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CO-EVOLVING IN THE ANTHROPOCENE: AN ORIENTED ANALYSIS TO RAISE AWARENESS THROUGH ARCHITECTURE AND SERIOUS GAMING

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Abstract

We're currently living in the Anthropocene, a geological age in which human-environment interaction utterly affects the biosphere balance. As stated by both Paul J. Crutzen (2000) and Christian Schwägerl (2014), with the term "Anthropocene" we refer not only to a new environmental condition but to a new paradigm in which nature and culture are seen as a component of the same system and not anymore as independent categories.

Although in the last decades the environmental consciousness has significantly increased, we are still in need to develop new strategies to face the actual critical global condition characterized by lack of resources, progressive temperature increase and sea level rise. From our perspective to increase the effectiveness of sustainable practices and processes, a higher level of social awareness and civic engagement has to be reached. With this in mind, we propose a two-sided analysis based on the approach of ecological thinking through serious gaming and bio-digital prototyping to generate new bottom-up strategies. The category of serious game (Ulicsak & Wright, 2010) represents a still relatively understudied space of opportunities to develop new tools for scientific analysis and methodologies regarding urban design and planning strategies and to involve different actors in developing more significant problem-solving means. On the other side, bio-digital prototyping, through the hybridization of organic and non-organic matter, opens new research fields to induce new behavioral patterns through human interaction and, therefore, to generate a sense of empathy between anthropic and biological environment.

Alongside the theoretical frame, we will present two case studies - "Solve the Crisis! An alternate reality game to tackle Cape Town's water crisis" and the biomimetic structure "Physarum Shelter" - to highlight how serious games and bio-prototyping can be used to empower the ecological consciousness and lead to more integrated design strategies.

Keywords ecological thinking, social awareness, civic engagement, serious gaming, bio-digital prototyping

Introduction

Anthropocenic entanglement: bridging the gap between anthromes and biomes.

The concept of the Anthropocene represents a significant paradigm shift in Human and Earth history, promoting a new way to conceive the relationship between man and nature.
The term, originally coined by the biologist Eugene F. Stoermer during the early 1980s, has received ever-increasing attention in the scientific community since the Intergovernmental Geosphere-Biosphere Program (IGBP) held in Mexico in 2000. While many geologists and biologists kept referring to our geological era as the Holocene, Nobel Laureate Paul J. Crutzen publically declared that the massive human intervention on earth system and nature utterly affected the biosphere balance leading us to a new geologic era: the Anthropocene.
The transition from the Holocene to the Anthropocene, even if still not officially recognized as a geological epoch, entails the redefinition of the human-environment relation. Many scientists agree to date the beginning of the new era in the late Eighteenth Century: since the Industrial Revolution, in fact, man has undeniably altered the biosphere, often in an irreversible way. In this perspective, environmental and drastic climate changes are strongly related to human actions and can be considered as anthropogenic products. This concept leads to new reflections on the boundaries between the natural and the artificial realms: in an era during which men constitute a dominant force shaping and influencing biological balance, can we still talk about nature and culture as distinct forces?

Bruno Latour argues that contemporary matters of public concern, such as global warming or emerging biotechnologies, are not meant to be seen as entirely natural or artificial phenomena, but as hybrid outputs resulting from the interaction between these two complex fields (Latour, 1993). The idea of untouched wilderness is obsolete and promotes a "getting back to nature" philosophy that does not help us move towards the much-needed paradigm shift. Moving from the idea of an environment that simply contains us in a relationship of subordination to a more interconnected one, means embracing the radical cognitive transformation produced by ecological thinking and recognize that we are knots networked into a global system of relations, mutually connected to each other (Capra, 1997). As human beings, we can adapt to new environmental conditions and to shape our habitat, which cannot be considered as a glass cabinet to protect and preserve. We should rather imagine our relationship with the environment as a complex "entanglement" (Ingold, 2000) in which nature and culture are conceived as constitutionally linked, merging into a meshwork and stimulating a cognitive switch in human perception.
In this evolving scenario, scientific process and new theories, in particular those from biology, biotechnology and cybernetic, are the leading factors to address the research towards "an emerging new nature that will make earth more humanist rather than just humanized[1]."
Bridging the gap between anthromes and biomes, and shifting from a reductionist model to a systemic one, can help people perceiving themselves as active, integrated, participant actors to global changes. While the protectionist model was based on a set of imperatives, the new anthropocenic paradigm asks for self-

[1] Schwägerl , C. (2014) The Anthropocene. The human era and how it shapes our planet: Synergetic Press

responsibility and promotes a new concept of nature based on the intersection between biosphere and technosphere.
Nevertheless, rethinking human presence as strictly embedded with natural ecosystems, and not only as a mere observer is the key to switch from a reductionist to a bio-systemic approach and to tackle the global ecological crisis. As designers, we can improve human consciousness and cognition on the environment by converting the destructive human presence into a constructive force through our creativity. The aim of this theoretical shift is proposing new design strategies that stimulate human-nature interaction and increase social awareness and civic engagement on environmental problems.
The relationship between citizens and environment can generate design solutions that embody metabolic and ecological processes, expressing an ideal symbiosis in which human and non-human inhabitants can relate through interactive devices. The active presence of the user through his body experience, can activate processes of feedback loops, based on user-environment relationship, and stimulate the embodied cognition of natural and environmental processes. We believe that this more profound, emotional connection with the environment can lead to a more empathic understanding of ecological problems.

Objectives

Our objectives are threefold. On the one hand, we propose a two-sided analysis that addresses ecosystem issues - related to human activities - and climate change through the lens of serious gaming and playfulness, helping other designers to benefit significantly from having more design methodologies at hand, thus improving lateral thinking (De Bono, 1970). To do so, we will present an Alternative Reality Game (ARG) - *"Solve the Crisis! An alternate reality game to tackle Cape Town's water crisis* - that sets the scene for Capetonians to deal with the severe water crisis that affects their city. On the other hand, we deal with a specific design experiment regarding a computationally designed urban canopy to show how to tackle the climate change crisis with digital technologies, smart environments and responsive interfaces to prove new conceptual and operative tools to discuss and reflect on how to facilitate long-term planning processes. As we do so, we aim to contribute to an ecological design agenda to architects, designers and game scholars in specific. We argue for multiple design approaches that can empower multiple stakeholders towards more integrated and inclusive design strategies, and initiate a dialogue between game scholars and architects.

From our perspective, human and nature not only co-exist, but they can also co-evolve in a symbiotic and productive way.

Figure 1. David Thomas Smith, "Three Mile Island Generating Station", Middletown, PA, USA (2010-11). As part of the "Anthropocene" series, the purpose is to reflect upon the complexity of landscapes as hybridization between natural/artificial fields

Methodology

Serious Games. A brief overview

Serious gaming (Ulicsak & Wright 2010*)* represents a still relatively understudied space of opportunities to develop new tools for scientific analysis and methodologies regarding urban design and planning strategies and to involve different actors in developing more significant problem-solving means.
In the last decades, serious games and gamified applications – centered on the use of specific game features to incorporate ludic qualities (Deterding, Dixon, Khaled & Nacke, 2011) - have been widely employed within design and participatory planning processes. Many studies have shown that their use can be beneficial in situations where these tools could be implemented as part of the planning phase (Ampatzidou, Gugerell, Constantinescu, Devisch, Jauschneg & Berger, 2018) and if their development phase is based on co-creation with multiple stakeholders and participants. Design research is a transdisciplinary academic field that integrates elements from interaction, experience, service, product and graphic design, as well as other design-related disciplines such as architecture and urban planning. The design of games and playful interactions can undoubtedly offer a contribution to design research, as recently remarked by Lankoski and Björk (2015) and Lankoski and Holopainen (2017).
Nevertheless, Research through (Game) Design has already shown promising results "for the objective of making complex situations more understandable and accessible for researchers and stakeholders alike [such as] in the Hackable City project, [where] games were not simple "deliverables" but an integral part of the

inquiry process" (Schouten, Ferri, De Lange, Millenar, 2017; Ampatzidou, Bouw, van de Klundert, de Lange, de Wall 2017; Ferri & de Waal, 2017).
A fundamental question, at this point, is to discuss what the category of 'serious games' itself actually means and which are the positive claimed effects of such games in the fields of urban planning, design thinking, and citizen engagement practices. Some researchers have argued that, even though the term "serious games" has become more popular, there is no current single definition able to give an exhaustive understanding of this field of study (Susi, Johannesson, Backlund, 2007). Therefore, it is clear that before we can seriously task the issue of what a (serious) game based research agenda for ecological thinking could be, we must define what the term means. A brief survey of the already existing literature shows that there are as many definitions available as there are many different researchers involved, but most of them agree on a core that "serious games are (digital) games used for purposes other than mere entertainment" (Susi, Johannesson, Backlund, 2007).
The Serious Game Initiative, emerged in 2002, describes serious games as it follows:

> The SGI is based on uses for games in exploring management and leadership challenges facing the public sector. Part of its overall charter is to help forge productive links between the electronic game industry and projects involving the use of games in education, training, health, and public policy.

Even though other definitions argue for serious games to be more of a movement than a defined area of its own, we believe that the chance to experiment with novel tools and technologies, such as digital apps and gamified environments, are valuable efforts to diversify the typologies of media involved to trigger citizenship engagement and empowerment. With this paper and the examples reported in it, we aim to support the development of lateral thinking design methodologies, based on serious games and gamified applications, to reach a different and innovative result and tackle specific design issues related to various fields (Rowe and Frewer, 2000; Shipley and Utz, 2012). To do so, our Alternative Reality Game example (ARG), is based on Zyda's (2005, p. 26) more formal definition of serious games where the entertainment phase is considered the main ingredient:

> Serious game: a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives.

This explanation also points out the importance of pedagogy arguing for a strong-based learning phase that can be associated with a series of benefits for participation and civic engagement. According to the strong concepts we have been highlighting, our deployment phase for the ARG aims at providing new conceptual and operative tools to discuss and reflect on how games facilitate long-term design/planning processes, where citizens themselves could take their responsibility and contribute to durable solution to tackle one major contemporary crisis for contemporary environmental balance.

Avert the crisis! An interactive narrative game to tackle Cape Town's water crisis[2]

As stated in the "Hack the Cape Town water crisis" website (hackthewatercrisis.org), the City of Cape Town is struggling to face a severe water crisis that affects the entire urban population. The dams, currently Cape Town's primary source of water, have dropped to a historic low due to a prolonged drought combined with a variety of political, human migration, climate and other factors. To address this issue, the municipality has been implementing an aggressive program to help its citizens drop their water consumption rapidly, while also working around the clock to bring alternative sources online. Day Zero, when the water supplies will completely shut down, is more just an ephemeral concept and the city strongly needs to find quick and effective ways to solve this upcoming issue.
With this in mind, during the 24th and 25th of February, a worldwide hackathon[3] took place to develop new ideas and solutions for this crisis. Our aim, as designers involved in the event, was to set the scene to include Capetonians themselves in taking an active part in the process and illustrate the complexity of urban matters with a serious gaming-based approach to make this issue more tangible to be tackled.
We deployed a visual narrative game (Avert the Crisis) that could help the different stakeholders involved to trigger actionable interventions in the Alternate Reality Game. Our primary goal is to generate an emotional connection to Capetonians and their current struggle that would foster meaning-making for a global community of citizens and innovators to respond to.

Figure 2. Screenshot from the ARG – Avert the crisis! - interface (2018)

[2] "Avert the crisis! An interactive narrative game to tackle Cape Town's water crisis" is an ARG – alternative reality games – developed by Valerio Perna, PhD candidate in Design and Theory at DiAP, Sapienza – University of Rome and Adam Van Herdeen, PhD candidate in Platform Design for Smart Cities, Eindhoven University of Technology, Department of Industrial Design, Systemic Change. The ARG was developed as a side experimentation within the STEC – Smart Technologies, Empowered Citizens – project (NWO Funded Research Project 2017-2021).

[3] According to Wikipedia an hackaton is a form of problem solving. People come together to engage in creative discussion to solve real world problems. It emerged from the computer industry although today its usage is far broader

The 'WWW_Day Zero' Alternate Reality Game challenges players to imagine themselves on the brink of a severe water shortage that will affect their entire city and to propose measures that could curb this impending doom. The city has just one month of water left if inhabitants remain within the daily average of 50 liters of water per resident per day. Players are tasked with documenting their journey, ideas and discoveries along the way, and to share this on any public social media platform. This stream of crowd-sourced solutions is linked to a web platform, and curated daily by the game's designers, with the best suggestions for earning themselves a spot in the official ARG narrative as it unfolds.
The narrative structure of the game is based on three different storylines to reach different goals: engage people from an emotive standpoint; develop social connections between the different players involved that represents all the different social classes of South African society; improve the currently poor sharing of resourceful information and to prepare the foundation for starting a brand new design phase to tackle the crisis.
The game interface was developed with TyranoBuilder Visual Novel Studio[4], a software that allows you to design multi-platform visual novel stories and to mix different kinds of graphics and media inside the same plot (images, sounds, footages, etc.).
Some private sessions have been played in Amsterdam, where the research team is currently based, to highlight issues and incongruences in the game dynamics and mechanics, and the public diffusion of the game was set to take place between April and May 2018. Following the different gaming events, all ideas will be stored in an online database of potential solutions made freely available to any city-hackers out there.

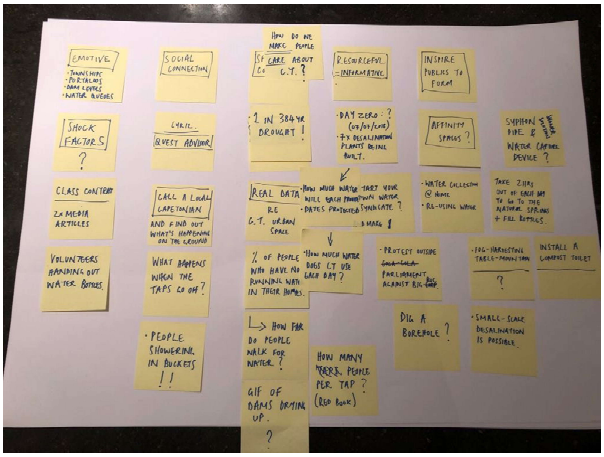

Figure 3. Storyboard of the ARG developed during the Hackathon by V. Perna and A. van Herdeen (2018)

We are well aware that ecosystem and ecological challenges are much more complex than what a single game can portray but this attempt and further schematizations are necessary simplifications that can hopefully become generative for new design solutions. We believe that serious games can allow learners to experience situations that are impossible in real scenarios for reasons of safety, cost, time, etc. (Corti, 2006;

[4] https://store.steampowered.com/app/345370/TyranoBuilder_Visual_Novel_Studio/

Squire & Jenkins, 2003), but they are claimed to have positive impacts on the players' development of some different skills (Susi, Johannesson, Backlund, 2007).
Further implementation of the game will include co-creation design sessions in which different stakeholders will be involved. The results will be analyzed with the use of Liisa Horelli's[5] (2002) methodological scheme for participatory planning, an evolutionary process consisting of five major points in which different tools are used to facilitate transactions between all the participants. A latter phase will continue concerning the proposal of some design artifacts based on the strong-principles that emerged during the design process and will be proposed to the Cape Town municipality as speculative solutions to tackle the water crisis.

Bio-digital design: the biomimetic approach

Embracing the Anthropocene era does affect not only the way we perceive and interact with the social and natural environment, but also the way we design it. Bio-digital architecture ties in the more general framework of the so-called systemic design, a procedural approach to urban and architectural design that tackles three cultural and ecological issues: the limited resources available on the planet, the need to shift from an anthropocentric environmental ethic to a biocentric one and the new instances introduced in the current paradigm by complexity sciences (Baldissara, 2018). If this specific design strategy indeed roots in the informatics paradigm (Saggio, 2007), the advent of the Anthropocene definitely determined a significant shift towards a more bio-oriented one: indeed the evolution of the ecological knowledge, alongside with the continually increasing computational power available, is leading more and more often to the hybridization of organic and non-organic matter in design processes.
In this ever-changing scenario, Bio-digital architecture can be identified by the presence of five main features (Saggio, 2014). First, it is the result of a genetic approach: thanks to computational design methods, Bio-digital architecture is a process-oriented product. The design artifact is algorithmically compiled by the architect to generate a species of designs and not a finite, concluded shape (Estevez, 2003). Bio-digital design grants compatibility and fosters synergy: learning from the way natural ecosystems works, architecture should be not only capable of rooting itself in the existent system without interfering with its cycle, but should be able to generate new, virtuous relationships among its components. A bio-digital architecture is synthetic and connective: moving from a reductionist scenario to a complex one is a key element to motivate designers to shift from an analytical approach to a synthetic one. By adopting an ecological and transdisciplinary thinking, this kind of design opens to the implementation of the so-called hidden connections (Capra, 2001) that shape our world. Another important feature for the bio-informatics paradigm is adaptability: taking advantage of the possibility offered by automation processes, architecture can now pursue a homeostatic balance and gain the capacity to re-shape some of its element to react to external inputs. Finally, Bio-digital architecture has to behave like a proper ecosystem, without producing waste and being able to recycle any component in a closed loop in a zero-waste system.
There are many ways to achieve these goals, which may or may not involve the use of actual biological components in the building process. In the last years, one of these research fields has seen an exponential growth: the biomimetic approach. The terms biomimetics has been first used by Otto Schmitt during the 1969 symposium "Some interesting and useful biomimetic transforms", even though it has been recently

[5] Horelli's metholodogical scheme is made up of five major points: i) initiation of the project. ii) planning and design, iii) implementation, iv) evaluation and research, v) maintenance

brought to the broad public through the work of several authors such as J. Benyus (1998), M. Pawlyn (2011) and P. Gruber (2011). Biomimetics (or biomimicry) is a discipline that, through the strategic research of biological models, produces solutions of sustainable design emulating forms, processes and natural systems in an environment of computerized ecology (Baldissara, 2018). It is a complex discipline that imitates biological organism at three main levels: the formal one, in which case is characterized as 'shallow biomimetics', the behavioral one, the so-called 'behavioral biomimetics' (Radwan e Osama, 2016) and the systemic one, 'ecosystems biomimetics'. Depending on the depth and the object of the analysis, the designer can either extract from the organism a complex strategy, a design process or a proper shape. Regardless of what approach is chosen, every biomimetic experimentation goes through several phases: the identification of the biological characteristic to emulate, its translation into mathematical and computational terms and its implementation in the final design (Baumeister et al., 2011).
As biomimetics belongs to the broader field of complex disciplines, exact procedures and design processes are hardly defined by a step-by-step method but are more likely to be understood through the following case study.

Physarum Shelters, an adaptive device to promote ecological thinking

The first step when approaching a biomimetic design is to understand to which biological organism it is related and which of its characteristics it embodies. The Physarum Shelter is a small architectural installation, designed on the behavioral patterns of the Physarum Polycephalum, also known as slime mold. The slime mold is a unicellular protist that, despite its simple biological composition, shows highly interesting behaviours: a basic form of spatial intelligence, shown in the ability to resolve simple mazes and to find optimized paths in several kinds of networks; a surprising form of spatial memory, thanks to the protoplasm that he secrets; the ability to memorize and therefore predict or adapt to changings in environmental conditions. All these emerging qualities have been analyzed, translated into mathematical patterns and computed into a digital genetic model to create a new morphogenetic process able to embody the main characteristics of the slime mold.

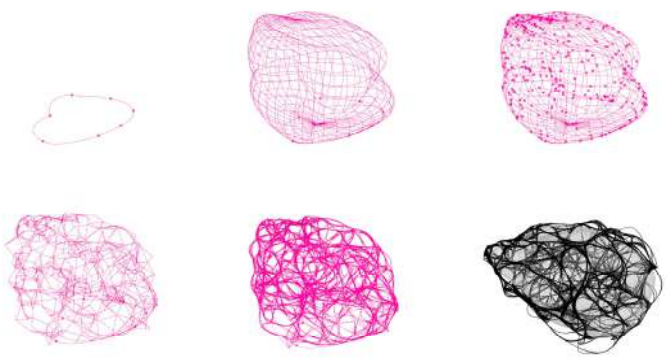

Figure 4. Physarum Pavilion design diagrams. Design: Matteo Baldissara (2018)

The interest in the Physarum Polycephalum has grown through the last years, since Heather Barrett founded the Slime Mold Collective, and many experiments and studies have been conducted on this simple

organism. Therefore, many mathematical models that describe or approximate its behavior are available in literature and on the web. For this specific piece of design, we used the General Stern Tree and the A* algorithms to reproduce and expand the behavioral patterns of the Physarum Polycephalum. These algorithms, both belonging to the more general theory of graphs, were implemented within the well-known parametric development environment Grasshopper, and the intensive use of Agent-based-modelling plugins. As complex as a computational model can be it is pointless unless it can determine a precise correspondence between digital data and environmental ones, with the aim of implementing them through the design process. To do so, we established a strict correlation between the path network that the Physarum model can describe and a structural system that can be 3D printed or built through robotics extrusion of fibrous material. This relation is driven by environmental factors such as the density of the net that is adjusted to radiance values and can be computed to fit in any environment. This correlation determines different levels of density in the structure and different level of shading inside the shelter. The result of the process is a dense network of thin, fibrous elements which describes a well-defined space, capable of hosting up to two people. The enclosure of this tiny architecture is realized with a thin layer of ETFE, a plastic, transparent and utterly recyclable material that can be sewn to fit the external structure properly. This inner layer can be inflated by an air compressor connected to a proximity sensor and activated only when someone is in the proximity of the pavilion. This simple form of interactivity can be used to encourage civic engagement and to create proper ludic installations. If the Physarum Shelter was to be built in series and installed in a public space, it could create a network of communicating spaces that, without the presence of citizens, would appear crystalized, and that could be only activated by the proximity of visitors.

Figure 5. Physarum Pavilion. 3d view. Design: Matteo Baldissara (2018)

Conclusions and discussions

Inspired by Action Research (Foth & Brynskov, 2016) our research strategy's purpose is to solve a particular problem and to produce guidelines for effective practices. We found inspiring to address the ecosystem topic starting from different theoretical frames and delivering various and heterogeneous design

solutions. We are all engaged in design and architectural design education from different perspectives, and we found the differences in our approach inspiring through our design work.
All the deployment studies presented in this paper are currently still in development and have only been tested in private sessions or through computational simulations. This is why, in lieu of a conclusion, let us finish the paper with a reflection on our experimentation so far, and on what we expect this paper could set the scene for the ecological research agenda.
From the get-go, we did not want to frame the selected topic from a one-way perspective, but we aimed to sparkle a wider dialogue to include not only architects but experts coming from different fields, to facilitate a lateral design thinking phase that could link to more effective and long-term solutions.
We looked at the topic through the lens of the "Research through Design" (RtD) approach (Zimmerman, Stolterman, Forlizzi, 2007, 2010). RtD is one of the many methodologies and epistemologies that are leveraged in the broader field of design research and has to do with the use of design practice as a form of scientific inquiry. In other words, an RtD approach involves the designing of experimental artifacts as means of raising interesting scientific questions and answering them: as John Zimmerman noted how design is a process but also a form of research. Following Donald Schön's (1983) assumptions, we strongly focus on design as a reflective practice where the designer critically reflects on the action to improve design methodology and thinking. Indeed, the design phase is a process but also a form of research, and the design of games and playful interactions in relation to architecture and urban development can undoubtedly offer a contribution to address the contemporary crisis in the urban fabric. The examples presented in this paper clearly show how biomimetic computational design processes can comfortably co-exist, thus be enhanced, by the use of interdisciplinary novel tools such as digital media, serious games and open platforms.
Furthermore, the domain at the crossroads on ecological thinking, urban planning, civic media, activism, and game design is becoming more and more critical (Nijholt, 2017; Tan, 2017; Gordon and Mihailidis, 2016). For this reasons, we honestly felt the need for a more comprehensive research approach that could, on the hand, provide new conceptual and operative tools to deal with the topics of coexistence and co-habitation, and on the other side be able to set the debate for shaping and support architectural and game design decisions. Nevertheless, in the last decade, we have seen the rise of urban play as a tool for community building and city-making (Tan and Portugali 2012; Tan 2017), and Western society is actively focusing on play/playfulness as a way to approach complex challenges and emergent situations and to foster civic engagement through participatory/co-design tools (Brown & Chin, 2013; Irvin & Stansbury, 2004; Tonkens, 2014; Bødker, Grønbæk & Kyng, 1993; Spinuzzi, 2005).
In sum, with this work we argue for a more inclusive design process and to set an open dialogue for a new ecological design research agenda that could benefit from new speculative research fields in order to explore unexpected solutions, address the challenge of biological diversity and manage the Earth's resources sustainably in the decade to come.

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