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Biomimetic Leadership: Core Beliefs for Sustainable Organizations

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Abstract

Biomimetics is the science of applying nature-inspired designs and processes to human engineering and social innovation in order to solve complex problems. Emulating life's blueprints and patterns, chemical processes, and ecosystem strategies leads to sustainable and regenerative solutions for a biosphere able to support all life on our planet. In a similar vein, Biomimetic Leadership encourages western 21st century leaders to rediscover the value of nature, apply life's design principles, and utilize biomimetic thinking for the sake of improving organizations. Four core beliefs—Respect, Relate, Reflect, and Replicate—provide the foundation for Biomimetic Leadership as a new type of leadership. Each belief is a source of inspiration and offers insights into a hands-on approach to leading in an era of unprecedented environmental and economic concerns. Educating leaders for Biomimetic Leadership is a challenge that must be addressed by organizations with the objective of reaching equality, and by doing so, focusing on incorporating the four core beliefs described in this paper.

Keywords: Biomimetic; Biomimicry; Leadership; Beliefs; Sustainability

Introduction

Biological metaphors are alive. Mechanical metaphors are dead.

(Charles & Samples, 2004)

Organizations today are facing unprecedented social, political, and environmental changes, yet their leadership persists in utilizing traditional 20th century top-down methods of control and competition (Narayandas & Casnocha, 2019). The conventional modus operandi is no longer viable, and solving 21st century problems requires new leadership skills. DeLuca (2016) advocated for the integration of practices inspired by nature to address the challenges that lie ahead. Their previous research focused on the replacement of practices and habits centered on conflict with synergistic, emergent, and collective ways of thinking (DeLuca, 2014). Celep et al. (2017) discussed relationships between biomimicry and managerial concepts and correlated leadership and biomimicry in terms of harmonized individuals and teams. Hutchins and Storm (2019) proposed Regenerative Leadership as a new approach that values life. Olaizola et al. (2021) presented a biomimetic leadership model considering nature as a model, measure and mentor, proposing specific traits a biomimetic leader should possess. Their

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previous research introduced Organizational Biomimicry as a new model of corporate management (Olaizola et al., 2020).

The terms biomimicry and biomimetics are frequently used interchangeably in scientific publications, however Drack and Gebeshuber (2013) postulate that biomimicry places importance on sustainable and environmentally friendly solutions while biomimetics not necessarily takes into consideration sustainability. For the purpose of this discussion, the terms biomimicry and biomimetics are congruent as both fall under the umbrella of biologically informed disciplines and are focused on nature centered practices, human–nature ethos and sustainability (Iouguina et al., 2014). To stimulate a new frame of mind that can in turn assist the restoration and sustaining of limited resources, as well as advocate for healthier policies, leaders must re-engage with natural systems.

Undergirded by the fields of biomimicry, sociobiology, and systems thinking, biomimetic leadership offers a way forward for today’s leaders. Biomimetic leadership can be defined as “a pioneering framework viewed through the ecological lens, in which every living system reveals practical applications and sustainable solutions to systemic challenges “ (Somoza-Norton & Whitfield, 2019. p. 14). By implementing nature-based strategies, leaders who employ biomimetic insights initiate growth, facilitate optimal interconnection and interdependency within organizations, and promote sustainable, restorative, and regenerative practices. A recent mixed-methods research study showed encouraging results on the application and implementation of biomimetic leadership approaches in a graduate school leadership program. After completing an instructional unit of study on biomimetic leadership, 89% of the students agreed biomimetic leadership could have a role in improving organizations (Somoza-Norton & Whitfield, 2019). A few of the instructional examples used in this study were inspired by Bogatyreva and Shillerov (2015) research, who have extensively studied animals’ social organization such as ants and bees to find the answers to human management issues. These insects engage in collaborative and mutualistic solutions that positively impact their environment. The objective is not to replicate every single behavioral aspect of an ant or bee community but to observe and learn from, for example, their resource-efficient practices. The outcomes of these investigations have resulted in sustainable collective-based management solutions.

The nature-centered leaders exercise a tremendous amount of influence over decision-making in both local and global organizations, but bringing a vision of an equitable future to fruition requires the development of innovative practices that ensure the preservation of nature. For these leaders this entails an understanding sufficiently comprehensive to allow organizational development and navigation to be directed toward a future that is more sustainable (Stober et al., 2013). It is the responsibility of leaders to recommend new educational policies and industry technologies to provide equitable resources, promote cultural diversity, and encourage environmental stewardship. In order to be truly successful, leaders need to consider marginalized cultural groups impacted by the climate crisis and economic turmoil. The voices of individuals in disadvantaged populations have been neglected for far too long, and individuals in charge must advocate for a more-inclusive decision-making process (Bowers, 2001).

In the early 1990s, Janine Benyus (1992) coined the concept of *biomimicry*. Since then, biomimicry has revolutionized numerous industries, for example the construction (Oguntona & Aigbavboa, 2019), the agriculture (Othmani et al., 2021) and the chemical industry (Geiser



et al, 2005), among others. The process of *biomimetics*—the art of emulating nature to resolve human predicaments—has been successfully applied in popular product designs such as Velcro (Nachtigall, 1974), to processes such as passive cooling (Jamei & Vrcelj, 2021) and swarm computing (Karaboga & Akay, 2009), as well as in the design of solar panels (Martín-Palma, & Lakhtakia, 2013), wind turbines (Shrestha & Ravichandran, 2021), and water purification systems (Azzi & Beyrouthy, 2015).

The pillars of biomimicry involve recurring deep patterns and life principles present in the natural world, such as *evolve to survive, adapt to changing conditions, be locally attuned and responsive, integrate development with growth, be resource-efficient, and use life-friendly chemistry.*

Benyus (1992) pointed out that “life creates conditions conducive to life, “ and human beings should learn from and emulate Earth's operating conditions in general conduct.

Similarly, biomimetic leadership encourages individuals to observe nature and learn from its strategies, employing such principles as self-organization, adapting to change, and being locally attuned to organizational innovation. Accepting nature's mentorship necessitates a change in attitude, intentionality, and introspection. It entails a personal commitment to a particular belief system. As Usó-Doménech and Nescolarde-Selva (2016) explained:

Belief systems often include representations of alternative worlds, typically the world as it is and the world as it should be...The world must be changed in order to achieve an idealized state, and discussions of such change must elaborate how present reality operates deficiently, and what political, economic, social (etc.) factors must be manipulated in order to eliminate the deficiencies. (p. 149)

Biomimetic leadership, therefore, rests on a philosophy of change that both reflects natural patterns while generating tremendous shifts in outlook. While this approach does not imply a one size fits all solution for all world leaders, it does offer a much-needed nature-centric perspective to leadership. The four core beliefs of biomimetic leadership—Respect, Relate, Reflect, and Replicate are simple to understand yet challenging to carry out, requiring the leader to deeply self-assess the given view of nature's value and genuinely experience or, as Fleming (2016) put it, “encounter “ nature on nature's own terms. Each actionable “R “ adds a layer of awareness and knowledge that informs the next step. We propose exploring the “Rs “ in the order presented above, beginning with Respect as the point of departure. Each stage is uniquely fitted and conceptualized for biomimetic leadership, following a nature-centric approach that other contemporary leadership theories, such as distributive, transformational, and servant leadership, do not incorporate in their conceptual framework. Such progressive stages in the proposed sequence lead to higher levels of consciousness, embodying a leadership style that better fits the needs of today's contemporary leaders and the kinds of challenges faced. Leaders whom achieve height levels of post-conventional consciousness become better facilitators of organizational learning and agents of change and more effective and productive (Baron & Cayer, 2010).

The following sections describe the core beliefs of biomimetic leadership, illustrate the significance of each phase and were developed based on a review of published literature.

Respect

At the 2018 Climate Change Conference in Poland, renowned naturalist Sir Richard Attenborough conveyed an urgent message to the world:

Right now we are facing a man-made disaster of global scale, our greatest threat in thousands of years: climate change. If we don't take action, the collapse of our civilizations and the extinction of much of the natural world is on the horizon (as cited in McGrath, 2018).

Sir Attenborough's urgent plea raises the question of how the point of imminent catastrophe had been reached. Many would lay the blame for the tremendous impact human beings have had on the natural world on the sense of superiority humans have cultivated (Crist, 2017). Unhinged anthropocentrism and human actions have resulted in disrespectful behavior towards the natural world for decades threatening more species than ever before. According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), nearly 1 million species already face extinction (Diaz et al., 2019). The anthropocentric perspective places humans on a higher plane when compared to nature and is used to justify the exploitation of natural resources—whether flora, fauna, or minerals—for the sole advantage of humankind (Cafaro & Primack, 2014). The philosophical outlook of anthropocentrism has profoundly shaped how humans think and behave towards nature and life in general.

Respect (from the Latin *respectus*) involves the act of looking back. In order to live in healthy ecosystems, humans must have a renewed appreciation for nature, not only in attitude but also in promoting regenerative and sustainable practices at both a personal and a professional level. The topic of respect for nature and the question of the right of humans to consume every resource that the Earth has to offer has been debated extensively (Schweitzer, 1919/1988; Leopold, 1949/1987; Rolston, 1979). One prevalent *respect for nature* viewpoint is that of Paul Taylor's (1986) biocentric outlook, which is based on four tenets:

1. Humans are members of the Earth's Community of Life in the same sense and on the same terms in which other living things are members of the community.
2. Human species, along with all other species, are integral elements in a system of interdependence (determined by physical conditions and relationships with other living things).
3. All organisms are unique individuals pursuing their own good in its own way.
4. Humans are not inherently superior to other living things. (pp. 99–100)

Using Taylor's framework, the first phase of biomimetic leadership that reflects a respect for nature is acknowledging the profundity of nature's presence and becoming cognizant of an individual's place in the Earth's Community of Life. By endorsing and advocating for a nature-centered view of life, leaders build a foundation for respectful practices in organizations. For example, when developing new products, technologies, and educational programs (i.e., HVAC systems design inspired by bees' reduction of energy loads, and professional development on sustainability for employees), at the center of a biomimetic leader's vision should be the desire to protect nature in a respectful, restorative, and regenerative manner. Margo Farnsworth (2021) alert us, "Gravity, sunlight, water, cyclic processes- and limits and stretching



boundaries. We're not good at recognizing and/or respecting this operating condition- not by margins. " Biomimetic leaders are therefore mindful of the damages an anthropocentric mindset can have within organizational structures and the policies and products produced.

Furthermore, leaders adopting an eco-justice perspective know how to interact with the environment and assess any possible harms personal decisions can have on either the local or global scale. As Rob White (2013) explained, "Development of an eco-justice perspective requires both appreciation of the wider political-economic context within which exploitation of the human and the nonhuman occurs, and practical strategies that can be used to navigate complex and problematic moral and ethical dilemmas " (Introduction, para. 25).

White (2013) meant that leaders adopting an eco-justice perspective both appreciate the manifold ways members of the natural community could be commodified as well as how to address these issues—for instance, by anticipating the risks that any actions pose to current and future generations. By proactively promoting the use of Earth's limited resources in a sustainable manner with the objective of minimizing impacts on the environment, biomimetic leadership is a source of eco-justice inspiration and creative problem-solving techniques. By promoting regulations to recycle all materials, using low-energy processes, and developing multi-functional designs, leaders effectively endorse sustainability and the protection of living systems.

Biomimetic leaders do not just merely acquire strategies from nature but reciprocate in a positive manner that is environmentally responsive. In emulating nature's strategies, leaders not only learn and apply effective practices but ultimately build the groundwork for a better future and a biosphere able to support all life on our planet, understood as a planet that supports life for all species. The leaders that apply effective practices do not ignore Rolston's (1979) cautionary words warning against explicitly imitating nature in an ethical sense because of its amoral dimension and lack of discernment of right or wrong. Instead, the aim is to respectfully embrace nature as a tutor of the best technical and strategic practices. As Schauburger and Coats (2000) expressed, "You must look at the processes of motion in the macrocosmos and microcosmos accurately and copy them! " (p. 19). Emulating nature and aligning with natural processes grants human-led organizations a framework to foster and generate respect for the planet and natural resources.

The biomimetic leadership approach is influenced by eco-centric traditions and considers Marshall and Lozeva's (2009) suggested qualities of a more environmentally sensitive and socially just application of biomimetics:

- Inherently sustainable from an environmental and social point of view;
- Encouraging of decentralization and localism;
- Democratic when it comes to decision-making regarding technological change;
- Understood by all, not just by the experts;
- Sensitive to the need to disperse power rather than to concentrate it (p. 7).

Biomimetic leadership can have extraordinary implications for society; by fostering an ethos based on sustainability, deep-seated attitudes, customs, and cultures in individuals and organizations are challenged. As Dayna Baumeister (2014) explained, "The real ideal is to create a biomimetic culture that looks to nature for advice in all endeavors " (p. 69). Changes

in mindset and assumptions are challenging to achieve (Bruhn, 2021). Consequently, respect for nature must be at the inception of any initiative that embraces biomimetic leadership. Unless there is sincere and authentic acceptance of humans' role and actions in the web of life, the next three steps of biomimetic leadership—Relate, Reflect, and Replicate—will be difficult to truly embrace and embody.

Relate

Biomimetic leadership proposes that leaders must reawaken a lost connection with the environment and an inherent desire to relate to nature, or what Edward Olson Wilson (1975) called biophilia. Nature has intrinsic value for humans by providing resources to satisfy human material needs (Millennium Ecosystem Assessment, 2003). However, human affiliation with nature is not only related to the physical exploitation of resources but also in how contact with nature affects humans emotionally and in human personal and professional development. The human connection to nature influences the decisions made every day, such as choosing the environment in which an individual lives and works, as well as specific details related to life and work (Kellert, 2006).

Although the relationship of humans to nature might seem subjective, several tools have been developed to assess the relatedness of the person to the natural world. Mayer and McPherson Frantz (2004) proposed the Connectedness to Nature Scale (CNS) as a tool to measure an individual's level of feeling emotionally connected to nature, which has been tested for validity and reliability via different studies. Lawrence Letourneau (2013) developed the Biophilic Attitudes Inventory (BAI) with the objective of having a reliable, stable, and viable instrument to measure individuals' attitudes towards biophilia. Additionally, a comprehensive conceptual framework—the Intergovernmental Platform on Biodiversity and Ecosystem Services, or IPBES—has been developed to specifically study the connection between nature and people. Six main elements were identified in order to capture the relationship between nature and people, including nature's benefits to people, anthropogenic assets, and quality of life (Díaz et al., 2015). Furthermore, Stephen R. Kellert (1993) proposed a typology for classifying the tendency towards biophilia: utilitarian, naturalistic, ecologicistic-scientific, aesthetic, symbolic, humanistic, moralistic, dominionistic, or negativistic, defined as universal expressions of basic human affinities and/or valuations of nature. Regardless of whether an individual identifies with any of the valuation systems for understanding subjective relationships with the natural world, all of the valuation systems serve as reflections of the dependence of humans on nature.

An important point at issue in understanding relatedness to nature is the perception of being both part of and/or separate from nature. The perception might very well be influenced by an individual's specific background and previous or current experiences with the natural world. Vining et al. (2008) evaluated human perceptions of connectedness to nature, observing that although many individuals report being part of nature when asked about natural environments, the individuals simultaneously described natural environments as being void of any human contact and interference. The cognitive dissonance related to the individuals' self-consideration of being a part of nature but at the same time viewing natural environments as not being influenced by humans might have implications related to human behavior towards the natural world and how perceptions of nature can complicate decision-making and environmentally responsible behavior.



The disconnection with nature may not only be contributing to the deterioration of ecosystems writ large and to a corresponding lack of pro-environmental behavior, it may also be harmful to humanity. Kellert (1993) noted that the degradation of the human-nature connection increases the likelihood of a diminished human existence, while Eleonora Gullone (2000) observed that substantial evidence was found in the literature to establish that individuals living a modern lifestyle, characterized by a rapid pace of change at odds with nature, tend to exhibit diminished psychological well-being.

Reconnecting with nature by, for example, embracing ancient lifestyles or intentionally including elements of the natural world in day-to-day life, may help to improve individuals' psychological well-being (Gullone, 2000). To illustrate, allotments (small strips of land available to individuals) are very popular and part of British culture. A study conducted in South East England showed that "allotment cultivation did indeed help foster environmental consciousness by allowing gardeners to conceptualise their everyday allotment activity within the framework of complex global debates, such as those relating to sustainable development" (Hawkes & Acott, 2013, p. 1128). Even more importantly, re-establishing a relationship with nature encompasses an understanding of the interconnectedness of all other living things on Earth (Nisbet et al., 2009), and is considered a critically important tool for the promotion of environmentally sustainable behavior in individuals (Zelenski & Nisbet, 2014) contributing to maintain a biosphere able to support all life on our planet (Capaldi et al., 2014).

But what does improving the human relationship with nature mean for leaders? To start, people must be seen as being a part of nature, and the traditional mindset that considers people and nature as two separate entities must be changed. Examples of biomimetics offers leaders the unique opportunity to exploit the desire for reconnection—an opportunity to once again feel a part of nature—irrespective of whether the connection is just starting to be built or is being rediscovered. An individual does not need to be an expert in the scientific aspects of biomimetics in order to reconnect with nature. For instance, spending time outdoors, writing observations in a journal are basic steps to discovering nature-based strategies. Moreover, being aware of a renewed relatedness or reconnection through the prism of biomimetics implies a conscious "shutting down" of human cleverness and becoming open to the richness of solutions that life has created as a result of evolution (Baumeister, 2014).

Leaders will likely find the embrace of an anti-human-cleverness attitude the most difficult step of the process, as many might equate unique capacities and skills at problem-solving to an individual's leadership style. Nevertheless, if leaders allow the possibility of learning from nature's wisdom, the right path that incorporates proven strategies into the leadership toolbag and improves leadership skills can be established and followed.

Relatedness to nature can be revived by spending time outdoors and re(discovering) a connection to the natural world. Regrettably, regions around the world are enduring high levels of pollution and extreme weather events that affect particularly outdoor laborers (Barthwal et al., 2022). Therefore, whenever possible, leaders can promote nature-connecting activities to family and colleagues, confident in receiving in return a positive outcome, for the individuals being led, on the physical, emotional, and intellectual planes that ultimately leads to a general feeling of well-being.

Reflect

To be successful in today's world, leaders must reflect on the efficiency of leadership practices in order to understand how actions are connected to the natural world. In the book *How We Think*, American philosopher John Dewey (1933) described the process of reflection as “active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends “ (p. 7). Throughout, Dewey emphasized the benefits of using reflective thinking as an integral part of the learning process. Philosophers have continued to expand upon the idea of using reflective thinking; for example, Donald A. Schön (1987) introduced the act of reflection into the workplace as a way for professionals to gain knowledge and refine skills. More specifically, Schön wrote that reviewing experiences is a vital process that allows individuals to gain understanding, both as events happen (reflection-in-action) or afterward (reflection-on-action). The approach has come to be known as the Reflective Practitioner model. Reflecting-in-action gives the opportunity to alter solutions used in the past and apply them to current problems. On the contrary, reflecting-on-action surfaces after the attempt to solve problems. Typically, novices to the reflection process may feel more comfortable with reflection-on-action until they gain sufficient skills and experience to interpret and make connections right away; for example, the implementation optimization of energy and water resources in an organization. Although “reflecting “ means to bend back, the act of merely remembering previous experiences is not sufficient. To indeed be beneficial, reflection must incorporate the process of taking a step back to gain perspective and of giving serious thought and consideration to one's actions to achieve a clearer understanding of the motivations and processes that influence actions. As a part of the learning cycle, the act of reflecting is a critical step, mandating that users dedicate sufficient time to evaluate actions and contemplate methods for improvement. Biomimetic leaders periodically and intentionally reflect on and self-assess relationships with the natural world and ensure that professional practices respect living systems.

Effective leadership involves more than the ability to produce desired results. It also demands that leaders use past experiences to build upon understandings and perceptions, and to become self-directed learners by actively managing personal growth and development. Reflection is a vital part of this process because it gives leaders the tools needed to learn from experiences and to apply the lessons so learned to future actions. For example, active reflection encourages biomimetic leaders to remain open-minded, challenges deeply held ways of thinking, and compels a greater awareness of leaders' roles within the larger system of nature.

Examining an action or method of decision-making using reflection allows leaders to engage in a deeper process of self-awareness, which leads to a more in-depth understanding of personal motivations and reveals the potential for change to take place, if warranted. Conversely, when leaders abstain from the practice of reflection, the risk of having a self-image that does not reflect reality becomes increasingly possible. Leaders can be deceived into believing performance to be effective or excelling when performance is instead failing or resulting in unproductive decisions. Leaders are most at risk of duplicity when the process of reflection would produce a contradictory view. Additionally, leaders who do not engage in reflection fail to consider alternative possibilities or recognize trends and patterns, which can have unwelcome consequences. The act of reflection can incorporate information gathered



from a range of sources, including self-observation, feedback, interested parties, and peers. In short, the process of reflection itself is not enough; leaders must commit to a rigorous, deep-level analysis.

Employers can create environments that facilitate the act of reflection. One such way biomimetic leadership can encourage and facilitate the reflection process for employees is to assess and improve the work environment. As suggested by Leather et al. (1998), incorporating nature into the workplace reduces stress and fatigue while improving mental health. Also, Sherman et al. (2005) noted in their research that nature operates as a “restorative environment “ capable of replenishing mental and emotional processes that become exhausted when subjected to the kind of focused attention that work involves. Interestingly, employees gaining mental reprieve through exposure to nature have a higher chance of making meaningful connections while participating in reflective practices. Therefore, leaders can capitalize on the health benefits nature provides by incorporating nature into the reflective process. It is important to note that complete immersion into nature is not necessary to experience positive psychological effects (Ulrich, 1984). Merely viewing nature can have positive psychological effects, and data suggests that a natural view is preferred over an urban one in a variety of settings (Raanaas et al., 2011).

There are two ways that leaders can facilitate employee interaction with nature. To be clear, when talking about bringing “nature “ into the workplace, wholesale architectural changes to office spaces are not being suggested. Nature in this context refers to the vegetation and greenery on or around an organization's property (Li & Sullivan, 2015). The first way to improve the connection to nature is by providing employees with a natural view. This can be achieved by incorporating vegetation within the organization's building, displaying images of a natural landscape, or by highlighting windows with a direct sight of greenery (Dravigne et al., 2008; Leather et al., 1998; Ulrich, 1984). The second way to increase contact with nature is through providing employees with access to a green outdoor environment, such as a garden or a greenhouse (Lotttrup et al., 2012; Sherman et al., 2005). If that is not feasible due to variety of work settings that exists everywhere, interaction with nature can be encouraged by incorporating images of aquatic, desert, grassland, forest and tundra biomes.

By enabling more direct interaction with nature, leaders facilitate a reflective process through which employees avoid strictly internal insights in order to make broader global connections. The act of reflection is often thought of as an internal process that may lead to a phenomenon known as cocooning. As a result, employees are more inclined to retreat into isolated introspection without feeling responsibility for others (Kalischuk & Davies, 2001). While internal processing is critical to reflection, employees must balance cocooning with connecting, augmenting the process of reflecting through interaction with other people (Kalischuk & Davies, 2001). As employees ruminate within a collective of individuals, reflection is had on the experiences of the group and therefore more global linkages are made. In this state of consciousness, biomimetic leaders can encourage employees to integrate nature into the reflection process. Several studies suggest that contact with nature is positive for the human psyche (Hartig et al., 2014; Kaplan, 1995; Scopelliti et al., 2019).

In the face of finite resources, natural forms, systems, and processes capitalize on efficient designs. Biomimetic leaders benefit from taking the time to reflect on how the principles of sustainability and biomimetics can be applied to the needs of business. Such leaders also

benefit from reflecting on how practices and policies affect nature and strive for more sustainable and economically conscious methods (Anderson, 2002). When leaders incorporate the natural world into their reflective process, efficiency is maximized, profits are increased, and waste is minimized both for the organization and for the natural world (Harman, 2014).

An important step of the Reflection process is to acknowledge that organisms have developed leadership strategies which human beings can Replicate. For example, nature has developed strategies to maintain community by developing specific mechanisms to coordinate activities, systems or by self-organizing itself. Brilliant ideas can emerge from reflection and taking the time to observe the interconnectedness and interdependency that exists in nature. Gebeshuber and MacQueen explain,

If we look at living nature, one of the first things that strike us is the amazing combination of beauty, structure and function. This butterfly uses just local materials to achieve his coloration – no transport over thousands of miles. Not mining as we currently do, no resource depletion, but regrowing materials that achieve functionality via structure, and that even when the organism is dead serve as input for others (food, fertilizer). Structure rather than material is one deep principle that can be identified in living nature (2013, p. 157).

In the “Replicate “ section some of these strategies are further discussed.

Replicate

Replication of nature’s working models is the fourth and final key principle of Biomimicry and is usually the principle most related to the practice of the discipline. Biomimetic leaders understand the benefits of following nature’s working models and emulating to the maximum extent that organisms have developed over years of evolution. Translating and incorporating nature-replicating approaches to address particular situations within an individual leader’s respective field—asking in effect what would nature do (Tazzi, 2014)—is the final step towards fulfilling the promise of biomimetic leadership. Emulating nature could optimize and revolutionize the manner in which current production processes are engineered and reimagine the static and ubiquitous 40-hour work week schedule.

Nature offers brilliant models of cooperative relationships and mutualisms that are vital to the success of enterprises. Emulating nature provides leaders with an array of ingenious and efficient strategies such as stigmergy, defined by March and Onof (2008), as “the phenomenon of indirect communication mediated by modifications of the environment “, *self-organization, self-renewal, feedback loops, building cooperative relationships, and being resource-efficient* (among others). However, acknowledging the context in which strategies borrowed from nature work is important and means depicting Earth’s operating conditions accurately, as well as honing in on specific circumstances that can be translated into concrete challenges organizations face. Equally critical is understanding that the context in which organizations thrive is always changing, similar to the way the natural world is always changing. An organization’s ability to adapt to changing conditions is of the utmost importance when adopting a solution based on nature, such as stigmergic behavior observed in non-human organisms such as ants, termites and bacteria.

Biomimetic leadership employs the replication of nature through identifying the principles, patterns, strategies, and functions found in nature, and incorporates natural features into



planning and solutions. Incorporating replication can be accomplished on three levels: form, process, and system (Baumeister, 2014). Form represents replication of the natural world based on the structures, shapes, appearance, and/or arrangement of elements. Process replication means to imitate specific procedures, techniques, methods, or series of actions derived from nature. The most sophisticated type of replication occurs at the system level, involving holistically reproducing approaches, frameworks, or schemes, always with the awareness of taking into consideration every part or element of the system which, in the end, forms part of a more complex whole. System replication is often compared to the imitation of a mature ecosystem (Baumeister, 2014). Alternatively, replication can be classified as materials, structures and processes (Gruber et al., 2011).

In addition to particular types of replication, Tamsin Woolley-Barker (2017) proposes specific nature-inspired strategies that leaders can follow in order to improve performance and build wealth:

1. Sharing diverse perceptions to help expand collective understanding by promoting local disruptive information (gathered from the bottom-up, as opposed to a global vision imagined and shared from the top-down). Meeting in the middle is a challenge that all superorganisms face, and it is also the key to their success.
2. Forming specialized modular teams as needed in order to permit an organization to be flexible and adapt to changing conditions. The key is to specialize in generalism, forming modular teams that are able to form and reorganize into working groups as needed.
3. Distributing leadership in order to integrate local information with a global vision. Superorganism leaders actively seek diversity and suppress conflict and dominance in order to avoid interferences with collective intelligence. Distributed leadership helps an organization to bring together diverse individual knowledge into the organization's global vision.

A third perspective on the importance of replication is found in Herzlich and Allen (2018), who postulated six Living Systems Leadership Practices—which also serve as leadership tools that can be incorporated into organizations, communities, and social change initiatives. The practices include *adapt and evolve*, *attune to local context*, *activate feedback loops*, *cultivate cooperative relationships*, *self-organize using simple rules*, and *optimize diversity*. The biomimetic leadership principles reflect a deep appreciation of how replication supports and sustains organizations over the long haul:

Adapting and evolving encourages organizations to be resilient in the face of disruptions that would inevitably cause changes. Developing strategies that would enable an organization to adapt to change would make the organization more flexible when disturbances arise and more readily poised to incorporate adequate responses to changes leading to organizational evolution (e.g., preparedness for succession planning).

Attuning to local context encompasses understanding the context in which an organization thrives. The practice involves identifying organizational selection pressures, predictable cycles faced at different timescales, and adaptation possibilities to changing contexts—not only to *activate feedback loops* but also to proactively maintain cyclic information flows among different stakeholders of the organization.

Fostering community can be accomplished by *cultivating cooperative relationships* that establish different types of interactions amongst stakeholders. Aiming towards mutualistic interactions,

where all parties involved secure a positive outcome, is an essential criterion for long-lasting partnerships. *Self-organizing using simple rules* allows an organization to assemble networks with smooth information and resources flows, organizing as well as building from the bottom-up and granting members enough flexibility and freedom to create collective intelligence aiming towards stigmergy and emergence.

Finally, aiming to *optimize diversity* amongst the individuals and working groups that comprise an organization, as well as incorporating diversity into processes and activities a company performs, brings the positive outcome of resilience and the ability to appropriately respond to dynamic contexts. A diverse, equitable and inclusive organization attracts and retain individuals from different age groups, ethnicities, races, abilities and disabilities, gender identities, cultures, etc. Among the value of optimizing diversity is “Giving diverse members equal standing in decision making processes and insider status in contributing to organizational success.” (Bernstein et al., 2019)

While replicating patterns, processes, and strategies from nature is not a remedy to every organizational and environmental ailment, emulating living systems that have been performing efficiently for 3.8 billion years (Benyus, 1992) is sensible and rational.

Conclusion

Biomimetic leadership’s core beliefs of Respect, Relate, Reflect, and Replicate are actionable pathways to running more responsive and accountable organizations. Bio-inspired approaches are urgently needed today to find sustainable and regenerative solutions, and produce healthier living conditions on the planet Earth. Biomimetics has not only proven to be the inspiration for the development of products and economic prosperity, but of a promising leadership ideology with the capacity for transformative change.

At present, individuals responsible for organizational success and survival continue to employ outdated leadership philosophies and strategies. Current circumstances demand a new leadership framework. The four Rs exemplify a fresh mindset for leaders in trying times and a path to implement practices that express appreciation for natural ecosystems.

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