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Paradigm-Based Evaluation for Eco-Just Systems Transformation

Beverly A. Parsons
Executive Director, InSites

Katherine Winters
Principal Consultant, Insight for Action

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Introduction

Welcome to an exploratory journey of evaluation's role in the transformations necessary to engage with today's polycrisis. We are two white women with a cumulative 60+ years of evaluation experience. As we have plunged deeply and broadly into **system**[1] theories, thinking, and practice, we have experienced a liberation from old assumptions that we now recognize were grounded in an exclusionary set of **system science theories** and **paradigms** and shaped our evaluation practice. Table 1 shows how we are defining terms that are especially important to our orientation.[2]

Table 1. Definitions of Terms

Term	Definition
Axiology	What is valued.
Colonization	The act or process of settling among and establishing control over the people, territory, and resources of an area. (Merriam-Webster, n.d.-a).
Decolonization	The act or practice of decolonizing—to free from the dominating influence of a colonizing power, especially to identify, challenge, and revise or replace assumptions, ideas, values, and practices that reflect a colonizer's dominating influence and especially a Eurocentric dominating influence (Merriam-Webster, n.d.-a).
Eco-just civilization	Our term "eco-just civilization" builds on the work of the Institute for Ecological Civilization (n.d.-a), which describes an ecological civilization as one in which human societies are "structured to promote a cooperative relationship between the planet's human inhabitants and the biosphere they inhabit" (para. 2). To incorporate the importance of justice in societies we are using the term "eco-just civilization."
Ecology-based system paradigm	A social-ecological paradigm with the purpose of evolving life within the increasing complexity of the larger whole.
Emergence	The phenomenon in which new, unexpected structures, processes, properties, or patterns arise in self-organizing systems (Zimmerman et al., 2001).
Epistemology	What is knowable and by whom.
Governance and management of social-ecological systems	Governance: What the system does and what it should become in the future. Management: How the system reaches its goals and aspirations.
Indigenous people; Indigenous, Indigenization	Indigenous peoples: Practicing unique traditions, [Indigenous people] "retain social, cultural, economic and political characteristics that are distinct from those of the dominant societies in which they live… they are the descendants of those who inhabited a country or a geographical region at the time when people of different cultures or ethnic origins arrived… [they] have retained distinct characteristics which are clearly different from those of other segments of the national population." (par.1-2) "Indigenous peoples are the holders of unique languages, knowledge

[1] The first use of a term defined in Table 1 is shown in bold in the text.

[2] This article represents our synthesis and interpretation of a myriad of writings about systems as well as their integration with evaluation practice. We are not attempting to reference all of those sources. Rather, we reference sources that we especially used and/or are accessible via the internet for a wide audience.

Term	Definition
	systems and beliefs and possess invaluable knowledge of practices for the sustainable management of natural resources. They have a special relation to and use of their traditional land. Their ancestral land has a fundamental importance for their collective physical and cultural survival as people" (United Nations, n.d., para.7). Indigenous: "Produced, growing, living, or occurring natively or naturally in a particular region or environment" (Merriam-Webster, n.d.-c). Indigenization: To have Indigenous characteristics or personnel (Merriam-Webster, n.d.-b).
Machine-based system paradigm	A social-ecological paradigm with the purpose of producing something for human consumption and use by extraction of energy and matter from nature (including people).
Methodology	How one obtains knowledge.
Ontology	How the world works.
Paradigm	"*Paradigm* is a term used to capture a worldview or perspective that, in the case of research and evaluation, includes conceptions of methodology, purposes, assumptions, and values. In evaluation, a common use of the term is in characterizing the distinction between quantitative and qualitative approaches as in contrasting positivism, postpositivism, constructivism" (Mathison, 2005, p.289. It stems from Kuhn's classic work *the Structure of Scientific Revolutions* (1962).
Reductionism / Reductionist	"Reductionism is the practice of analyzing and describing a complex phenomenon in terms of elementary parts that exist on a simpler or more fundamental level… The aim of reductionism is an explanation showing how the higher-level features of a whole system arise from the elementary parts." (Systems Innovation, n.d.-a, p.13).
Self-organizing	The process within complex systems where emergence occurs without being externally imposed on the system (Zimmerman et al., 2001).
Social-ecological system	Interdependent and linked systems of people and nature that are nested across scales (Bouamrane et al., 2016; Colding & Barthel, 2019). We view this interdependence and linkage as highly important to our orientation here. Thus, we do not talk about social systems and ecological systems separately.
System	Basic definition: "Dynamic units that we distinguish and choose to treat as comprised of interrelated components, in such a way that the functioning of the system, that is, the result of the interactions between the components, is bigger than the sum of its components." (Magro & van den Berg, 2019, p. 144). Tailored definition: "A perceived, integrated entity with a pattern of organization of interconnecting purpose, structure, and processes that is doing something." (see the section Perceiving Social-Ecological Systems).
System science theories	Scientifically investigated theories about systems, what they are, and how they function

Term	Definition
System science theory clusters (as used in this article)	We organize systems sciences theories into these four clusters: *General systems theory* encompasses broad systems concepts, including the notion of wholeness over reductionism, differentiation between open and closed systems, and the relationship between system structure(s) and function(s). *Cybernetics* focus on how closed systems work, with emphasis on constraining their behavior through feedback mechanisms tied to system structure. *Transitional system science theories* focus on power, multiple perspectives, emancipatory approaches, and values, and differentiate living and nonliving systems. *Eco-relational system science theories* emphasize humanity's relationships to nature and one another, offering guidance for governance and management of social-ecological systems in keeping with our evolving, changing world.
Systems paradigm	A coherent set of basic concepts and axioms that form the worldview underlying systems theory and thinking. What defines the systems paradigm as distinct from others is that it is based on a holistic view of the world. Holism means that we are thinking about things in reference to the whole that they form part of (Systems Innovation, n.d.-a).
Systems thinking	A broad area that brings together the many different ways of thinking that holistically interpret the world. Such thinking seeks to understand phenomena as intimately interconnected with the greater whole of which they are a part. Two concepts fundamental to systems thinking are that (a) a system is different from the sum of its parts and (b) a system is a unified whole. (Systems Innovation, n.d.-b; Magro, & van den Berg, 2021). Systems thinking contrasts with reductionism (see the section From Reductionism to Systems Thinking).
Western thinking	Generally, Western culture rooted in ancient Greek philosophy, with a focus on mathematics and natural sciences, generally rejecting mystical answers. Western thinking plays out over centuries, largely in European philosophical thought.
Yin-yang relationship	A visual metaphor applied in this paper to help us recognize the ongoing and dynamic relationship between the machine-based and ecology-based system paradigms. It helps us recognize the continual presence of two types of system dynamics in an ongoing relationship.

The evaluation approach presented here builds from our understanding of two deep system paradigms on which **social-ecological systems** are built: the **machine-based system** and the **ecology-based system**. The approach requires a shift from reductionist thinking to **systems thinking**. It also involves framing system science theories in a way that emphasizes their relationship to these two paradigms and provides the basis for transforming the balance between them. We metaphorically present this as a **yin-yang relationship**. Perhaps most important, our approach involves a transformation of evaluation itself from a focus on individual projects, programs, policies, and initiatives to the **social-ecological systems** in which they exist.

We begin by distinguishing **reductionism** from systems thinking. We then move from systems thinking in general to perceiving a specific type of system—the social-ecological systems that shape our everyday lives. We present two system paradigms that shape these social-ecological systems. Our intention in presenting these paradigms is to help evaluators locate and use

systemic leverage points to help transform social-ecological systems. Next, because evaluators ground their work in theories, we focus on theories about systems and their differing connections with the two system paradigms. We present a cluster of system theories—eco-relational system theories—that are often not included in texts about the system sciences. This understanding can help evaluators align theories and paradigms to use system theories more effectively. When evaluators do not recognize these differing alignments, they can easily misapply system theories.

After this grounding in system paradigms and theories, we shift our attention to the implications for evaluation design. In essence, the paradigms and system theories help us attend systemically to how the world works (**ontology**), what is valued (**axiology**), and what is knowable and by whom (**epistemology**). Such grounding helps evaluators then appropriately select evaluation **methodology** (how one obtains knowledge) that aligns with the paradigms and theories that they are using in a given evaluation situation. Throughout this article, we relate this paradigm-based evaluation approach to the **decolonization** and **Indigenization** of social-ecological systems.

From Reductionism to Systems Thinking

Two concepts are fundamental to systems thinking: (a) A system is different than the sum of its parts, and (b) a system is a unified whole (Meadows, 2008; Magro & van den Berg, 2019; Capra & Luisi, 2014; Systems Innovation, n.d.-b). A systems perspective contrasts with reductionism. A reductionist approach breaks objects or situations into small parts as a way to understand the behavior of the groupings of parts (Systems Innovation, n.d.-a). The reductionist approach does not necessarily attend to interconnections and the dynamic of the phenomenon in its entirety. Recognizing patterns that come from seeing both parts and interconnections versus discrete entities is a fundamental aspect of systems thinking.

Reductionism has ruled many philosophical, scientific, and research trends in past and current centuries. Program evaluations are often based in reductionism, emphasizing a list of attributes or components with limited attention to the interconnections among them or how a program functions as a whole in its context.

Systems thinking began to gain momentum in Euro-centric Western cultures during the second half of the 20th century as a means to understand and respond to unpredictable situations and experiences. When applied to program evaluation, systems thinking views the unified whole of the program and its internal and external interconnections and interrelationships. Its unity is woven into the very context or environment in which it is present. General sources of information on systems thinking that we recommend to evaluators include the Waters Center for Systems Thinking (2020), Donella Meadows (2008), Open University (2011), and Magro & van den Berg (2021).

Perceiving Social-Ecological Systems

We all live within multiple social-ecological systems—the combined ecological and social systems in a given situation. For example, a human community residing in an ecological system (ecosystem) near the equator functions differently than one living near the arctic region. Those living near the ocean are influenced by different ecosystems of flora and fauna than those in the desert. We often focus so much on human-to-human relationships (e.g., the economic, transportation, communication, education, and health systems) that we forget we are part of ecosystems that greatly affect how we live. As we build our systems thinking capacity, the social-ecological systems we encounter every day become increasingly apparent.

Despite their diversity, social-ecological systems are infused with similar patterns—both negative and positive. Examples include increasing inequities and rampant environmental degradation alongside advances in health services, renewable energy, environmentally responsible housing, and more. What gives rise to these patterns? We contend it is the two basic system paradigms and their interconnections that undergird our social-ecological systems. Each system paradigm has its own strengths and weaknesses.

To recognize system paradigms and to focus specifically on social-ecological systems, we have integrated definitions and concepts from three sources (Capra & Luisi, 2014; Meadows, 2008; Open University, 2011) to create our working definition: *A system is a perceived, integrated entity with a pattern of organization of interconnecting purpose, structure, and processes that is doing something*. We apply this definition to social-ecological systems, but it is not necessarily limited to them.

Note four key features:

- **integrated entity:** While some definitions (e.g., Meadows, 2008; Open University, 2011) use the phrase "collection of entities interacting

together," we are using the phrase "integrated entity" to emphasize the deeply connected unity of a system.
- **perceived:** A system is not necessarily a physical entity. It is something that people *perceive* to exist, be it as a mental image and/or through senses such as taste, smell, touch, hearing, and emotion. How one perceives a system brings in their history, beliefs, values, culture, and personhood. Perception is experienced through one's integrated body, mind, and spirit—sources that are often disconnected in **Western thinking**.
- **pattern of organization:** Capra and Luisi (2014) suggest that a pattern of organization can be recognized through the use of three dimensions—purpose, structure, and processes. Thinking in terms of a pattern of organization presents a systemic unity. When we recognize how purpose, structure, and processes create a system's pattern of organization (i.e., the underlying design), we gain a powerful frame for investigating how both the social and ecological systems in which we live are governed and managed and can be transformed. The three dimensions are not separate aspects of a system; they provide different angles from which to view the same holistic entity.
- **doing something:** A system is dynamic and energized. It may have a regular repeating pattern of change and motion or an irregular, evolving one.

We posit that evaluators can design evaluations that more significantly contribute to social transformations toward well-being for humans and nature with this orientation to social-ecological systems and system paradigms. We refer to the focus of transformation as an **eco-just civilization** in which human societies promote cooperation between themselves and their biosphere in a manner that is just and fair.

Basic System Paradigms of Social-Ecological Systems

A paradigm is a worldview that encompasses an understanding of how the world works. Understanding how the world works is referred to as ontology. Our exploration of systems thinking has led us to recognize two basic intertwined system paradigms that provide contrasting views of how the world works in terms of humanity's relationship to the natural world. We refer to them as the machine-based system and the ecology-based system paradigms. [3] Understanding their interconnections bears similarities to comprehending an optical illusion that contains two images within it. Both images are within the picture, but if one is overly dominant in our perception, we can't see the other.

These paradigms have different basic patterns of organization comprised of their purpose, structure, and processes. Here, "purpose" refers to the system's meaning or intention. The two different patterns of organization influence how evaluators and others approach decolonization and Indigenization of social-ecological systems.

Machine-Based System Design

The basic pattern of organization of the machine-based system is as follows:

- The core *purpose* is to produce something for human consumption and use by extraction of energy and matter from nature (including people).
- The *structure* is composed of assembled parts that work together to do something. The parts may be composed of smaller parts and may be replaceable. Their interconnectedness creates the system. The structure is designed to be stable, controlled, and predictable, and to function within a specified range of operation. It is hierarchical, with nested repeating structures and looping structures.
- The *processes* of this type of system include establishing rules and monitoring for quality, control, predictability, and efficiency.

The system as a whole is energized by previously living (e.g., fossil fuels) and/or currently living species (e.g., trees, people). The boundaries of the machine-based system are such that it functions as a relatively closed system that is isolated from its environment. These systems tend to produce waste that is externalized rather than reused by the system.

Ecology-Based System Paradigm

[3] While we seek to be well grounded in the system sciences, we cannot be comprehensive in this short article. Thus, we have taken liberties with some system science concepts for clarity, with the expectation that readers will delve more deeply into the relevant concepts and their application.

Comparatively, the core focus of the ecology-based system is the deep interconnection of living organisms with their environment through the following basic pattern of organization:

- The *purpose* of an ecology-based system is to evolve life in relationship with the dynamic complexity of the larger environment.
- The *structure* of an ecology-based system is that of a **self-organizing**, nested, weblike network characterized by **emergence**.
- The *processes* of an ecology-based system are grounded in the principles of interdependence, symbiosis/partnering, resilience through flexibility and diversity, and cycles (generally with the waste of one life form being the food of another; Capra & Luisi, 2014).

Ecology-based systems are fundamentally open systems that are energized by the sun—an ongoing, renewing, external energy source—through connections to living entities that engage in photosynthesis. Differing from the processes of machine-based systems, which focus on rules, the processes of ecology-based systems focus on principles.

See Table 2 for a summary of the pattern of organization of each paradigm.

Table 2. Contrasting the Patterns of Organization of Machine-Based and Ecology-Based Systems

Pattern-of-organization aspect	Machine-based system	Ecology-based system
Purpose	To produce something by extraction of energy and matter from nature (including people), usually for human consumption/service and welfare	To evolve and regenerate life, even with increasing complexity of the larger context
Structure	• Hierarchical top-down control • Nested repeating hierarchical units • Relatively closed boundaries • Replaceable, siloed parts • Regulating structures (feedback loops) for stability and consistency within a range of tolerance of operation determined by the system boundaries	• Distributed controls • Nested web-like network • Flexible, relatively open boundaries • Emergence of complex features • Self-organizing with context
Processes	Grounded in *rules* focused on: • Homogeneity • Resilience through stability • Predictability • Linearity, with waste generally externalized • Quality • Control • Efficiency • Monitoring	Grounded in *principles* of: • Symbiosis/partnering • Resilience through flexibility and diversity • Cyclicity (generally with the waste of one life form being the food of another) • Interdependence • Expectation of unpredictability

A given real-life social-ecological system is not based solely on one paradigm or the other, but rather on some combination of the two. There are endless variations in the combination of these basic patterns of organization as humans and the rest of nature interact as complex social-ecological systems. However, distinguishing the two underlying patterns helps one to think in terms of how to differentially work with each one.

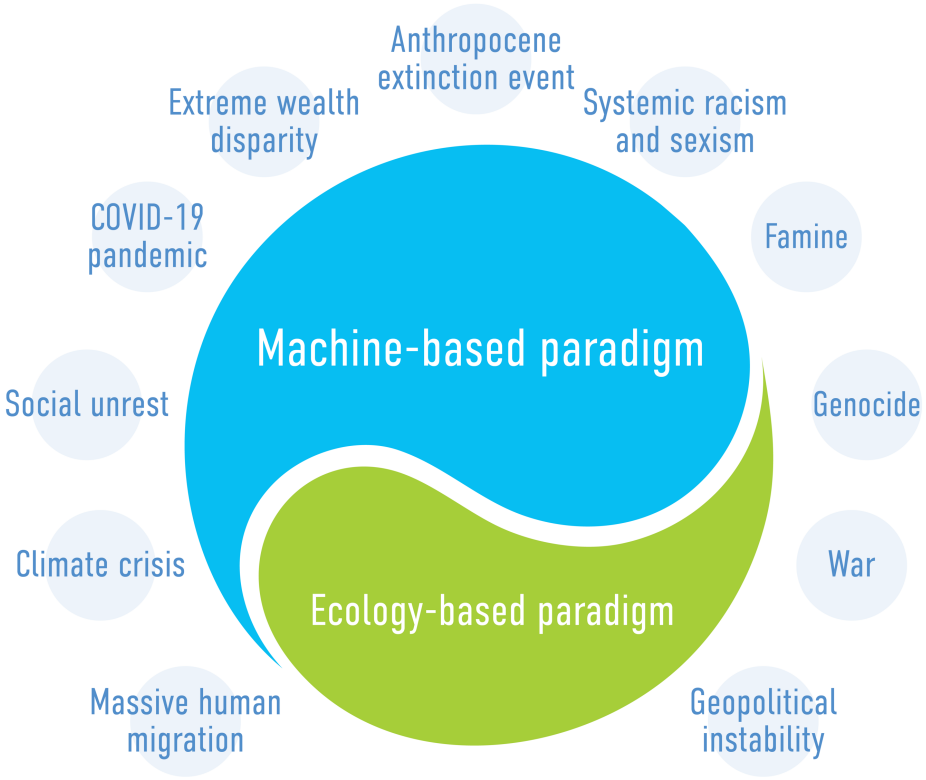
For example, our exploration of these paradigms is leading us to the position that the machine-based system paradigm is the foundation

of the colonizing practices that have so influenced our world globally, while the ecology-based system paradigm is the grounding of an Indigenous orientation to living. To decolonize our current social-ecological systems, we need to constrain and/or refocus the systemic patterns of organization that are based on the machine-based system paradigm. At the same time, the fundamentally different pattern of organization of the ecology-based system paradigm needs to be built up to rejuvenate our social-ecological systems and move toward an eco-just civilization.

Rebalancing the System Paradigms

Our premise is that evaluation can support humanity's liberating movement to a different balance between these paradigms that transforms human-to-human and human-to-nature relationships. The purpose of attending to the two paradigms is not to impose one or the other. Rather, consideration of their presence in a given situation provides a simplifying (but not a simplistic) way to guide actionable evaluative inquiry to facilitate a shift toward an eco-just civilization. The two contrasting paradigms can be thought of metaphorically as in a yin-yang relationship in the planetary living system overall. Their current imbalance is contributing to myriad social, political, and environmental problems (Figure 1).

Figure 1. Imbalances, Strengths, and Weaknesses of Two System Paradigms Have Produced a Global Pattern of Environmental Degradation and Human Suffering



How Did We Get Here?

The historical development of the machine-based and ecology-based patterns of organization and system science theories has contributed to today's global polycrisis situation. They have also contributed to the theory and practice of evaluation.

The History of the Ecology-Based and Machine-Based Systems' Patterns of Organization

Each of the two system patterns of organization has its own history and origin story. The oldest of these is the ecology-based system paradigm, which has been evolving on this planet for billions of years and is congruent with **Indigenous** ways. While specific **Indigenous** civilizations have varied in how they perceive reality, overall, they recognize that something greater than themselves exists, and they view things through a relational lens of interdependence with nature in their particular context (Capra & Luisi, 2014).

The machine-based system paradigm has more recent roots in the planetary timescale, aspects of which can be tracked back to the Middle Ages. At that time and in certain cultures, the social order was organized into a hierarchy of the clergy, nobility, and peasantry for the purpose of consolidating power and resources (Abram, 2013). Building on this social order, the machine-based system paradigm is especially grounded in the Industrial Age model of social organizations, which started in Britain around 1760 and persists today. Its focus has been on extracting resources from nature and producing products for consumption. In this worldview, the world works like a machine that is controlled by humans. This "modern" worldview prioritizes progress, improvement, rationality, predictive science, individuality, humanism, self-consciousness, market capitalism, and hierarchical legal and governmental institutions. Humans are viewed as the center of a meaningful life and the masters of nature. These ways of thinking have become deeply embedded in the Western perspective and have significantly influenced the whole world through **colonization**.

Framing Theories in the System Sciences Field

From our perspective, many system concepts and theories that are commonly referenced in key texts have largely arisen from what we are calling the machine-based system paradigm, whereas the system concepts connected to the ecology-based system paradigm have secured a lesser place in the Western world's scientific consciousness. This differential uptake has significantly influenced the application of system concepts in evaluation and management, seemingly without awareness of their underlying system paradigms. There are many system transformations needed today, and we contend those transformations must focus on building up the ecology-based system paradigm (e.g., Indigenizing social-ecological systems) while repositioning and constraining the machine-based system paradigm (e.g., decolonizing social-ecological systems).

Clusters of System Science Theories

In the sections to follow, we describe a selection of system concepts and theories that are relevant to evaluation and the human actions of **governance and management of social-ecological systems**. These concepts were selected based on our experience in the United States and international settings in the fields of education, health, social services, agriculture, and environment, which has ranged from working in diverse local communities to engagements with governors and legislators in the United States on policy and leadership. It has included extensive work with cross-role and cross-agency collaborations, both public and private.

We first discuss three clusters—**general systems theory, cybernetics**, and **transitional system science theories**—that incorporate theories well-recognized in the system sciences field. Sources informing our descriptions of these clusters include Capra and Luisi (2014), Ison (2010), Ison and Straw (2020), Jackson (2003, 2019), Meadows (2008), Midgley (2007), Ramage and Shipp (2009), Senge (1990), Stacey (2007), Williams and Hummelbrunner (2011), and Zimmerman, Lindberg, and Plsek (2001).

Then we turn our attention to a fourth, less recognized cluster—**eco-relational system theories**—that needs far greater attention when pursuing social-ecological system transformation. There is considerable diversity among the system theories we are clustering as eco-relational. We bring them together here to demonstrate their legitimacy and congruence with the ecology-based system paradigm. We posit that the eco-relational systems cluster contains system science theories that are foundational to the ecology-based paradigm. In our view, these theories are necessary in designing evaluations for social-ecological system transformation. While they are richly explained separately in various scholarly sources, they have not been lifted up as a recognized cluster within the system sciences field.[4] We have found the following sources both informative and insightful: Benyus (1997), Bollier (2014), Coll

[4] The 66th annual conference of the widely recognized International Society for the Systems Sciences (ISSS) held in 2022 showed growing attention to such theories in the systems sciences field. However, the connection to underlying system paradigms was not discussed.

(2021), Goodchild (2021), Hernandez (2022), Kimmerer (2013), Korten (2021), Lent (2017, 2021a), Raworth (2017), Simard (2021), Stockholm Environment Institute (n.d.), and Yunkaporta (2020).[5] Although these theories do not all arise from Indigenous scholars, they appear to us as having congruence with an Indigenous perspective that can serve as the basis for what we are referring to here (in shorthand) as Indigenizing social-ecological systems.

General Systems Theory

General systems theory (a commonly used labeling of certain systems theories) contributes to both broad systems concepts and ways to describe systems. The notion of wholeness over reductionism—that the whole is different from the sum of the parts—is a basic general systems concept. Another key concept from this cluster is the differentiation between open and closed systems, which requires attention to boundaries. It is their openness that causes open systems to evolve with the changing complexity in their surroundings (Ramage & Shipp, 2009). Evaluators who are unfamiliar with the differences between open and closed systems can easily treat evaluands such as neighborhood initiatives as closed systems, when they are actually more aligned with the concept of an open system. In such a case, the evaluator might easily give insufficient attention to the context in which a system exists and its interconnection with that larger context.

General systems theory also contributes attention to system structure and function. Specifically, a system's structure affects how it functions and how energy flows (Capra & Luisi, 2014). It is our experience that evaluation often focuses on the function of the evaluand, while neglecting or underestimating the influence of the structure, e.g., not addressing the difference between partnerships of hierarchical organizations and partnerships of informal neighborhood associations. Finally, this systems theory cluster contributes attention to values—the notion that our experiences are mediated by values, which influence how we perceive and understand a system. "Habits of a Systems Thinker" (Waters Center for Systems Thinking, 2020) is an example of a tool that facilitates the application of general systems theory.

Cybernetics

Cybernetics is a well-recognized cluster of system science theories and is fundamental to what we are referring to as the machine-based system paradigm. Early on, cyberneticists zeroed in on closed systems, developing theories about how closed systems work and testing them with various methods. The early emphasis within cybernetics was on constraining the behavior of a system within a particular set of desirable parameters, such as ensuring that a missile would hit a target or that a thermostat would maintain a desired temperature (Ramage & Shipp, 2009; Meadows, 2008).

Communication processes are central to cybernetics. Cyberneticists examine how messages, feedback, and self-regulation affect how machines, people, and physical phenomena work. From its early days, the evaluation field has focused on operational adjustments, based on feedback, in a program or process to bring about accuracy and efficiency. The commonly used management approach of continuous quality improvement generally fits here.

Viable Systems Model. While feedback and self-regulation are relevant to both of the system paradigms we discuss, here is an example of a well-known contribution from the cybernetics cluster—the viable systems model (VSM)—that is primarily applied to the machine-based system paradigm. It was created by Stafford Beer (1926–2002), a British cyberneticist, to show how viable systems are contained (i.e., nested) within other viable systems.[6] The VSM applied cybernetic principles to the management of large organizations (which have the pattern of organization of machine-based systems). The model added adaptability to management systems (Ramage & Shipp, 2009) and is sometimes treated as a methodology for understanding systems (Williams & Hummelbrunner, 2011).

Of special importance in this article is the model's conception of the structure of an organization. In the 1970s, Beer studied biological organisms and other living systems to see what he could learn from them about how a system endures and develops. Beer was looking for viability—what keeps something alive and surviving for a long time. While he studied living systems, he was looking for

[5] We have much to learn about this cluster and look to others for elaboration of this cluster.

[6] Our description of VSM is our interpretation of how we have seen the model in social-ecological systems grounded in the machine-based system paradigm. It is not necessarily what Beer intended.

mechanisms that could be modeled by managers to exercise greater control over people and natural systems. His focus was on stability and control, features that build strength within the machine-based system paradigm. Beer drew out from nature those features that provide stability and control and applied them to large organizations.

Beer developed a model of organizations consisting of recursive interlocking and nested systems with three elements: the operation system that performs the basic work of the system; the metasystem that holds different units of the work together, providing information and communications; and the environment in which the system remains viable.

Beer emphasized recursiveness as a central aspect of the VSM. Each unit in an organization includes all aspects of the operation system and metasystem and is repeated throughout the system. Consider, for example, the education system in the United States and in many other countries. In nearly all U.S. states, there are three levels—local, district, and state—that use the recursive system model, emphasizing control, stability, and standardization. You'll see similar recursive system models in nearly every area of state government in the U.S.; for example, we have seen them in departments of social services, natural resources, health, criminal justice, and more. This is also the case across many businesses, especially large corporations. This type of recursiveness in structure is often a defining feature of a machine-based system.[7]

From its early days, the dominant orientation in the evaluation field has fit within the VSM; it has supported making decisions efficiently, monitoring the environment, helping an organization become more controlled and/or adaptive, and maintaining the purpose of an organization. As a result, organizations have often become increasingly stable and controlled—that is, as long as the external environment does not change too much. In today's increasingly volatile social and ecological environment the stability and control in such organizations can prevent their ability to adjust and transform with the environment.

System Dynamics. System dynamics is a branch of system sciences that emerged from cybernetics. It is another example that illustrates the importance of recognizing system structures. It is based on the work of Jay Forrester at the Massachusetts Institute of Technology (Ramage & Shipp, 2009). It became especially popular in organization management through the work of two of Forrester's colleagues—Peter Senge (1990) and Donella Meadows (1999). Forrester emphasized that system dynamics were driven by a looping structure in the system. As an internal aspect of the system's structure, these loops function like a servomechanism in a machine, keeping it within a certain tolerance range. They are different from external feedback loops. Internal looping structures are integral to the structure of the system itself. The "tragedy of the commons" and "success to the successful" are well-known examples of these looping structures within the machine-based system paradigm (Meadows, 2008; Senge, 1990). When evaluators focus on system dynamics of this type, they often do not recognize the underlying theoretical connections to the looping structures. They often incorrectly assume these same looping structures apply to social-ecological systems grounded in the ecology-based system paradigm.

Transitional System Science Theories

In this article, we bring together two branches of system theories: (a) soft and critical system theories and (b) complexity theories (Ramage & Shipp, 2009). We refer to them as transitional system science theories because, in our view, they represent important movements away from the cybernetic and machine-based system theories (and the machine-based system paradigm) toward the theories that we are referring to as eco-relational system theories (and the ecology-based system paradigm).

Soft and critical system theories focus on power, multiple perspectives, and emancipatory approaches, especially as related to management of organizations. For example, soft systems methodology and critical systems heuristics are approaches to viewing situations that move toward a more open and value-based way of understanding social-ecological systems (Ramage & Shipp, 2009).

Complexity theories emerged in the 1970s, propelled by increased computing capacity. Central to complexity theory is the differentiation of living and nonliving systems. Living systems are autopoietic (i.e., self-producing) and self-maintaining (Maturana & Varela, 1998). For example, James Lovelock's Gaia theory (as cited in

[7] Another type of recursiveness in nature that sustains life in a more dynamic environment (that is, aligns with the ecology-based system paradigm) derives from flexibility and has a fractal pattern and network structure. It is associated with complex adaptive systems and eco-relational system theories rather than cybernetics.

Ramage & Shipp, 2009) argues that Earth, including the physical planet and all living organisms, is a single living system. Of importance to evaluation, complexity theories describe the behavior of complex adaptive (e.g., living) systems, including concepts such as self-organization, emergence, attractor patterns, and sensitive dependence on initial conditions (Zimmerman et al., 2001; Eoyang, 1997; Parsons, 2012).

These living system features align with the ecology-based system paradigm, and contrast with the non-living fundamental nature of the machine-based system paradigm. Although the expression of the machine-based system paradigm in social-ecological systems interacts with and contains living things, such as people and resources, the structure and boundaries of this type of social-ecological system can be so firmly defined that the living entities are not able to affect the system. For example, changing the principal of a school may affect some relationships between teachers, parents, and students, but they are still constrained by the rules imposed on the school by the district or state. A common misstep is to overestimate the change that is likely to occur when changing one part of a machine-based system (in our example, changing the principal). When people are operating within structures that are designed to maintain control through top-down dominance, significant change in their behavior is unlikely unless purposes, structures, and processes are all reconfigured in a transformative way.

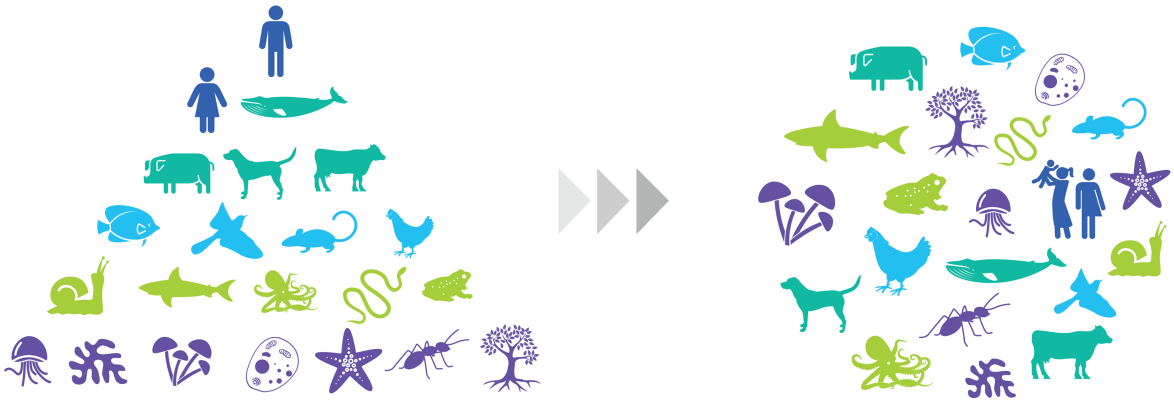
Eco-Relational System Science Theories

Eco-relational system science theories elevate humanity's relationships to nature and to one another in dynamic, living ways rather than through the hierarchical formal systems grounded in the machine-based system paradigm. They are connected by their emphasis on human responsibility to cultivate insight into lifeways that support sustaining harmony, balance, and life itself. This cluster has roots in non-Western sources, especially those grounded in Indigenous sciences and philosophies (Goodchild, 2021; Hernandez, 2022; Kimmerer, 2013). While Indigenous sciences and philosophies are not monolithic, they tend to position humans as living symbiotically with other forms of life and to emphasize sustaining life. We also include Eastern cultures and sciences (Coll, 2021) in this cluster, with their emphasis on nondualist philosophy and a more integrated view of the mind-body-spirit relationship. Other theories include the feminist notion of partnership over dominance (Eisler & Fry, 2019); economic models such as management of the commons (Nordman, 2021); democratic ownership (Next System Project, n.d.); and the ecological ceiling (Meadows et al., 1972; Raworth, 2017; Stockholm Environment Institute, n.d.). These areas of scholarship—grounded in legitimate science—expand greatly upon the fundamentals of living systems. They lead to governance and management models for social-ecological systems that are grounded in sustaining life and in keeping with our evolving, changing world.

Connecting Theories, Paradigms, and Social-Ecological Systems Transformation

Figure 2 summarizes the movement from today's global conditions to the human-to-nature relationships embedded in decolonization and Indigenization. It positions humans as part of nature, not dominant over it. It is another way of describing and visualizing an **eco-just civilization**: a shift in humanity's relationship with the whole of nature, such that we see ourselves as a part of the web of life, no more important than the tiniest microbial life-form. Under such a shift, all of life is viewed as sacred, and the rights of nature are to be honored (Global Alliance for the Rights of Nature, 2022). This shift repositions our thinking about the design, governance, and management of social-ecological systems as we seek to decolonize and Indigenize social-ecological systems in practice.

Figure 2. A Fundamental Paradigm Shift in Humanity's Relationship to One Another and With the Whole of Nature



Working with the two interfacing system paradigms and using aligned system science theories, evaluators can contribute to the transformation of social-ecological systems. The machine-based system paradigm can be viewed as the basic pattern of organization that has been the basis of colonization and needs to be decolonized and redirected toward a new purpose. The ecology-based system paradigm, which is congruent with an Indigenous perspective[8], has been undervalued and underdeveloped. This paradigm can be key to strengthening social-ecological systems locally and globally.

As we now prepare to move to a discussion of evaluation design, here's an example of a situation where we explored the two system paradigms and their alignment with system theories as the basis of the evaluation.

In 2021, the Hawaii-Pacific Evaluation Association (HPEA) leadership invited us to conduct a workshop at their annual conference about systems-oriented evaluation to transform social systems. We asked about possible local evaluations that might serve as the basis for the workshop to ensure that it was grounded in the local setting. We wanted to approach the topic from the orientation of decolonization and Indigenization of social-ecological systems and make transparent the two system paradigms described in this article.

Fortunately, the Lili'uokalani Trust was on a journey with community members and other organizations to explore how to break cycles of intergenerational poverty among Native Hawaiian families. Through this initiative, Native Hawaiian evaluators and program leaders were already using system dynamics theory and tools to gain insight into how to adjust the state's education system and its social services system. The use of system dynamics theory aligned well with understanding the social-ecological systems (education and social services) that are based on the machine-based system paradigm. In effect, they were attempting to decolonize these systems.

Concurrently, they were convening Native Hawaiian community members to explore stories and visuals arts to understand the meaning of well-being within Native Hawaiian communities and families. They were exploring expressions of well-being among families and communities (i.e., social-ecological systems) that aligned with the ecology-based system paradigm. Here the emphasis was on building up the Indigenous social-ecological ways of living within schools and communities. In the workshop, co-led with the Native Hawaiian evaluators and program leaders, we discussed the paradigms in relation to their work to bring greater transparency to the important connections among theory, practice, and underlying system paradigms

[8] The Indigenous perspective is not the only perspective based on the ecology-based system paradigm, as is described below in relation to eco-relational systems sciences. However, it is a leading one in efforts to build an alternative orientation to social-ecological systems based on the dominant colonizing machine-based paradigm.

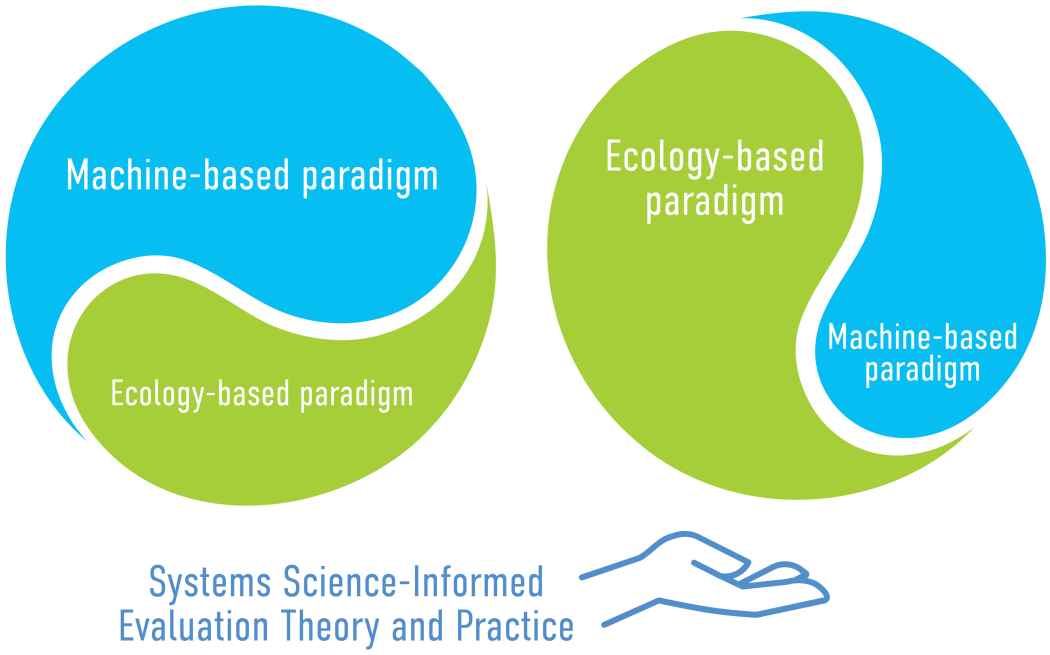
when seeking to transform social-ecological systems.

With this grounding, in facilitated breakout groups, we collectively explored the yin and yang portions of a potential evaluation design that might be used to continue the organizations' and community's long-term work of social-ecological system transformations to find an eco-just way of living in their setting.

Implications for Evaluation Design

To highlight the importance of the two system paradigms in social-ecological system transformation, we propose what we are referring to as a yin-yang system transformation evaluation design (Figure 3). This visual metaphor emphasizes that the ecology-based system and the machine-based system are in continual relationship to one another; neither is ever transformed into or eliminated by the other. Because the machine-based system paradigm is so dominant in today's world, it is easy to unconsciously bring ecology-based systems into machine-based systems in a subservient position; that is, allowing the machine-based systems to "colonize" the ecology-based systems. Figure 3 presents the opposite orientation. Generally speaking, the machine-based systems need to be constrained or diminished, while the ecology-based systems need to be amplified. We have found that a yin-yang system transformation approach facilitates working with the basic pattern of organization of each of these paradigms. This approach seeks a harmonizing balance by informing efforts to change the expression of each.

Figure 3. Yin-Yang Systems Transformation Evaluation Design



Note that a yin-yang system transformation evaluation design is different from a mixed-method evaluation. Here the mix is at the evaluation *design* level, not the method level. A yin-yang design ensures that the evaluation directly attends to the differences in how the transformation of machine-based and ecology-based systems and their relationships proceed. We refer to the evaluation design portion for investigating an ecology-based system as the yin portion and the evaluation design portion for investigating a machine-based system as the yang portion. The yin and yang portions of the evaluation are each likely to incorporate mixed methods, and they are likely to be intertwined. It is important to keep in mind that the overall goal of social-ecological system transformation is to rebalance the underlying machine-based and ecology-based patterns of organization, propelling movement toward an ecological and just civilization (eco-just civilization) that promotes a cooperative

and just relationship between the planet's human inhabitants and the biosphere they inhabit (Institute for Ecological Civilization, n.d.; Lent, 2021b).

To construct the evaluation design for a specific situation, first consider four system concepts that the American Evaluation Association's Systems in Evaluation Topical Interest Group (SETIG) has put forth (2018): boundaries, interrelationships, perspectives, and dynamics. While these features are important in the design of evaluative inquiries about systems, their expression is different in the two types of system paradigms. Table 3 summarizes our conceptualization of the major differences in the two system paradigms in terms of the four features. These differences need to be considered in an evaluation design focused on social-ecological system transformation.

Table 3. Contrasting Key Inquiry Design Features in Machine-Based and Ecology-Based Systems

Key inquiry design features	Machine-based system	Ecology-based system
Boundaries	• Well-defined boundaries	• Open to the flow of energy and matter
Interrelationships	• Hierarchical • Controlled, stable	• Networked • Evolving, emergent, self-organizing
Perspectives	• Competing interests, benefits, and values to be negotiated • Extraction for consumption • Individualistic	• Generative, cooperative values and benefits • Regeneration and evolving life • Connected
Dynamics	• Servomechanistic system dynamics • Linear	• Evolving, self-organizing, renewable • Nonlinear

The evaluation design will likely include a combination of monitoring, measuring results, research, reflection, and learning activities. These activities differ in their intended use, design, and expression in the two paradigms.

Developing a Yin-Yang System Transformation Evaluation Design

The steps in developing a yin-yang system transformation evaluation design may seem quite familiar. However, each step has a special twist necessary to maintain the fundamental yin-yang way of thinking. Consider these three steps:

- *Describe the situation* in terms of the social-ecological systems involved;
- *frame key questions* about both the current and a future eco-just situation around matters of ontology, axiology, epistemology, and methodology; and
- *focus the evaluation design* on reharmonizing social-ecological systems.

We recommend beginning by drafting two components of your evaluation design: one that investigates the yin (ecology-based systems portion) and one the yang (machine-based systems portion). Once you have those drafted, consider how you might interconnect them for expeditious movement toward greater eco-just conditions.

Describe the Situation in Terms of the Social-Ecological Systems Involved. Describe the situation in terms of the social-ecological systems that are most likely to be involved in the transformation.

All evaluations exist in complex situations with multiple social-ecological systems at play. Begin by asking: What social-ecological systems do we perceive in this setting? Engage a breadth of perspectives, but avoid the trap of seeking total clarity or scope—simply get started in an exploration that keeps both types of system in view. Your description may only scratch the surface of the systemic patterns and issues.

Frame Key Questions About the Current Situation and an Eco-Just Future. The second step in developing the evaluation design is to identify key questions about both the current situation and a future eco-just civilization in the setting. While a

typical evaluation is often framed in terms of the current and "desired" conditions, we choose not to use the "desired" label. Too often people respond with unrealistic dreams uninformed by the realities of today's world. The system transformations needed in today's world require major rethinking about what is necessary for the continued existence of humanity and nature for current and future generations. The questions need to attend to planetary boundaries and the need to right past wrongs and reestablish healthy relationships among cultures (Stockholm Environment Institute, n.d). Table 4 offers example questions that touch deeply on ontology (how the world works), axiology (what is valued), epistemology (what is knowable and by whom), and methodology (how one obtains knowledge) to explore the current situation and an eco-just future. This is long-term and intentionally deep work. Note the differences between the questions related to the current situation and those related to an eco-just future for the overall yin-yang system transformation evaluation design.

Table 4. Key Questions to Consider in Developing a Yin-Yang Transformation Evaluation Design

Focus	Key questions about current situation	Key questions about the necessary future eco-just civilization
Ontology: Identify social-ecological systems at play.	• Which existing social-ecological systems have the machine-based system pattern of organization? • Which existing social-ecological systems have the ecology-based system pattern of organization? • Where and how do the identified social-ecological systems intersect (e.g., are they operating in parallel; is one nested inside the other)?	• What dynamic balance among paradigms and social-ecological systems holds promise of a eco-just future?
Axiology: Identify what is valued and who has these values.	• What are the current clusters of shared values? • Who shares these values? • How explicit are the values? • Who explicitly shares these values?	• What are the "common ground" values? (Common ground values are those that can serve as the basis for hard choices as realistic scenarios of an eco-just future are considered.)
Epistemology: Identify what is knowable.	• What is currently considered knowable, by whom, and in what ways? • How are facts and opinions distinguished, and by whom? • How and to what extent is nature's knowledge and wisdom known, and by whom?	• What is knowable about an eco-just civilization when a full range of perceptions of human-to-human and human-to-nature relationships are considered?
Methodology: Identify how to obtain knowledge needed for a mixed systems-based design.	• How do the methodologies align with the purpose of the evaluation and with the pattern of organization of the social-ecological system(s) being addressed? • Are the underlying assumptions of the methodologies appropriately aligned with the social-ecological system(s) being investigated?	• What are the ongoing methodologies that support a transformative and resilient rebalancing of the social-ecological systems in this situation?

Ontology (How the World Works). In considering the ontology, examine the three facets of the pattern of organization of the two system paradigms—the machine-based system and the ecology-based system (Table 2). Focus the conversation on living within our planetary boundaries.

Axiology (What Is Valued). Evaluators working with systems built on the machine-based paradigm must attend closely to the difference between what the system is currently doing and what is necessary for an eco-just future. Many social-ecological systems based on the machine-based paradigm have become excessively extractive and have consolidated wealth and power among a few people. The values of concentrating power and wealth have become the controlling forces of many systems (Korten, 2021; Lent, 2017, 2021a, 2021b; Raworth, 2017). (This is a core feature of colonization.) Such systems have become so powerful that they are not going to be changed by looking at only one facet of the pattern of organization—purpose, structure, and processes—or with casual attention to each of them. For example, to transform a governmental or industrial organization designed to consolidate power or wealth to align with an eco-just future requires substantial redesign. In fact, the organization may need to collapse and be rebuilt with a new combination of purpose, structure, and processes. This requires evaluators to clarify and continually attend to their own values and to surface the values of those involved in the situation.

Social-ecological systems that are grounded in the ecology-based system paradigm are often less developed and/or less recognizable than those which are grounded in the machine-based system paradigm (Eisler & Fry, 2019; Nordman, 2021). At the same time, they are ubiquitous throughout human society and nature and can be mobilized. We see this especially in social movements. Ecology-based systems are grounded in principles rather than rules, and the principles are based on the values of a person or group (Hasa, 2016). Commonly held values that are congruent/aligned with the ecology-based system paradigm include collaboration, cooperation, compassion, caring, integrity, and nurturing. These values undergird the purpose of sustainability within increasingly complex conditions. When considering axiology, look for the values that are supportive of an eco-just way of living, and contrast them with those that are dominant in the situation.

Epistemology (What Is Knowable and by Whom). When considering epistemology, be conscious of your own mental boundaries. For white evaluators, it is likely that your epistemological boundaries have been heavily shaped by dominant Euro-Western perspectives. For example, it is very easy for such evaluators to slip into reductionism, lose the emphasis on systems thinking, or undervalue the power and significance of the work of Indigenous scholars and the eco-relational systems sciences. Other examples of mental boundaries that must be overcome to raise up the ecology-based system paradigm and Indigenous wisdom and knowledge include:

- **Euro-Western perspective:** As discussed earlier, whole bodies of system sciences —the eco-relational system sciences—have been overlooked in evaluation.
- **expert privilege:** Evaluation commonly privileges academics and disciplinary experts, who historically have been men from Euro-Western cultures, excluding other genders, cultures, and races. Evaluators must learn to embrace lived experience and practice wisdom from diverse sources.
- **social science privilege:** While the sciences of nearly all disciplines have expanded humanity's understanding of what is knowable, evaluation has tended to rely heavily on the social sciences. This tendency has resulted in insufficient attention to the natural sciences. This bias also can easily limit the use of data from the natural sciences, arts, spiritual ways of knowing, and measures of patterns and dynamics.

By recognizing and legitimizing the power of the ecology-based system paradigm and eco-relational system sciences, we broaden the possibilities for what is knowable and by whom and make transformative systems change more possible. Collectively, we can find a deep wellspring of undertapped insight in the rich and deep connection of Indigenous science to the sacredness of all of life; the spiritual perspectives and yin-yang orientation of Eastern philosophies; the orientation toward collaboration and partnership in feminist systems thinking; and the social, cooperative web of life.

Methodology (How One Obtains Knowledge). Methodological questions are the last ones to consider when developing a yin-yang system transformation evaluation design. For decades, the machine-based system paradigm, with its underlying ontology, axiology, and epistemology,

has heavily shaped the methodologies used in evaluation. Methods and methodologies are often taught without acknowledging their underlying assumptions about how the world works, what is valued, and what is knowable by whom. Examples include:

- The underlying assumptions of linearity in commonly used statistics and logic models is often not understood as connected to the fundamentals of a machine-based system.
- Qualitative data are often used to verify or enrich quantitative data, which implies that quantitative data are more scientific (i.e., more valuable) than qualitative data.
- Storytelling is often not recognized as integral to an underlying ecology-based worldview. Stories embody a wholeness that is diminished when considered as simply one more type of qualitative data.

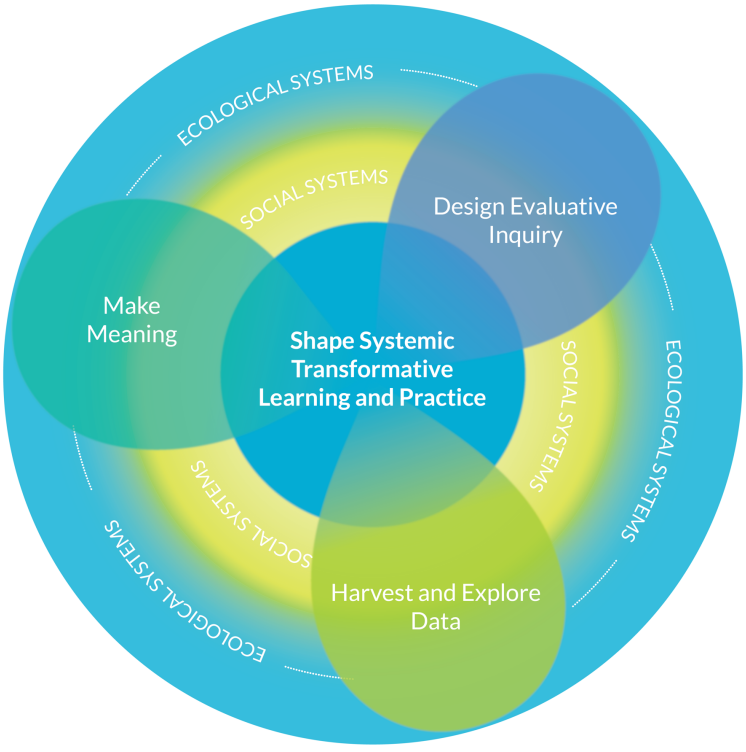
Focus Evaluation Design on Reharmonizing Social-Ecological Systems. We suggest three design considerations:[9]

First, as a practical way to approach this type of evaluation design, we encourage starting with a focus on one machine-based system and one ecology-based system in the situation. The example given above from Hawaii used this approach (although it addressed two machine-based systems—education and social services). Because of the deep interconnections of the situation's systemic wholeness, don't worry that you might miss other important systems (for example, the health system). You'll get to them as your inquiry brings you more deeply and systemically into the situation.

Second, consider the ecological setting in which you are working to be the *primary* context within which you are working. Keep in mind that nature is the source of all of life. Human life is sustained by the rest of nature. Position both the yin portion of the evaluation design and the yang portion of the evaluation design within the ecological setting in which you are working.

Third, assuming considerable transformation is needed in the social-ecological system with which you are working, use a flexible and iterative inquiry-and-action design. Figure 4 illustrates such a design.

Figure 4. Flexible, Iterative Inquiry-and-Action Evaluation Design for Systems Transformation



[9] This is a rudimentary description of the essence of the yin-yang system transformation evaluation design. We encourage other evaluators to build from these ideas and develop their own versions of this basic orientation.

The phases of the evaluation process for this design can be thought of as fractals of the whole. For example, if you are working at the point of designing the evaluation (one phase of the evaluation process), you may find that the design phase contains within it a fractal cycle of inquiry that may go through all four phases of the evaluative inquiry process. Thus, the diagram shows each of the phases (design, harvesting and exploring data, and making meaning) as looping into shaping practice through ongoing learning and, in so doing, being affected by the other phases of an evaluative inquiry process. This type of design encourages generative and creative learning. Learning is the primary purpose, and evaluation is likely to be very embedded within the activities of the system. Multiple and iterative inquiry and action cycles are likely.

Although much more needs to be said about developing a yin-yang systems transformation evaluation design, we hope these ideas provide a starting point for designing evaluation to support the system transformations that are needed to rebalance the social-ecological systems of today's world toward an eco-just civilization.

Concluding Comments

For millennia, many human societies have been organized within hierarchical systems in which leaders exercise control over other human beings and nature itself. There is a growing consciousness of how these social systems are moving at an exponential rate toward exploiting human and natural resources to the detriment of the well-being of the global populace and the planet itself. It is being expressed in growing wealth inequality, the climate crisis, environmental degradation, and the rise of authoritarianism.

Human communities at multiple scales are now, consciously or unconsciously, in the throes of formulating and evolving new governance and management systems that can handle the complexity of today's interconnected world. We urge evaluators to consider the yin-yang balance of the machine-based and ecology-based system paradigms to address the transformation of the governance and management of social-ecological systems.

Might it be that such an orientation could help evaluators play a greater role in evolving the governance and management of social-ecological systems in a manner that moves toward eco-just civilizations where they live and work? Science has shown us that species do not necessarily survive times of major disruption in nature's patterns. The question we are addressing here is not whether the planet will survive, but rather, whether humans individually and collectively can evolve in their consciousness and relation to the rest of nature in such a way that they survive and the rest of nature flourishes. There is no assurance at this time that we will move in this direction and, even if we do, it is very unlikely to be a smooth and easy transition.

We encourage evaluators to reflect on how they can immediately take even small steps to work with the system science theories, system paradigms, and nascent evaluation design presented in this article. We encourage evaluators to further explore and explicate the yin-yang system transformation evaluation design, using it as a jumping-off point for their own designs. We view our work as one portion of a journey toward transformed social-ecological systems. We especially encourage evaluators to facilitate decolonization and Indigenization of social-ecological systems to assist in bringing forth systemic changes in governance and management. Finally, we encourage evaluators to hone their ability to work at the level of a paradigm without seeking the perfect paradigm. Paradigms will keep changing and evolving along with the evolution of the rest of life in our universe.

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