Beasts in Collaboration: A Study of Biomimicry and Evolutionary Principles applied to Management Innovation

by
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ABSTRACT

This research describes the frontier of bio-inspired management innovation and how it may lead to a paradigm shift in how we structure and lead organizations. As an exploratory foray into a subculture of bio-inspired experts, it asks how we might apply evolutionary principles to creating more resilient and adaptive organizations. The experts hail from both science-based and organizational management backgrounds, showcasing a distinct divergence in how biomimicry is applied in their work. A review of contributions from these pioneering practitioners discovers the impetus and resulting benefits of their application. This is contrasted with the barriers that currently limit further development of biomimicry for organizational change. Ultimately there remains a common understanding among these practitioners that involves the intention to learn from nature. The research therefore analyzes the study of nature for informed and intentional change, and provides examples of edge corporations leading the way. As we are frantically racing to reverse the consequences of our actions on the planet's finite resources, the potential for a new paradigm that might consciously change how we model our organizations will have a direct impact on our resilience as a species.

Keywords: biomimicry, bio-inspired, bio-inspiration, nature-inspired, evolutionary theory, organizational change, management innovation, sustainability, social innovation, life-inspired innovation, innovation culture, regeneration

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The more we learn to be true to our unique self, the more it dawns on us that we are just one expression of something larger, an interconnected web of life and consciousness. That realisation can be elating but also painful—we now comprehend how deeply our relationship with life and nature has been broken. We see the foolishness and arrogance of mankind's stance of putting itself above the rest of life and try to find a more truthful and humble place in the midst of it.

~ Frederic Laloux

Man is the only animal for whom his own existence is a problem which he has to solve.

~ Erich Fromm

The mechanistic management approaches of the Industrial Revolution were based on top-down engineering concepts of throughput and productivity—linear efficiency models that outperform in a static, predictable world. Since then, complex global economies have driven fundamental changes in management practice, through the Information Age to current day. These changes have brought us to a point in time where we are perhaps open to another much-needed revolution in management innovation. As such, we are poised to allow the "thought that is ready to be thought" (Conscious Capitalism, 2018), in this case a consideration of bio-inspired management innovations that have started to sprout among a handful of pioneering advocates and applied by outlier organizations looking for impactful change.

In parallel, we are witnessing the proliferation of biomimicry as an innovation design principle. The practice of biomimicry seeks to understand, abstract, and emulate proven biological structures that offer innovative solutions to our most challenging problems. These solutions currently are mostly applied to product design, material sciences and the built environment. Founded in 2013 by Toby Herzlich, Biomimicry for Social Innovation (2019) is a newer attempt to emulate nature for cultural and social transformation. This concept looks beyond emulating form and function and looks to larger systems in which these evolutionary end-points might exist. More nascent still is the study of biological processes as inspiration for management innovation, and this is the focus of this research paper. Furthermore, this research indicates that emulating nature to create more adaptive organizations is a foundational requirement for the emulation of form and function to succeed. This

study offers the application of biomimicry to management innovation as a prerequisite to its successful application to innovation design. As such, the forefront of bio-inspired research offers the potential for management innovation guided by evolutionary principles (designing organizational structures through biomimicry).

Management innovation may seem irrelevant compared to the critical challenges of climate change and sustainability issues. Certainly, these can no longer be ignored. The complexity we face in meeting market demands is exacerbated by our efforts to produce goods and services that will not have detrimental effects on future generations. The bridge between our application of design thus far and the potential to reconsider this space through a possible shift in design innovations is best described by Carlos Fiorentino:

> The preceding era of industrialization from which design has evolved has led to the current global crisis—climate change; inequality; energy, food and water security; among other planetary problems. Design has been an instrument of progress and an instrument for current models of development based solely on economic growth. All the systems, artifacts, products, buildings, cities, all the material man-made world that surrounds us has been purposely designed. Natural resources are being depleted. Materials created, the manufacturing processes needed, and the energy demanded is consequence of this human-designed world. This reality makes designers highly responsible of the state of things and influential stakeholders at the time of changing. Therefore, the post-industrial, post-carbon world of the 21st century demands

> evolutionary responses from design that lead to innovation and radical change. This is the context in which biomimicry is placed today, at the verge of change where only two options arise: change by design or by disaster. (Fiorentino & Montana-Hoyos, 2014)

Where Fiorentino suggests a requirement for change in design approach in general, this research paper focuses on the potential change in design *capabilities* within the management structure of an organization. What are the management practices required that will be conducive to "evolutionary responses from design that lead to innovation and radical change"? (Fiorentino & Montana-Hoyos, 2014)

Festering beneath urgent global crises is other fallout from organizations with roots in the Industrial Revolution: employees who are unengaged and frustrated, yet purpose-seeking and hopeful. With the current workplace based heavily on the digital economy, chaos and sudden change are the norm. Organizations can thrive only if they are able to nurture, empower, and encourage creative talent nimble enough to work and thrive in environments requiring flexible mindsets and always-on preparedness. Critical thinking is a key skill for success in the global economy. As such, we have two situations to consider: the very urgent issues of global climate crisis, coupled with the stagnant organizational structures that are in place today. How might bio-inspired research navigate the crossroads of these issues?

Theorists have long noted that complex systems adapt effectively to chaos and sudden change, even in the absence of a centralized management structure. Examples of Complex Adaptive Systems (CAS) are the brain, cells of the body, ant

colonies and political parties; entities that have many members which interactively create the environment in which these entities exist. All have common attributes of remaining at the edge of chaos and order, evolving in correlation to their environment, and operating as building blocks (Dodder & Dare, 2000). Most importantly, in CAS "order is emergent, instead of predetermined, always unfolding and always in transition (perpetual novelty)" (Dodder & Dare, 2000). In the context of nature, these systems may contain tens of millions of individuals (as in leafcutter ant colonies), yet they utilize no predefined structures to provide order or instruction (Dr. T. Woolley-Barker, personal communication, October 1, 2019). Instead, they operate on continuous feedback loops that guide the required adaptation for survival from the bottom up. Think of the intricate variety of a forest or the mysterious fungal networks that exist just beneath the surface; there is no chain of command or power hierarchy that could begin to manage the complexity of these systems (Stamets, 2005). With these examples as our models we are poised to begin learning ways to build adaptive networked organizations for the future.

Where do we begin to learn how to apply the natural mechanisms and processes available through the study of biomimicry and evolutionary principles? Fortunately we are preceded by the tremendous work and contribution of a number of bio-inspired experts who are asking "What would nature do?" when considering better approaches to management (A. DesLandes, personal communication, October 4, 2019 and L. Gorissen, personal communication, October 17, 2019). In most cases, these experts are bringing specialized understanding of biology and evolution into

their work with organizations that are looking for greater resilience and agility in a rapidly changing world. Working in research, education, business consulting or organizational change, these experts have created a pioneering subculture of evolutionary thinking in the space of management innovation. This research paper attempts to describe these pockets of individuals, identify where they converge and diverge in theory and practice, and define the common, core issues they seek to solve. Thus, through an exploratory foray into the subculture of bio-inspired management experts, the main research question this paper asks is: *What is the frontier of bio-inspired management innovation and how might it lead to a paradigm shift in research, design and application of evolutionary principles in order to create more resilient and adaptive organizations?*

Below I present the secondary research questions that will support this.

First, what is the impetus for these solutions—the wicked problems that continue to frustrate today's organizations? The research sub-question here asks: *What are we trying to change as we consider the future of work?* Literature review reveals dismal employee engagement levels in most organizations. This was supported by the experts which, through interviews, shared specific organizational challenges they were tasked to resolve in the various companies where they worked. This research presents areas where the experts diverged on how to educate or apply this thinking to an organizational challenge, and this divergence may uncover interesting barriers to adoption. This research also presents areas where the experts converged, especially around potential avenues of advancing their work. Finally, extreme use cases are presented where edge organizations have changed their entire

organizational structure to ensure adaptive capacity through evolutionary practice. These outlier organizations have been "so strange that people haven't seen them" (Laloux, 2018), and are therefore the perfect frontier examples.

Next I ask: *Who are the pioneers in bio-inspired management innovation practices? What benefits do they see when considering models in nature to improve our social processes?* Answering these secondary questions first begins with understanding biomimicry and how it is applied today, as well as its application to social innovation—which currently appears fragmented, somewhat inaccessible, or not easily applicable. Once we have established the basis of this practice, the expert interviews conducted in this research begin to reveal the suggestion that organizations consider the "simple, easy and benign tricks that nature uses to survive" (Evolution Institute, 2018) as applicable models for change. Detailed analysis of the interviews is presented where I examine the primary differences and commonalities in the experience and application contributed by these individuals. I present options on how we might gainfully apply their insights, starting with a careful examination of where they have witnessed barriers and enablers to adoption.

Literature review revealed that analytical study of biomimicry principles is critical for success in its application. This is a caution offered by Dayna Baumeister from Biomimicry 3.8 who explains, "With millions of species and time-tested strategies to draw from, Biomimicry offers us endless creative potential. Ensuring we get nature's lessons right requires being diligent to the science, translating nature's design principles with integrity, and making that wisdom accessible to those who will

put it in practice" (Baumeister, 2017). Further we are reminded that not all concepts from nature can or should be applied, a warning from Dr. Taryn Mead who describes the "naturalist fallacy" (Mead, 2018). Therefore, here the research study begins to ask: *What are the barriers to adoption of nature as a model?*

Part of the reason it may be difficult to emulate how nature "manages" to "get things done" might be because it simply doesn't. Evolution just does what is required for survival: Molecules and cells and creatures organize themselves moment-to-moment, using simple rules to make the most of whatever they find. Life just moves to the next best possibility. Whatever works better now will make the most later (Woolley-Barker, 2017, p. 19).

Very differently from this, we design our organizations with hierarchical structures that follow plans, forecasts, and quotas that target return on investment. This research shows that many of the experts interviewed have determined that these very structures and measures create organizational limitations, stunting our own capacity to innovate, however, they believe these current structures are movable if we can find ways to shift toward a systems thinking mindset. These insights are presented in Findings, Chapter 4. Most important is to understand that the current knowledge and ever-evolving publications in this space are mostly being created by subject matter experts with a background in science or biomimicry and, less predominantly, business or organizational management. In fact, many of them are "regular people" who want to contribute solutions to pressing problems by providing the input they have due to their science-based background. As an example, in her

book *Biomimicry: Innovation Inspired by Nature*, Janine Benyus brings forward unknown but influential individuals who are making waves in this space. Hardin Tibbs spoke of remaking industry in nature's image at the 1992 EcoTech Conference in Monterey, California. Bob Laudise is a chemical director at AT&T Bell Laboratories. These individuals are mentioned in Janine Benyus's description of how their perspectives bring about new considerations for management:

> People like Laudise and Tibbs pack the house because they have a simple, compelling idea that hails from a group of people that industry traditionally hasn't consulted. You won't find their books in the airport business bookstalls. They don't come from Harvard Business School or California think tanks or Japanese productivity institutes. The consultants of the nineties come blinking into the artificial lights of corporate conference rooms fresh from butterfly counts, gorilla watches, and bird bandings. As they put their first carousel of slides—coral reefs, redwood forests, prairies and steppes—even EF Hutton is listening. This is what's so amazing to me. In the most unlikely and promising cross-fertilization of our times, the Birkenstocks are teaching the suits. (Benyus, 1997, p247)

Having examined the tremendous contributions and progress of the leaders and experts in this space, this research ends by looking ahead to possible future developments. This includes a review of upcoming publications and workshops which may bring about new models or maps for convergence. I provide a summary of the triumphs and limitations of the field of experts as a way to understand the direction

in which the application to management innovations might continue, and how this precedes a potential paradigm shift in organizational management as a practice.

Looking Ahead At The Research

Before continuing into the details revealed through the exploratory research, Chapter 2 first introduces the two main research methodologies used in this study, namely literature review and semi-structured expert interviews, selected due to the nascent nature of the concept and best suited to establish a foundational understanding. Selection of interview candidates is explained, presenting an intention to connect with both published thought leaders and unpublished active advocates of the practice. Consideration of alternative research methods that could be used to further this study are also provided.

In Chapter 3, I present the first tier of findings (the foundation) of the research by outlining the rise of biomimicry, its evolution as a practice, and its most recent application to organizational theory and change. Through studying the emergence of the practitioners and influencers in this space, this research is able to reveal the seemingly disparate yet somehow deeply interconnected network of individuals and organizational leaders who are putting great efforts towards better understanding how biomimicry can create the necessary change in organizational structures. This presents a window into not only the increased awareness of biomimicry as a practice but also the importance of applying its teachings into this problem space. Potential future research methods are also presented.

Chapter 4 dives into the substantial insights derived from a synthesis of the findings. A detailed synthesis of the data gathered from the expert interviews explores their professional journeys and progress as well as the limitations and barriers they have faced. The research reveals their convergence on the apparent need to revisit management innovation through a new lens and the benefits therein while examining the divergence in how this might be applied and promoted for adoption.

Concluding remarks and recommended areas for future research are presented in Chapter 5. I also present my hopes for actionable future developments that might facilitate connections between the advocates and enable new contributions through my work and that of others.

There is much work to be done. Let's begin!

CHAPTER 2 – RESEARCH METHODOLOGY

We build problems and then we try to figure out how to solve the problem we created. For example: we build a box that we call a building and then try to think about how to heat, cool and manage it.

~ Bruce Hinds

You need the ground under your feet to be grounded.

~ Leen Gorissen

In this chapter I review the two main research methodologies used in this study, namely literature review and semi-structured expert interview, and why these particular methods were selected. These research methods, in combination, identify the origin and establishment of biomimicry as it might be applied to organizational management innovation. In this chapter I outline the preliminary research that led to this bio-inspired research through literature review. For the expert interviews I provide reasons for the sampling domain, the challenges and benefits of the interview process as a method, and the approach to data collection and synthesis. From this work I am able to present the network of individuals exploring this nascent topic and how this might determine future developments in this space. This establishes the information required to answer the exploratory research questions presented in this study: Who are the players and why? Based on their work to date, in which direction is this practice going? What are the factors to ensure this practice continues? We end with alternative research methods that could have been applied had there been additional time for continued research.

Selection Of Methods

As a research method, extensive literature review was used to build a preliminary foundation of the history and emergence of biomimicry, its origins and adoption, and why it has been proliferating as an innovation design method. This work quickly revealed pioneers in the application of this practice to social innovation. This method also provided ample return on the many examples of innovation from companies that had succeeded in using biomimicry as an innovation design practice.

All of the experts in this space had published research, books, and TED talks or webinars on the topic, which helped provide a starting point for the selection of interview candidates. In reviewing other research papers on this topic, it was interesting to see that all of the future research recommended at the time of their publication had since developed into theories of practice, and spawned companies in some cases. This proved that biomimicry applications are a fast-growing area of interest. This also uncovered how quickly biomimicry was being considered as a potential design approach to uncharted problem spaces. One example was Jamie Brown-Hansen, who works for Biomimicry Switzerland and has been researching the intersection of biomimicry, ecovillages, and community credit. In her online profile she states her research question: "How would nature design a financial system?" and explains her work with community credit systems locally and globally to look at this space (Brown-Hansen, 2019). Since then there are more workshops and presentations around the application of this thinking to financial systems. As an example a recent *Towards a Sustainable Financial Ecosystem* conference at the Club of Rome, European Union Chapter had one of the interviewees presented herein offer "Natural Intelligence - Can we learn from nature how to develop more sustainable and resilient financial systems" (Club of Rome, 2019) as part of the consideration for future financial systems.

The literature review was, however, somewhat limiting. Biomimicry and the application of evolutionary principles to develop better business structures is an evolving field, and therefore in a state of continuous growth and change. For example,

the consulting firm Biomimicry 3.8 was established in 2010 and continues to make headway in bringing its guidance to the design table via their Life's Principles, guidelines they created to help define this design framework (Biomimicry 3.8, 2015). Evolution Institute, mentioned often in this paper, continues to work on its "ProSocial" project which seeks to increase the efficacy of teams (Evolution Institute, 2019). Because these projects are ongoing (at the time of writing), it was clear that literature review alone would not suffice for this study. It did, however, provide a basis for understanding the otherwise disparate areas which all consider nature as a model. It also provided insight on previous research done on the broader field of Design-by-Analogy and its relationship to bio-inspired design.

To answer the main research question, *What is the frontier of bio-inspired management innovation and how might it lead to a paradigm shift in research, design and application of evolutionary principles to creating more resilient and adaptive organizations?* we begin with an investigation of the individuals who are contributing research and work in this frontier. As such, the expert interviews provided the most illuminating collection of information on this nascent topic. It was through understanding the work of these individuals, their successes and disappointments, that the research could reveal the prevalence, importance, and future direction of this topic.

Prior to beginning the expert interview process, a detailed Research Ethics Board (REB) review and approval was conducted. This process confirmed no ethical issues with the research study. However, it also uncovered a critical assumption I

had made as graduate researcher: that all the experts would prefer to be cited for their experience, insight and contribution to this problem space. Although none of the experts chose to remain anonymous, the importance of providing the option to remain anonymous is a perspective the REB provides. The tools and materials for data collection submitted to the REB for approval were therefore updated to reflect the option that allowed the candidates to attribute comments and quotes they provided. Interviews were captured in digitally protected documents and provided the additional benefit of giving the interviewees an opportunity to clarify and correct their captured input.

During the REB process the candidate selection criteria was defined. The interviewees were selected on three main criteria: individuals who had established domain knowledge on the broader topic of biomimicry; individuals who had asked the same or similar questions on this research topic and had published their results; and individuals who were learning from these thought leaders and seeking to apply their learning directly to their work. The candidate pool was expanded through the contribution of the initial interviewees who generously provided introduction to individuals in their network for connection and potential additional interviews.

In the first case (individuals who had established domain knowledge on the broader topic of biomimicry) I was connected to Professor Bruce Hinds, Chair of Environmental Design at OCAD University. The insights gathered from Professor Hinds provided a basis for understanding the structures we study when we look at nature and helped define the questions we ask when we look to nature as a model.

Professor Hinds offered insights on the significant efforts humans make to create and sustain built structures instead of working with the existing energy flow of structures available in nature. He used the movement of water as an example. "There is continuous movement in nature. For example, trees use the molecular structure of water to move water. They use evaporation to move water as a mechanism of its natural structure. Humans instead engineer ourselves OUT of the environment and have to pump water for heating, cooling, etc." (B. Hinds, personal communication, October 10, 2019). It was interesting to further this insight by finding research teams in universities who had joined forces in 2008 to turn this concept into a "synthetic tree" which emulates the pumping capability of a tree:

> engineers at MIT and their collaborators have designed a microfluidic device they call a "tree-on-a-chip," which mimics the pumping mechanism of trees and plants. Like its natural counterparts, the chip operates passively, requiring no moving parts or external pumps. It is able to pump water and sugars through the chip at a steady flow rate for several days (Chu, 2017).

This and other examples provided by Professor Hinds illustrate the cutting-edge applications of biomimicry still in research phase today.

Preliminary insights from Hinds also informed the research in two additional ways: first, by influencing the questions I asked in future interviews: and second, by changing the original Research Question in this study. In fact, it was early on in the research that the interviews helped morph the original Research Question into what it became, which of course then changed the intention of the research. The original

study looked at the concept of organizational biomimicry. The interviewees informed and morphed this viewpoint by separating the application of biomimicry from the challenges with organizational management and introducing the study of nature and evolution as a system.

In the second case (individuals who had asked the same or similar questions to this research topic and had published their results) literature review quickly led to Dr. Tamsin Woolley-Barker who had already not only asked but answered the same research questions. Using her work with Fortune 500 companies and her background as an evolutionary biologist she had recently distilled her findings into her 2017 book *Teeming: How Superorganisms Work Together to Build Infinite Wealth on a Finite Planet (and your company can too).* This research was proven to be current when I found that January of 2019 (same year as this writing) she had established Teem Innovation Group to help companies apply the teachings from her book.

The final candidate pool was validating because I was able to find fellow researchers who were also seeking to learn how to help make our workplace more collaborative. This group (individuals who were learning from forums such as Biomimicry 3.8 and seeking to apply their learning directly to their work) I found entirely through the interview process, academia publication forums, and most importantly, social media channels. I saw individuals who, like myself, had based their careers on organizational change, strategy development and even mergers and acquisitions (the most painful of corporate processes, especially in how they affect the human psyche). These interviews felt like speaking to peers who had been following

a similar career journey and had started to explore biomimicry, much as I had, to find some answers. One especially insightful interview was with Astrid DesLandes, with whom I shared our parallel interest in helping individuals within companies find meaning in their work through contribution and collaboration. We discussed the merits of nature as teacher and were grateful for having both been immersed in it from a young age, which informed our development. This is a privilege many people do not have. More unfortunate are those of us who have access to nature, but because of the technology-infused world we have created, no longer spend adequate time in nature. DesLandes described this well: "For many people, and for most large businesses, certainly, Nature is a resource, not a part of who they are" (A. DesLandes, personal communication, October 4, 2019). Our ongoing proximity to nature might be future consideration for examining the questions asked in this study.

Data Collection

This section describes the data collection and synthesis in greater detail. It is followed by alternative research methods that could be used for future research based on the ones chosen for this study.

Literature review was mainly conducted online with search engines, as well as searching for publications in Academia.edu. To get a finger on the pulse of this nascent movement I subscribed to many forums and blogs, including The Zygote Quarterly, Academia.edu, Science Direct, Biomimicry 3.8, Biomimicry for Social Innovation, AskNature, The Biomimicry Institute, and The Growth Institute. This is not an exhaustive list, but it led to pertinent workshops and events as well as

providing additional resources. From the online presence it is important to note that the aforementioned Biomimicry 3.8 was the common hub from which many of the learning had collectively developed. Founded by Janine Benyus and Dayna Baumeister as an amalgamation of previous profit and non-profit establishments that Benyus had created, Biomimicry 3.8 is now considered a leading consulting firm establishing bio-inspired practices globally.

Books and publications of the experts I was fortunate to interview were also a significant source of information. The data collected from these works informed the questions for the semi-structured interviews. Along with online publications, two books were the most informative resources: Dr. Woolley-Barker's *Teeming: How Superorganisms Work Together to Build Infinite Wealth on a Finite Planet (and your company can too)* published May 2017, and Dr. Taryn Mead's *Bioinspiration in Business and Management: Innovating for Sustainability* published in 2018. These books mark an emerging source of exploration and explanation in this space.

Interviews were conducted late in the research process due to delays in Research Ethics Board approval of the study. Once approved, there followed a rapid succession of six interviews conducted in a span of four weeks. All interviews provided incredible insight but also provided additional connections which in most cases turned into additional interviews. Due to limited time, I was not able to interview two contacts provided by Leen Gorissen: Bowine Wijffels, founder of Nature Wise, and Saskia van den Muijsenberg, founder of Biomimicry Netherlands. Not interviewing these individuals very likely limited insights into further examples of

biomimicry application to management innovation. At the time of this writing Wijffels published *Eco-mimicry: Ten perspectives from Nature*, which would be invaluable input to further research. Both Wijffels and van den Muijsenberg are active contributors to the network of individuals currently active at Biomimicry for Social Innovation.

Through studying social and educational websites which revealed individuals' biographies, I came across two other individuals of note. One of the few here in Canada, Astrid DesLandes, established BioWise and uses biomimicry as inspiration for her management consultancy practice: "All the lessons are there and if we know how to observe, understand, translate and apply them to human challenges. Nature has been conducting a gigantic 'Research and Development' lab of sorts, for the past 3.8 billion years. It knows what it's doing." (A. DesLandes, personal communication, October 4, 2019). DesLandes knew Dr. Woolley-Barker, Gorissen, and Mead, who I also found via LinkedIn as I found DesLandes. These individuals were globally located but well connected, having either participated in the initial creation of Biomimicry 3.8 or been a part of its immersive workshops as learners and contributors. DesLandes advises that these workshops have spawned pockets of individuals creating their own organizations that are trying to apply their learning from nature to how they might help organizations succeed (A. DesLandes, personal communication, October 4, 2019). The final interview was with Dr. Taryn Mead, who describes herself as a Scholar, Lecturer and Researcher in Innovation and Creativity for Sustainability and Nature-Inspired Innovation. She is a professor at Western

State Colorado University where she teaches biomimicry at the School of Business and the School of Environment and Sustainability. At this point the network came full circle as Mead spoke of her seat at the table when the Biomimicry 3.8 group was just establishing its presence. As the loop of connections in the network closed, I realized the experts were well connected and operated in pockets of genius around the world.

Interview responses were captured directly into the interview script prepared in advance of each interview. In only the first case was the original interview script followed; all subsequent interview scripts were customized in preparation for the individual being interviewed taking into consideration their background, organizations in which they worked, and expertise they demonstrated through publications, including books. In all cases the interview proceeded with a review of the consent form, which allowed the interviewee to either remain anonymous or be attributed for their contributions. As stated previously, all interviewees chose to be recognized for their contribution. In cases where they asked to review the interview and provide attribution for quotes, the full interview script was sent to them showing the answers collected for their review and confirmation.

The interview responses were then collected into a matrix whereby the analysis could begin of the areas where the responses converged and diverged (Appendices C and D). Outlier responses or tangents to the interview responses were specifically studied and included; they may indicate new directions in which this

nascent practice might go. All the findings from these interviews are presented in subsequent chapters.

The semi-structured interviews were conducted via phone as all respondents except one were located outside of Toronto. The interviews were an excellent way to create appreciative inquiry and informative dialogue on the research topic. It was interesting to discover the network of connections that, at first, seemed vast and interspersed. Upon closer inspection, it is clear the network is formed by a distinct group of individuals who had learned, experienced, and applied this practice together. Each knew the other or had been inspired by the same theories and research to get to this point in their journey. The interview process therefore confirmed the communication networks that can start a movement such as this one, communicate on its learnings, and develop its future direction.

In addition to reviewing the interview responses, I mapped the progression over time of the biomimicry guiding principles devised by the organizations and thought leaders in this space. This mapping can be seen in the following figure and is further detailed in Appendix E.

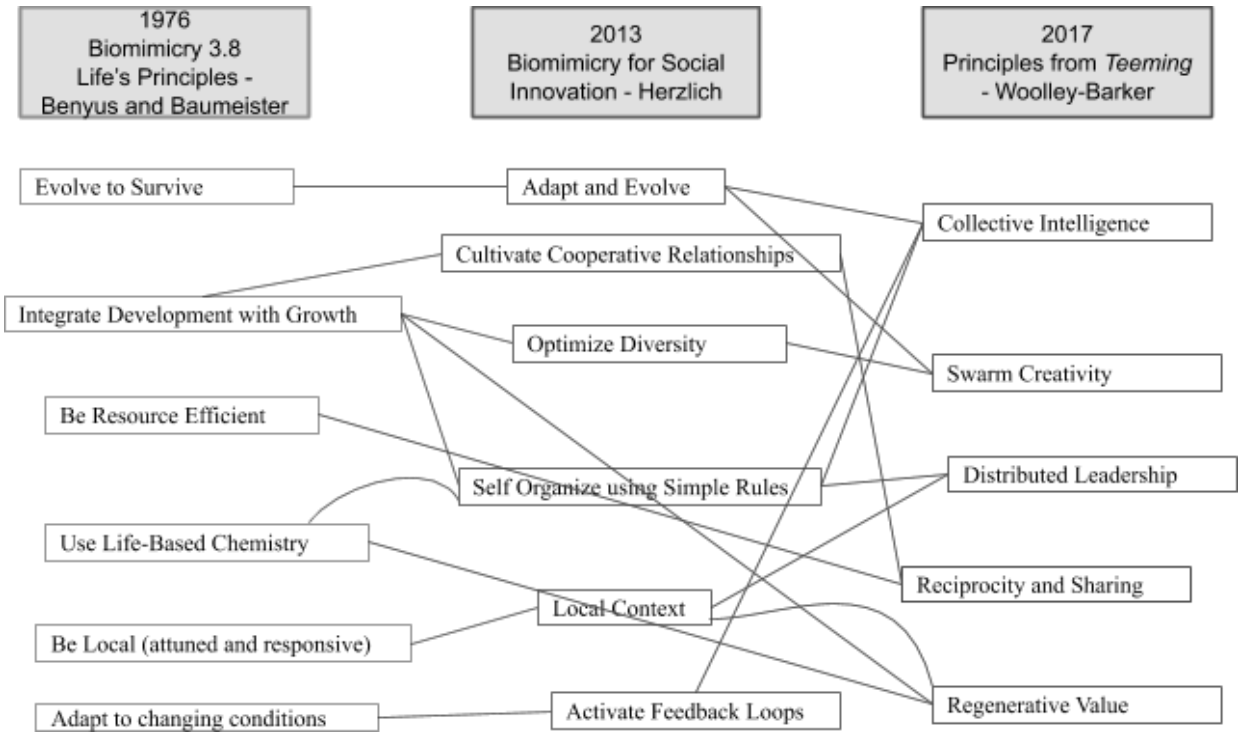

Figure 1- Mapping of three dominant guidance provided in the space of Biomimicry

Figure 1 presents potential overlay of guidelines provided from the various thought leaders in biomimicry. Biomimicry 3.8 presented Life's Principles shown here in 2015. Biomimicry for Social Innovation was founded in 2013 and focused on application of principles to leadership and organizational management, yet links to the Biomimicry 3.8 guidance can be seen. Finally Dr. Woolley-Barker presents an alternative viewpoint to application of evolutionary functions presented in nature such as distributed leadership and reciprocity. This mapping is further articulated in Appendix E where the information from each of Biomimicry 3.8, Biomimicry for Social Innovation, and the evolutionary principles provided via Woolley-Barker's *Teeming* are analyzed for potential future research. In Appendix E, further research is suggested whereby both the experts and practitioners of these principles may choose

to collaborate in a workshop where they might study the convergence and divergence presented herein.

Future Methods

Given the limited timeframe in which to complete this major research paper, there are a number of research methods that would have been beneficial in furthering the research question toward more applicable concepts of mimicking nature for organizational resilience. These would include, but are not limited to, a patent search for existing work that may be informative, a participatory workshop for experts and practitioners in the field, and foresight tools. Dialogic design as the basis of the workshop would inform practices and approaches used today against specific use cases. These use case examples could then be compared for synergies of benefits gained, which would then inform the practitioners in future assignments. The workshop could attract new interest in this discussion, from individuals with not only backgrounds in both organizational change management and biomimicry, but other approaches such as financial system management, to potentially reveal use cases not yet considered. Another significant area of research would be the developments in evolutionary theory, biomimicry and transition science overlaid with systems thinking in educational systems, as these are the foundational structures to improvements to our ways of working.

The findings uncovered using these research methods are presented next. I begin with a landscape of the origin, history and emergence of biomimicry, then begin an exploration of the individuals who have spearheaded how this design method can

be applied to social innovation. I then present the common experiences and diverging viewpoints of the individuals exploring this space, which helps reveal the barriers and enablers to adopting this practice in applications to management innovation. Through this exploratory research I first attempt to uncover the main questions the pioneers of this concept seek to answer, namely: What is the future of work and how might we want to structure our organizations differently, through guidance from evolutionary principles?

Chapter 3 – Context: Landscape & Pioneers

Organizations, like religious groups, perhaps have been engineered from the top down, creating inability for individuals within the organization to evolve, making it very difficult for new ideas to emerge.

~ Dr. Tamsin Woolley-Barker

Why are institutions, everywhere, whether political, commercial, or social, increasingly unable to manage their affairs? Why are individuals, everywhere, increasingly in conflict with and alienated from the institutions of which they are part? Why are society and the biosphere increasingly in disarray?

~ Dee Hock

In this chapter, I set the context for this research. I describe the origins of bio-inspired research on organizational theory and change and introduce the advocates and experts who have established this understanding. A detailed chronology of the varied backgrounds of these advocates and experts reveals a very distinct subculture of individual contributors who seek to create a bio-inspired approach to how humans exist as a species, and how this might apply to their practice. Through insights gained from these experts, I create a foundation of understanding for how this approach might shift our worldview to something very different than the currently engrained institutional ideologies on which we base our organizational structures today.

Something Has To Give

Post-industrial revolution we see that simplistic systems allow for simplistic management structures where the inherent humanity of the organization is not considered vital in the assessment of its success. Many theories have highlighted the mechanistic viewpoint of organizational structure with humans (employees) seen as cogs in an ever-turning tireless machine meant only to achieve productivity for profit (Merchant, 2011). These models are based on efficiency and suffice when work is linear and predictable. Today our more complex, global, technologically connected world means these simple mechanistic models are no longer sufficient. As employees, we are overworked, stressed, and exhausted. Most organizations, built on traditional paradigms of linear rigidity, struggle to adjust to chaos and complexity presented by the ecosystems of which they are a part. After continuous attempts at external environment scanning, stakeholder analysis, market research, and millions of

consulting dollars, many companies are left with little to show for all their efforts (A.DesLandes, personal communication, October 4, 2019).

It is clear that complex systems need broader networks of resources that can make informed decisions locally and at the source where the problem resides. This will allow distributed decentralized teams to contribute to the larger organizational vision at the local level and from the ground up. For this to occur a change is required in the fundamental structure of the organization. Frederic Laloux is a thought leader in organizational change who advocates for such holacratic approaches. His work, which is described later in this chapter, reassures us that not having a boss does not mean lack of discipline and structure (Reinventing Organizations, 2014). He argues the organizational network successfully operates within the looser structure of common vision and direction provided by leadership. He suggests running an organization through "evolutionary purpose" instead of a corporate strategy, which he argues allows companies to "ignore reality" (Reinventing Organizations, 2014). He likens strategy to the metaphor of steering a ship and suggests instead to consider the organization as a complex living system. This system is continuously assessing its environment against its capabilities, adjusting course based on threats and opportunities. All experts studied in this research suggest the same; however, they look beyond enhancements to regular management practice for answers.

The Future Of Work

According to a 2016 analysis presented by Gallup (which has been tracking employee engagement since 2000), the world's organizations are experiencing an

engagement crisis. Gallup's definition is straightforward: "Engagement is about investing in everyday working moments and incorporating engagement concepts into the workflow, even as businesses change and adopt new initiatives" (Harter & Mann, 2016). Based on this definition, apparently only 32% of U.S. employees are engaged; globally, the rate drops to 13% (Harter & Mann, 2016). Further, the authors caution against measuring engagement for the sake of a survey and not incorporating this into the cultural development of the company.

Instead they advocate for "scientifically and experientially validated approaches that lead to changes in individual and business performance, supported by strategic and tactical development and performance solutions that transform organizational cultures." (Harter & Mann, 2016) as a means to ensure employees are able to contribute to the company goals. "Though these approaches require more intentionality and investment, companies that use them are more likely to see increases in employee engagement. (Harter & Mann, 2016)

This study examines whether looking at biomimicry and evolutionary principles of adaptation provides a scientifically sound basis for innovation and adaptation. Many experts, especially those with a background in evolution, would say yes. However, so do the advocates who do not possess formal scientific backgrounds; these individuals have witnessed results which are also likely due to the systemic methods that science provides.

With technological advancements threatening to replace most jobs, the future of work will be based on the exchange of tacit knowledge. Knowledge workers are

prevalent today and no one is certain what jobs will exist in the future due to the rapid pace of change. What is certain is that continuous inward examination of our strengths and opportunities to apply them, coupled with ongoing learning, will mean success in our working lives. The World Bank Group (2019) has a recipe for success in the job market of the future:

> Three types of skills are increasingly important in labor markets: advanced cognitive skills such as complex problem-solving, socio-behavioral skills such as teamwork, and skill combinations that are predictive of adaptability such as reasoning and self-efficacy. Building these skills requires strong human capital foundations and lifelong learning. (p. 3)

In order for an organization to be nimble enough to meet the demands of a complex global economy it needs to enable decision-making at the local level where the employees are able to apply tacit knowledge to resolving ongoing challenges. This micro-level maneuvering allows the organization to adapt daily even minute-by-minute towards the required change.

How Do We Change?

How do we develop and update the workplace practices that can no longer adapt to the pace of change we need to maintain? In the HBR article, "The Why, What and How of Management Innovation," Business consultant Gary Hamel (2006) asks why management innovation matters. According to Hamel, companies with big budgets for design and innovation labs, which support technology and product innovation, rarely invest in what he believes is the most impactful form of innovation:

management innovation. “A management breakthrough can deliver a potent advantage to the innovating company and produce a seismic shift in industry leadership. Technology and product innovation, by comparison, tend to deliver small-caliber advantages” (Hamel, 2006).

Global examples abound of companies recognized for their ability to leverage their most important resource (talent) while frustrated, less successful and generally stuck leaders of other organizations pore over books, articles, and frameworks that promise engagement, productivity, and an increased return on investment. Perusing the titles in the “Business Success” section of an urban bookstore, one sees a common thread of hope. Answers abound via book titles promising ways to heal burnt-out employees by simply following a 12-step process to better leadership, management and ultimately, control. Attention seeking titles such as “Surrounded by Idiots” (Erikson, 2019) may resonate with frustrated employees, while “The Workplace Engagement Solution” (Harder, 2017) suggest answers for managers.

Layer on top of this the acceptance that companies need to ensure that not only the product or service of an organization but the entire value chain of which it is a part is marching to the order of sustainability goals. Today 90% of CEOs agree this is important to their company success (Hoffman, 2018). There is no choice but to start transforming because market demand has long shifted. At the time of this writing the Global Climate Strike (September 2019) is the largest climate change youth advocacy movement in the world to date, affirming that the next generation is demanding that organizations enact sustainable change now.

Ready To Evolve

Are we ready for the tremendous work ahead? Three fundamental concepts revealed through this research posit that organizations are not only ready but actually need to look to evolution to adapt their business models. First, the knowledge available to us through nature's examples is vast and informative. BioTRIZ founders established that biomimicry is only at the beginnings of its contribution. It was estimated that we are actually only leveraging 12% of potential innovations by emulating nature—88% of nature has novel ideas we could learn from. (Woolley-Barker, 2017, p. 23) Second, we are primed for a change in worldview. With climate change no longer an abstract concept we are reminded daily of our impacts on the world. More importantly, people are taking action, organizations specifically are being asked by the youth of the world to change their processes toward sustainability if we hope to survive given finite resources. We have already witnessed revolt (climate strikes put forth by youth) and changes in consumer and workplace behaviour, i.e., Generation Y refusal to work for organizations that are not sustainable (Woolley-Barker, 2017, p. 143). As such we might have, perhaps unconsciously, decided to return to nature to show us the way. Benyus reminds us that, being relatively new to the planet, we have much to learn from our teacher (nature):

> We're basically this very young species, only 200,000 years old. We're one of the newcomers, and we're going through the same process that other species go through, which is, how do I keep myself alive while taking care of the place that's going to keep my offspring alive? (Benyus, 1997)

This regenerative perspective means organizations of all sizes are changing the essence of their value proposition. Social businesses such as NGOs are created on the outset for a purpose that is more than just making profit and larger organizations are changing towards a triple bottom line model. Dr. Woolley-Barker provides insight to the types of change the more traditional organizations are introducing as a way to gain market share:

> These companies take a regenerative approach to long term business prospects, by bringing products and services - like nutrition, sanitation and financial infrastructure - to underserved communities, creating newly empowered customers and employees in the process. [For example] At Unilever they say you can't buy shampoo if you don't have water. (Woolley-Barker, 2017, p. 142)

Regardless of the motive, organizations are therefore primed for a new way to create value and they are listening to innovation design methods that are, above all, regenerative and proven.

Finally, and perhaps most important, this research posits that biomimicry can only be successful at the product or service level if we also consider its teachings from the perspective of how an organization adjusts to change. In a webinar hosted by the Evolution Institute entitled "Evolving more adaptive, resilient, regenerative companies," Dr. Woolley-Barker presents that, in her experience with Fortune 500 companies, despite the initial excitement of product-based innovation using

biomimicry principles, companies struggle with change due to existing traditional structures:

> What happens, I found, is when you go check back in with them six months, a year later, nothing has happened. The engineers are disengaged and frustrated because their organizations were never designed to accept those kinds of changes…we can show people the coolest things, but they are not going to go anywhere because these organizations are not designed to adapt to change. (Evolution Institute, 2018)

This reaffirms that applicable and meaningful innovations at any level cannot truly establish a foothold if the base company culture is not designed to accommodate change overall. This was also the impetus for Woolley-Barker to write her book *Teeming*, where she explains how organizations, by empowering their individuals, can better respond to the challenges of our VUCA world. Perhaps the proliferation of this concept starts from an application to product (*how can we make the product bottle biodegradable?*) or the entire value chain (*how can we create a more sustainable value chain with our suppliers and consumers?*). Proven as still profitable and valuable, it might then work its way into the larger, more encompassing DNA of the organization, embedding itself in the culture of the employees. This is presented in more detail in the next chapter.

Companies That Inspire

To help inform the changes we know we need to make, we might consider the popular examples of companies that decided to emulate nature for diverse reasons.

First, we look at Dee Hock leading Visa toward improved processes using nature as a model and, very differently, we study Interface's journey toward the goal of zero emissions by 2020. Both examples are foundational for the overall organizational change we examine in this study. Additionally, we briefly review Buurtzorg as the primary example of frontline collective intelligence. Finally, we examine stok, a company established in 2008 whose mission is to deliver sustainable real estate. These use cases help establish the context for this study.

The Visa example dates back to the 1960s, when Dee Hock decided to change the way organizations were structured. M. Mitchell Waldrop is the author of the article *The Trillion-Dollar Vision of Dee Hock* in which he takes an in-depth look at the challenges of organizational change. He highlights the difficulties Hock foresaw in implementing change at Visa:

> What he read convinced him that the command-and-control model of organization that had grown up to support the industrial revolution had gotten out of hand. It simply didn't work. Command-and-control organizations, Hock says, "were not only archaic and increasingly irrelevant. They were becoming a public menace, antithetical to the human spirit and destructive of the biosphere. I was convinced we were on the brink of an epidemic of institutional failure." Hock also had a deep conviction that if he ever got to create an organization, things would be different. He would try to conceive it based on biological concepts and metaphors. (Waldrop, 1996)

Hock is known for creation of the concept of the chaordic organization which looks at complex adaptive systems to better understand adjusting to inevitable challenges. Though not specifically looking at biological structures or evolution as a theory the overlap here is looking at complex systems (such as nature) as a structure we can emulate for change.

In 1994 Ray Anderson, former CEO of the flooring company Interface, was fortunate to have his team ask him for his corporate evolutionary vision, which he admits he did not have. Struggling to provide an inspirational speech to his teams that wanted to revamp Interface business processes to be more sustainable, Anderson sought inspiration from and was forever changed by Paul Hawken's *Ecology of Commerce*. From that pivotal moment, Anderson revamped Interface into an exceptional company that could become more profitable by becoming more sustainable (Davis, 2014). H. Lovins, a business professor and founder of Natural Capitalist Solutions, chronicled Anderson's journey in her book *A Finer Future*:

> Savings from sustainability paid for all of the costs of the transformation and became an enduring source of profit. In the first four years of Interface's work on sustainability, sales increased by two-thirds, profits doubled. Cutting waste 40 percent created $76 million in cost savings. (Lovins, 2018).

The healthcare organization Buurtzorg is an example of a company that has not explicitly used biomimicry to develop its management approach, but has hit upon some deeply biological mechanisms for enabling complex and collaborative work.

Their nurses work in self-organizing, self-managing teams, with decentralized decision-making close to the source. Laloux uses this example often in his TED talks, speaking about the intrinsic success of this type of organizational structure which distributes knowledge, allowing local nurses to make timely and ad-hoc decisions from the bedside of the patient where decisions are most applicable, rendering centralized management to mere administrative tasks such as accounting and payroll. (Reinventing Reorganizations, 2014). Through its proven success Buurtzorg is another extreme yet simple example of an approach that works.

All experts interviewed for this study mentioned these predominant use cases as examples of organizational change based on and inspired by biological principles. As we uncover these examples we ask: Why is this not happening more often?

The final example is stok, a real estate/building company established entirely on sustainability practices. During the first interview, I learned that Dr. Tamsin Woolley-Barker was familiar with this example as individuals at stok had approached her with the intention to put into practice the theories of organizational improvement provided in her book *Teeming*. (Dr. T. Woolley-Barker, personal communication, October 1, 2019) Therefore, it was not a surprise to see that stok had instigated practices for self-managing teams that collaborate on everything from project priority to compensation. The company worked with Biomimicry 3.8 to both rebrand externally and restructure internally. Although the company is structured into traditional HR, Finance, and Project teams, the decision-making is bottom up with employees establishing the overall company vision, then executing on it. This use case

is described in detail in Appendix F and shows a successful example of a company able to thrive due to unconventional practices. The data gathered and presented in the appendix asks: First, did the company decide on the outset to adopt this structure? Second, has this model created success by way of the triple bottom line? How does stok measure this?

These examples show the success bio-inspired approaches can have; so what is preventing more companies from considering this approach? Who is teaching the applicable methods? Is it resonating with decision-makers? To determine this we trace back historical applications of management innovation. We then review the candidates with whom we conducted semi-structured expert interviews, profiled here, and follow the research as it reveals the work being done in this space. The findings from these interviews are then presented in the next chapter.

There is no shortage of ideas for improved management practices; notably, the idea that organizations are living systems dates back at least to the 1970s with Senge and Capra (Capra, 2004, pg6). The already mentioned Frederic Laloux is a prominent figure in this space, he wrote "Reinventing Organizations" in 2014 which introduced the Teal organizational paradigm that outlines steps for a company to evolve into its own purpose instead of just serving management. (Bernstein, Bunch, Canner & Lee, 2016). On a similar trajectory are the living system science practitioners such as Giles Hutchins, who wrote *The Nature of Business: Redesign for Resilience* in 2012, followed by the more recent *Future-Fit* in 2016. Together with Laura Storm, Hutchins established Regenerators, a collaboration forum of researchers, educators and

corporate leaders who look to living systems science for regenerative practices. Regenerators website states their intention to create "Organizations & leadership designed to facilitate regenerative, conscious, life-affirming cultures geared for the current and future challenges of our times. Cultures inspired by nature's regenerative, vibrant, self-organising, resilient models. Organizations that thrive." (Regenerators, 2019). Hutchins references Daniel Wahl's *Designing Regenerative Cultures*, another commonly referenced publication on regenerative practices. Although there is collaboration between them, these collectives are distinctly separate from the biomimicry advocates coming out of Benyus and Baumeister's Biomimicry 3.8.

The practice of biomimicry is not new, however was resurrected in the mainstream through the aforementioned 1997 book from Benyus who suggested that organizations invite a "biologist to the design table" (Benyus, 1997) as there is much to learn from innovation design by studying naturally existing solutions. The research presented here came full circle when literature review uncovered that Benyus herself was the biologist advising Interface through their evolution to becoming more sustainable in their production of carpets and flooring (Interface, 2019).

Dr. Olga Bogatyreva is an invaluable asset and well published author and speaker on the topic of bio-inspired organizational behaviour. Her most applicable book to this research topic is *Biomimetic Management: Building a Bridge Between People and Nature* on which Dr. Woolley-Barker, introduced shortly, has provided

positive critical review. Interestingly, Dr. Bogatyreva's background and approach to this topic points to Complexity Theory, which has a basis for the learning from complex systems such as nature. Complexity Theory is defined as interpretation of the four areas of complex systems— Self-Organization, Nonlinear systems, Network Theory and Adaptive System Theory (Systems Innovation, 2017). Since evolution and ecology are an inherent part of Adaptive Systems Theory, it is not surprising to see that many of the leaders in this space have applied this or any of the other four components of Complexity Theory when devising and describing application of biomimicry to management innovations.

Figure 2 - Timeline view of the Origins and Emergence of Biomimicry with an exponential growth in research and publication in this space in the past decade.

Predominant hub of work for the evolution of this practice in North America is Biomimicry 3.8. This firm was established in 2010 by co-founders Benyus and Baumeister and currently offering certification programs in affiliation with Arizona State University. Baumeister is a critical player in this field having been the instructor to most of the current professionals looking to biomimicry for guidance and designed the first of a kind Certified Biomimicry Professional Program. (Biomimicry 3.8, 2016) This B-Corp also produced the Biomimicry Design Lens which is a framework design tool presented later in this study. (Biomimicry 3.8, 2016)

More recently the development of Biomimicry for Social Innovation, predominantly led by Toby Herzlich, looks at non-engineering applications of biomimicry. The Biomimicry for Social Innovation website articulates their specialization as follows: "Our niche builds on Biomimicry's design and engineering successes, focusing on social transformation, business / organizational leadership, and culture change" (Biomimicry for Social Innovation, 2015). In recent years, Biomimicry 3.8 has held immersive workshops specific to asking the questions this research study addresses. A recent workshop was held in June 2019 in Slovenia, while I was writing the proposal for this research. Entitled "Discover Nature's Genius for Social Innovation," the website describes the workshop: "This seven-day immersion will explore the lessons nature has to teach us about creating a more adaptable, resilient, cooperative, and networked world. It's a results-driven approach that's been used by organizations of all kinds." (Biomimicry 3.8, 2016).

However, as a specific example of applying nature-inspired principles to organizational structures, Dr. Woolley-Barker is one of the few current advocates to clearly define how one might attempt to do this. Her background is in primate behavior and ecology, human evolutionary history, social systems and their evolution, population genetics and evolutionary theory, and ecology. Dr. Woolley-Barker found an opportunity to apply her training to the corporate world first through executive coaching for scientists; later, having joined the team at Biomimicry 3.8 as an independent contractor, she worked in R&D applying biomimicry. She references this in her book *Teeming: How Superorganisms Work Together to Build Finite Wealth in an Infinite Planet (and Your Company Can Too)* which was published in 2017 and has been referenced by multiple companies including stok (use case presented earlier) to apply the suggested theories to potential changes to organization management. In early 2019 she founded Teem Innovation Group. Much of her inspiration came from evolutionary biologists EO Wilson and David Sloan Wilson of the Evolution Institute. Currently she is working with companies such as Cisco and Google to build evolutionary theory into the organizational DNA as a practice (Woolley-Barker, 2018).

Dr. Woolley-Barker was the first expert interview conducted in this research and was influential in connecting me with other advocates of biomimicry. The first connection was with Leen Gorissen, who had attended several workshops organized by Biomimicry 3.8, finding them beneficial to informing her practice. Gorissen founded Studio Transitio, which enables innovation and corporate change through

workshops based on her background in biology and transition science. Dr. Woolley-Barker also connected me with Andrew Brady, the current Chief Evolution Officer at The XLR8 Team. Brady holds a Master's degree in Applied Positive Psychology from the University of Pennsylvania which he completed as a way to help himself and others find ways to derive purpose in our day-to-day work. Not surprisingly, Brady met Dr. Woolley-Barker through his engagement in the Evolution Institute. The research started to formulate around an understanding that most of the experts in this space came from a foundational basis of evolution in their practice and used its teachings in their work.

Interspersed within these interviews were opportunities to speak to other individuals whom I had found through literature review as well as conducting a search for practitioners seeking to apply biomimicry to management consultancy or organizational theory. Dr. Taryn Mead is a researcher and professor who was one of the biologists working with Biomimicry 3.8, whose book *Bioinspiration in Business and Management: Innovating for Sustainability,* informed our interview discussion. Also coming from a biomimicry background is Professor Bruce Hinds, whom I was able to meet at OCAD University. Astrid DesLandes, mentioned in the chapter on Research Methods, was also in attendance at the Biomimicry 3.8 workshops, eager to learn from the core team of Janine Benyus and Dayna Baumeister. DesLandes falls into the avid practitioner portion of the interviewee pool in that her work as a management consultant provides applicable insights into how she promotes and

practices bio-inspired changes in organizational behaviour and structure within the corporations with which she works.

In the following chapter I provide a detailed synthesis of the data gathered from the expert interviews, and an exploration of their professional experience and progress as well as the limitations and barriers they face.

Chapter 4 – Research Findings: Emergence of Bio-inspired Management Innovations

Asking 'How would nature…?' is a powerful way of becoming part of the solution rather than being part of the problem. Innovating like nature is a potent framework to vitalize and energize hope, creativity and ingenuity in your organization.

~ Leen Gorissen

There is something to be said for basing your knowledge and expertise on a proven theory instead of creating something from scratch or believed to be right. Stop making it up! The real thing is so much better, so just go with that.

~ Dr. Tamsin Woolley-Barker

Having established the broader space of biomimicry as an innovation design practice and how it might apply to organizational change, we now take a closer look into the intentions, insights and contributions of the experts interviewed in this study. The findings of this research are not intended to prove or disprove the application of any learning from nature, be it biomimicry or insights gained from evolutionary theory. Instead the intention here is exploratory research into the backgrounds and experiences of the thought leaders in this space and how they intend to move this discipline forward. The research also identifies the enablers and current barriers to adoption.

Ultimately, we like any other species are driven to ensure our species is able to continue into future generations. Some believe that in order to do so, we need to embrace an ecocentric worldview. This would necessitate a potential paradigm shift starting at the individual level and proliferating into our work and our communities, establishing an awareness of the ecosystem in which we attempt to thrive.

So we begin the journey towards change which, according to Leen Gorissen, is no small feat: "If we want to shift from *doing things better* to *doing better things* then we need to change our mindset" (L. Gorissen, personal communication, October 17, 2019). In the following visualization of Social Innovation Inspired by Nature, the questions are re-framed by asking how superorganisms might view human approach to work (in this visual an ant asks 'Why are humans working like that?'). Focus on feedback loops, relationships and fail fast innovation is directly linking back to Woolley-Barker's work in *Teeming* (Studio Transitio, 2017).

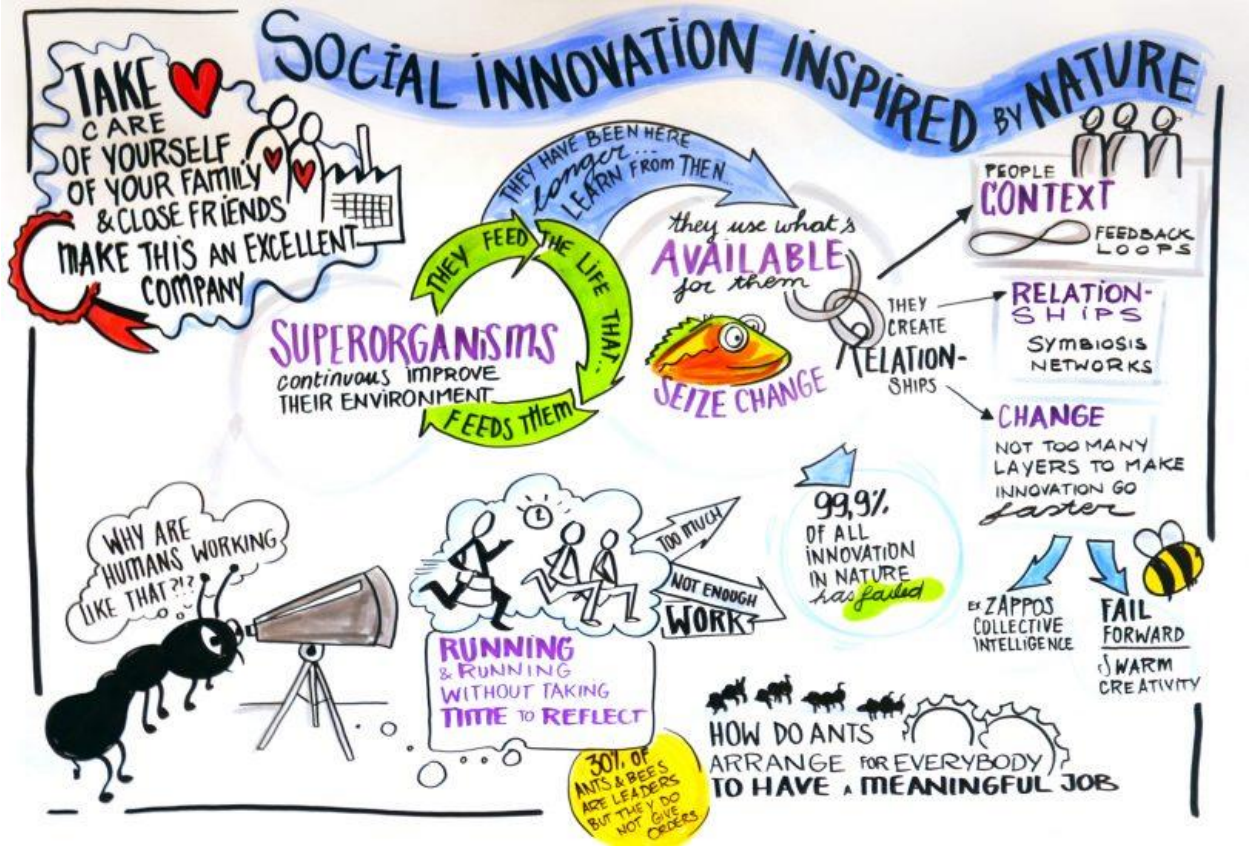

Image source: studiotransitio.com, image attributed to Axelle Vanquaillie of nexxworks

Figure 3 – Studio Transitio, founded by Leen Gorissen, provides this visual rendition of Social Innovation inspired by Nature.

A recap here of the questions I intend to answer in this paper as a roadmap for the findings which are presented next. Main research question is: *What is the frontier of bio-inspired management innovation and how might it lead to a paradigm shift in research, design and application of evolutionary principles in order to create more resilient and adaptive organizations?"*

Which further breaks into the sub-questions of:

- *What are we trying to change as we consider the future of work?*

- *Who are the pioneers in bio-inspired management innovation practices? What has their work revealed are the benefits to looking at models in nature to improve our social processes?*
- *What are the barriers to adoption of nature as a model?*

Answering these questions then provides us with an outlook to potential future developments and contributions to management innovation.

Origins Of Biomimicry

I started by looking at biomimicry as a design practice to better understand its potential application to management innovation. Biomimicry, as Mead defines it, is:

> "..imitation of biological models for human design and innovation solutions. This application can be metaphorical or analogical...but the premise is the same. Nature is a treasure trove of innovation ideas, many of which humans have never considered, and there is much to be gained from seeking solutions from natural systems" (Mead, 2018).

To date the applications of this practice have predominantly gained traction in product design, engineering and architecture. Popular examples are emulating the Kingfisher beak for aerodynamic design of the bullet train and termite mounds for emulating sustainable climate control systems in buildings (Biomimicry Institute, 2019). Research indicates two reasons for this uptake. First the application of scientific methodology implies the use of approach and language is similar and transferable between biologists and engineers, therefore making application more fluid. Second is a suggestion that the ability to inspect a tangible form or function in

nature and emulate a technological solution is easier to implement, and that anything beyond these types of emulations often becomes metaphorical. In this respect we mean "easier" compared to less tangible aspects of biological structures such as communication through pheromones, sounds, and even movement. For details on a popular example of this see Figure 4 which describes how honeybees perform a waggle dance to communicate and select from potential locations for a new hive.

Image source: Camazine (2006). Medical, Science and Nature Images: Photographs and Illustrations by Scott Camazine.

Waggle Dance

Honeybees can show us how it's done. When a hive is successful, it will split, and half must find a new home. Most cluster nearby on a branch, while the oldest and most knowledgeable go out to scout. They fly in different directions, looking for suitable spots. When a scout finds one, she inspects it. Is it dry? Safe? Could it store enough honey for the winter? Then she flies back to the swarm and does a "waggle dance" – a series of symbolic movements that tell the other scouts where it is. Some fly out to see for themselves. If it meets their approval, they return and dance for it too. The dance-floor grows noisy, as bees waggle for different sites. Over time, dances for good sites grow, while poorer site dances fade away. Eventually, one site acquires a critical threshold of support – it's a forest dance party – and the entire hive takes to the air, making a beeline for their new home. The process appears chaotic – there are no leaders or committees, and the computing power is low and distributed. None of the bees are particularly clever – each one blunders, just as the junebug does. But by gathering a diverse selection of independent and truthful possibilities, and staging an honest competition without hearsay, the bees converge on one choice. And amazingly, they nearly always choose the best site. (Woolley-Barker, 2017*)*

Figure 4 – Dr. Woolley-Barker presents the "waggle dance" as communication method between honeybees who need to find a new home. (Woolley-Barker, 2016).

Yet another definition is provided by DesLandes, the previously mentioned organizational change and development consultant interviewed as an expert for this study:

> If we look at one of the simplest definitions of "mimicry", it says "the act or art of copying or imitating closely; mimicking", which is what Biomimicry does. The practice requires one to observe, understand, and translate the scientific, physical structure of an organism, or system, and apply it to a human problem or challenge. (A.DesLandes, personal communication, October 4, 2019).

This definition helps us open the concept of biomimicry into expandable, likely limitless, applications. As mentioned previously, Biomimicry for Social Innovation has started to focus on this aspect. Their website states their intention as follows:

> We help leaders bring nature's adaptive genius into their organizations and enterprises. We apply a whole systems approach and a living systems lens. We engage with practitioners, cross-pollinating among innovators and organisms, to discover and design collaborative, resilient pathways into the emerging ecological age. (Biomimicry for Social Innovation, 2015).

The applications of this learning are provided via immersive workshops, usually held annually. The connection to Biomimicry 3.8 confirms the specific network of individuals working in this space.

A typical example provided is how cities thrive and evolve as new inhabitants arrive, while organizations, having reached a certain size, collapse under the weight

of their inability to innovate (Evolution Institute, 2018). If we are able to work together productively in our communities, what is it about organizations that stymies us? In the next section, and building on studying nature for societal change, we begin by understanding the stakeholders who would benefit from an application of new (previously untried) principles devised from nature to how we set up, run, and evolve our organizations.

To begin, I observed through this study that the experts I interviewed ultimately have a specific commonality that drives them forward, which I describe as informed and intentional hope. *Informed* by an education and applied experience in proven scientific theory, principles and most importantly, objective observations; and *intentional* in their means and ability to apply this informedness to their practice. These individuals know that our current ways of life are not sustainable; humans will either go extinct or find ways to fit within the finite ecosystem of which are a part. The fact that we have overgrown our allotted capacity is similar to other species on this planet yet these species have found ways to continue to exist, and have done so for millions of years. "Like ants or termites (which also have a huge footprint on the land!), it is only by regenerating the habitats around us that future generations can survive and thrive" (Dr. T. Woolley-Barker, personal communication, October 1, 2019). We would be foolish to not see the hope in the proven and time-tested models available to us (we are just beginning to see them) and even more foolish to not observe, learn from, and apply them. We need to start.

What is particularly enticing with this approach is the vast knowledge that (we finally realize) we have access to and could learn from instead of trying to create solutions from scratch. Dr. Woolley-Barker reminds us of the fallacy of reinvention:

> From the humblest creatures to the most humbling, nature's four billion year old R&D lab inspires a bottomless treasure-trove of energy efficient, low-toxic, time-tested innovations. With the right mindset, any company can profitably emulate nature's solutions to produce new kinds of value. (Woolley-Barker, 2017, p.22)

Therefore, if we have the sense to observe and learn from nature, our next intention should be to apply its principles correctly. As stated in Chapter 1, this group of practitioners are "translating nature's design principles with integrity" (Biomimicry 3.8, 2016) To do so we need to be cognizant of the ways in which we use the knowledge gained from nature and apply it correctly. This falls into two main categories of potential failure. One, remembering that nature's solution to a problem is not the only, the most effective, or the correct solution we must apply. This has been called out by several experts in the practice of biomimicry. Dr. Taryn Mead says this issue of misconstrued "trust" in how nature solves problems is known in biomimicry circles as the "biomimetic promise"—a fallacy that we should be aware of and ensure that examples are analyzed for application:

> Biomimetic Promise: The common belief that innovations that model natural systems will be inherently novel, better performing, and more sustainable because they are based on natural systems. This represents a

naturalist fallacy because it implies that because something is *natural*, it is also *good* without further critical analysis. (Mead, 2018)

The second potential failure is in our ability to translate this knowledge into an applicable design, without inadvertently causing additional problems. Mead suggests this isn't for lack of trying. Yet she argues our solutions tend to focus on the immediate outcomes instead of looking at design from a broader, more systemic lens:

> The source of our environmental challenges is not a moral or ethical one, but is largely one of poor design. We design things that do not perform well in the conditions of the biosphere that support the diversity of life forms that live here, including ourselves. Most other organisms, on the other hand, have been adapting to live on this planet for much longer than we have, and we have a lot to learn from these other organisms about well-adapted design for the conditions on earth. (Mead, 2018)

Professor Bruce Hinds offers a similar analysis of our design (in)abilities thus far. As stated earlier he offers that there is continuous movement in nature, an energy that can be derived for function—as in the case of the previously mentioned example of trees using the molecular structure of water to extract it as required. The convergence in thought here is that we tend to find ways, perhaps inadvertently, to work against the energy available in nature, a concept I bring forward again later in this chapter.

Another important aspect of nature that does not easily apply itself in our minds is that of destruction. Nature uses destruction as a structural control

mechanism—destruction creates conditions that are conducive to regenerative processes, allowing them to come into play. (Festival of Faiths, 2019). Some examples of this may appear brutal such as certain species deliberately killing members of the population that are no longer contributing (therefore cannot continue to be a mouth to feed) or elimination of genetic weakness by deliberately killing weak offspring in favour of the stronger. Yet, what appears to us humans as ruthless and unethical is nature's way to ensure the overall survival of the species. (Woolley-Barker, 2017)

Hinds adds that destruction and construction in nature are of equal value and allow the cyclical process of life to be both waste-free and regenerative: "Unlike nature we fear collapse. We are not able to see it as destruction that can lead to betterment. Nature allows decomposition because this enables the release of nutrients. Movement and allocation and reallocation of nutrients is a natural flow [that we have broken]" (B. Hinds, personal communication, 2019, October 10).

We Are Nature

Another common (and fundamental) worldview of the experts interviewed is that we are nature. Since we are animals, we must take our place in the finite ecosystem in which we want to survive. All experts interviewed agreed with this wholeheartedly, creating the basis for an ecocentric worldview. "The more fundamental paradigm shift is understanding that we are part of the fabric, co-evolving with other species, no better or worse, just different (and perhaps, in our current formulations, unsustainable)" (Dr. T. Woolley-Barker, personal communication, October 1, 2019).

Image source: Kellner (2012) Oyster mushroom (Pleurotus ostreatus) mycelium growing in a petri dish on coffee grounds. CC BY-SA 3.0.

What the Fungi?

The collapse of our planet's natural ecosystem is accelerating, but it turns out nature may have already developed the technology to save us. And it's right under our feet. Mycelium is the vast, cotton-like underground fungal network that mushrooms grow from—more than 2,000 acres of the stuff forms the largest known organism on Earth. Omnipresent in all soils the planet over, it holds together and literally makes soil through its power to decompose organic and inorganic compounds into nutrients. (Bierend, 2015)

Figure 5 - Vast and intricate tendrils of mycelium is an example of hyper-connected networks created in nature.

Along these lines is Janine Benyus, in her book, asking that we consider "swallowing our own hubris", stating that we have long considered ourselves above the natural world by separating human from non-human as to say that non-human is a lower entity. Industrial revolution has focused on harvesting finite resources, mining, drilling, blasting, and chemically morphing the ecosystem for the production of goods and services for consumption. Benyus describes what material scientists call heat, beat and treat behaviour as follows: "Carving things down from the top with 96% waste left over and only 4% product, you heat it up, beat it with high pressures, you use chemicals. Heat, beat and treat. Life cannot afford to do that" (Benyus, 2007).

This behaviour has since enough to allow some organization to claim corporate social responsibility; however, we are still far from moving beyond sustainability to regeneration. In sum, we have started to move in the right direction:

> We've only recently expanded our kinship circle to include indigenous cultures, to accept the so-called primitives' knowledge. It's taken those of us in the Western culture too long to do that, and in the process we've lost the opportunity to learn from tribes now scattered. Finally, we're beginning to include animals in our circle of consideration - hoping against hope that we are not too late. (Benyus, 1997, page 183)

We Are Curious Futurists!

Finally, as a species, we are curious and intentional. We want to collaborate (rare) and we want to learn. Additionally, we have futurist intentions:

> Humans have the rare capacity to imagine other futures, and convince others to join us in making them happen...There is no shortage of big goals for us to focus on - poverty, famine, disease - and companies are uniquely positioned to tackle them...Purpose is the glue that integrates our work of one into the work of many, and it's what gets us up in the morning. How will the world be different from our actions? The bolder and more ambitious our collective goals the greater our potential in the world." (Woolley-Barker, 2017, p. 133)

Here again, is where the experts interviewed bring forward the informed hope mentioned earlier, with an intended willingness to find ways to apply nature's teachings.

Learning and Awareness

Where can one make use of this curiosity? Currently both Biomimicry 3.8 and Biomimicry for Social Innovation provide immersive workshops, usually in conjunction with each other. According to Mead**,** who was one of the participants when Biomimicry 3.8 first started, the main participants tend to be:

1. Sustainability experts looking for another toolkit
2. Corporate innovation teams seeking new tech solutions
3. Nature lovers seeking a deepened connection with nature (T. Mead, personal communication, October 23, 2019)

This list might provide insight on future adoption based on the backgrounds of the individuals the workshops attract. The following table presents a listing of recent workshops with a biomimicry focus. What may be interesting is how the location of the workshop, often immersed in nature, potentially impacts the desire to future connect with nature.

Recent Examples Of Bio-inspired Workshops

When considering the locations in which these workshops often take place, I ask the reader to consider: Is proximity to nature critical for workshop success and overall adoption and application of the knowledge gained?

Workshop	Dates	Locations	Offered by
Biomimicry Thinking for Design	March 2016	**El Rancho Robles, Arizona, USA**	Biomimicry 3.8
Biomimicry for Social Innovation	June 2016	**De Spreeuwelse Heide, near Eindhoven in Westelbeers, the Netherlands**	Biomimicry 3.8, Biomimicry for Social Innovation, and Biomimicry Netherlands
Discover Nature's Genius	Dec 2017	**La Cusinga Eco Lodge Uvita, Costa Rica**	Biomimicry 3.8
Think like an Ecosystem	June 2018	**New York Botanical Gardens, New York City**	Biomimicry for Social Innovation, Biomimicry 3.8
Discover Nature's Genius for Social Innovation	June 2019	**Lenar Farms, Logar Valley, Slovenia**	Biomimicry for Social Innovation, Biomimicry 3.8
Living Systems Leadership Workshop	July 2019	**Ocamora Retreat Center, Northern New Mexico**	Biomimicry for Social Innovation,
Innovation inspired by Nature	Oct 2019	**EcoHouse in Antwerp, Belgium**	Studio Transitio
Discover Nature's Genius	March 2020	**La Cusinga Eco Lodge Uvita, Costa Rica**	Biomimicry 3.8

Other participants are corporations seeking new approaches to management innovation. Dr. Woolley-Barker reports that her primary clients are corporations seeking technology solutions, and usually ones where the R&D department is using Agile practices:

"For corporations looking to improve organization management, I am seeing the impetus come from (e.g., software, healthcare) companies that have taken up Agile. They want a more comprehensive management philosophy that supports this rapid reiterative and systemic way of working." (Dr. T. Woolley-Barker, personal communication, October 1, 2019).

In her experience this is a very different approach than that of corporations who begin from a sustainability front.

There are alternate groups of thought leaders in this space who are coming from a more nature-focused approach, suggesting immersion in nature itself as the modus for change; an example is the concept of "bio-leadership" led by Andres Roberts (The Bio-Leadership Project, 2016). Yet another group comes from a living system science background, with experts such as Carol Sanford (focused on corporate strategy) and Giles Hutchins (corporate sustainability). As mentioned earlier, Hutchins is co-founder of the group Regenerators and other forums which offer workshops such as "Learning Journey on Regenerative Leadership" (Regenerators, 2019) and author of *Nature of Business*, which looks at regenerative approaches to organizational change. Around the same time, Carol Sanford wrote *Regenerative Business* in 2017.

In most cases, aside from annual or biannual workshops, there are spinoffs of groups or individuals who are actively incorporating nature's principles as guidance into their consulting practice. What and how are they teaching this practice? One group that returns to evolutionary theory is Studio Transitio (Studio Transitio, 2017) founded by Leen Gorissen, who has a background in biology and transition science. An example of a workshop provided by this team is described here:

> Workshops are experiential and combine different elements: examples of the ingenious ways in which nature deals with challenges, exercises about system thinking and self-organization and brain hacks, exercises that make us

think about our thinking so that we can become aware of our mental models. (L. Gorissen, personal communication, October 17, 2019)

During our interview discussion, Gorissen said what workshop attendees most often take away from workshops is a better understanding of the limitations of linear, reductionist thinking and the importance of learning new skills like systemic thinking (L. Gorissen, personal communication, October 17, 2019). When I asked why she believes we are resistant to change, she said that in her experience it seems our brain patterns (once set) are relatively immobile due to fear. "One of my teachers in Transition Science said, 'The trouble with change is you know what you will lose but you don't know what you will get.' I think that this is what is blocking people" (L. Gorissen, personal communication, October 17, 2019). We may also have an aversion to change because we have not been trained to look at change from the perspective of an unfamiliar entity. If the example is not familiar or at least similar, are we ready to learn from it? Dr. Woolley-Barker also adds the human evolutionary aspects: "If we feel change is being done to us, and we have no say in how we respond, we resist adoption. But free-range humans are always exploring and experimenting, observing and adapting" (Dr. T. Woolley-Barker, personal communication, October 1, 2019). Therefore, we might ask how can we change our organizations to enable free-range collaboration amongst employees?

Another practitioner using biomimicry is Astrid DesLandes, Senior Process Consultant to the City of Calgary, and founder of BioWise Canada - Biomimicry for

Organizations. According to DesLandes the application of biomimicry makes business sense:

> Historically, Biomimicry has been focused on three areas of specialty – product development, architecture, and pharmaceuticals. Why not apply biomimicry to help organizations function better? Certainly, there are lessons in nature to learn, and which can help us work more collaboratively. For example, if we [like nature] collaborate with competitors then we can increase the size of pie and all win, rather than compete for the same small pie. (A. DesLandes, personal communication, October 4, 2019).

In her case it is more applicable to provide examples from nature to demonstrate the thinking required to solve the problem. She suggests instead that we look to nature as a way to study the operational environment:

> We must first understand our environment. How do we access resources —this will change depending on the layer of a forest. [The consulting companies active today] are trying to apply a structure to the organization instead of understanding the context. In nature it would be like a pine tree in the desert—force it, water it, use so much resources to try to make it survive but it won't work because you didn't take into account the context and the operational conditions. (A. DesLandes, personal communication, October 4, 2019)

Another important factor the interviews confirmed is the significant work it takes to bring nature examples to the table. These individuals exhibit a passion and

rigour in modifying and applying science-based thinking to assisting individuals and organizations one workshop, one project, or one example at a time. Small micro-shifts in mindset, starting with these pioneers, is perhaps exactly the informed and intentional change this research uncovered. This fits within the intention set out earlier: If we accept our relative youth as a species, our imaginative willingness to foresee a better future, and no choice but to face the finite world we are in, then we are ready for change. The participants attending workshops or organizations hiring the consultants to bring forward this way of thinking are acting on this mindset shift.

The Outliers: Edge Corporations

In the next section I present barriers to applying this practice to organizational structures; but first I would like to bring forward an edgy and unique example of a company that has grasped this concept completely. Few companies today outright declare that they mimic nature's practices in their organizational structure, however stok is the perfect and unfortunately somewhat rare example of this. As mentioned before, stok is a real estate firm that "delivers buildings that are healthy, regenerative, and more valuable" (stok, 2019). During literature review, stok was the only example of a company stating the basis of its organizational structure being set on "Organizational Biomimicry." During the interview process Dr. Woolley-Barker shared that some individuals at stok were inspired by her book *Teeming* and hired Biomimicry 3.8 to implement biomimetic approaches. By learning from Dr. Woolley-Barker how they might bring to life the theories presented in her book, stok created and publicly shared a booklet of how they have changed their internal team

structures, minimizing hierarchy in favour of bottom-up decision making (stok, 2019). They now group employees into Pods responsible for key aspects of running the company such as payroll, HR, and Finance. They have established all decision-making power at the employee level, including change in compensation for each employee. It would be interesting to determine whether there are specific areas where stok is more successful as a result of this change and how much turnover, if any, this fundamental change caused. stok is presented in more detail as a use case provided in Appendix F.

It is important to note that stok is a small company with less than 100 employees. However, all the aforementioned resources (such as the team from Biomimicry for Social Innovation) and Dr. Woolley-Barker have engaged in projects with larger companies. IDEO, a global design and innovation company, worked with biomimicry practitioners, called the Biomimicry Guild at that time, to guide the United States Green Building Council (USGBC) in redefining connections within the organizational structure. Not surprisingly the triad involved all started from a common place of using design to inform and create sustainability; the USGBC being noted for its creation of the LEED certification system (Walker, 2010). The teams found more overlaps between IDEO's design toolkit and practices used in biomimicry than expected; but it was also clear that the biomimicry approaches would not easily address challenges in the area of motivation or other human-specific attributes (Walker, 2010). The fundamental aspects of tapping into information at the source and ensuring bi-directional communication were all based on biomimicry principles

from main biologist at the table Tim McGee. However, McGee sensed that what user-centric design did well was uncover human aspects of motivation that biomimicry did not, as a scientific practice, address.

> McGee agreed that this is an ever-evolving biomimicry challenge. "As a scientist I'm constantly looking for where the science ends," says McGee. "In working with designers it seems like they have a knack for asking the questions that biologists never ask." For a biomimetic solution, says McGee, the trick is to translate a question like 'How does nature motivate?' to a sound scientific basis. "Motivation implies much that is human, and to ask a biologist this question is outside the realm of much of biological science," he says. "So we would have to break it down to 'How does life structure itself to achieve goal-oriented behavior?'" (Walker, 2010).

In this example the concept of motivational differences in species is a barrier for applying biomimicry to human communication. Further research would be prudent to determine how human aspects of ego and motivation play into bio-inspired design for management innovation. Also interesting would be to revert back to this exercise now almost ten years later to see how much of the information devised remained at use at the USGBC.

As in the example above there are companies open to the idea of applying biomimicry principles to enact management change, but this shift is in its very early stages. In most cases, the organization is already focused on sustainability, and might already embrace an ecocentric approach to running the business. Hinds suggests that

in these cases, the company may be more open to adopting other applications of biomimicry (B. Hinds, personal communication, October 10, 2019).

Barriers To Adoption

This section details the barriers to applying nature's principles to management innovation ideas through insights gained from the expert interviews, highlighting especially points of convergence.

Domain Knowledge and Terminology

From a domain knowledge perspective: Most of the practitioners of this topic have training or experience in biology and/or evolution. Many are hands-on advocates of bio-inspired research by way of their educational background or they are involved in this practice as it supplements their work. The gaps lie exactly herein as the formal learning from which these individuals hail is an uncomfortable fit with the traditional business mindset and therefore does not easily inform the organizational structures in place today. This chasm creates a communication and learning barrier. DesLandes advises that the mere difference in language disconnects these diverse groups from being able to collaborate effectively (A. DesLandes, personal communication, October 4, 2019).

From a terminology perspective: Grasping the concept first entails coming to terms with how we fit into nature and "the ecosystem in which we are operating" (A. DesLandes, personal communication, October 4, 2019). All interviewees suggested that the term biomimicry itself might pose a hindrance to effectively disperse this kind of thinking within business minds because the term is unfamiliar to most non-

biologists. Dr. Woolley-Barker approaches her work from evolutionary theory and suggests avoiding the term biomimicry in the approach. Leen Gorissen supports this thinking:

> I prefer to use bio-inspired innovation or innovation inspired by nature instead of biomimicry because it is more straightforward and people are faster to understand it. An even better formulation would be life-inspired innovation, because we are also nature. (L. Gorissen, personal communication, October 17, 2019)

The determination here is that the application may need to be bespoke, with case-specific language that is carefully introduced and clear explanations of how the nature-based thinking applies to the particular problem a business is trying to solve.

Traditional Structures Fear Change

Our tendency as humans is to continue with understood concepts, as this is where we are comfortable; as Gorissen says, we fear the unknown. The organizational structures we have in place today use managing, planning, and resource-allocation processes in an attempt to control and predict outcomes. Agile and Lean practices adjust the increments of time and allocation for productive work; but the fundamental structures underlying these paradigms remain as bureaucratic approaches we have used since the Industrial Revolution. These traditional methods make sense if the work is a simplistic input of material goods and output of product; but in the current complex economy we need processes that are adaptive. The experts I interviewed each propose alternative approaches to these processes. One example is teams structured

into self-managing entities. Dr. Woolley-Barker provides an example of teams "zipping together" for a common purpose where the strengths are complementary; then unzipping once the task is achieved to create another grouping to produce work.

> Small, modular units zip and unzip together to deal with shifting conditions on the fly. Individuals within them do their thing, with no top-down control. Their interactions are simple - one ant follows a trail left by another, a termite daubs sand next to a blob placed by someone else. But together, these simple interactions build into complex, intelligent—even creative—solutions. There are no predictions, strategy meetings, targets, or bosses. No individual has the whole picture, and yet they accomplish the same kinds of things we do, with far less computing power. (Woolley-Barker, 2017, p.80)

The convening of team members where they can bring forth their skillsets makes their contribution more fruitful in comparison to current management practice which normally assign the work to an employee based on expected skillset or job description—not conducive to the fluid, cooperative, knowledge exchange that Dr. Woolley-Barker describes. Laloux reminds that not having a boss does not mean not having structure but warns of the capacity for current business minds to grasp this: "It took me 2 to 3 years to understand self-management for a larger complex organization." (Conscious Capitalism, 2018) This is similar to the stok example whereby smaller organizations with fewer layers of communication can more readily create transparent matrices. Since everyone knows what everyone can and is willing to do, the work environment is more conducive to collaboration when needed. This

also works in the manner of trial and error; much like evolution, the paradigms of failing fast support innovation and may help improve how individuals work together. "Strategy happens organically, all the time, everywhere, and brainpower stays where it's needed at a moment's notice...Decisions are frequent, small, imperfect, independent, and local." (Woolley-Barker, 2017, p. 80)

What might be a more difficult barrier to identify is the fear that these less hierarchical organizations structures might create in individuals positioned in the executive levels of the organization. What will be the role and purpose of executives if decisions are informed and made from the bottom up? To address this, Laloux advises that the role of upper management simply be redefined into vision-setting with a reduction in decision-making. If executives are informed of decisions that are made bottom-up and at the source, they are then able to set direction on fact-based decisions of what is happening "on the ground" in the organizations. This empowerment enables the leadership and the organization to move forward while also providing the employees closest to the problems a chance to contribute solutions. Dr. Woolley-Barker agrees that leadership is a barrier and offers a different perspective to consider: "30% of all ants are leaders at some point." (Evolution Institute, 2018). This provides an option very different than current organizational hierarchies which may have only a single executive or a small, static team in charge of the entire business.

My professional experience has shown me that for learning to occur, participants must trust the process and connect with relevant examples of potential change. What are the practical applications of management innovation when looking at nature? How can we observe, learn from, and then apply nature's way?

In Dr. Woolley-Barker's experience, the initial curiosity response of, "Oh wow this is cool!" goes a long way to elicit action to try to apply the learning. However, without a parallel change in the organization to be adaptive to change, the innovation is often too frustrating to implement and the original intentionality is not able to be maintained.

From the interviews it was understood that most practitioners applied a combination of approaches as was demanded by their industry standards, clients, customers, and regulatory bodies, and many practitioners relied on intangible indicators such as intuition and the changes of perception of their clients. What is necessary, however, is to approach a bio-inspired innovation process with the same critical eye and rigor that we would any other innovation process and to resist falling into the trap of assuming that something intended to be like nature actually is.

Finally, we need to consider whether applying this practice to the softer skills of how we communicate and collaborate is metaphorical thus requires more practical examples. The original goal of the biomimicry advocates was to provide easy-to-download blueprints that described solutions in nature to everyday problems of form and function. How to prevent water leaks? How to create efficient filtration systems? Scientists, scholars, affiliated universities and researchers were encouraged to

contribute to centralized information portals such as Asknature.org. From here teams could download easily accessible ideas on product design, architecture, and engineering found in nature. However, far fewer examples exist for inspiration on leadership, team collaboration, or engagement. Usually the examples provide a logical idea pattern on optimizing productivity. One example is on individual workload carried by forager ants which nature has optimized by not loading each ant to maximum capacity, and how this might translate to cargo loads. (AskNature, 2017) Will it as easily translate to resource allocation?

Dr. Taryn Mead suggests that we not overcomplicate the approach and apply it at the level where it works:

> First, when decontextualized, not all biological strategies may provide useful insights. Second, it is difficult to justify relying on biological strategies when existing engineered strategies are already quite effective. Third, in-depth research into biological strategies can be incredibly difficult to accomplish within the timeframe and budgets of commercial projects. (Mead, 2018)

Access and understanding of bio-inspired information and research is a large potentially immovable barrier. According to Woolley-Barker, "The innovation process for biomimics requires extensive (and expensive) literature review and/or encyclopedic knowledge of living systems" (T. Woolley-Barker personal communication, October 1, 2019) Thus it appears Benyus's suggestion to have a "biologist at the design table" (Benyus, 1997) was a longer term impact than even Benyus likely predicted and will require many biologists to contribute.

Finally we are perhaps limited in our ability to notice the examples around us because we have forgotten to be curious towards what we might learn from nature:

> ..humans need to have the humility to consider the possibility that we might not have the most effective solutions and that we could have something to learn from ecological systems. Janine Benyus refers to this as *quieting our cleverness*, and it is a skill that we can all benefit from learning. (Mead, 2018)

The idea from Benyus of "quieting our cleverness" (Benyus, 1976) is analyzed further in the following section.

Drowning In Our Own Hubris

I ask the reader to consider: Are we part of nature or above it?

Does "biomimicry" as a term imply that we are separate from nature, which is why we look to it as if to say from afar, and study it as if to say from above. Whatever we do learn we may see as our higher-level wisdom as opposed to our humble ignorance.

What does this mean? It is at this point in the research that I stopped to question the term biomimicry. The definition of mimic is what cast a curious angle to this term for me.

The online Merriam-Webster online dictionary definition of *mimic* provides 4 results:

1. to imitate closely
2. to ridicule by imitation

3. To simulate another object or behaviour such as vegetable dishes that mimic meat
4. to resemble by biological mimicry - a butterfly that mimics a leaf

In the first case do we not need to see ourselves as separate and different from in order to imitate something. Does the definition not imply that we are observing to copy? Had time permitted future research would delve into whether it is even correct (ethical?) as it might be viewed as a form of exploitation.

For the second definition we can elect to ignore it or once again realize that we might be considering it beneath us again as in the case of ridicule.

To simulate is a good definition as it hopes to achieve the same caliber result as the original incarnation, yet we've seen time and again that our solutions are never as elegant.

Finally, the fourth definition is laughable since nature has been smart enough to mimic itself from the outset, we were the only ones late to show up in any sort of a meaningful way. By that we mean that we have long since emulated nature, but for what purpose?

This herein is the main finding from the reasons why we practice biomimicry in any format. So far, we have emulated nature for our selfish and intentional benefit. Only lately have we started to see that the closed system and circularity of nature's approach is the overall mutual benefit to the ecosystem. This is exactly the reason why we need to question the terminology at all times, and this is further unpacked in this chapter. Experts, such as Mead, suggest continually questioning our intention

and accepting our place in nature is the start: “Practicing bioinspiration forces us to address any assumptions we may hold about whether humans are part of nature or separate from it” (Mead, 2018)

Findings – Changing Worldview

This section consolidates the findings of this research study. I begin by suggesting that asking the right questions means having a mindset that considers the entire system in which we are operating; and that this mindset is the basis for imminent change. **“**As we embed complexity and systems sciences into our worldview of the modern era, it enables us to perceive our relationships with each other and with nature differently than previous eras.” (Mead, 2018).

In all cases the experts interviewed for this research converged on the following: Every interviewee said that the organizational structures we have in place right now are limiting our capacity to collaborate because they are set up for competition created by silos that promote isolation. We are not able to be creative or bring our best selves forward due to the organizational structure itself. Gorissen says this is holding us back from being able to contribute and development as individuals: “The way organizations are structured today is that they actually *prevent* development. This is why we experience burnout. The organization is not allowing employees to develop the potential inside them that wants to come out - it does not provide the right conditions” (L. Gorissen, personal communication, October 17, 2019).

Second, all interviewees advocated a minor but significant shift in our working approach by developing the habit of asking how nature, or more specifically other species, would handle the particular challenge in question. Furthermore, all converged on the following reasons for making this question a basis for all problem solving: nature is proven innovation through evolution, uses feedback loops for adaptive response and as humans we are part of nature therefore should work within not against it. This next section reviews these reasons in more detail.

Wisdom Of Evolution

Nature is wisdom proven through evolution. All interviewees quoted the 3.8 billion years of innovation that nature had accomplished ahead of our engineered human-made solutions as a generally understood norm and humbling appreciation for solutions that we could not fathom to achieve with the same elegance that nature has demonstrated. The simplest response is provided by Woolley-Barker: "It works so don't reinvent it" (Dr. T. Woolley-Barker, personal communication, October 1, 2019). To this Hinds adds: "If [studying how nature solves problems] raises your awareness on the ways to achieve things that we have not considered, we may solve all kinds of problems" (B.Hinds, personal communication, October 10, 2019).

Feedback Loops

As a system, nature has built-in feedback loops to which its players are finely attuned. From this information the system reacts; as DesLandes said, it is not a planned proactive approach— emergent, not engineered. Building feedback loops into the problem we are trying to solve might give clear indicators on our progress.

Andrew Brady, Chief Evolution Officer at The XLR8 Team (XLR8, 2019) says being aware of the issues by listening to feedback loops is critical: "I haven't seen academic research but the effectiveness of a team is in direct relation to the lag between how soon they notice there is a problem and how soon they say 'this is a problem'. The goal is to tighten the feedback loops." (A. Brady, personal communication, October 7, 2019)

Brady advised of many companies that are looking closer at how to read and react to feedback loops. He provided Google's Project Aristotle as an example where the company set out to determine how to establish psychological safety in teams as a means to ensure employees are able to speak up about issues and risks without fear of negative consequences. (Google, 2019)

> Reason evolution helps us be productive is because it gives us continuous feedback loops. If employees can't speak up to get timely feedback due to fear and the potential their concerns will be swept under the rug, this hampers our ability to learn grow and evolve. Silence can be really dangerous to organizations. (A. Brady, personal communication, October 7, 2019)

We Are Nature

All interviewees advocated that we ought to remember that we are nature. In general, the idea of returning to nature to learn from it is relatively new for us as a species. We have most recently drilled, mined, exploded, blasted, and otherwise exploited our way out of, around, and through nature, demonstrating little respect. As such we have placed ourselves, perhaps inadvertently or perhaps intentionally, above nature. That being said, nature itself can be destructive—but for a purpose.

Returning to Hock's chaotic organization theory may guide companies in finding the balance of structure to chaos in their internal structures where self-organized and self-managed teams provide conceptual guardrails on company direction and vision.

Ebb and Flow

Working with the ecosystem that exists (instead of against it) is fundamentally *easier* than our current dogged and determined act of "swimming upstream" that we seem to have mandated for ourselves. We should therefore consider the smarter approach of working with naturally available mechanisms, instead of building mechanistic solutions which are ultimately less effective, more costly and a waste of effort and resources to implement. We may then understand that stepping over and through nature is harder than to go with the ebb and flow that it makes available to us.

How will this work?

The practice of studying nature to emulate where it works on collaboration, engagement, leadership and communication cannot be packaged into an applicable checklist-based management framework or practice. Or can it? An interesting divergence in opinion between the experts occurred in the interview responses on this question. According to Gorissen and DesLandes, learning from evolution or biomimicry as an application to management change needs to be applied on a case-by-case basis that most closely resembles the challenge a particular organization is trying to understand and solve. The main undertaking is to ask what nature would do and be open to bio-inspired options.

> "There can be no blueprint for teaching this [evolutionary practice or biomimicry] for organizational change. It has to be tailored as you go. Nature has patterns and follows a path of least resistance. So maybe you could look for the patterns that help the transformation? Right now, organizations are mostly looking at growing bottom line – yet maybe they can start to look at contributing to life on earth (L. Gorissen, personal communication, October 17, 2019).

However, Woolley-Barker says there are many proven practices from social insects and other superorganisms that we can emulate which she guides companies in applying today. At time of writing Woolley-Barker is working on two additional books that provide ways to put into practice the theories offering in *Teeming*.

> I would argue that the processes of evolution are quite simple and easy to emulate (in theory). That is why I work on embedding "first principles" (like diversity, autonomy, game theory models of cooperation and interaction. However, larger emergent systems (e.g. ecologies of work) will always be bespoke (Dr. T. Woolley-Barker, personal communication, October 1, 2019).

Business For Change

Finally, what we might realize is that mimicking evolution is an example of applying systems thinking principles to create success through innovation that is adaptive and resilient. Evolution is the application of fail fast trial and error where the successful innovation moves forward and the entire system is considered in this journey.

This informed systems-thinking approach needs to be applied at the most impactful level. I suggest that the best place to begin is where we spend most of our time: in the organizations and communities where we work. Our contribution within these organizations has far-reaching potential and power as these are the entities that determine the global economy:

> Changing the way we do business is essential to addressing the challenges of environmental degradation. The market is the most powerful institution on earth, and business is the most powerful entity within it. Business transcends national boundaries, and it possesses resources that exceed those of many nation-states. Business is responsible for producing the buildings we live and work in, the food we eat, the clothes we wear, the automobiles we drive, the energy that propels them, and the next form of mobility that will replace them. This does not mean that only business can generate solutions, but with its unmatched powers of ideation, production, and distribution, business is best positioned to bring the change we need at the scale we need it (Hoffman, 2018).

As such, we must be cognizant of the choices we make in where we contribute as this impacts the entire system.

All of the above micro-shifts in change will lead to a much-needed paradigm shift in how we design our organizations moving forward. The proven model to emulate is available to us as a guide:

> What is the new pattern that has to emerge to make this happen? We already know hierarchy and long chains of command cannot keep up with the pace of change. What is the pattern that can deal with such rapid transformation? What is the pattern that can tap into the collective intelligence? My bet is on decentralized self-organization because nature has been doing that successfully for millions of years. (L. Gorissen, personal communication, October 17, 2019)

In conclusion, as a researcher I realized what I had set out to do was not as nature intended. The learning came full circle when I realized that my business management education had limited me to linear patterns of thinking. The places where I had worked so far required disciplined rigour to manage, measure, and deliver to corporate revenue targets. Looking back, in most of the corporations where I have worked with and managed people, resources are not naturally aligned to work in roles where they can exhibit their strengths. Reflecting on this learning, I see individuals continuously wanting but unable to contribute as it is not part of their job description or "mandate."

Upon first learning about biomimicry as an application to sustainable ways in which an organization creates a product or service, it was inspiring to consider whether it could be applied to managing the organization itself. This research uncovered the work that is being done and the progress it has made despite existing barriers. What began as an expectation to find management practices on how we could behave more like efficient and hard-working ants turned into a realization that

we are far from being able to emulate nature due to our inability to see ourselves as part of it, and our lack of awareness of what it can teach us. What began as an intention to learn about existing applications, or a chance to contribute a new management framework based on nature's principles, evolved into an understanding that this is precisely what should not be done. One of the best quotes from the interview with Dr. Woolley-Barker on the application of biomimicry as a new management framework: "Top-down engineering of emergence—good luck with that!" (Woolley-Barker, personal communication, October 1, 2019)

Instead, the most effective method would be to suggest a much-needed micro-shift in our approach to creating a better human-made future by 1) asking the right questions; and 2) seeking answers first by being curious. There are many apparent reasons why in this current state of affairs we would turn to nature for answers. If we can return to it with curiosity, and remember to ask "What would nature do?" prior to any action we take, we have a chance at making the incremental mindshift required for a better future.

"It's a big job…but it's an Apollo project worth pursuing."

~ Janine Benyus (Biomimicry Institute, 2015)

Chapter 5 – Conclusions & Future Research

The ants aren't choking on smog or stuck in traffic and the fungi aren't counting carbon credits or worrying about the Pacific Garbage Patch. Termites don't have slums. All have grown and prospered for hundreds of millions of years, through all kinds of radical change – and they have the same biomass we do, or more, and work in teeming cities of tens of millions of individuals, making more with each generation, and enriching the landscapes around them – there is no reason we can't do it as well.

~ Dr. Tamsin Woolley-Barker

Instead of fixing a problem, let's look at the organization from possibility, potential, how can it become an enabler in its community, then in the larger landscape, and eventually in the biosphere?

~Leen Gorissen

This paper started by looking at the origins and emergence of biomimicry and its application as an innovation design method. Still nascent in its general adoption, biomimicry is even newer as a guidance for management innovation. By applying biomimicry principles to management change, the organizations themselves may become more resilient to rapidly changing environments, and better adapted to creating not just sustainable but regenerative products and services. Due to the sheer impact of some of these corporations, this shift in the organizational structure and culture will allow organizations to become enablers of this same adaptability within their larger communities and, as Gorissen says above, the entire biosphere.

In reviewing the pioneers who are spearheading this work I presented the convergent patterns of thinking where informed and intentional application of evolutionary and biomimicry principles provides opportunities for changing organizational structures that can no longer adapt to the complex global economies in which they must survive. There is quick-moving activity in this opportunity space with continuous research and exploration. Currently any and all acquired learning is being applied real-time by individuals and within organizations which are ready to try something different. A model such as nature makes sense because it is proven, beautifully complex yet simple, and provides a means of applying systems thinking and adaptive design. Some advocates such as Woolley-Barker are eager to provide applicable management practices because the evolutionary concepts on which these can be based are both simple and proven. Others are currently applying an ad-hoc approach, looking at each wicked problem and asking "What would nature do?" as a

way to inform their purpose and practice. All share a common mindset of informed and intentional hope.

In order to continue the growth of knowledge, connectivity and application we need more publications of the thought processes and applications behind this work. Further research is also required to consider the directions in which this concept could expand, and the beginnings of this process is provided in Appendix E. Appendix E provides a list of guiding principles provided by the current predominant biomimicry firms and thought leaders. I present a very preliminary mapping between these guiding principles as a means to see where they converge and diverge on their instruction. In this case a mapping of principles is created across three groupings: *Life's Principles* from Biomimicry 3.8 Design Lens, *Living Systems Leadership Practices* as developed by the Biomimicry for Social Innovation and the principles of biomimicry application provided by Dr. Tamsin Woolley-Barker in *Teeming* (as well as via her consulting firm *Teem Innovation Group*). Where the mapping analysis uncovers clear overlaps in some of the core principles may be convergence points that indicate principles which are tested and proven. Where the mapping analysis shows visual outliers or possible gaps may suggest the need for further inquiry and discovery. Continuing the analysis of these principles, the guidance they provide and the experience and expertise that underpin them would provide ample research that might then inform the application of the principles. This future research may also provide insights for applying these principles in practice.

There are many approaches and methods that continued research in this space can bring additional learning. From the perspective of expanding the practice, continuing the immersive workshops presented earlier will help proliferate the benefits of this way of problem solving. As with the goal behind Herzlich's Biomimicry for Social Innovation, this may introduce biomimicry into problem spaces to which it has not yet been applied. From the perspective of deepening the knowledge space and application of these principles, participatory workshops, attended by both experts and practitioners, may uncover existing use cases and their successes and failures, which may indicate further barriers and enablers of adoption than was presented in this study. Finally, and from the perspective of continued learning, there are numerous educational institutions already teaching biomimicry. However further research would be required to determine how prevalent the application of biomimicry for management innovation is being considered within programs for business management and organizational behaviour.

The good news is there are evidently many reasons to be hopeful that we will not only continue to thrive as a species but actually do so in and amongst the survival of other species alongside us. In this study we have seen that the pioneers in this space believe that it is prudent to seek knowledge from the species that have thus far thrived longer than humans (we may consider them our elders). If we choose to observe, learn from and correctly apply the vast and simple knowledge that is available around us then our hope is warranted.

As Benyus says “We just have to reimagine everything. That's all.” (Bioneers, 2014)

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APPENDIX A – ORIGINS AND EMERGENCE OF BIOMIMICRY

The following images show a timeline of seminal publications, emergence in education, and creation of forums and organizations that most likely played a critical role in the development of biomimicry as a practice. The practice of biomimicry is not new, however was resurrected in the mainstream through the 1997 book from Benyus, "Biomimicry: Innovation inspired by Nature". This timeline also suggests that learning from nature started with focus on ecology and biophilia which look at nature from afar and more recently beginning to look at nature as a system of which humans are a part.

The switch to finding ways to operate within the same system as nature appears to have started with key publications such as book by Senge "The Necessary Revolution" published 2010. Even more recent is application of biomimicry for reconsideration and redesign of organizational structures through the examples from Herzlich and Woolley-Barker which were presented in this study. These words were produced within the last decade from time of writing.

APPENDIX B – EXPERT INTERVIEW: SEMINAL INFLUENCERS

The following presents interview responses on the seminal resources, publications, books, forums and thought leaders who most influenced the trajectory of the interviewee's learning in this space. All experts converged on their connection with Biomimicry 3.8 and founders Janine Benyus and Dayna Baumeister. However, the interviews uncovered a divergence in the education and industry experience that brought each expert to incorporate biomimicry into their work. These ranged from evolution and evolutionary biology to influence from myriad practices and concepts including transition science, regenerative design, organizational change and development, and architectural engineering. The variety in influences in highlighted below.

Interviewee	**Influenced by**
Dr. Tamsin Woolley-Barker	❑ E.O. Wilson ❑ Paul Hawken ❑ David W. Sloan, Evolution Institute ❑ Janine Benyus and Dayna Baumeister ❑ Pascale, Millemann, and Linda Gioja. 2000. *Surfing the Edge of Chaos: The Laws of Nature and the New Laws of Business*. ❑ Senge, Peter M. 2010. *The Necessary Revolution: Working Together to Create a Sustainable World.* ❑ Benyus, Janine M. 1997. *Biomimicry: Innovation Inspired by Nature*. McDonough, William, and Michael Braungart. 2002. *Cradle to Cradle: Remaking the Way We Make Things***.**

Andrew Brady	❑ Sisodia, Sheth, Wolfe. 2007, *Firms of Endearment* ❑ Chapman and Sisodia. 2015. *Everybody Matters: The Extraordinary Power of Caring for Your People Like Family* ❑ Edmondson. 2018. T*he Fearless Organization: Creating Psychological Safety in the Workplace for Learning, Innovation, and Growth* ❑ David W. Sloan, Evolution Institute ❑ Conscious Capitalism
Astrid DesLandes	❑ Janine Benyus ❑ Biomimicry 3.8 multiple workshops including *Discovering Nature's Genius* in Uvita, Costa Rica ❑ Carlos Fiorentino
Leen Gorissen	❑ Mang and Haggard. 2015. Regenesis Group - Regenerative Development and Design ❑ Flemish Institute for Technological Research (VITO) - transition science ❑ Dee Hock, VISA ❑ Ray Anderson, Interface ❑ Biomimicry 3.8
Bruce Hinds	❑ Janine Benyus ❑ Ray Anderson, Interface ❑ David Oakey of David Oakey Designs, industrial engineer ❑ Center for Biologically Inspired Design (CBID) at Georgia Tech
Dr. Taryn Mead	❑ Janine Benyus and Dayna Baumeister ❑ Biomimicry 3.8 ❑ E.O. Wilson ❑ European Biomimicry Alliance ❑ Ellen MacArthur Foundation

APPENDIX C – EXPERT INTERVIEW: NATURE AS MODEL

The following table provides direct quotes taken from the experts interviewed in this study on the principle of observing and learning from nature as a model. According to these experts, evolutionary success is driven by feedback loops, fail fast approaches, and carefully mitigated use of available resources, all of which are built into their practice of biomimicry, and highlighted in their responses shown here.

Interviewee	**Nature as Model - Structures and Principles**
Dr. Tamsin Woolley-Barker	❑ Organizations should structure themselves so they are not in the way of **natural behaviours of collaboration that humans want to exhibit and act upon**.
Andrew Brady	❑ I haven't seen academic research, but the effectiveness of a team or organization is in direct relation to the lag between how soon they notice there is a problem and how soon they say 'this is a problem'. **Goal is to tighten the feedback loops**. **Silence can be really dangerous to organizations.**
Astrid DesLandes	❑ There are **many pockets of individuals** creating their own organizations that are trying to apply their learning from nature to how they might help organizations succeed.
Leen Gorissen	❑ There can be **no blueprint for teaching this [evolutionary practices or biomimicry] for organizational change.** It has to be tailored as you go…. I don't think there will be a blueprint or a process on How they get there[to this type of thinking] – what's more important is to **keep them thinking and evolving**.

Bruce Hinds	❑ Unlike Nature we fear collapse**. We are not able to see it as destruction that can lead to betterment. Nature allows decomposition as it releases Nutrients. Movement and allocation and reallocation of nutrients is a natural flow [that we have broken].**
Dr. Taryn Mead	❑ **Biomimicry is a more divergent thinking tool then a convergent tool and creates an expansive space for ideation**. Say you have a Communication problem. What I might do in the workshop is provide 20 examples of communication in nature to see if this resonates as a potential inspiration for solving the problem. Then I let the group co-create a story based on those examples to emulate the change they are seeking. It's an inspirational model yet we have no way to predict what will inspire someone/a group. This helps them to see how it might inform their challenge.

APPENDIX D – EXPERT INTERVIEW: NATURE AS INSPIRATION

The following table provides direct quotes taken from the experts interviewed in this study on the principle of observing and learning from Nature for inspiration. In these responses, the experts share their continued intention to look to nature as teacher and mentor. Their responses suggest that looking to nature for guidance allows humans to thrive due to the positive mindset that is created when humans remember they are connected to and ultimately a part of nature.

Interviewee	Nature as Inspiration
Dr. Tamsin Woolley-Barker	❑ [This practice] should not be based on metaphor, should be based on evolution. **Putting it in the evolutionary context applies well as its math based, robust and based on algorithms and inherently resilient.**
Andrew Brady	❑ Organizations that leverage these [evolutionary] principles were able to have **healthier happier employees** and connected in with a more profitable company.
Astrid DesLandes	❑ It is good to have the concept of biomimicry as a framework for **thinking and asking 'what would nature do?'** when solving challenging questions for organizations. We can look at nature and see how it might solve a problem in the human world or take a human problem and ask how nature might solve it.
Leen Gorissen	❑ [When I bring nature to the office or factory floor] All those executives light up and get as enthusiastic as a group of children …this means **reconnecting people to nature is the way in**.

Bruce Hinds	❑ **If [studying how nature solves problems] raises your awareness on the ways to achieve things that we have not considered,** we may solve all kinds of problems**.**
Dr. Taryn Mead	❑ **Biomimicry was a way to say 'Yes!'** Instead of following the (more common) dystopian view, when I started teaching, I wanted to introduce more utopian models – to change the perspective. Biomimicry and related disciplines provide a healthier, productive and just perspective for the future.

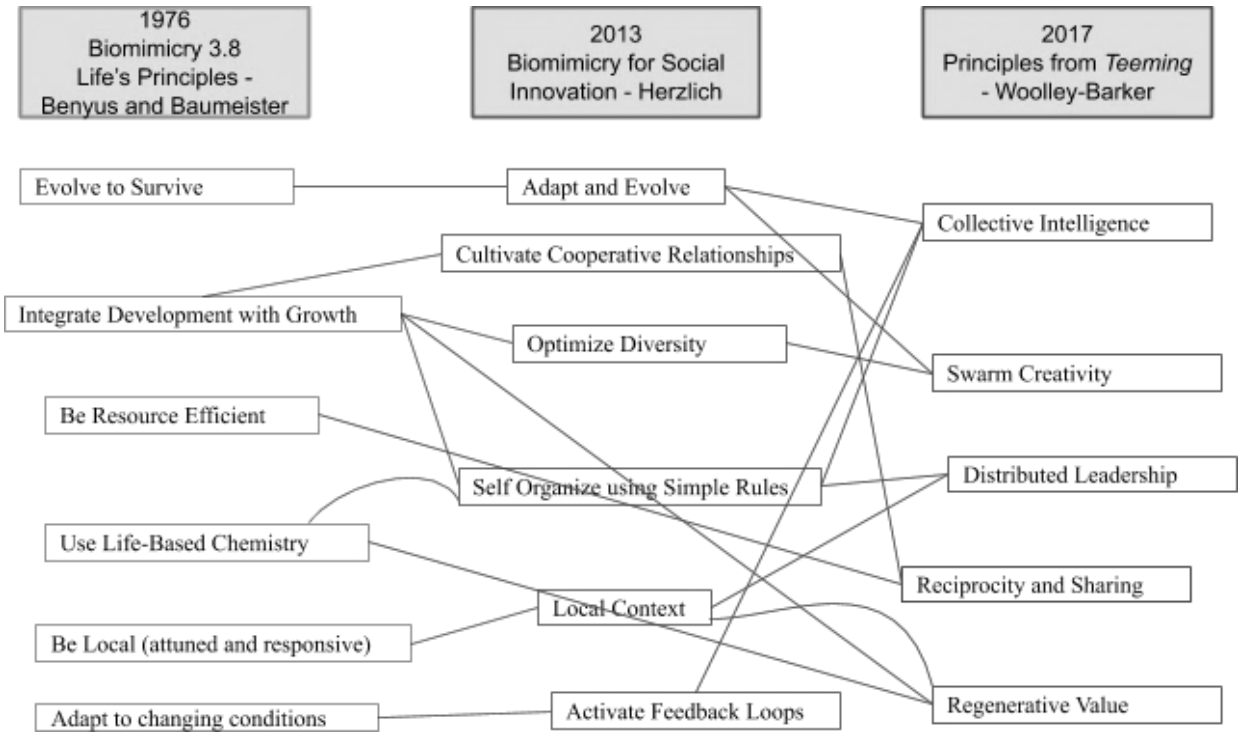
APPENDIX E – BIOMIMICRY PRINCIPLES MAPPING ACROSS THOUGHT LEADERS

Principles Mapping

The following figure is an exploratory attempt to map the principles advocated by the following thought leaders and their organizations. The research intention here was to develop a means to present the confluence between these experts' viewpoints as well as uncover potential gaps in their work.

The figure below (as presented in Chapter 2 - Research Methodology, Figure 1) is a mapping of the following:

- *Life's Principles* created by the team at Biomimicry 3.8 lead by Janine Benyus and Dayna Baumeister, originally defined in Biomimicry: Innovation inspired by Nature (Benyus, 1976) and further developed by the team at Biomimicry 3.8
- *Living Systems Leadership Practices* as developed by the Biomimicry for Social Innovation teams lead by Toby Herzlich, circa 2013. (Festival of Faiths, 2019)
- Dr. Woolley-Barker presentation of the five broad components that unite superorganisms in the ability to create compounding value (Woolley-Barker, 2017) as provided in her 2017 book *Teeming: How Superorganisms Work Together to Build Infinite Wealth on a Finite Planet (and your company can too).*



As seen in Chapter 2, Figure 1 - Mapping of three dominant guidance provided in the space of Biomimicry.

Data in Column 1 are from/From "*Biomimicry Design Lens a visual guide*" by Biomimicry 3.8. Released December 11, 2015, Generation 1.1, p. 7. CC-BY-NC-ND.

Mapping Analysis

From this analysis we can see the links between the common guidance components provided by each organization or individual. For example, a common substantiation is to approach an opportunity or challenge from the 'local' perspective. In the case of Life's Principles this is presented as "Be Local (Attuned and responsive)". Biomimicry 3.8 Design Lens further breaks this concept into the following details:

- ❏ Leverage Cyclic Processes
- ❏ Use Readily Available Materials and Energy
- ❏ Use Feedback Loops
- ❏ Cultivate Cooperative Relationships (Biomimicry 3.8, 2016)

This last guidance 'Cultivate Cooperative Relationships' is listed as a practice provided by Herzlich in the Living Systems Leadership Practices. On the far right of the mapping Dr. Woolley-Barker provides Distributed Leadership where her book further breaks this concept into

- Zip specialized modular teams together as needed
- Distribute leadership to integrate local information with a global vision (Woolley-Barker, 2017)

In this example the ability to tune into local information is the common guidance. Life's Principles adds that the local and readily available resources can then be used. Biomimicry for Social Innovation adds that cooperation creates transparent sharing of this information so that the decision-making is informed. Finally, the principles from *Teeming* suggest this local knowledge is used to inform decision making while ensuring the resulting action supports the overall vision. Distilling all three viewpoints into a single guidance might bring each of these variances to a simple principle for example "Use local knowledge and cooperation to inform global decision-making". This common focus on application of local knowledge and information also raises the questions of whether the teams involved have access to this information and further, if they are aware of how to be regenerative within the local ecosystem.

Another factor in this analysis is to determine any guidance or principal which may be missing from these three viewpoints. For example, how might teams be better connected to each other via networked communication channels to ensure this

knowledge is shared. In order to 'activate feedback loops' (Festival of Faiths, 2019) and 'reciprocity and sharing' (Woolley-Barker, 2017) require a mechanism or medium upon which to communicate. Building multi-directional communication channels will be critical to support these principles. How can this be done in a way that ensures teams receive this information in a timely manner? Research into the efficacy of workplace collaboration tools to support these principles may be a focus for further research.

Finally, where are the principles redundant amongst the three viewpoints? In which cases are they management principles stated in a new and bio-inspired way yet fundamentally mean the same thing? For example, there are existing business practices such as Agile methodology which share many of the same core principles and might be better suited to the understood language in business circles. Also noted is that the principles are reduced and simplified as the principles in more recent years emerge. For example, Toby Herzlich advised that her intention was to simplify the 26 Life's Principles into what can be more specifically applied to our organizations and ways of communicating. (Festival of Faiths, 2019)

To further this analysis, I hope to facilitate a collaborative workshop whereby both the experts and the practitioners of the above principles may provide additional insights on the convergence and divergence presented herein. This workshop might also inform how to bring these principles to life in applicable day-to-day practices in our lives.

APPENDIX F – USE CASE: BIOMIMICRY IMPACTS ON ORGANIZATIONAL STRUCTURES

image source: (Nagel, 2016)

Stok presents a demonstrable use case for this study as it is leveraging bioinspiration at both external and internal aspects of the organization. Biomimicry is applied to its external service as a company, which is incorporating biophilic design in their creation of built spaces. It is also applied to how stok manages internally which is through the setup of an organizational structure based on biomimicry principles.

Building for the future

stok is in the business of designing high performance buildings by which they mean creating spaces that are intentionally created to work with the occupant in mind. This user-centric approach focuses on the organization's talent pool ensuring wellness, productivity and ultimately retention which they indicate has a direct impact on the financial success of the organization. (stok, 2018)

Founder Matt Macko started stok in 2008. Not surprisingly literature review uncovered Macko as an expert with much the same characteristics as those interviewed in this study: devoted to global sustainability and sharing, fully committed to enabling teams to innovate and whose work is fueled by healing time in nature:

> The good news is we have a team in place committed to constantly innovating, as well as tech clients who teach us every day about where the industry is headed. I try to get into nature when keeping up overwhelms. We didn't need cognitive research to tell us the outdoors heals. (Snow, 2017)

Also not surprising was Macko's inspiration coming from Laloux's *Reinventing Organizations*. Clearly Macko was seeing that existing structures were not going to work for the culture he intended for his company: "I worry that this corporate controlled, data driven world we'll live in might not be what humanity intended. Corporate ethics are really challenging in a world where money is such a powerful force." (Snow, 2017)

It is likely this learning led to the change that brought stok to the Biomimicry 3.8 team. In late 2015 the company decided to re-engineer their brand both externally and out. Dr. Woolley-Barker, working via Biomimicry 3.8, was engaged via this partnership to achieve this mission. Needless to say her book *Teeming* was likely homework reading for the individuals involved in determining how stok might apply the principles presented therein.

The company came out with its new brand and mission in February 2016, excited to tout their achievement of two main goals via this business structuring; first that of engaged employees who are ready to contribute their best to stok and the second to have a net positive impact on the world. They achieved this through work with Biomimicry 3.8 and came out successful:

> We designed our structure similar to how nature would design an organization. Think of overlapping concentric circles that move away from traditional hierarchy to efficient, self-organized teams of peers. There are no bosses, and instead of being motivated by money and status, we're motivated by autonomy, mastery and a shared purpose. Autonomy allows us to have mastery over whatever we're passionate about, and a shared purpose helps us not only maximize our human potential, but also our social and environmental impact. (Nagel, 2016)

The output of this work was posted in a blog for other companies to consider. In an interview with Neil W partner at stok the industry is listening and many companies are already moving in this direction:

> Today we have major REITs setting goals to become carbon neutral by 2020, the world's most valuable company [Apple] is running its facilities on 100% renewable energy and some of the world's tallest buildings are incorporating biophilia and air quality controls at a level never seen before (Littman, 2018)

In summary the approach is a matrix organizational structure whereby teams are organized into "pods" which deliver at the employee level what in traditional organizations would be left for the executive level to manage. This provides employees a chance to contribute directly to the decision-making and ultimately direction that the company ventures. Leadership and accountability skillsets are therefore developed and the team is able to meet the company's three-factor mission of

autonomy, mastery and shared purpose mentioned above which stok attributes to Daniel Pink.

This structure is also applied to the performance and compensation measures at the company, whereby employees present a case on their achievements, developments and contribution for the year, in essence appealing to their peers on the increase (or decrease) to their compensation. This is based on a system stok developed that is used for continuous feedback among employees:

> Human Capital Contribution (HCC): Twice a year, each team member takes HCC surveys for the people they work most closely with, answering questions that evaluate performance in six key areas that provide long-term value to stok: emotional intelligence, effective communication, work style, guidance, entrepreneurship, and relationships. The HCC scorecard results act as a guiding principle to examine how people are adjusting to the continual feedback they are receiving throughout the year. (stok, Lessons Learned, 2019)

Why it works

It is important to consider that the small size of the company (under 100 employees) is a distinct factor in the ability to incorporate the approach. Consensus on decisions and agreement on an approach is likely easier when there are fewer individuals involved. The company also spends significant time and effort on recruiting the types of individuals that seek this type of structure in which to work. Employees who are interested in self-organizing and open to environments where this contribution is valued will be attracted to this type of organization. This is likely more

feasible for the younger generations who have been raised on a system that doesn't reward autocracy. Generation Z apparently makes up one quarter of the working force in North America (Rampton, 2017). Common traits from Generation Z onwards is autonomy, consistent feedback and work life balance (Rampton, 2017). Self-managing teams, mutualism and cooperation over competition, all based on evolutionary principles, appear to be better suited to the mindset of these generations - and stok provides an organizational structure that honours these values. What other companies may follow in its path?