Ecological-thinking and collaborative design as agents of our evolving future

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Abstract. The paper depicts emerging scenarios of environmental design, in connection to the paradigm shift brought about by digital technologies, and awareness of future challenges. It reviews selected researches and projects applying ecological thinking principles. It aims at raising awareness on heuristic approaches in research and design. The paper focuses on collective design as a way to improve the governance of complexity in the current anthropogenic era. The main conclusion highlights cultural marks depicting contemporary research trends, with a view to translate theoretical insights into practical experiences.

Keywords: Environmental Design; Heuristics; Digital technologies; Emergent Ecologies; Hybridization.

Background

A common sense of astonishment characterises our present time. The manifold challenges of our age call upon humankind to quickly adapt to new habitats – both physical and digital – within its lifetime. Such adaptation should not be really different from those which occurred in history. However, two new factors come into play: digital technologies, which reshape relationships among humans, machines and culture, and the tremendous impact of humans on the Earth, which has led to name the current geologic era "Anthropocene" (Crutzen and Stormer, 2000).

The combination of cultural and technological implications has produced an all-time shift in the scientific paradigm, notably in the relations between Artifice and Nature. The distinction between the two terms has become blurred, as the emergent capacity to produce hybrids offers a creative ground that merges biotic and abiotic systems (Gere, 2004; Brawnell & Swackhamer, 2015; Cantrell & Holzman, 2016). The fascination in hybridizing technologies and nature has been celebrated by the artistic avant-gardes since the 1970s[1], that considered the digital innovation potential as a cross-fertilization field between art and science, and more recently by artists as Eduardo Kac, or Kelly Jazvac or Aki Inomata, to name a few[2]. Indeed, the unprecedented alliance between humankind and technology supports the odds for improving both health and wealth, thus reducing the impact on finite natural capital. The failure of such alliance can accelerate the depletion of natural capital, bringing the Planet close to a real prospective of disaster: «It was the best of times, it was the worst of times» (Dickens 1859 quoted in Naam, 2013).

In light of such a large availability of technologies and devices, a new theoretical ground is required to foster creativity toward the achievement of common goals of well-being and prosperity. Furthermore, creativity and imagination can enlarge the borders of traditional research areas, thus establishing new domains inspired by collaborative problem-solving (Brian Arthur, 2011; Naam, 2013; Manzini, 2015). There is no need to substitute typical patterns of vertical research, rather we need to implement new cognitive habitats, resulting in shared knowledge and understanding. This is, indeed, the challenge of merging insights from the Anthropocene and Digital Revolution: leveraging a fast-growing demand for innovation in research border areas. These "cross-cutting fields" – as named in sciences – may generate unprecedented living conditions (Tagliagambe, 1997). The "cross-cutting fields" can produce new objects, new spaces and new behaviours, addressing anthropogenic habitats in which biotic systems interact with abiotic ones. This will establish a new leading position to which humans will commit: the «designer's role [*is evolving*, Ed.] as manipulator and carer of processes - considering both biotic and abiotic factors as equally engaged in shaping environment» (Cantrell and Holzman, 2016). This is, in a nutshell, the cognitive ground of Ecological-Thinking.

Ecological thinking and heuristics as paradigms for approaching cross-cutting fields in design theory

The awareness of living in a complex, inter-connected world has led to define new scientific fields of study. These are no longer limited to single disciplines; rather new fields are inspired by an epistemological approach rooted in the exceptional role of digital culture and data management; the latter produce a creative and pervasive framework of action. Acceptance of new fields allows to overcome the "obsolescence" of deterministic sciences (as per Bateson's terms), and to achieve advances and the integration of new fields, such as «the systems theory, the cybernetics, the ecology and the Gestalt psychology» (Bateson, 1978).

From this starting point, Ecological Thinking seems to be the proper experimental ground to develop new approaches. Ecological Thinking allows to develop design methods that provide effective and integrated knowledge that can shape the anthropogenic environment. We primarily refer to the term "Ecological Thinking" as this «seeks to eliminate the traditional dichotomy separating humanity (as subject) and nature (as object) as a route to understanding diverse, complex, multiply interconnected milieu»[3] (Code, 2006). Based on this definition, the key point for introducing Ecological Thinking among design fields is the idea of «Adaptation, appropriation and flexibility […] as the hallmarks of "successful" systems» (Reed and Lister, 2014). Moreover, ecological thinking moves ecology «away from classical determinism and the reductionist Newtonian […], in favour of more contemporary understanding of dynamic systemic change and related phenomena of adaptability, resilience and flexibility» (Reed and Lister, 2014). Additional outcomes of assuming ecological-thinking into the design method are further access codes to understand emerging socio-technical contexts, such as our contemporary milieu, that is «the site, habitat or medium of ecological interactions and encounter» (Code, 2006).

This insight is inspired by a complete revolution of the point of view, which is now centred on reducing the extreme specialisation and strengthening tolerance to contextual constraints (Lazlo, 1985), and on the technique known as "Muddling Through". This is specifically designed to investigate contextual (and progressive) changes of complex *milieu*, and it is based on both incremental progresses and small, pondered steps. Muddling Through has proven to be more

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convenient than tackling problems in one single step (Flatch, 2012). In the framework of the Design X experience, Donald Norman, of the Design Lab of the University of California, San Diego, underlines that changes in the operating pace of design processes accommodate indeterminacy and complexity as key points of design thinking: «with sociotechnical systems, it is seldom possible to follow the Independence Axiom: two-way or even n-way interdependencies are common. Moreover, these interdependencies are often unknown, discovered only after the fact»[4] (Norman and Stappers, 2016).

These advances are not limited to the design discipline, rather they define a fertile ground of innovation for many research fields, including social sciences and ecology. The "muddling through" technique is indeed similar to the trial-and-error mode (typically used in the digital culture) and to adaptation strategies of biological systems. In both cases, processes are based on incremental steps of opportunistic behaviour, which select potential solutions based on a "Darwinian evolution" of ideas (Naam, 2013).

Such cognitive patterns directly refer to the heuristics, which are, by definition, a tactical approach to problem-solving (Dale, 2015). The heuristic approach allows to overcome the ambitious goal of the "exact solution", which is somewhat aprioristic; while orienting cognitive processes toward potential solutions (or scenarios) that emerge from the process itself. Furthermore, the heuristic approach evokes terms, such as "plural" and "collaborative", whose practices also take advantage of digital technologies, and involve users in handling large data sets that describe local and site-specific habitats[5]. Access to digital tools - mainly those that embed sequences of sensing, visualisation, processing and returning feedback - moves projects beyond the borders of conventional design methods. It highlights an unprecedented capacity to forecast science-based scenarios, which feature new relations between users, technologies and nature (Cantrell and Holzman, 2016). The opportunity to monitor and adjust designs applies throughout the life cycle of projects, and makes projection tools suitable for managing the evolving nature of sites.The heuristic approach also activates collaborative processes, continuously involving different stakeholders in design, who can participate by defending their theories, while sharing embedded abilities and providing training about them.

New methods/ new processes/ new projects

The scenario proposed so far requires a different vision of the forthcoming future (Naam, 2013; Floridi, 2014; Di Biase, 2016). Work carried out by leading research centres, reviewed in the last section, shows the importance of introducing ecological thinking and the heuristic approach as scientific methods. Among research centres, it is worth mentioning the most trendy within the scientific community. First, the Institute for the Future (IFF), Palo Alto, California, which implements "narration" as a further research field. Second, the Santa Fé Institute (SFI), New Mexico, which merges deterministic and creative approaches with a view of tackling complexity as a primary research topic. Third, the Ann Wrigley Global Institute of Sustainability – a private branch of the Arizona State University – which particularly focuses on use-inspired research to advocate for sustainability, particularly in urban areas. Last, but not least, in Europe, the Institute for Advanced Architecture of Catalunya (IAAC), Barcelona, Spain, which works on collective urban design practices, whereby communities are key elements for problem-solving, and it applies digital technologies to facilitate knowledge transfer.

These leading institutions are characterised by a common interest in investigating multidisciplinary research areas with the aim to push the frontier of scientific knowledge. In order to achieve this goal, all these institutions share the view that education is a key field of action for expanding social empowerment and envisioning a sustainable future.

Altogether, three main elements emerge[6]:

- a growing interest in merging biotic with abiotic systems;
- the need to adopt collaborative design methods as "muddling through" practices;
- the need to implement digital technologies into design practices.

The IFF working philosophy posits the idea that non-deterministic creativity is an agent of innovation, ensuing selected "data points" and "signals of change" that serve as indicators of future socio-technical trends. Focus is on forthcoming lifestyles and on their high dependence on emerging technologies. The IFF philosophy emphasises both trial-and-error and self-education as collective attitudes for enhancing problem solving and defining the borders of research fields (www.iftf.org/home/) (Fig. 1).

Similarly, the vision of the Santa Fè Institute for Complexity moves beyond the rational-deductive approach (usually based on *a priori goals*, as in linear models), to leverage new cognitive patterns based on collaborative processes. In such patterns, every participant incrementally negotiates goals and results within the process itself (https://www.santafe.edu/; Flatch, 2012). Innovation applies to both research topics and to the model adopted. In the introduction to one of the basic courses of the Institute, participants are required to learn about «dynamics, chaos, fractals, information theory, self-organization, agent-based modeling, and networks. [*Students*, Ed.] also get a sense of how these topics fit together to help explain how complexity arises and evolves in nature, society, and technology». Courses do not require specific expertise, such as science or math background; rather students are expected to show «an interest in the field [*of complexity*, Ed.] and the willingness to participate in a hands-on approach to the subject» (https://www.santafe.edu).

Complexity and peer-to-peer collaboration also feature among the activities sponsored by the Julie Ann Wrigley Global Institute of Sustainability (ASU Wrigley Institute). In particular, the activities

focused on the advances in education and business opportunities for an urbanising world. In this case, the attention is mainly devoted to the evolution of the natural environment. The concept of sustainability is cast within adaptive and systemic processes promoting education, biodiversity, long-term ecological research, politics and economics (https://sustainability.asu.edu/about/). This approach emphasises the interaction of social, technological, and ecological domains in the transition towards sustainability, and the merger of socio-ecological and socio-technical systems.

Direct outcomes of this approach are also found in the projects of the IAAC, many of which are funded by EU research programmes. Education and digital culture are drivers for understanding the complex socio-technical environment of contemporary cities. Project typologies are not scale-dependent; thus they can accommodate both top-down and bottom-up initiatives, as inspired by adaptation practices and data management. Like in the ASU Wrigley Institute, also in the IAAC vision, education plays a key role in enabling local communities to manage complexity on their own, capitalising on cognitive abilities and emerging knowledge embedded within the community itself. The value added of the IAAC experience is in the implementation of collaborative digital platforms. These are devoted to projects, specifically designed for improving skills and knowledge of non-expert users. The stream of actions aims at empowering the community, and defines virtuous circles that help governing sustainability locally, while boosting social awareness.

Additional applications of heuristics within ecological thinking are in landscape design, which has discussed the importance of the systemic approach in shaping the environment since its theoretical foundation. In this area, the main scientific advance is the concept of "emergent ecologies", that is «the combination of intentional and unintentional futures shaped by ecology and human intervention» (Cantrell and Holzman, 2016). The term was first used in the title of James Corner's and Stan Allen's proposal to the 1999 Downsview Park Competition in Toronto. The project offers a paradigmatic example of indeterminacy as a part of the design outcomes, in which forms and performances strive to adapt to the new specific ecosystem, populated by humans and their socio-technical features[7](Corner and Allen, 2001).

The concept of "emergent" has also inspired a number of experiences with collaborative design. An example is the "Urban Circulatory System" project, which is founded on ecological thinking, and aims at empowering informal fragile communities in Brazil by improving their sanitation systems. The project has explored the potential of low-tech design to generate "emergent communities". Here, the combination of living-machines and collaborative design has driven small-scale actions that made people aware of how to manage the sewage remediation system, making users active subjects in the design proposal.

The heuristic approach also informs the New York competition "Re-Built by Design", which specifically calls for integrated solutions to reduce climate change risks. One of the five design teams involved, led by Kate Orff, presented a project titled "Living Breakwaters", which represents a clear example of collaborative design to achieve multiple objectives within a single design proposal (Rigillo & Tolla, 2016). The project aims at generating new marine habitats through the application of innovative concrete blocks built with oysters and other biological elements. These hybrid materials are used as seeding to support the new marine habitat. The Living Breakwaters project will reduce flood risks, restore habitats, and provide social education and urban renewal. Also in this case, education is a key part of the project, which mediates the transfer of technological innovation (both products and process) with the social awareness of the ecological potential of the coast.

Common marks (in form of conclusion)

The application of ecological thinking and of the heuristic method brings about major advances in design, especially in terms of the nature of creative processes, social education and enhanced anthropogenic environments. The new research fields result from a growing awareness of the need for specialised and generalist scientists to work together (Lazlo, 1985). This collaboration highlights concepts, such as socio-technical environments, emergent ecologies and responsive ecologies. These are new frontiers for shaping the environment, which allow to consider both biotic and abiotic systems in the design process. More reactive and responsive performances, as required by the anthropogenic environment, will enhance the heuristic method as the proper cultural framework, where the conventional dichotomy between artifice and nature disappears. Similarly, pairs such as "high tech/low tech", or "global scale/local scale", or "Big Data/on-field data" have lost their inherent traditional opposition, and become part of new integrated strategies to design sustainability.

In this framework, the socio-technical-ecological systems are recognised as cognitive structures allowing to better understand interfaces and interactions between different systems. They are effective means for developing new research areas, which facilitate the emergence of the risk of uncertainty (Ahlborg *et al.*, 2019).

Incremental design and the "muddling through" strategies involve the use of heuristic methods. In turn, these provide a new cultural model, which allows for the emergence of the wide potential of collaborative practices. Here the term "collaborative" is not meant as a mere substitute of "participative" (as per the Latin etymology of the term, collaboration results from *cum*, which means with, together, and *laborare*, labour, to work). Collaboration, in this sense, can be intended as a practice of responsible sharing, which contributes to create an updated "sense of community". Examples are co-working and co-housing experiences, which demonstrate a widespread adoption of collaborative dimensions within current lifestyles. Peo-

ple do share not only physical spaces, but also perspectives and expectations. The implementation of such design methods implies assigning growing importance to education, such as life-long training on technological and social advances. Education emerges as a key element for improving the ethical dimension of the human technical power on the environment. The concept of "culture of limits" (Dierna, 1994) anticipated this perspective.

Collaborative design is also meant to be an attitude, geared towards renovating the problem-solving approach through dialogue among stakeholders and common experiences and expertise in the form of embedded knowledge. The semantic renewal of the concept of "collaborative" within design processes calls for an active engagement of users and communities. Stakeholders should configure innovative solutions of co-production and co-government, encompassing material and immaterial dimensions in cognitive and operational terms.

Finally, the findings of ecological thinking operationalise the notion of "emergent" as a tool to understand new habitats and communities shaped by the project. The term hinges around the two dimensions of potential and unpredictability, which result from the complexity of the current socio-technical and environmental *milieu*. The term "emergent" considers digital aptitude as opportunity for implementing the design ability to sense and respond to natural processes. The "emergent" represents the cognitive (and operational) tool for applying a new ethical view, to shape the Anthropocene as our current era.

NOTES

[1] See the 1966 exhibitions "*9 Evenings: Theatre and Engineering*", and the 1968 "*The Machine as seen at the End of the Mechanical Age*" and "*Cybernetic Serendipity*", respectively held at the MOMA, New York and at the ICA, London, United Kingdom (Gere, 2004).

[2] We refer to the Alba Rabbit made by Eduardo Kac with the scientists Louis-Marie Houdebine e Patrick Prunnet, the series titled *Plastiglomerate* by the sculptor Kelly Jazvac with the geologist Patricia Corcoran and the oceanographer Charles Moore, the video *Think Evolution #1: Kiku-ishi (Ammonite)* by Aki Inomata.

[3] Similarly, Felix Guattari: «Ecology must stop being associated with the image of a small nature-loving minority or with qualified specialists. Ecology in my sense questions the whole of subjectivity» (Guattari, 1989, pp. 52).

[4] «These designs satisfice rather than optimize, and are related to the techniques of making progress by "muddling through"» (Norman and Stappers, 2016).

[5] Design process has strongly implemented its capacity of feedbacking the temporal and spatial evolution of the project, thanks to initiatives as crowd sourcing and crowd sensing, by which people comes into play and works as a virtual community for sharing and generating knowledge at the site scale.

[6] The analysis has been conducted through the review of the products feeding the dissemination areas of the institutional web-sites of the centres.

[7] Corner and Allen wrote: «We propose […] a matrix of interacting systems […] (where) the park identity will subsequentially evolve and be re-shaped as users inscribe their own traces […] We do not determine or predict outcomes; we simply guide or steer flows of matter and information. Thus we present the park as a precisely engineered matrix, a living groundwork for new forms» (Corner and Allen, 2001, pp.58)

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