labs. It must be people-centred, systemic and transversal, open to including users and other agents in the process of research and design of products or services, and systemic and transversal to coordinate the interests of the agents involved [70].

The construction sector should be seen from a circular perspective: house building along with infrastructure, and its aging, maintenance and demolition should be considered from its very conception, without drifting apart [24]. The life cycle of a construction (a building, bridge, etc.) and the sharing of available information should be boosted by the implementation of collaborative methodologies such as building innovation methodology (BIM). This needs regulators to support the take-off, and to become a required (institutionalised) norm.

There should be sandboxes for the curation of real estate legislation [71], in order to avoid the unprecedented increase in housing prices and the speculation bubbles which increasingly threaten the socioeconomies of the EU. Approaching housing as a basic need or human right, as opposed to an investment, should be carefully re-examined. Unequal money injections in response to the COVID-19 crisis and subsequent inflationary pressures reinforce the housing affordability crisis. This is also related to praxis and policies towards

renting housing. Moreover, unused properties should be addressed. Tax policies and benchmarking of the best practices can be important in alleviating these challenges [72].

4.2. Industry

Historical Bauhaus incorporated Industrial Revolutions into human life and its closest environment, as well as shifting art towards functionality and mass production. Some companies, such as IKEA, define themselves as followers of the Bauhaus idea. The democratic character of their creations, however, needs to be reconciled with their sustainability. From this perspective, 'cheap' production and high accessibility, when not matched by a strong circular perspective, can be 'expensive' for the environment when objects are produced to be 'used and thrown away'.

In addition, Bauhaus was one of the first entities to promote what in its time would be considered as an artistic style, and would now be conceived as marketing: a corporate trademark or identity [12]. From this outlook, the current over-presence of Bauhaus in the public imagination can be explained by its successful public relations and advertising of itself. The trademark 'Bauhaus', despite 40 years of discussions, is owned by a hardware store chain and another 80–100 entities [73]. These controversies are probably as old as the polemics on intellectual property rights regarding the dichotomy between innovation and the protection of the interests of big entities and developed countries, and its role in stimulating or hampering progress [74].

Globally, the construction industry has realised the opportunities and possibilities offered by methodologies involving collaborative processes. It has begun to develop its own frame of reference that establishes the basic parameters of work and collaboration, and that encourages the implementation of methodologies such as BIM at all levels. In relation to engineering, the mandatory worldwide introduction of BIM will mean a change in the rules of, and a process of cultural evolution for, the construction industry.

BIM contains and manages the information of the end-to-end project and the product life cycle which, together with IoT and AI-generated data and information treatment, can be reused. Furthermore, it allows for better monitoring and performance in construction, when following the guidance of the buildingSMART worldwide industry body.

The BIM model centralises all feedback in a joint digital model as follows: geometric (or 3D), time (or 4D), costs (or 5D), environmental (or 6D) and maintenance (or 7D).

In particular, BIM 6D and 7D technologies can be fully used in the design stage of sustainable infrastructure. The sixth dimension, or 'Green BIM' [75], provides an opportunity to determine how the venture will behave before important decisions are made and long before construction begins. It allows the creation of variations and iterations in the envelope, the materials used, the type of fuel used to cool or heat the project, and even takes into account the project's situation, position, orientation and many other aspects. BIM 7D empowers the management of the life cycle of a project and its associated services. It enables logistical and operational control during the useful life of the project, and supports the optimisation of important processes such as inspections, repairs and maintenance [75].

Financial and legislative support, especially in the initial project phases, should be provided by government in order to support the industry and meet its deadlines [76].

4.3. Academia

Historical Bauhaus was thought of as an inclusive educative space, which students were allowed to enter irrespective of their social background, previous education, or, in principle, gender. Maximum efficiency and spatial logic orchestrated the dispositions of relationships.

There were several Bauhaus education reform sources and dimensions [77]. They are discussed here because they still impact the current scholarship model [78]. The first dimension was the revision of the values and methods applied in education in general and art in particular; members of the school were taught to 'unleash participants' creative forces' through spontaneity and intuition [79].

Another influence on the schooling model was closely related to the Industrial Revolution. For the first time, industrial design was treated as a profession, with its own techniques, rules and purpose. It is projected that [80] the Fourth Industrial Revolution will cause 35% of current jobs to be taken over by robots and computers. A transition in education should accompany this increasing complexity [81], especially in the dimension of human–machine collaboration in the context of collective intelligence.

An additional source of Bauhaus' impact on pedagogy was its construction of the modern formal art theory. It aimed to find a uniquely optimal way to organise forms and their teleology, and to find a single and unique truth. The professed universality, atemporality, scientific grounding and metaphysics of such a theory, resulting in what today can be considered theorems or even dogmas and propaganda [79], seem too strenuous and insufficient for today's paradigms.

What is important is that education was centred on experimentation, participation and creation [82]. Thus, experimental practices and pedagogies were able to challenge the status quo, or predetermined forms of design, art and architecture, and to transcend the impasse of the sociotechnical landscape at the regime level, as Bauhaus students' success in the industry exemplifies.

Innovation and knowledge transfer are seen as the backbones of the innovation poles. It remains to be seen how the transference from the outdated concepts of applied arts and science (technology), towards 'involved', 'situational', 'embedded' or 'translational' science, is to be applied in the New European Bauhaus.

Moreover, Bauhaus had several entrepreneurial initiatives, which might today be called 'innovation spin-offs', and was, in a sense, an entrepreneurial university [83]. In 1925, the Bauhaus GmbH company was founded in order to sell school products. In 1927, Bauhaus signed a contract with the company Schwintzer to sell its lamps [84]. In the current era, collaboration between universities and industry, enabled and boosted by the government, is also necessary in pedagogical design, course delivery, and educational outcomes [85].

Designer and user/citizen participation (as the system's stakeholders) can be understood as a problem or a system state by situational reasoning. This presupposes thinking in terms of system or collective intelligence [6,86,87]. Gropius' visual intelligence needs to be thoroughly re-evaluated, and this re-evaluation should include the Moholy-Nagy relational vision and current environmental and social sustainability aspects, as well as the symbolic world or 'semiocosm' of the culture.

Urban, media or living labs can help to bring forward this perspective [88,89], especially because they take the participation of citizens into account. Knowledge pooling, research and experimentation are crucial in this sense.

These educational and research dimensions have been foreseen by the Commission, as the planning for the New European Bauhaus initiative is currently in the hands of the Joint Research Centre. Separate research calls are to be launched by Horizon Europe and the 'smart cities' mission. The different climatic areas of Europe are to be taken into account when assessing the proof of concepts of researchers' projects proposals.

Academia needs to take a leading role in this process, being a niche of ideas [90] from the multilevel and process perspectives.

In considering what is demanded by society in terms of aesthetics and cultural values, it should be possible to re-integrate the academic training of civil engineering and architecture into a renewed profession that is enriched by all kinds of cultural, scientific and environmental values. An integral vision of reality could decisively contribute to the construction of a complete and more harmonious human environment [91].

4.4. Society

The vision that society has of architecture, engineering and construction in a context of a broadly understood living space is a priority. Furthermore, it is crucial to comprehend how art and culture shape innovation at the landscape level.

All these changes are accompanied by a new vision of the individual and its place in the world. The international style of Bauhaus supposed a turn towards a nomadic modern man, without roots in a particular time or place. The new man was to live in machines, or ‘living machines’ [92] and the kind of austerity displayed by the style was called the ‘machine aesthetic’ [79].

Nonetheless, in the current, era human- and life-centredness [93] are proclaimed as a response to ‘Future of Work’ issues, which have left humans disempowered in the face of machine-centred systems. Furthermore, it is imperative that society understands that our economies are embedded in nature. They are not external to it, and the success of our present and future development is completely linked to the sustainability of the planet, not opposed to it [94]. An approach to the future of work and the sustainability of the planet which consists of merely improving skills, even if these are transversal, is considered to be insufficient in the face of these structural issues.

Inclusion and gender equality are fundamental to advancement at the outset of the Fifth Industrial Revolution. The Bauhaus ideal, in terms of gender policy, was, at the very beginning, very progressive, announcing the possibility of the incorporation of people irrespectively of age and sex. However, after what was considered as excessive female participation, even Gropius began to treat people in discriminatory ways, fearing the loss of the school’s prestige. Thus, a kind of ‘glass ceiling’ was introduced where women were steered toward the weaving workshop, which was considered of secondary importance, even if it was crucial to interior and fashion design. This workshop became the most long-lived and commercially successful of the Bauhaus workshops.

Some women managed to be incorporated in the rather strictly male-dominated workshops, and had flourishing—if publicly silenced—careers afterwards. It should, however, be recognised that Bauhaus was one of the first schools which provided diplomas that allowed women to work in the industry [95]. Effective inclusiveness and the empowerment of minorities is one of the declared focal points of the New European Bauhaus.

4.4.1. Vision of Construction

In historical Bauhaus, architecture and design were understood as an ideology, or a symbolic form of the expression of social phenomena in terms of provision of culture in technical, economic, social and spiritual or moral dimensions. Space, expression and art were to be unified under this ideology. The building was seen as a transparent illustration of a fluctuating balance of forces. The complexity of Gropius’ concept of architecture is multidimensional: not only technical, but above all aesthetic as well as semantic [12].

In practice, however, function was prioritised over artistic consistency. The activities to be performed in the house, and building placement, were the main premises for design articulation. In addition to the study of individual human needs, during Meyer’s time, the search for harmony in social organisation, the promotion of democracy, and expression was brought forward. Even so, the imposition of technical and functional rationalism on the individual received many critiques [92,96,97], especially when it ended up related to the reproduction and deepening of already very asymmetrical power relations in society.

Today, just as after the Second World War, a lack of housing means that having a place to stay is confused with having a place to live. Not only housing, but also civil engineering constructions and infrastructure, as well as natural environment, are important elements of human habitation. This idea is not new. At the end of the 19th century, there was a wave of thought in Europe about what new form housing should take, which included environmental values and a return to nature. This can be illustrated by the case of the Linear City of Arturo Soria in Madrid: “for each family a house, and in each house, an orchard and a garden” [98]. This was the first manifestation of the Garden City movement, which proposed a new urban design for a healthy life and healthy work in which agricultural land, forests and nature had a central role [99]. The COVID-19 pandemic has once more generated that urgent need to recover a healthy, open, social living space that is in contact with nature. Citizens of various countries and cultural environments have led an exodus to

rural areas in pursuit of a fuller and healthier life [100]. Thus, today more than ever, physical places that grant space for liveable, socially significant environments are necessary [101]. The New European Bauhaus must facilitate the sustainable creation of the buildings and infrastructure that will generate these places [102].

The creative process of traditional civil engineering is interrupted by the consideration of integration in the environment, in the sense of integration in nature, in physical space. On rare occasions, a social or cultural demand is met, or its importance in the community is taken into account. Place, as required by contemporary society, is understood as a matter of aesthetic experience, and a generator of discourse between the creations of man and nature and culture. Future engineering should thus focus on the generation of social relations, and collective and shared processes of public space. Concepts of collective authorship, and opportunities for the generation of social equality, are linked to the socio-cultural significance of engineering as characteristics of democracy.

Furthermore, it is necessary to overcome the old commonplace, inherited from the Industrial Revolution, of the functionality–beauty dichotomy which equates the useful with the unsightly [103]. Monotony is not gratifying; details are relevant, and society wants beauty because it makes people feel harmonious and happy [104], even more than the cleanliness or safety of the inhabited space [105].

4.4.2. Art, Aesthetics and Culture Roles

The contribution of the creative sector should overcome the purely formal added value of beauty and ephemeral pleasure. Culture is also essential to an exploration of the complex challenges, inquiry into our interdependence with the environment, and the nourishment of humans' collective life. It has a value in itself. Culture evolves society, fosters critical thinking, and transforms the sociotechnical landscape by expressing and negotiating collective narratives. Moreover, cultural diversity is at the very heart of the European Project, as stated in article 3 of its Treaty [106] and Charter of Fundamental Rights [107].

Historical Bauhaus was an attempt to include the practical application of scientific and technical advances into the artistic object, so that these could be integrated into everyday life. Viewed in perspective, it was a worthwhile experiment, however debilitated it was by the romanticism and medieval and baroque concepts of the total work, and also by the subordination of the arts to design and to architecture. The utilitarianism of the art object attenuated and diluted the power to generate critical and social meaning of greater scope [108].

Today's society sees 'art for art's sake' as normal, even if it is not understood or apprehended. However, this can be alienating, and any judgement of quality seem to be out the scope of society [84]. This can result in a dangerous 'anything goes' approach, the cynical, destructive dimension of which is worrying: there is no apprehension of beauty [109].

In terms of the social role of art, the next step in similar directions of paradigm shift is the concept of participatory art, with advocacy of art as resistance to any phenomenon of homogenisation or globalisation, which are considered to be anesthetisers of innovation. In this sense, authorships of all kinds are multiple and are continually indebted to others. What matters are the ideas, experiences, and possibilities that result from transversal interactions and relate dimensions which are at odds, such as Apollonian idealist or logical forces in opposition to Dionysian forces [110].

Art spaces should avoid disconnection from other forms of experience in day-to-day life [111]. Dualities and dichotomies should be avoided, so that they do not reduce the discourse into a choice between art and crafts, culture and science, aesthetics, and engineering, means and ends. In transversal relations, the concept of 'place' appears as social and cultural transcendence and development.

4.5. Natural Environment

The precursory vision of Bauhaus is also recognised thanks to the environmental sensitivity intertwined both philosophically and pragmatically in its endeavours [112,113]. The merger of ecology and design, art and science laid the foundation for modernist architecture. The ideas of ‘Spaceship Earth’ and closed systems [114,115] promoted the ideas of space ecology and environmental awareness, and the conception of harmony between humans and the built environment.

This interrelated or relational nature of every human construct is especially relevant, because buildings can be understood as skins or membranes for communications, but on the other hand, as an enclosure of the surroundings. It remains to be seen if closed circuits can really be applied in the circular dimension of sustainability [116], but the use of natural materials, as highlighted by Van der Leyen, may represent a step in this direction.

On the other hand, smart territories are advocated here as the mandatory evolution of smart cities [117]. The spatial geographic and relational context lends the ‘smart’ adjective more grounding and efficiency [118].

Cities grow into megalopolises with progressive migration towards urban areas, a trend that is partially counteracted by growing work virtualisation, which is partly a result of COVID-19. What has happened in the last year has shown that the city cannot be the only focus of interest for ‘smart’ concept, but should include all elements inside or outside the metropolitan area and the public infrastructure, and any municipality. The ‘smart strategies’ and dynamic capabilities of European cities are being analysed to achieve sustainable smart cities in Europe [119].

Such a network of articulations must transcend the rigidity of isolated artifacts such as buildings or cities and generate more and more sustainable, cohesive and inclusive collective places [120], as environments for cooperation and coexistence between dwellings and their surroundings whose purpose is to respond to the needs of the population, but also to the maintenance of biodiversity, which is crucial in the fight against future pandemics.

Smart territories are made up of a network of buildings, infrastructure, communications and communities whose elements are monitored in such a way that this system is nourished by data. This requires collaborative environments, citizen interaction and their involvement in new models of coexistence.

In the current era, the art component has often been trivialised by relating it to the search for new envelopes for construction. When construction projects are out of scale, they create oversized works with consequent problems of operation, conservation and extra costs.

In this post-industrial and information society, the focus has shifted from more production to less consumption in order to achieve sustainability. However, increased resilience is also required to allow adaptation to shocks brought about by climate change (such as extreme weather conditions and inclemency) or health challenges [121]. This requires real-time collaboration and both reactive and preventive feedback; in the case of smart territories and cities, this can be achieved with the support of technology. When modelling resilient systems, and in order to manage the cost and complexity that is in part due to required redundancies, innovation ecosystems should tend to make them simple at their core, but allow for diversification at their edges [122]. The scaling up and down, de-intensification, diversification, clustering and decoupling of systems from their material resources should be a part of embedded counter-mechanisms to adverse conditions.

Preventive or corrective actions need to be taken into account in the design process. Integrated models such as BIM and technologies such as Geographic Information Systems (GIS) [123] can help to deal with these challenges. Shared urban greenspaces, and the European strategy for Green [124] as well as Blue Infrastructure [125], can also be relevant to the promotion the relational social and environmental sustainability [126]. New forms of liveable houses and cities should reconcile the interrelation of sociability, but also privacy and social distancing when required. This has been made especially clear by the COVID-19 pandemic, which has brought forward physical and mental health considera-

tions. The concept of the network and smart territory must be emphasised in the face of the coming transformation.

The best formula to guarantee respect for the environment and for nature is to think that what we take from the environment when we build, we are obliged to return in culture [127].

5. Discussion

New European Bauhaus is necessary and, moreover, a worldwide Bauhaus is required: Bauhaus based on relations that propel innovation ecosystems, their actors, and their processes. These demand unprecedented and coordinated efforts from policymakers and theorists and practitioners in all spheres, as outlined by the innovation actors' dimensions described above.

At the level of the EU and its member states, governments need to provide physical, legal and financial infrastructure, and especially to address the issue of housing as a need or basic human right, as opposed to an investment. This is seen as a relevant new line of study, and extends the scope of this analysis. Private financing of innovation and the application of sustainable finance in this field is another relevant line of study.

From the perspective of industry, it is time to advance the development and implementation of collective methodologies such as BIM in construction engineering. Research on the appropriate strategy for the management of such tools, especially if they are not public and open source, also opens new scopes for this analysis. Collaborative methodologies should be vehicles for the design and management of fully circular life cycles in construction. A more detailed investigation on the propulsion of sustainability through circularity by design in the construction sector is necessary.

The climate crisis and the COVID-19 pandemic demand the reinforcement of approaches to resilience, which calls for an augmented relationality and for human-machine collaboration in a sense of conscientious collective intelligence orchestration. These must be inextricable from the full participation of society, whereby inclusiveness and the social shaping of technology are truly enabled. Structures of collaborative environments where data can be collected and operated by communities are needed. Without a doubt, both resilience and collective intelligence orchestration have potential for research scope enlargement. The Future of Work perspective, with regard to the orientation of the New European Bauhaus, is another necessary line of study.

The human factor, also known as ergonomics [128], as interdisciplinary and inclusive knowledge is in line with the assumptions of the New European Bauhaus and is of decisive importance for the success of the activities described. It is, broadly, about designing with respect to the capabilities of humans. Emphasis is placed on designing the products with which people work, the tasks or jobs people perform, and environments in which people live. Engineers [129] and researchers working on human factors will have to study different concepts of how different designs influence human behaviour.

The Academy is a fundamental link, because new education and research that deepens transversality, aesthetic considerations and the interrelation between disciplines and arts is required.

Sustainability requires inclusiveness and a conception of universal citizenship. Global society should proceed by 'relational inclusion' and overcome functional dialectics. Living and media labs which allow common knowledge creation and innovation advancement should be key in this process [130].

The ecosystem vision promotes the idea of the networked 'place for life', as well as the creation of public space; the smart city concept thus needs to transcend itself into a concept of 'smart territory' which revolves around the co-habiting of the planet Earth by both humans and nature. Only in this way can a compelling idea of the New European Bauhaus impact and transcend the current socioeconomy and create a New Sustainability Culture.

6. Conclusions

This is a transversal study, where different fields of knowledge such as economics, engineering, innovation, art and philosophy converge. This is a comprehensive approach, but due to this global character it also leaves many spaces which invite further developments in research and in praxis; only the most immediate ones are highlighted here.

The study is based on transversality and the innovation ecosystems outlook. The approach to transversality is carried out using the visual tool developed by the authors, CATI, and with the consideration of sustainability as the backbone of the study. The need for concrete actions on the part of actors in the innovation ecosystem is pointed out. Policymakers at government level should provide financial, physical and legislative infrastructure, and ensure a level playing field for all actors.

From the perspective of industry, collaborative technologies such as BIM are crucial for the development of collective intelligence, while creating an environment in which opportunities and synergies can arise.

Academia should be able to ensure a transversal, experimental and participative education in architecture, engineering, art, design and the humanities, as well providing a niche for disruptive innovation development.

From the perspective of society, a true social shaping of technology should allow for social sustainability, while embracing aesthetic and cultural dimensions. Full life cycle inclusion, circularity by design, and the integration of ecological infrastructure and landscape in the sense of smart territory, are critical from the perspective of the sustainability of the natural environment. This will provide resilience in the face of the climate and health crises.

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