

# Philosophical Foundations of General Systems Theory

John A Challoner, March, 2026

## Abstract

General Systems Theory seeks principles capable of explaining organisation and behaviour across physical, biological, and social domains. Despite significant methodological progress in systems science, many frameworks lack explicit philosophical foundations. This paper outlines the philosophical basis of the author's Extended Framework for General Systems Theory (EFGST). It argues that two philosophical positions, Cognitive Physicalism and Critical Realism, are jointly compatible and together provide a coherent ontological and epistemological grounding for systems science. Cognitive Physicalism asserts that everything that exists is physical and located in space-time while recognising that cognitive limitations necessitate simplified models of reality. Critical Realism asserts that reality exists independently of our knowledge of it while acknowledging that knowledge is mediated by social and conceptual structures. Integrating these perspectives yields a realist yet epistemically modest framework within which systems can be analysed as structured physical entities interacting through causal processes. The paper also introduces a translation of Critical Realist terminology into a systems idiom emphasising structure, process, and causal interaction. These philosophical foundations support the subsequent development of a unified systems framework spanning physical, biological, and social domains.

## 1 Introduction

Systems science seeks principles that apply across diverse domains, from physical systems and biological organisms to organisations and societies. Since the early work of Ludwig von Bertalanffy and the subsequent development of cybernetics, complexity science, and Systems Theory, researchers have repeatedly observed that similar organisational patterns appear across many different kinds of systems (Bertalanffy, 1968; Troncale, 1985; Mobus & Kalton, 2015).

Despite this progress, systems theory has often developed as a set of analytical tools rather than as a fully articulated philosophical framework (Mobus & Kalton, 2015). Many systems approaches assume a particular ontology or epistemology implicitly rather than stating these assumptions explicitly.

The Extended Framework for General Systems Theory (EFGST) addresses this issue by identifying the philosophical foundations required for a coherent systems ontology. Two philosophical positions are particularly relevant: Cognitive Physicalism and Critical Realism.

Cognitive Physicalism asserts that everything that exists is physical and located in space–time, while recognising that human cognition employs simplified representations of reality (GST D1.1). Critical Realism asserts that reality exists independently of human knowledge but that knowledge of it is mediated by conceptual and social structures (GST D1.2). Together these positions provide a philosophical foundation that is both realist and epistemically cautious.

## 2 Cognitive Physicalism

Cognitive Physicalism holds that all entities, processes, and interactions, whether they comprise matter, energy, information, or combinations of those things, exist within the physical universe and, therefore, occupy regions of space–time (GST D1.1). Mental phenomena such as perception, reasoning, and modelling are not exceptions to this principle; they are themselves physical processes occurring within cognitive systems.

However, recognising the physical basis of cognition also implies recognising its limitations. Human sensory systems detect only a narrow range of the signals present in the environment, and cognitive systems must simplify and abstract from these signals in order to construct workable representations of reality.

Scientific theories, for example, function as models that approximate real structures and processes rather than as complete descriptions of reality. The purpose of theory is not to reproduce the full complexity of the world but to capture the patterns that matter for explanation and prediction.

It is reasonable to suppose that representations of reality which are sufficiently accurate enhance organism viability by enabling effective engagement with opportunities and threats, whereas less accurate representations tend to diminish such viability. Over time, this creates a selection pressure favouring the emergence and retention of functionally adequate representations.

## 3 Critical Realism

Critical Realism provides a complementary perspective by emphasising the independence of reality from human knowledge (Bhaskar, 1975, 1979). According to this view, the world contains structures and causal mechanisms that exist regardless of whether they are observed or understood (GST D1.2).

Critical Realism distinguishes between three domains of reality:

- the **real**, comprising structures and mechanisms with causal powers;
- the **actual**, comprising events that occur when those mechanisms operate; and
- the **empirical**, comprising events as they are experienced or observed (Bhaskar, 1975).

This distinction is important for systems science because many systemic structures and processes are not directly observable. Organisational structures, ecological relationships, or economic dynamics may exist and exert causal influence even when they are not immediately visible in empirical observations.

#### **4 Compatibility of the Two Philosophies**

Cognitive Physicalism and Critical Realism are compatible and mutually reinforcing philosophical positions (GST P1.1). The former emphasises the physical nature of reality and the cognitive limits of perception, while the latter emphasises the independence of reality from observation and the mediated nature of knowledge.

Taken together, they support several key principles for systems theory.

First, they affirm that systems theory describes real structures and processes that exist in the physical world. Systems are not merely analytical constructs but organised physical entities interacting through causal relationships (Bunge, 1977, 1979).

Second, they recognise that human knowledge of these systems is inevitably partial and model-based. Scientific explanations therefore operate through abstraction and approximation rather than direct replication of reality.

Third, they highlight the importance of distinguishing between observed events and the underlying structures that generate them. Systems analysis frequently seeks to identify these underlying structures and mechanisms.

In this sense, the two philosophical perspectives are epistemologically complementary (GST P1.2).

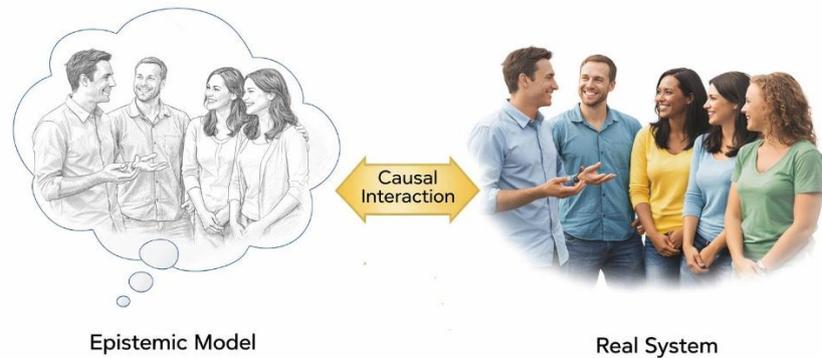
#### **5 Epistemology, Ontology, and Reflexivity**

Understanding the relationship between knowledge and reality requires distinguishing between epistemology and ontology. Epistemology concerns the nature and justification of knowledge (GST D1.3), whereas ontology concerns the nature of existence itself (GST D1.4).

Within the EFGST framework, epistemic processes are themselves part of the physical world. Thought, perception, and modelling are physical processes occurring within physical cognitive systems. Consequently, the epistemic domain is a proper subset of the ontological domain (GST P1.3).

When accurate, epistemic processes function as internal models of external structures. Knowledge can therefore be understood as a form of physical modelling in which the informational organisation of one system corresponds to the causal organisation of another (Bunge, 1977).

This perspective also implies a form of epistemic reflexivity. Theories and models are themselves systems operating within the reality they describe (GST D1.5). Systems theory must therefore recognise that observers and analysts are components of the broader systems they study.



**Figure 1** – *Epistemic models and real systems interact causally.*

## 6 The Probabilistic Nature of the Future

Another implication of this philosophical framework concerns the nature of systemic change. Within this framework, systems are understood as ensembles of interacting processes operating within constraint-defined landscapes. At any given moment, a system occupies a position within such a landscape, from which multiple future trajectories are accessible.

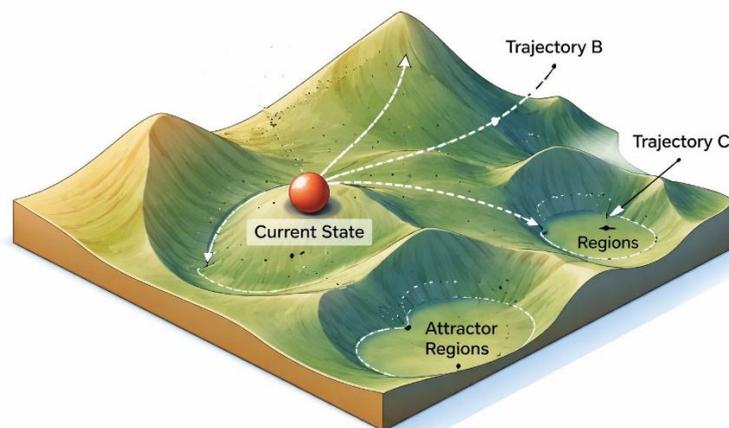
This follows directly from the combined commitments of Cognitive Physicalism and Critical Realism: systems are real physical processes, but their interactions are too complex and context-dependent to be fully specified in advance.

The particular trajectory realised depends on ongoing interactions among system components and between the system and its environment. These interactions are contingent, path-dependent, and often non-linear, such that small variations in conditions may lead to divergent outcomes. As a result, the detailed future state of the system cannot be predetermined.

In human systems, the presence of agency further expands the range of possible trajectories. Agents can interpret, anticipate, and act upon perceived possibilities, thereby reshaping both their own pathways and, in some cases, the local structure of the landscape itself.

The future is therefore probabilistic rather than predetermined (GST P1.4). System behaviour is best understood as the unfolding of trajectories within a structured space of possibilities, governed by constraints and realised through interaction, rather than as the execution of a fixed deterministic script.

For example, in a physical system, a ball resting on a contoured surface has multiple possible paths available to it. The shape of the surface constrains these possibilities, but small differences in initial conditions or disturbances determine which path is actually taken. The future trajectory is therefore constrained but not fixed in detail.



**Figure 2** – A ball on a contoured surface.

In a social system, similar principles apply. A government policy introduced into an economy creates a space of possible responses among individuals, firms, and institutions. These responses depend on interpretation, incentives, and local conditions, and may reinforce or counteract one another. As a result, the eventual outcome emerges from interaction and cannot be predicted with certainty in advance.

In this sense, the future is not arbitrary, but structured by constraints and realised through interaction.

## 7 Translating Critical Realism into a Systems Idiom

While Critical Realism provides a powerful philosophical framework, its terminology was not originally designed for systems analysis (Bhaskar, 1975). Concepts such as generative mechanisms are often expressed in dispositional terms rather than in terms of concrete processes.

EFGST therefore translates key elements of the Critical Realist ontology into a systems idiom emphasising structure, process, and interaction (Troncale, 2006). In this idiom:

- “enduring entities” correspond to structured configurations of components,

- “generative mechanisms” correspond to conditionally executable processes,
- “events” correspond to causal interactions involving transfers of matter, energy, or information.

This translation enables systems theory to move from abstract philosophical description to operational analysis of real-world systems.

## **8 Implications for Systems Theory**

The philosophical foundations outlined above provide a coherent basis for the development of General Systems Theory. They establish that systems are real physical entities composed of interacting components and processes. They recognise that knowledge of these systems is inevitably partial and mediated by cognitive and social frameworks. They also highlight the importance of analysing both observable events and the underlying structures that generate them.

These principles support a systems framework capable of analysing organisation and change across multiple domains of reality (Bertalanffy, 1968; Mobus & Kalton, 2015).

## **9 Conclusion**

This paper has outlined the philosophical foundations of the Extended Framework for General Systems Theory. By integrating Cognitive Physicalism with Critical Realism, the framework adopts a realist ontology while acknowledging the epistemic limitations of human cognition.

This philosophical foundation provides a basis for analysing systems as structured physical entities interacting through caus

al processes. It also supports the development of a unified systems framework capable of addressing phenomena across physical, biological, and social domains.

Subsequent papers in this series build upon these foundations by introducing the ontology of systems, the nature of systemic organisation, and the causal dynamics through which systems interact and evolve.

## References

- Bhaskar, R. (1975). *A Realist Theory of Science*. Leeds: Leeds Books.
- Bhaskar, R. (1979). *The Possibility of Naturalism: A Philosophical Critique of the Contemporary Human Sciences*. Brighton: Harvester Press.
- Bertalanffy, L. von. (1968). *General System Theory: Foundations, Development, Applications*. New York: George Braziller.
- Bunge, M. (1977). *Treatise on Basic Philosophy, Vol. 3: Ontology I – The Furniture of the World*. Dordrecht: D. Reidel.
- Bunge, M. (1979). *Treatise on Basic Philosophy, Vol. 4: Ontology II – A World of Systems*. Dordrecht: D. Reidel.
- Mobus, G. E., & Kalton, M. C. (2015). *Principles of Systems Science*. New York: Springer.
- Troncale, L. R. (1985). On the possibility of a general systems theory. *Systems Research*, 2(2), 87–97.
- Troncale, L. R. (2006). Towards a science of systems processes: Mapping universal properties of systems and processes. *International Journal of General Systems*, 35(5), 559–571.

## Appendix A – Definitions

### D1.1 – Cognitive Physicalism

A philosophical position that assumes:

1. everything that exists is physical and located in space–time, and
2. human perception and cognition are limited, requiring simplified representations or models of reality.

Cognitive Physicalism therefore recognises that knowledge of reality is necessarily mediated through cognitive processes that operate within physical systems.

### D1.2 – Critical Realism

A philosophical approach which holds that:

1. reality exists independently of human thought or perception (realism), and
2. knowledge of that reality is always mediated by social, cultural, and conceptual frameworks (critical).

Critical Realism distinguishes between three domains:

- **the real** – structures and causal mechanisms that exist independently of observation
- **the actual** – events that occur when those mechanisms operate
- **the empirical** – events as experienced or observed.

### **D1.3 – Epistemology**

The branch of philosophy concerned with knowledge: its nature, sources, limitations, justification, and validity. Epistemology therefore addresses the conditions under which informational states become beliefs or knowledge.

### **D1.4 – Ontology**

The branch of philosophy concerned with the nature of existence and the kinds of things that exist. Ontology addresses what exists in reality, independent of whether those entities are known or observed.

### **D1.5 – Epistemic Reflexivity**

The property of a theoretical or cognitive system by which it recognises itself as part of the reality it describes. In systems theory, epistemic reflexivity denotes the understanding that knowing, modelling, and theory formation are themselves physical and systemic processes operating within the world they seek to explain.

## **Appendix B – Propositions**

### **P1.1 – Compatibility Proposition**

Cognitive Physicalism and Critical Realism are compatible philosophical positions. Cognitive Physicalism asserts that everything is physical and exists in space–time, while Critical Realism asserts that reality exists independently of our knowledge of it. Together they establish a realist ontology grounded in the physical nature of reality.

### **P1.2 – Epistemic Complementarity Proposition**

Cognitive Physicalism and Critical Realism are epistemologically complementary. Cognitive Physicalism highlights the cognitive limitations of perception and modelling, while Critical Realism emphasises the social and conceptual mediation of knowledge. Together they provide a framework that recognises both the physical basis of knowledge and its interpretive limitations.

### **P1.3 – Ontological Subset Proposition (GST)**

The epistemic domain is a proper subset of the ontological domain. Knowledge, thought, and perception are themselves physical processes occurring in space–time.

When accurate, these processes function as internal models of other physical processes, encoding within their informational organisation aspects of the causal structure of the external world.

#### **P1.4 – Probabilistic Future Proposition (GST)**

The future is probabilistic rather than predetermined. System trajectories unfold within constraint-defined possibility spaces through branching pathways shaped by contingent interactions among systems and their environments. In systems possessing agency, reflexive decision-making further expands and reshapes these possibility spaces.