

## **A FRAMEWORK FOR COMPARING SYSTEMS THEORIES**

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### **Abstract**

Collaboration and integration is the theme of President Gary Smith's ISSS annual conference, but communication flounders when members come from different theoretical backgrounds. The Research toward a General System Theory Special Interest Group collected the various theories as a logical first step, but comparing them in terms of their various concepts has proven difficult. An alternative framework describes a theory in terms of its worldview, scope, intent/focus, a summary, its definition of "system," terminology, and the systems processes emphasized and described. Thirteen theoretical frameworks were compiled by either its theorist or proponent or by the author using Perplexity AI and approved by a theorist or proponent. This paper compares the scope and intent/focus of the thirteen theories and categorizes them by discipline and focus/intent. Theories are grouped into the primarily scientific, those starting from a particular systems process or processes and working out; those that combine philosophy, systems science, and practice; those that focus on application; and those that attempt to integrate. Important distinctions emerge, but more comparisons can be made using the data collected. Future work can show the way to better communication and possible integration.

### **Keywords**

Systems science, general system theory, complexity, systems, systems thinking

### **1 | Introduction**

The International Society for the Systems Sciences (ISSS) does not have an agreed-upon definition of systems science or even what a system is. The Research toward a General System Theory (GST) Special Interest Group's (SIG) organizing document states that "General Systems Theories (GSTs) are needed to unify the systems sciences under common frameworks of description, analysis, and explanation, and open new routes to systems-scientific innovation." The GST SIG "provides a venue for developing and discussing ideas, strategies, frameworks, opportunities, and challenges relevant to research towards developing and applying GSTs."

In keeping with those objectives, the GST SIG leaders asked members to submit general systems theories to their database for comparison. Bruce McNaughton and Rob Young logically researched the concepts common to various theories and then made tables listing which concepts were included and not in the various theories.

But putting Len Troncale's Systems Processes Theory or George Mobus' systemness project into conceptual tables was a stretch. Also, even when theories seem to use the same concepts, they have entirely different intents and purposes. Add to that a lack of agreed-upon terminology, and comparing various projects, much less their concepts, is daunting. Too frequently, we suffer from what in 1938, Stuart Chase called the "tyranny of words"—imprecise language and the overuse of abstract words that lead to miscommunication, misunderstanding, and even manipulation. This paper attempts to address that problem.

This paper presents a hypothesis: When comparing systems theories, before comparing concepts, first consider the worldview, scope, and focus or intent of the theory, and then look at its main ideas and terminology. In other words, when considering a systems theory or teaching, it is helpful to first helicopter up out of the details. Who wrote it and why? What is its context? What is the theorist/author trying to accomplish?

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### 2 | Methods

This framework for describing a systems theory or teaching includes (1) who compiled the framework, the theorist(s) and theory’s name, (2) its scope and what kinds of systems it is concerned with, (3) its worldview—from what and whose perspective it arises from, (4) its intent or focus—what the theorist and theory is trying to achieve, (5) a summary of the theory, (6) its definition of “system,” (6) its terminology and (7) “systems processes” it uses.

The thirteen theoretical frameworks are far from inclusive of all systems theories or the GST SIG list of GST candidates. Each framework was compiled by the theorist, directly pulled from a theory’s foundational paper, or compiled using Perplexity AI and then approved by the theorist or a recognized proponent of the theory. They were listed in order of when they were completed. The frameworks can be found on the Maui Institute [website](#).

### 3 | Results

Comparisons of scope and focus/intent showed distinct differences among the theories (Exhibit 1).

**Exhibit 1.** Comparing Theories Using Scope, Focus/Intent, and a Brief Summary

<b>Framework Name</b>	<b>Scope</b>	<b>Focus/Intent</b>	<b>Brief Summary</b>
Mobus' Mathematical Theory for Systemness	All systems; simulating any system	Design software and models for decomposing and simulating any system without losing interaction information	Proposes a universal ontology and mathematical framework (octuple model) for system structure, dynamics, and simulation.
Troncale's Systems Processes Theory (SPT)	Systems since the Big Bang; the sciences	Provide a scientific foundation for systems science via taxonomy of systems processes and their linkages	Identifies 51+ universal systems processes identified in the sciences as foundational, isomorphic mechanisms; aims for a taxonomy and linkage propositions.
Rasmussen's Introduction to SPT	All systems, including human, technological, philosophical systems	Practical introduction to systems processes as tools for understanding and application	Extends SPT to human, technological, philosophical, and indigenous/religious systems focusing on 19 core systems processes; emphasizes teaching and modeling.
McNaughton's GST Conceptual Framework	Knowledge about the universe as a system	Provide a conceptual and mathematical (category theory) foundation for integrating systems knowledge	Uses category theory and systems engineering to support modeling and knowledge sharing across disciplines.
Challoner's Framework for GST	All domains: physical, biological, social	Unify and extend classical systems science via open system thermodynamics and emergence	Presents foundational definitions and propositions about emergence, system lifecycle, and organizing principles.

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Kinneman's Relational Holon Theory	Any system	Provide a new foundation for modeling reality based on cyclical causality and holon structures	Centers on a four-quadrant holon, cyclical causality, and synthesis of Western and Vedic worldviews.
Cabrera's DSRP-483	Universal: mind and nature	Universal, teachable framework for systems thinking; aligns cognition with complex reality	Four universal patterns (Distinctions, Systems, Relationships, Perspectives) shown to organize all information in mind and nature.
Gary Smith's Meta-Framework	Systems knowledge across disciplines	Structure/matrix for classifying and comparing systemic knowledge; promotes integration	Uses fit, form, and function as heuristics; aligns with holonic and relational theory for transversal knowledge organization.
System Dynamics	Modeling complex systems	Analyze system behavior over time using feedback, stocks, flows, and delays	Uses causal loop and stock-and-flow diagrams for simulation and scenario analysis.
Complexity Science	Large, multiscale complex systems	Model and apply emergence, self-organization, adaptivity, network dynamics, and more	Focuses on nonlinearity, feedback, openness, multiscale organization, and agent-based modeling.
Jackson's Critical Systems Thinking	Broad range of systems theories	Integrate and critically evaluate systems methodologies for complex, wicked problems	Advocates pluralism, critique, emancipation, and practical orientation; uses the EPIC process.
Systemology	Inherent nature of all systems	Establish a transdisciplinary science of systems; unify philosophy, science, engineering, and practice	Emphasizes taxonomy and classification of systems, aiming for a unified disciplinary field.
Cybernetics	Broad: engineering, biology, social systems	Understand systems via feedback, control, and communication	Centers on feedback loops, self-regulation; distinguishes first and second-order (observer-involved) cybernetics.

While understanding that these theories overlap in profoundly important ways, the theories can be categorized loosely in terms of their focus (Exhibit 2):

- Scientific Foundations: Mobus, Troncale, Challoner, and Complexity Science focus on scientific modeling and foundational processes.
- Process-Based Approaches: Cybernetics, Complexity Science, and Cabrera's DSRP start from core processes and expand outward.
- Philosophical/Meta-Theoretical: Kinneman, Smith, and Systemology integrate philosophy, heuristics, and meta-frameworks.

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- Application-Oriented: Smith, System Dynamics, and Jackson focus on practical modeling and organizational change.
- Integration: McNaughton provides a framework for integrating and comparing diverse systems theories.

**Exhibit 2.** Comparing Disciplines Emphasized, Focus, and from Rasmussen’s Perspective of Systems Processes Theory

<b>Theory/teaching</b>	<b>Discipline(s) emphasized</b>	<b>Focus</b>	<b>From perspective of SPT/Rasmussen</b>
SPT/Troncale	Science	Systems processes and linkage propositions; developing a taxonomy	A foundational taxonomy will improve communication, integrate theories, and describe how systems work generally. Yet to be developed.
Mobus’ systemness	Science	Modeling/simulation of a minimal system	What is the minimal # of SPs and how can we know what “minimal” means/what is enough? The work is in progress and feeds into the SPT taxonomy.
Challoner Framework	Science	Description of how systems work based on established systems theories/science	Requires the SP taxonomy so that terms can be consistently defined/modeled and compared
Complexity science	Science	Focus on complex systems; starts with self-organization and emergence, and out to network theory, evolutionary theory, and more.	Limited to “complex” systems. Ontogenesis, how increasingly complex systems have emerged through time, is key to understanding systems.
Cybernetics (first order)	Science	Starts with feedback loops. First identified in mathematics and engineering, then in biological and social systems. Now seen as ubiquitous.	Important contribution to a particular group of SPs. Start with any SP and it will appear central and essential to the whole.
Cybernetics (second order)	Philosophy/ science	Determining a system and its boundaries depends upon the observer.	Science as grounded in the observation of Nature’s regularities and the modeling of those regularities. Yes, we all live in separate personal and cultural realities. Needed are “realities” more compatible with Nature’s processes.
Systemology	Philosophy → Science	Systemology=systems philosophy + systems science + s + systems engineering + systems practice Science = GST* + general systemology + specialized systems sciences + hybrid systems sciences	Philosophy is about reason and thought. Science is observation of regularities that can be modeled, and then as more is observed, it evolves. Systems science transcends what has been before the purview of philosophy. Philosophy can inform and be informed by systems science.

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Kinneman	Vedic worldview + Science	Causality in cyclic relationship in the cosmic order	Kinneman’s quadrant is made up of foundational SPs and their relationships. Calls for a shift from hierarchical to a cyclical worldview.
Cabrerias	Cognition	Systems thinking principles	DSRP starts with foundational SPs.
McNaughton	Integration	Integration of candidate GSTs by comparing concepts	Comparing concepts until you’ve first compared scope/focus/intent. Also “concepts” are unrelated lists of SPs, descriptions, functions, features, etc.
Jackson	Application in organizations	Pulls from decades of systems practice to choose the right application for a particular instance	A reasonable approach to applying has been developed in the systems thinking/systems operations world.
Smith	Integration + application	Matrix integrates Kinneman’s relational theory SPT, and Bill Smith’s xxx	Smith considers Kinneman foundational, then interprets it with SPs, and continues to add SPs to the matrix.
System Dynamics	Application	Sees systems as feedback loops, stocks and flows and time delays; used for decision-making and	Offers modeling and application of a small set of SPs. Start with any SP and it will appear central and essential to the whole.

### 3.1 | Scientific Foundations

As a biologist with over four decades as a systems scientist, **Troncale** claims that “systems processes” are universal patterns of interactivity, that all systems are made up of networks of interacting systems processes, and that systems processes form the future taxonomy of the science. They have different names in different theories and disciplines. Identifying, categorizing, and modeling them is the primary work of the science. In the last century, although he saw that they were ubiquitous, Troncale looked for systems processes in the various sciences.

**Rasmussen**, writing well into this century, with computing well established, focuses on nineteen systems processes; provides examples in technological, social, philosophical, indigenous, and religious systems; and includes examples of modeling of each systems process.

With a background in biology and engineering technologies, **Mobus**, along with Thornton, is modeling “systemness,” the minimal requirements for simulating systems. In his first two books, Mobus, although he doesn’t call them “systems processes,” describes dozens of “attributes,” “concepts,” and “processes” and how they interact, all toward the purpose of developing the simulation of systemness.

As a systems engineer with a broad cultural background, **Challoner** offers a GST that describes how systems work using what Troncale calls “systems processes.”

Championed by the Santa Fe Institute and the New England Complex Systems Institute, and a number of university departments, **complexity science** focuses on complex, evolving systems and multi-disciplinary applications to real world problems. They develop, model, and apply now established systems “concepts,” what SPT calls systems processes. In contrast to complex systems science, Mobus, Troncale, and Challoner describe the increasing complexity of systems from the beginning of the universe.

### 3.2 | Process-Based Approaches

The process-based approaches start from a particular set of systems processes and then develop out. The founders of **complexity science** started with self-organization and emergence and **cybernetics** was founded

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on feedback processes. Although **Cabreras'** DSRP is a systems thinking framework, three of its four universal rules describe systems processes. Founded by engineer Jay Forester who moved to MIT's Sloan School of Management to apply his theory, **system dynamics** defines systems and practice in terms of feedback processes.

### 3.3 | Combining Philosophy, Science, and/or Engineering Heuristics,

As a physical scientist, theoretical ecologist, and frequent visitor to India, **Kinneman** connects Vedic teachings with Rosen's relational theory in a quadrant model. From the perspective of Systems Processes Theory, his foundational quadrant includes systems processes-boundary conditions, cycles, feedback, entrainment, hierarchy (or holarchy), anticipatory processes, and more.

As a systems engineer with a strong systems science background, **Smith** combines heuristics of fit, form, and function and philosophy's epistemology, ontology, and axiology with Kinneman's quadrant (in the form of observation, reflection, planning and action), for a framework for organizing systems processes. The result is a matrix that outlines a series of questions for analyzing and improving any complex system.

### 3.3 | Theories for Application

As a professor emeritus of management systems and former business school dean, **Jackson** pulls from decades of methodologies grounded in systemic reasoning.

**Smith's** meta-framework is designed for practical application. **Complexity science** applies models to tackle complex problems. **System dynamics** has been adding value to organizations for decades.

### 3.4 | Integrating Theories

Systems engineer and former leader of the GST SIG, **McNaughton** calls for the development of a GST based on a systems engineering architectural approach to organizing concepts and category theory to structure a core mathematical foundation for modeling any system of interest.

Outlined by four systems theorists with broad and diverse backgrounds, **systemology** puts systems philosophy, systems science, systems engineering, and systems practice on the same plane, and then defines systems science as a combination of a GST\* (a general system theory for the science), systems processes theory, the various systems theories, and sciences.

## 4 | Discussion

The various theories have the power to compliment each other. Communication toward integration requires an understanding of their interrelationships.

Troncale emphasizes the need for a taxonomy of systems processes and their linkage propositions to ground the science. A taxonomy requires not just identifying but also ordering the systems processes from the simplest to the more complex and how they interact. Challoner pulls legitimate terms from various sciences and theorists but his theory is difficult to fully understand and accept without unifying terminology and a taxonomy.

The work building a foundation falls to the wayside when after exposure to a particular group of systems processes, people are inspired by the sheer usefulness, expansiveness, and beauty of the systemic worldview. Cybernetics began with feedback and complexity science with self-organization and emergence. Kinneman's quadrant and Cabreras' DSRP begin with four principles and expand out.

Complexity science applies familiar systems processes in a multidisciplinary way toward our biggest challenges. But with a working taxonomy and models of minimum systems, a more complete and integrated science will emerge.

Kinneman demonstrates how for centuries, Eastern philosophies have described systems processes and how systems work, but only recently have we had the capacity to scientifically model them and test the models in the various disciplines.

Smith's matrix provides the questions needed to approach any systems engineering project systemically.

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Jackson, concerned a pragmatic application of critical systems thinking to organizations and change efforts, looks to existing human systems theories that feed into his efforts. With models of how systems work, we could map out which methodologies would better work in different contexts.

McNaughton and systemology are more “meta” regarding systems theories. McNaughton describes how to structure the effort toward reaching a consensus on a general systems theory by focusing on conceptual analysis of the various theories and eventually, category theory. This framework compares other aspects of theories and then considers concepts in terms of terminology used and systems processes applied by a theory. Category theory offers a future mathematical framework for systems science in terms of systems processes, their linkages, and how systems work as wholes.

As a GST, systemology starts with systems philosophy, systems science, systems engineering, and systems practice. In a scientifically grounded GST, philosophy and applications are informed by and contribute to the science. In the case of systems science, as a science that is not fully developed and a science that represents a worldview, revealing and comparing worldviews and what is learned in engineering and practice is important work.

### 5 | Conclusions

This framework compares theories in terms of their scope and focus/intent, and then summarizes the theory and lists terminology and systems processes. This paper offers a few comparisons. More comparisons can be made with the data collected. More theories can be included. Graphs of the relationships among the theories can be constructed.

Taking a more systemic view of systems theories pays off. More similarities than difference emerge. With more work, there is strong evidence that a long-awaited GST will emerge.

### 6 | Acknowledgements

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