

The New Ecological-Architectural Imperative

Hugo Rodrigues Ferreira da Silva Cunha, ARCHITECT

Master of Architecture

hugocunha.pt@gmail.com

Luís Pinto de Faria, ARCHITECT

Associate Professor, Faculty of Science and Technology – University Fernando Pessoa

CAPP – ISCPSP, Universidade de Lisboa | LEP – FCT, Universidade Fernando Pessoa

lpintof@ufp.edu.pt

RESUMO

No actual contexto do século XXI, amplamente integrado numa 'Era Ecológica' e alegadamente em plena 'Época do Antropoceno', cresce o consenso geral em torno da especificidade do momento de mudança que atravessamos e da necessidade de proceder a readaptações e desenvolver acções mais coadunáveis com uma nova realidade sócio-ecológica. Torna-se cada vez mais evidente que o fenómeno global das alterações climáticas e o corrente processo de urbanização planetária estão profundamente relacionados com o agravamento de cumulativos problemas ambientais, económicos e sociais que se conjugam numa profunda 'crise ecosistémica', no epicentro da qual surgem as cidades e, inevitavelmente, a Arquitectura. Hoje confrontada com profundos 'desafios ecológicos' – que afetam a sua própria 'orgânica' interna –, a Arquitectura procura libertar-se de preconceitos e readaptar-se a novas realidades, através de uma 'metamorfose' disciplinar que lhe permita evoluir novos modos de interpretação e acção – 'ecologização'. Nesse sentido, enunciamos aqui a génese e os fundamentos de/para um novo imperativo ecológico-arquitectónico.

PALAVRAS-CHAVE

Antropoceno, Crise, Desafio, Imperativo, Ecologização

ABSTRACT

In the context of the 21st century, broadly integrated in the 'Ecological Era', and allegedly in the epoch of the 'Anthropocene', grows a general consensus regarding the specificity of the current moment of change and the need of proceeding to re-adaptations and developing actions more compatible with a new socio-ecological reality. It is increasingly evident that the current phenomena of global climate change and the ongoing process of planetary urbanization are deeply interrelated with the aggravation of cumulative environmental, economic and social problems that combine in a profound 'ecosystemic crisis', at the epicenter of which are cities and, inevitably, Architecture. Now confronted with profound 'ecological challenges' – that affect its own internal organic –, Architecture seeks to overcome preconceptions and readapt to new realities, by means of a disciplinary 'metamorphosis' that allows it to evolve new modes of interpretation and action – 'ecologization'. In this sense, we enunciate the genesis and the fundamentals of/towards a new 'Ecological-Architectural imperative'.

KEYWORDS

Anthropocene, Crisis, Challenge, Imperative, Ecologize

THE ECOLOGICAL CONTEXT AND CHALLENGE

In 2008 the world hit an invisible but momentous milestone: the point at which the percentage of the world population living in urban spaces crossed the mark of 50%¹ – in 1950 this value was inferior to 30% – what can be seen as the second major civilizational revolution after the planetary sedentarism that occurred 10.000 years ago [Seixas, 2004, p. 54]. Considering that today exist 20 'megacities' with more than 10 million inhabitants – whereas in 1950 New York and Tokyo were the only cities with more than 10 million people [Worldwatch Institute, 2007, p. xxiii] –; that the United Nations predict this number will raise to 22 in 2015; that 10 of these 22 cities will have more than 20 million inhabitants; and amongst these 10 cities only one will belong to a developed country [Ledo, 2004, p. 19], one can deduce the immense responsibility that rests on the several agents who plan, condition and 'sustain' the processes and patterns of urban development.

Coinciding with this unprecedented geo-demographic reality, today we find an equally unprecedented global environmental condition, one that already gave origin to a widely debated and broadly resonant concept which has been gaining acceptance in a growing number of fields – the '*Anthropocene*'. A term coined over a decade ago by Nobel Prize-winning scientist Paul Crutzen and colleague Eugene Stoermer [Crutzen *et al.*, 2000, pp. 17–18] to characterize the new geological epoch we have entered – one defined by human activity and denoting the idea of humans as a new planetary forcing agent.

A growing number of scientists now believe that human activity has so irrevocably altered our planet that we have pushed Earth into a new geological epoch of our own making. The Anthropocene hypothesis was put forward at a time of dawning realization that humanity has been transforming the Earth and the Biosphere² in a way that matches the great forces of nature and on a scale only comparable with some major events of the ancient past. The complex range of man-made effects that result from human activities (beginning in large scale with the industrial revolution) such as industrial production and consumption, natural resource exploitation, urban development and construc-

tion, landscape remodelling and mass transportation, has reached a tipping point, after which science and society in general cannot ignore the causative human element and its decisive influence on planetary systems – i.e. its 'ecological impact'.

Indeed, a growing evidence base of scientific and empirical observations demonstrate how human activity has been directly and indirectly linked to profound changes in the climate system over the past several decades. Changes which in turn induce further alterations on planetary processes and ecosystems. From altering the carbon, nitrogen, water and phosphorus cycles, to changing and degrading Earth's life support systems: the atmosphere, oceans, waterways, forests, ice sheets, and biodiversity that ultimately allow us to thrive and prosper, not least survive. Basically, human civilization has become the prime driver of global environmental change – we are rapidly changing the physics, chemistry, and biology of the entire planet – and we have already exerted such influence on the biogeophysical world to the point where we need to take responsibility for our very existence.

While the underlying idea of the Anthropocene can be understood as a broad metaphor to denote human interactions with planetary systems – interactions that are likely to increase in scale and intensity – it is also a reminder that the previous epoch of the *Holocene* – during which complex human societies and settlements have developed – has been a stable accommodating environment. Therefore, the Anthropocene is also an alert to the reality and risks of a very different set of global ecological conditions, as it represents the acknowledgment that the world has substantially changed through human activity – an acknowledgment akin to the Intergovernmental Panel on Climate Change (IPCC) consensual statements on climate change.

The headline statements of the latest IPCC Fifth Assessment Report – which provides a scientific basis for considerations of the impacts of climate change on human and natural systems and ways to meet the challenge of climate change – states that "[...] the warming of the climate system is unequivocal [...] human influence on the climate system is clear, and evident in most regions of the globe [...]";

that "[...] continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system [...]" – which implicates in the increasing intensity and frequency of extreme weather phenomena like heat waves or increased flooding –; and also that "[...] as a result of our past, present and expected future emissions of CO₂, we are committed to climate change, and effects will persist for many centuries even if emissions of CO₂ stop." [IPCC, 2013(b)] Although the first conclusions of the latest IPCC Report (to be completed later this year) are not new or unexpected to most of us, they underline and reaffirm the seriousness of climate and environmental changes, and stress the need for corresponding ecological strategies and actions.

The advent of the Anthropocene hypothesis indeed poses a wide range of implications, but it is mostly the scientific acknowledgement and the collective awareness of a whole new ecological reality, and the perception of our place and our role within it, that brings up additional problems, new challenges, and unique opportunities – some of the most critical regarding a necessary 'shift' in our built-environments, our cities, our buildings, and even our lifestyles. As Paul Crutzen mentions:

"To master this huge shift, we must change the way we perceive ourselves and our role in the world. [...] Rather than representing yet another sign of human hubris, [the Anthropocene] would stress the enormity of humanity's responsibility as stewards of the Earth. [...] It would highlight the immense power of our intellect and our creativity, and the opportunities they offer for shaping the future. [...] Living up to the Anthropocene means building a culture that grows with Earth's biological wealth instead of depleting it." [Crutzen et al., 2011]

Considering the context of global climate and environmental changes, in the perils of both an ever growing human population – projected to exceed 10 billion inhabitants later this century (United Nations, 2012) – and an ever expanding 'urban planet', we can easily predict the rise of even more overwhelming socio-ecological problems and challenges. The contemporary process of 'planetary urbanization' that Henri Lefebvre anticipated over four decades ago by hinting

at a whole new urban-social reality – not just of expanding cities but the phenomena of a rapid and complete urbanization of society worldwide (Lefebvre, 2013) – with the subsequent increase in demand for inputs (water, food, energy and material resources), shelter, infrastructure, transport and so on, not only rises environmental pressures but also brings up additional demographic, humanitarian, economic and socio-political problems.

"We spread our man-made ecosystems, including mega-regions with more than 100 million inhabitants, as landscapes characterized by heavy human use – degraded agricultural lands, industrial wastelands, and recreational landscapes – become characteristic of Earth's terrestrial surface. We infuse huge quantities of synthetic chemicals and persistent waste into Earth's metabolism." [Crutzen et al., 2011]

While these endemically anti-ecological 'anthropization' processes unfold, both cities and architecture – due to their extensive and undeniable effects on the Biosphere – are inevitably pointed out as the main source of the global ecological degradation. However, Jaime Lerner states that:

"If the last century was the century of urbanization, the twenty-first will be the century of cities. It is in the cities that decisive battles for the quality of life will be fought, and their outcomes will have a defining effect on the planet's environment and on human relations. [...] Cities are not problems, they are solutions." [Worldwatch Institute, 2007, p. xx]

The remarkable work and experience of Jaime Lerner – former mayor of Curitiba, Brazil, who implemented and coordinated a strategy that turned the city into a world reference in waste management, sustainable public transport, ecological restoration, green industry and public services – may help to avoid the fallacy of reactively holding cities (and the urban condition in general) as the main cause of environmental problems but not their solution, especially considering that problems and solutions are often interdependent. There are also many ways in which cities are key to both human development and environmental sustainability. Indeed, cities are now both pioneers of groundbreaking ecological initiatives and the direct or indirect source of most of the global resource depletion, environmental pollution and

ecological degradation. This ambiguity means that the cause of the problem is not urbanization *per se* but the mode of urbanization – and the predominant kinds of architecture.

There is a growing awareness that urban development, constructed landscapes and architecture have been playing a very significant role in exacerbating the environmental problems that threaten humanity. However, they are also a crucial part of the solution. Urban sociologist Saskia Sassen explains that:

"Cities are a type of socio-ecological system that has an expanding range of articulations with nature's ecologies. Today, most of these articulations produce environmental damage." [...] "The enormously distinctive presence that is urbanization is directly and indirectly contributing to change a growing range of nature's ecologies, from the climate to species diversity. [...] Urbanization and industrialization have made humankind the major consumer of all significant ecosystems. [...] Major cities have become distinct socio-ecological systems with planetary reach, going well beyond urban space." [...] "The city is today a strategic space for the direct and often brutal encounter between forces enormously destructive of the environment and increasingly acute needs for environmental viability. Much of what we keep describing as global environmental challenges becomes concrete and urgent in cities." [Sassen, 2009, pp. 45–52]

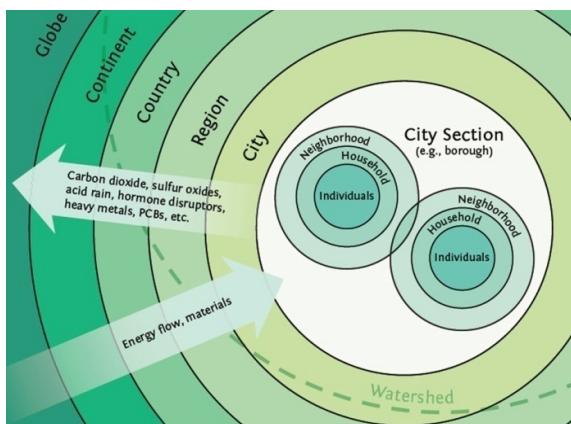


Fig.1 The Nested Scales of Urban Impacts on the Biosphere.
Figure shows the interconnectivity of the world from the largest scale to the scale of the individual, with watersheds showing across regions. Energy and materials – which release carbon dioxide, sulphur oxides, acid

rain, hormone disruptors, heavy metals, PCBs, and other poisons that are often shipped from developed countries to developing countries – flow into the city. Each urban combination of elements is unique, as is the way it fits within local and regional ecosystems. (Source: Berkshire Encyclopedia of Sustainability, (2012). Volume 10: The Future of Sustainability, p. 37. Berkshire Publishing Group.)

The global urban condition and the massive process of urbanization under way today are clearly major factors in our common urban-environmental future. Therefore, Saskia Sassen also states that:

"It is now urgent to make cities and urbanization part of the solution: we need to use and build upon those features of cities that can re-orient the material and organizational ecologies of cities towards positive interactions with nature's ecologies. These interactions, and the diversity of domains they cover, are themselves an emergent socio-ecological system that bridges the city's and nature's ecologies. [...] Cities have long been sites for innovation and for developing and instituting complex physical and organizational systems. Up till now many of these systems have been driven by narrow market criteria and corporate profit logics. [...] It is now time to develop and implement complex systems that address our environmental challenges." [Sassen, 2009, pp. 45–52]

This 'urgency' highlights the need to develop more integrated studies and implement more effective measures in the framework of 'sustainable development' and 'ecology', focusing the urban context. At the centre of this new agenda and the target for change is not only 'the city' but also Architecture, now facing increasing scrutiny and inquiry of its capacity and competence – as a presumed autonomous discipline – to properly consider, integrate and respond to the new social-ecological solicitations. This means that cities and Architecture are now simultaneously in the epicentre of the problem and the solution; both are strategic and decisive in defining our ecological future.

The current global urban condition – and the corresponding social-ecological reality – undoubtedly requires a profound change and a reorientation in the ways we interpret and engage with it. It stresses the need to alter our relationship with the planet we inhabit, calling for new kinds of 'human

agency'. It forces us to ask new kinds of questions and demands deeper reflections in the ways of thinking and doing Architecture, requiring a critical reassessment of values and practices, and a greater accountability for our actions as architects and citizens.

On a more subjective level, this particularly critical moment of our history – marked by profound environmental, economic, and socio-political crises as parts of a whole 'ecosystemic crisis' – also brings forward the perception of what the French philosopher Bruno Latour characterizes as the "*entanglements*" of all those things that were once imagined to be separable – science, morality, religion, law, technology, finance and politics. All of the human and non-human associations are finally coming to the center of our consciousness. Science, technology and demography now make clear that we can never separate ourselves from the nonhuman world – that we, our culture, our technologies, and nature can no longer be "*disentangled*". [Latour, 2011]

The perception of these deep interconnections underlines the necessity of seeking new perspectives and new comprehensive syntheses, while cultivating our capacity to discern complex-ecological systems – what the key ecological-thinker Gregory Bateson once called "*the patterns that connect*" (Bateson, 1979, p. 16). This implies thinking ecologically and transversally across different meanings, ideas and fields, which is particularly important at a time when the density and complexity of relations between the ecological and the social are increasingly evident and critical.

Considering the necessity of properly dialoguing with new realities and intervening in territories that are ever more complex, mutable and interconnected, Architecture – in its current plurality – tends to explore new conceptual and methodological approaches, which must be specific enough to keep sense of the most particular aspects of the individual and contextual, but also comprehensive enough not to lose sense of the integrity and reciprocity of reality – the correlation between the whole and its parts.

In view of the current crisis and following an impulse to reinterpret today's reality, we detect a new or renovated interest for the 'natural/living world'. A tendency which,

along with the advance of new technologies; enlightened by the new 'complex sciences' – i.e. those epistemologically distinct sciences that challenge the scientific revolution's mechanistic and reductionist view of nature, like the science of Ecology itself –; and integrated in the evolving 'planetary consciousness' and 'ecological paradigm' these help to inform, seems to provide a prolific metaphor, either in conceptual, formal, functional, or methodological terms. Besides, the natural/living world constitutes an appealing reference for practices that are intended to be more resonant of current environmental problems, eventually providing the arguments for new architectural interventions, presumably in response to those problems.

In this sense, 'ecology' – despite frequently reduced to a mere rhetoric – has been gradually integrated in the discourse and practice of Architecture, first through the 'alternative' environmentalist movement to which was initially associated with, and then, very reluctantly, regarded as a relevant source of knowledge and a potentially useful methodological tool, scientifically and philosophically capable of dealing with organic-complex-ecological processes and systems.

THE <>ECO> PARADOX

Despite still residual, the importation of some conceptual and methodological principles of Ecology into the discourse and practice of Architecture has been generally preconditioned by certain idealist notions to which 'ecology' is still connoted with, thus being frequently associated with vague adjectives such as 'green', 'natural', 'bio', 'eco' or 'sustainable'. Consequently, the indiscriminate use of these adjectives creates a few misunderstandings within the field of Architecture – feeding rhetoric discourses, general doubts and scepticism – which tend to result in a widespread incomprehension of what exactly is 'ecology' about. Effectively, by analysing many studies and debates dedicated to this subject, we can prove some misconceptions and confirm that both a reductionist-dualist tendency and an idealist-environmentalist tone still prevail.

Considering that the sophistication of the current means of communication and the subsequent globalization of information have been ensuring an immediate and widespread divulgence of a series of global environmental issues which clearly translate the damage inflicted in the Biosphere, and that the factors most directly associated with the climate, natural resources, and energy are those which most perceptively affect populations, the oversimplification and reduction of complex ecological problems to a set of separated environmental[ist] issues was a predictable risk. Although to some extent, this 'globalized and mediatised environmentalism' also has counterproductive effects, since its reductionism³ hampers adequate understandings and responses to major complex-ecological problems. Some of the most evident and quotidian examples of this are the new forms of 'green consumerism' and the growing market[ing] of products and services that are simply labelled as 'eco-friendly' without a critical evaluation – part of the 'green' building industry and 'greenwashed' architecture included.

Meanwhile, global climate change, pollution, depletion of resources, deforestation and desertification, degradation of ecosystems, loss of biodiversity and extinction of species continue apace, and we remain largely unable to slow, let alone reverse, the rise in man-made greenhouse gas emissions responsible for global warming. Despite the multiple signs of global ecological decline, it is clear that we are not properly responding to the problems around us and their endemic causes are not being effectively addressed. Hence, some contemporary ecological thinkers, noting that there is an environmental problem but also a problem with environmentalism, now argue that mainstream environmentalism, in its current formulations and apparent incapacity to evolve, has even become an obstacle in addressing the most critical ecological problems [Nordhaus *et al.*, 2011]. Following this line of thought, Bruno Latour proposes "*a breakthrough from environmentalism to postenvironmentalism*" [Latour, 2011, p.17], while in the essay "*To Modernize or to Ecologize*" the author questions the roots of our notions of 'nature', hinting at the possibility of understanding ecology beyond preconceived notions – as "*a new way to handle all the objects of human and non-human collective life [...] another way of considering everything*" [Latour, 1998, pp. 220–242]. From a different perspective, 'dark ecologist' Timothy Mor-

ton advances a more radical idea – an "*ecology without nature*" [Morton, 2007]. Without necessarily subscribing to these polemic conceptions, they are thought-provoking and can raise pertinent questions about our inherited or idealized notions of 'nature', 'environment' or 'ecology', and eventually can help us rethinking and reformulating them. Something that might be useful within our field – more critical-reflexive and creative thinking – so that we can stay present in the current reality and participate in it more meaningfully, without unconscious prejudice.

Nevertheless, the attention that the media has been providing to environmental issues – despite often in a sensationalist and decontextualized way – and their subsequent globalization and mediatisation phenomena, are ultimately translated in the growth of a collective environmental awareness. The beginning of the new millennium was marked by aggravated experiences of confrontation with the global environmental damage, followed by an increasing public concern about new ecological problems, above the usual environmental concerns such as pollution, extinction of species or deforestation. Global Warming stood out from other environmental concerns and it was generalized the notion that it would induce further systemic impacts, bringing severe consequences to most of the world population. Suddenly, the global environmental problem turned into a 'glocal' socio-ecological problem that affects everyone's individual and collective sphere, being now perceived as a threat to our health and well-being, to our safety and prosperity, and even to our chance of survival – especially that of future generations. The turn of the millennium corresponded to a moment of decisive change in the way how environmental issues were acknowledged all over the world. It stressed the need to pay close regard to the more complex aspects of the environment and it was definitely a 'tipping point' in our collective ecological awareness. At the same time, 'ecology' – even if subverted or reduced to environmentalism – quickly became one of the main themes of the 21st century, and has been subject of the most profound and critical debates of our time, also within the field of Architecture.

However, this apparent sensibility to environmental issues, and the associated mediatisation-globalization phenom-

ena, contrasts with an endemic separation and disconnection – i.e. an antagonist instead of symbiotic relation – between the built environment (architecture) and the natural environment. Noticing how buildings have become so sealed and divorced from their surroundings, William McDonough pertinently asks: *"Could we be any further from an architecture that sustains us and connects us with the natural world? Perhaps not."* [Gissen, 2002, p. 8]

Confirming this dualist tendency we notice that despite the multiplication of architectural publications and formalizations explicitly dedicated to environmental issues, the majority is still (almost exclusively) focused on a reactive 'techno-functional' response to the 'energivorous' character of modern construction methods, following a 'techno-environmentalist' imperative that seeks to mitigate the global environmental problem by aiming at reducing CO₂ emissions through simple technocratic measures. Apparently, this short-sighted focus limits the understanding of environmental (and architectural) issues as a primarily techno-functional matter, leading to an equivocal sense that environmental problems can be dealt with through technical fixes. Therefore it has generally resulted in the enunciation of normative, determinist and prescriptive 'models', often reliant on specific products and technological-fixes, as being the optimal or even the only possible responses to the pre-enunciated problems. In turn, this has led to an uncritical adoption and indiscriminate replication of standardized architectural solutions – a tendency that seems to suggest a new, or renovated 'functionalism' in Architecture, following a particular kind of thinking that resembles the paradigmatic (and pathological) 'mechanistic-rationalist-reductionist' ideal of Modernity, and even a return to Le Corbusier's canonical notion of buildings as (now presumably more efficient) "*machines for living in*".

Too often in mainstream architecture, environmental issues are linearly and directly attached to the building in terms of control, performance and mitigation. It results that buildings tend to be treated as mere technical devices; architecture is conceived as a detached 'object'; and environmental concerns are focussed on a rigorous optimization of systems – often applied with a linear and mono-causal logic that acknowledges strictly functional, objective and

quantitative criteria – to reduce energy use. In effect, the recent sustainability agenda towards low-energy buildings – despite the positive achievements concerning efficiency in energy consumption – if no other criteria are considered, actually tends to subvert sustainability itself by contradicting elementary ecological principles. A clear example of these contradictions is given by Tom Wooley, who exposes the questionable specification of synthetic, petrochemical based, and highly toxic materials that are commonly used, almost by default, to achieve predicated energy-efficiency levels, while often disregarding the embodied energy and CO₂, the process and methods of construction, the life-cycle analysis, human and ecosystem health issues and many other environmental and social drawbacks implicated in the adoption of these solutions [Wooley, 2013, p. xiii] – thus creating what we see as an 'ecological paradox'.

This practical example serves to highlight the limitations, problems and risks of too narrow 'mechanistic' responses to broad 'complex-ecological' problems. As it shows that the imperative for 'low-energy buildings', if nothing else, is narrowly focused and misses elementary aspects both of a genuine conception of sustainability and the real possibilities for more appropriate and effective ecological-architectural responses, thus also missing the significance and critical potential of Architecture in a much wider ecological framework.

Undoubtedly, designing with concern for the environment is a fundamental part of Architecture, and energy efficiency and reduction of CO₂ emissions are fundamental environmental aspects that must be addressed, but these are inseparable parts of a much larger spectrum that includes other 'vital' ecological, architectural, and social aspects that must be considered in order to effectively address major environmental issues. Due emphasis should also be given to other 'ecological functions' – such as local climate; bioregional conditions; endogenous natural resources; ecological flows and cycles (of materials, energy, water, nutrients and waste); ecosystem services; human and ecosystem adaptability and resilience – and to other qualitative and 'post-functional' aspects – such as the modes of architectural production; the design and building process; matters of occupation and use; adaptation to context, people and place;

urban and landscape integration; spatial and organizational patterns; temporality and contingency of the built-environment; cultural and socio-economic preconditions; ways of living and inhabiting; or psychological and phenomenological factors.

This is to say that technical issues are important, but our main concern should be giving them context and connecting them into a consistent and coherent whole – in other words, seeking a 'full-spectrum' integrated application, while preserving intrinsic ecological and architectural qualities. Neither ecological issues nor Architecture can be reduced to strictly objective-quantitative criteria or strictly technical measures. Neither can those be solely focused on normative standards, 'mechanistic' models and methodologies, nor simple technological-fixes. Instead, the focus should be primarily placed on more qualitative, comprehensive and competent ecological-architectural design. As William McDonough concludes, the fundamental solution isn't more regulations or quick technological fixes, but better design – which means better Architecture – while observing that:

"The sustainability agenda tends to be a framework for the reform of the existing industrial system rather than a fundamental redesign, a way of being "less bad" by being more efficient. Most architects who are sensitive to sustainability issues try to do more with less by designing buildings that make more efficient use of energy and resources. But is being less bad the same thing as being good? Does mere efficiency meet our need to connect with the natural world or does it just slow down ecological destruction? And if sustainable architecture falls short of fulfilling our needs, what would a sustaining architecture be like?" [Gissen, 2002, p. 8]

It is clear that adopting more comprehensive-holistic-ecological approaches is crucial, whether to advance effective responses to pressing environmental problems or to preserve the integrity of Architecture, enabling its wider socio-ecological contribute. However, evidences suggest that the mainstream education and practice of architecture are failing to [co]respond both to the current socio-environmental solicitations and to the call for an 'ecological shift' in Architecture. In this respect, we should acknowledge that the current ecological crisis is also a crisis of design – a crisis

of our own discipline and profession – and further a crisis of perception, culture, paradigm and epistemology⁴. As Sim Van der Ryn observes:

"The everyday world of buildings, artifacts, and domesticated landscapes is a designed world, one shaped by human purpose. The physical form of this world is a direct manifestation of what is most valued in our culture. [...] In many ways, the environmental crisis is a design crisis. It is a consequence of how things are made, buildings are constructed, and landscapes are used. Design manifests culture, and culture rests firmly on the foundation of what we believe to be true about the world. Our present forms of agriculture, architecture, engineering, and industry are derived from design epistemologies incompatible with nature's own." [Van der Ryn, 2007, pp. 24–25]

This evident gap between what we already know and what we still do, between our awareness and our actions, between our scientific knowledge and our technical capacities, between the necessary changes and the rooted paradigmatic-civilizational models, leads to this <>eco> paradoxical reality: if on the one hand, the collective consciousness about the critical environmental threats we are facing seems to be gradually reflected on some behaviours of our society, on the other hand, its true integration on a much profounder socio-cultural, ecological and civilizational transformation is still in its early infancy.

THE SHIFTING AND EXPANDING ROLE OF ARCHITECTURE

"If beauty, function and structure have been throughout history the basic drives of architecture, today, the environmental constraints have become another basic requirement that architecture must integrate and solve. [...] The challenge is to know whether humanity, with the tools of technology, will be capable of fixing the errors that threaten the natural living conditions. Ecology also talks us about the search for a new modernity where paradigms are transformed, an overcomed modernity where architecture and urbanism have the biggest responsibilities in overcoming the most destructive elements of the dominion of rationalism and modernity itself." [Montaner, 2001, pp. 196–204]

Over the years, the concept of 'sustainability' acquired many different meanings which exceeded the most common and apathetic definition born out of the highly influential Brundtland Report "Our Common Future" (World Commission on Environment and Development, 1987), in which sustainable development was unobtrusively and unambiguously defined as "*the development that meets the needs of the present without compromising the ability of future generations to meet their own needs*". Meanwhile, more informed, mature and pluralist understandings were developed, and the current meaning of sustainability, far from being a single movement or approach, is now as varied as the groups and interests grappling with the many issues it raises. Considering the diversification and complexification of the concept, and analysing how it has been imported into the architectural discourse, it is noticeable that the subject gained attention and rapidly became mainstream – with the so-called 'sustainability' now explicitly appearing in the list of concerns and design intentions of many architecture practices worldwide – while also expanded its scope and application within our discipline. In effect, despite the overuse of the term, we notice that the general understanding of sustainability in architecture has evolved and, in more committed circles, has been gradually shifting from an initial short-sighted focus – almost exclusively based on objective and quantitative criteria – towards a new '[eco]systemic focus' – i.e. a broader, more qualitative and holistic perspective, which without neglecting the previous criteria is capable of including and transcending them, contemplating other organic, complex and ecosystemic aspects (both quantitative and qualitative, objective and subjective, multi-functional and post-functional).

One of the first concrete reflexes of global environmental concerns within the architectural discourse was officially registered on the document "A Declaration of Interdependence for a Sustainable Future", written in July 1993 – right after the Earth Summit of 1992 – at the World Congress of Architects in Chicago, by combined initiative between AIA (American Institute of Architects) and UIA (Union Internationale des Architectes). A declaration in which architects, aware of the emergent environmental, social and political solicitations, committed to:

- > Place environmental and social sustainability at the core of architectural practices and professional responsibilities;
- > Develop and continually improve practices, procedures, products, curricula, services, and standards that enable the implementation of sustainable design;
- > Educate the fellow professionals, the building industry, clients, students, and the general public about the critical importance and substantial opportunities of sustainable design;
- > Establish policies, regulations, and practices in government and business that ensure sustainable design becomes normal practice;
- > Bring all existing and future elements of the built environment – in their design, production, use, and eventual reuse – up to sustainable design standards.

If we compare the "Declaration of Interdependence" of 1993 with the following "Barcelona Declaration on Sustainable Design" – "Declaración de Barcelona sobre Edificación Sostenible" –, subscribed in May 2003 by the president of UIA – Jaime Lerner –, the Royal Institute of British Architects [RIBA], the American Institute of Architects [AIA] and the Consejo Superior de los Colegios de Arquitectos de España [CSCAE], we detect quite significant differences. Let us focus on the first three of the eight topics that constitute this declaration:

- > The design of cities and buildings is responsible for the urban metabolisms that can give rise to serious consequences for the quality of life of human inhabitants;
- > The complexity of global ecological problems should inspire change in the course of uncontrolled growth of the human habitat;
- > Urban phenomena of crisis produce conflicts that must be studied with new criteria, using new tools and providing new approaches.

We can notice that while in the first declaration the repeated concept of sustainable design appeared as a pre-conceived notion that was important to promote and implement in the practice of Architecture, the following Declaration of Barcelona clearly highlighted the complexity of the ecological problems faced by humanity and the consequent necessity of seeking new perspectives, tools and methods more capable of dealing with this complexity. The gradual constitution of a new ecological consciousness within the field of Architecture can be noticed once more by comparing the previous documents with the more recent "Ljubljana Declaration on Urban Regeneration & Climate Change" of June 2008, where the European Forum for Architectural Policies [EFAP]:

- > Stresses the importance of national and regional governance frameworks, including at local community level, for evaluating public policies for the improvement of the built environment;
- > Calls for a greater involvement of the professional representative organisations in the governance process and stresses their capacity to assist in devising holistic approaches towards implementing adequate and concrete solutions in preserving the public interest;
- > Recognizes the essential role of civil society in improving the quality of the built environment and achieving a change in individual and corporate behaviour.

As this demonstrates, the need to comprehend a philosophical and methodological readaptation in the ways of thinking and doing architecture is officially considered in the theoretical agenda of the discipline, making clear that the multiple aspects that constitute the ecological *problematique*, as well as the different perspectives, narratives, interests and "[...] aspirations that cohabit in it and, quite frequently, compete against each other" [Alphandéry et al., 1993, p. 175], are not compatible with the level of superficiality and marginality with which this subject tends to be treated, neither with the lack of understanding, attentiveness and commitment that still persists in our field.

Ecology is now too important and complex an issue to be ignored or left neglected in the niche position of an 'alternative' movement. As it is also too important an issue, even for the sake of Architecture, to be simply relegated to other disciplines as just another 'externalization' – something that has got nothing to do with the discipline of Architecture as traditionally understood, with its own internal logic, its self-referential discourse and its self-presumed autonomy. Professional and academic bodies of Architecture, and society at large, should acknowledge that 'ecology' today – in the context of a global ecosystemic crisis – is no longer an optional or ideological issue, but a real paradigmatic condition and problem; and that the marginalisation of ecological issues leads to a marginalisation of Architecture itself, and consequently to a loss of social relevance and value. But perhaps even more important, the problem with this marginalisation concerns missing the very significant role that Architecture can play in the ecological debate at large, and its considerable potential in solving critical problems. As Rory Hyde observes:

"The world today is defined by a constant state of crisis. From environmental degradation, ageing populations, financial instability, natural disasters, housing shortages, global migration, xenophobia, and a growing wealth disparity, to name just a few; our societies are increasingly challenged by systemic issues on an unprecedented scale. All of these crises have spatial consequences that architects are well prepared to confront, and yet instead of diving in, we seem to be having our own crisis: a crisis of relevance."

[Hyde, 2013, p. 17]

However architects are well positioned to critically interpret the essence and the paradigmatic aspects of this '[eco] systemic crisis', and eventually recognize an historic opportunity to engage it meaningfully, rather than diverting from it. Effectively engaging this crisis probably implies assuming ecology not as an 'alternative', but as the appropriate and, more than ever, necessary way forward.

THE EVOLVING ECOLOGICAL-ARCHITECTURAL CONSCIOUSNESS

"The future ecological consciousness should not conform to concerns with environmental factors such as the atmospheric contamination, the predictable consequences of global warming, or the extinction of numerous species, but should also respond to the ecological devastation relative to the social and mental realms." [Guattari, 2003, pp. 38-47]

Whether regarding the preservation of certain intergenerational and multicultural values; the search for an ecosystemic relationship with our planet based on social values of coexistence; or the development of a post-industrial and post-capitalist economy that accounts broad environmental, social and ethical values; the evolving ecological consciousness of our society tends to gather consensus not only about the intrinsic value of nature – the Biosphere in all its complexity – as part of our common heritage, but also about its inextricable character, significance and vitality regarding the environmental, cultural and socio-economic sustainability of our civilization – what Gregory Bateson once called, our "*ecological health*" [Bateson, 2000, p. 502].

Therefore, invoking Ecology as an inevitable philosophical and methodological metaphor in the process of interpretation of, and intervention in a reality that is known to be complex and multi-relational, implies adopting an ecosystemic comprehension of that reality, including not only the environmental but also its social and mental spheres – what Félix Guattari referred to as "*the three ecologies*" [Guattari, 2005, p. 41]. This requires an ecological conception of Architecture that is not reduced to environmental[ist] concerns, but one that also addresses the wider conditions of the whole environment, of social relations, and of human subjectivity.

The architect – due to his condition of citizen; his privileged relation both with the client, the potential users and the biophysical context in which he intervenes; the symbolic character and the socio-cultural influence of his work; and his active role as a designer and transformative agent of 'living' environments and places – certainly has additional responsibilities, and possibly more capabilities and oppor-

tunities than most to make positive changes. Indeed, with his transversal knowledge, design skills and creative vocation to put forward new scenarios, conditions and relationships within place, the architect is uniquely positioned to influence ecosystemic changes. Co-operating on a wider field, architects can play a key role in bringing about socio-ecological transformations for the better, while contributing to urban and social life.

However, if the ecological debate in architecture (and Architecture itself) remains trapped within a 'techno-environmentalist' framework and keeps being reduced to the energetic performance of buildings, it risks compromising its real significance by only contemplating partial 'technical' aspects which, despite integrating our disciplinary scope, are just another basic requirement that Architecture, whether for ethical reasons or legislative impositions (more the latter since the implementation of the Energy Performance of Buildings Directive in the EU), must definitely comply with. Yet, solely meeting these (now mandatory) energetic requirements should not be considered a sufficient argument for legitimizing an alleged 'ecological' architectural intervention, neither a justifiable reason for overriding other qualitative (and eventually more substantial) aspects of both Architecture and 'ecology'. For as much as buildings consume less energy, emit less carbon, or use fewer material resources, there are no circumstances in which these techno-environmental extrapolations, when broadly considered, actually constitute or promote an 'ecology'. In fact, Architecture and contemporary building practices generally do more than simply deplete resources and energy, they also tend to reduce biodiversity and land fertility; increase pollution and waste production; disconnect people from nature; affect human physical and psychological health; among many other social and ecological effects.

Likewise, as fertile and promising as the 'natural/living' metaphor may be – whether in discursive, formal, or symbolic terms – its exploration within the field of Architecture, motivated by environmental[ist] concerns or not, does not imply, just by itself, the idoneity of the architectural intervention nor its immediate and linear association with 'ecology'. In fact, the pertinence and use of the natural/living world as a metaphorical reference is not exactly new since

Architecture has sought inspiration from, and integration within nature throughout most of its history. Yet, we should be aware that the very idea of 'nature' – as a cultural-paradigmatic construct – is as prolific as it can be misleading if we are to advance an authentic ecological – or 'ecologized' – [re]conception of Architecture. As Sim Van der Ryn observes, nature is not a model for designs that are then kept rigidly apart in a purely cultural realm; it is a matrix within which designs find an identity and coherence that contribute to the integrity and health of the whole system. [Van der Ryn, 2007, p. 127]

THE SHIFT TOWARDS AN 'ECOLOGIZED ARCHITECTURE'

Given the inherent holistic nature and the intrinsic complexity of Ecology as a 'new science'⁵, and considering its distinct 'ecosystemic focus' on the interrelations, dialogues and syntheses of the complex phenomena of reality, it would be contradictory to substantiate an alleged 'eco-architecture' subjugated by any dualist, idealist, naturalist, environmentalist or techno-functionalist preconceptions. Instead, we advocate that Architecture should acknowledge the new ecological realities, recognize its new ecological responsibilities, and engage the new ecological challenges by means of an ecologically informed, dialectic, comprehensive and integrated approach.

This means that, without neglecting the 'energetic imperative', or any technical requirements, we consider it is essential to draw attention to the wider significance of an authentic Ecological Architecture, fundamentally for its ecosystemic focus; its transversal and transdisciplinary scope; the comprehensive way it interprets and relates with a [non-idealized] complex-ecosystemic nature; and the distinct paradigmatic-epistemological way it adopts 'ecology' as a philosophical and methodological referential – providing other ways of dealing with reality, and other ways of thinking, doing and experiencing/living architecture.

Only by understanding the dialectical condition of the association between Architecture and 'ecology' it becomes possible to realize its actual significance, relevance and potential. In the broadest sense, 'ecology' provides a new

perspective, a comprehensive framework, a matrix of coherent principles and a holistic core basis, that are capable of [in]forming Architecture, broadly expanding its scope and field of action. Therefore, 'ecology' does not so much constrain Architecture – as often presumed – but rather complements and radically expands it beyond the most predominant notions, crossing disciplinary and professional boundaries; promoting the convergence of different types of knowledge; enabling more flexible, participatory and collaborative (design) practices; opening up new ecological-architectural possibilities and opportunities.

An 'ecological method', as a tool of dialogic relation with the multiple complexities of reality, should guide architecture, not through a dualist and linear logic of reaction – technological or not – but through an 'eco-logic' of informed and conscious action. By adopting new critical perspectives, creative approaches and flexible strategies that are free of preconceptions – instead of determinist models and rigid methodologies – this distinct ecological-architectural method should be capable of evolving new formal, spatial, technical, functional, typological, organizational, procedural and relational capacities.

While the aptitude of 'ecology' to metaphorically (re)organize our knowledge in a whole new system through complexity thinking – the 'complex-ecologized thought', – correlated with a new ecosystemic perspective of reality, inevitably transforms the ways we perceive ourselves and our environment, and the ways we interact and transform it. As Edgar Morin explains:

"The ecologized thought has a paradigmatic aspect, as it breaks with the paradigm of simplification and disjunction, and requires a complex paradigm of eco-self-organization." (Morin, 1996)

This means that, only through an authentic paradigmatic-epistemological shift – from the 'mechanistic' (Newtonian-Cartesian) paradigm towards a 'complex-ecological' paradigm – it becomes possible to apprehend the complexity of our (urban) socio-ecological systems and engage their inherent processes, patterns and relationships – such as the 'ecological flows' and 'metabolic cycles', or the processes of

'emergence' and 'eco-self-organization' that occur within those systems.

"In order to successfully integrate ecology and design, we must mirror nature's deep interconnections in our own epistemology of design. We are still trapped in worn-out mechanical metaphors. It is time to stop designing in the image of the machine and start designing in a way that honors the complexity and diversity of life itself." (Van der Ryn, 2007, p. x)

Only this fundamental shift in the perception of our place and role in the world – a 'metamorphosis' of our human consciousness – can unlock the true potential of the 'ecological metaphor', both applied in the integrated study of the environment and society as one, and in the foundation of comprehensive ecological-architectural practices and strategies that are fit for the many challenges and opportunities of the 21st century.

This 'ecological shift' suggests not a simple dislocation, but a profound transformation and reorientation – what we call an 'ecologization' of Architecture. It further hints at the emergence of an 'Ecologized Architecture', truly (in)formed by, integrated in, and interrelated with the new ecological and civilizational paradigm. This 'ecologization' should bring forth an Architecture that seeks far more ambitious and qualitatively different kinds of outcomes, implying a fundamental reformulation of its main intents: from seeking 'low-negative' impact towards achieving real 'positive' impacts; from 'minimizing' environmental damage towards 'maximizing' socio-ecological benefits; from being less harmful and 'malign', towards being better and more 'benign'; from solely meeting normative goals by replicating 'models' and code-minimum solutions, towards advancing more ambitious, creative and progressive responses; from designing 'disconnected buildings-as-objects' that 'consume less', towards designing 'ecologically [re]connected buildings-as-systems' that 'generate more' (water, energy, food, resources, and relations); from adopting 'palliative' measures that 'mitigate' or slow degeneration, towards deploying 'regenerative' interventions that 'restore' and enhance human and natural systems; from only making things less unsustainable, towards promoting a truly sustainable condition by 'ecologizing' our socio-ecological systems.

With this in mind, architects can broadly rethink the current and the potential role of architecture in our (urban) socio-ecological systems, and explore how human intelligence, ingenuity and agency can be better applied. Then we should be able to liberate our many skills and design creativity to [re]create integrated and non-formulaic solutions, with knowledge, responsibility, competence and a committed ethical-ecological sense of purpose as to how architectural interventions can affect both people and the environment for the better. This points at what architects should ultimately aim for: socio-ecologically benign architectural interventions, capable of creating aesthetic and economic as well as social and ecological values within community and place; focusing on 'more positive' effects instead of 'fewer negative' ones.

Furthermore, as a social practice and as an act of cultural expression, Architecture can be a catalyst for wider socio-cultural and environmental transformations. In many ways, Architecture 'cultivates' and promotes our awareness of different environments and places, while fostering multiple interactions, relationships, cultures, values and 'ecologies'. This aspect underlines the critical role and the radical potential of Architecture in promoting other kinds of 'living' places, as well as more 'ecological' cultures and modes of existence.

Considering architecture within this wider socio-ecological framework requires a radical rethinking of the 'architectural object' and the predominant design assumptions, posing a significant challenge to the profession, which consists in shifting from a focus on the building to a broader ecosystemic focus on the processes and relationships that exist within and beyond it, which means shifting the focus from what buildings supposedly delimit and represent as inert objects to what they promote, generate and make possible as socio-ecological interfaces. The expanded notion of architecture as a socio-ecological process – with its intrinsic dynamics, complexities and ecologies beyond the boundaries of the building – implies a much greater accountability for the relationship between the built-environment and the life that goes on within it.

This wider ecological framework inevitably challenges inherited notions of what is to be an architect and brings new understandings of what architecture can be. As it also challenges normative conceptions of what a space, a building, a place, or what learning, working, living might look and be like. Indeed it represents a fundamental challenge to our profession – which many committed architects have already embraced – and a much richer set of possibilities that give new scope, purpose and hope for architectural practice.

The consolidation of this set of propositions based on today's reality, on the emergence of a global ecological consciousness, and on the urgency for effective strategies and actions in response to a looming ecosystemic crisis, reconfigures Architecture and the City – the primordial objects of our discipline – as inseparable parts of a whole socio-ecological system. Now reintegrated in the several 'ecologies' which dynamically configure our habitat, Architecture should be better prepared to reassume its primordial role of mediation in a new symbiotic relationship between Man and the Environment. 'Ecology', and desirably Architecture, is all about re-establishing this missing link, creating a wider dialogue and allowing interventions that are mutually advantageous.

At the dawn of this 'new century', [in]formed by an emerging 'ecological–civilizational paradigm', and projected into an uncertain future, Architecture re-emerges from its theoretical origins to recombine itself technically, aesthetically and ethically. This time, not only having to justify itself for its real ecological intents and consequences, but also being able to legitimize and revalue itself through the social recognition of its virtues. Ultimately, the real value of Architecture lies in its ability to sustain life, and how it allows for a continuous (re)generation of social and ecological meaning.

As Edgar Morin concluded:

"From now on, [...] we can understand better what was secondary and what was essential in the emerging ecological consciousness. What was secondary, which some mistook as the principal, was the energetic alert." (Morin, 1996)

THE NEW ECOLOGICAL-ARCHITECTURAL IMPERATIVE

In synthesis, based on the previous arguments which clarified that the meaning and pertinence of the association between 'ecology' and Architecture is not reduced to the energetic efficiency of buildings or the use of sustainable building materials, but broadly concerns socio-ecological, ethical, epistemological, processual, relational and systemic issues, we can now enunciate a set of fundamental 'steps' towards the constitution of a new ecological-architectural imperative, which are summarized as follow:

- > To understand our ecological paradigmatic condition – which implies understanding the unprecedented urban socio-ecological reality of the 21st century; while acknowledging the complexity of the contemporary ecological crisis and its correlation with broad urban, environmental, economic and socio-cultural aspects; thus the critical role and responsibility of Architecture, due to its many socio-ecological implications;
- > To overcome predominant misconceptions – which means overcoming 'mechanistic' ways of thinking, paradigms and epistemologies, as well as dualist and idealist notions, misconceived frameworks and determinist 'models'; this implies questioning professional values, motives, norms, procedures and possibilities, so that new ecological practices and conditions can emerge;
- > To integrate 'ecology' – by promoting ecological literacy and improving ecological thinking/design skills within Architecture (and beyond it), while comprehending the essence of ecology, the dialectical association between ecology and Architecture, the interrelation between the built-environment and ecological systems, and the interdependency between the ecological realms of the environment, society, and mind;
- > To change Architecture – meeting the new and emerging challenges of our time requires the adoption of new ecological frameworks, and the development of comprehensive approaches, methods and strategies; it demands new kinds of ecological-architectural prac-

tices and urges us, architects, to 'ecologize' our ways of thinking, our knowledge and design epistemology, our cultural-paradigmatic models and core values, our concepts and metaphors, our methods, procedures and actions;

- > To ecologize beyond Architecture – the 'ecologization' of Architecture should integrate and further contribute to a broader 'ecologization' [urban, environmental, technological, industrial, economic, socio-cultural, political, epistemological, mental-behavioural and civilizational]. The reinterpretation of the role of Architecture [in both a construction industry and broad socio-ecological context] hints at a new understanding of the architect as a proactive agent of ecosystemic change. Considering architects are in a privileged position to critically intervene in all these fields, they can play a prominent role in creating synergies and enabling positive socio-ecological changes.

Ultimately, these five steps lead us in a progressive path to an essential ecological-architectural imperative, which is: to 'ecologize' Architecture and through/beyond Architecture.

In conclusion, today's greatest social and ecological challenges imply fundamental changes in the expectations, responsibilities and capabilities of Architecture in the 21st century, demanding deeper reflections on its ideals. Global climate and environmental changes, depletion of natural resources, mainstream building trends and increasing social inequities, to name a few, undoubtedly frame an imperative for change to the architecture profession and academia, requiring a radical change of mindset and behavior, urging for committed architectural practices with ambitious design intents. Architectural practices that reflect not only an aesthetic and technical competence, but a real recognition of the critical challenges ahead of us – authentic ecological-architectural practices, capable of taking a central role in the future of ecological buildings and cities, and in our very own [urban] ecological future.

As Saskia Sassen asserts, it is critical that we understand and enable the capabilities of cities – and of Architecture

– to transform what is today a negative ecological impact into a positive one; it is now urgent to make cities, urbanization and architecture part of the solution. This might be our greatest challenge and responsibility as architects – 'ecologizing' – finding innovative and integrated ways of turning urban-environmental problems and constraints into socio-ecological solutions and benefits. Herein lays an emerging role for architects, regarding the necessary redesign of our built-environments, and a crucial opportunity to play a decisive contribute in the emergence of new socio-ecological systems.

Just as a building's ecological impact and resource use cannot be divorced from its surroundings – as it is always a part of a larger ecology – architects should understand themselves to be part of, and not outside of, a complex web of social-ecological processes and relations, because only through a dialectical-ethical approach that comprehends and values these, can Architecture play a truly meaningful and benign role, instead of being part of the problem – architects are part of the whole ecology.

At the point that 'green' and 'sustainable' have become so ubiquitous as terms that they have come to mean nothing and everything to everyone, we hope these insights serve to remind us of the real possibilities and relevance of the 'ecological' in Architecture. In the broadest sense, 'ecology' does not refer to an ideology, a trend, a style, a label, a formula, or a 'model', but rather to a distinct approach, another way of dealing, thinking and doing Architecture. Indeed it provides new perspectives and a comprehensive framework that includes and transcends Architecture, providing the means for [re]thinking, [re]designing and 'ecologizing' our landscapes, buildings, cities, systems, and even ourselves.

This 'Age of Ecology' indeed challenges us as human beings, and our capabilities as architects, to envision new systems, new built-environments, new natures, new cultures, new values, new relations, and new/emerging ecologies. Now is the time to bring forth new 'ecologies of ideas', 'ecologies of design', 'ecologies of practice', and 'ecologies of our actions'; while minding for the fragile 'ecology' of our profession itself.

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NOTES

1. According to UN-Habitat's statistics, more than two thirds of EU citizens live in cities or other urban areas, whereas the current level of urbanization in Portugal is estimated around 65%. [UN-HABITAT, 2012, p. 148]
2. Supreme ecosystem that contains and includes all other planetary ecosystems. [Morin, 1996]
3. Reductionism can be defined as "*[...] the task of every scientist to find the simplest, most economical, and [usually] most elegant explanation that will cover the known data. Beyond this, reductionism becomes a vice if it is accompanied by an overly strong insistence that the simplest explanation is the only explanation. The data may have to be understood within some larger gestalt.*" [Bateson, 1979, p. 230]
4. Gregory Bateson defines epistemology as "*a branch of science combined with a branch of philosophy. As science, epistemology is the study of how particular organisms or aggregates of organisms know, think, and decide. As philosophy, epistemology is the study of the necessary limits and other characteristics of the processes of knowing, thinking, and deciding.*" [Bateson, 1979: 228]
5. As Edgar Morin explains: by studying ecosystems formed by physical, biological and social constituents, each one depending on specialized disciplines, ecology constitutes «*a new type of science*» that, contrary to the dogma of hyper-specialization that ruled the development of scientific disciplines, focuses on a global organizational knowledge that is competent in different domains and is capable of articulating the specialized competences in order to understand the complex realities. [Edgar Morin, 1996]

