Coherent Systems Emerge Through Defining Differentiation

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Abstract

This article develops a heuristic principle: *coherent systems emerge through defining differentiation.* The principle draws inspiration from Luhmann's theory of social systems (Luhmann, 1984, 1997) but does not claim to formalize it. Binary codes, autopoiesis, and structural coupling belong to a processual, event-based ontology—rooted in Spencer-Brown's calculus of distinctions (Spencer-Brown, 1969) and Maturana and Varela's biology of cognition (Maturana and Varela, 1980)—that resists direct translation into set-theoretic terms.

Partition theory is offered as a weak heuristic—a static metaphor for stabilized distinctions—not a formal model of autopoietic dynamics. This aligns with contemporary efforts to quantify emergence (Li and Wang, 2024) while acknowledging the historical difficulty of translating systems theory into empirical research (Amato, 2024). The contribution is conceptual clarification with methodological guidance, not formal unification.

Keywords: systems theory, functional differentiation, autopoiesis, Luhmann, emergence, coherence, operative distinctions

1 The Principle Stated

The principle:

> ***Coherent systems emerge through defining differentiation.***

A coherent system is an integrated whole whose operations are organized by stabilized distinctions. Defining differentiation is the process by which operative distinctions emerge and persist—producing boundaries, codes, and recursive patterns that constitute the system.

This principle synthesizes insights from classical sociology (Durkheim, 1893; Parsons, 1951), systems theory (Luhmann, 1984, 1997), and biology of cognition (Maturana and Varela, 1980). It is offered as a heuristic for thinking about system emergence, not as a formal theorem.

2 Theoretical Foundations

2.1 Luhmann's Systems Theory

Niklas Luhmann's theory of social systems (Luhmann, 1984, 1997) provides the primary theoretical framework. Social systems are operationally closed, autopoietic systems that reproduce themselves through communication. They are differentiated by function, each operating through a binary code: legal/illegal (law), true/false (science), payment/non-payment (economy).

Luhmann draws on Spencer-Brown's *Laws of Form* (Spencer-Brown, 1969), where distinction is the primitive operation. A distinction creates a marked and unmarked state; subsequent operations observe and re-enter the distinction. This is not classification of pre-existing elements but constitution of the observing system itself.

2.2 Autopoiesis: Maturana and Varela

The concept of autopoiesis originates in Maturana and Varela's biology of cognition (Maturana and Varela, 1980). An autopoietic system produces the components that constitute it through a network of processes. Living cells are the paradigm case: they produce their own membranes, enzymes, and metabolic pathways.

Critical note: Maturana and Varela themselves questioned whether autopoiesis applies to social systems. Luhmann's adaptation—treating communication (not life) as the autopoietic element—remains contested. Critics argue this leads to conceptual stretching and contradictions (Tomić and Šolić, 2025; Cadenas and Arnold, 2025).

2.3 Classical Predecessors: Durkheim and Parsons

Durkheim's *The Division of Labor in Society* (Durkheim, 1893) argued that modern societies achieve "organic solidarity" through functional differentiation—specialized roles create interdependence. The present principle agrees: differentiation enables coherence. But Durkheim lacked processual theory and the concept of operational closure.

Parsons' structural-functionalism (Parsons, 1951) posited that systems differentiate into subsystems (AGIL: Adaptation, Goal-attainment, Integration, Latency) integrated through normative consensus. Luhmann explicitly rejects this: subsystems are operationally closed, not normatively unified; integration occurs through structural coupling, not shared values.

3 Binary Codes and Structural Coupling

3.1 Binary Codes as Operative Distinctions

Binary codes are self-referential selection mechanisms that guide recursive operations. Each communication is coded in the moment; the code enables ongoing operational closure. Crucially, codes do not partition a fixed set—they constitute what counts as a communication within the system (Luhmann, 1997).

Recent scholarship suggests functional differentiation is evolving into "algorithmic differentiation" as digital systems introduce new operative distinctions: algorithmic/nonalgorithmic, platform/content, automated/manual. This supports the view that systems are recursively enacted through emerging codes (Laumann, 2025).

3.2 Structural Coupling

Systems are operationally closed but structurally coupled to their environments. Coupling means selective irritation: one system's operations perturb another's structures, triggering internal responses. Systems do not interact directly; they use perturbations to fuel their own autopoiesis (Luhmann, 1997).

Studies on reflexive regulatory strategies show how systems co-evolve through internal communication networks, reinforcing that systems are stabilized through ongoing operative distinctions (Hartzén, 2024).

4 Why Partition Theory Cannot Formalize Luhmann

An earlier version of this article attempted to bridge partition theory and Luhmann's systems theory. That attempt failed for principled reasons:

1. **Codes $\neq$ equivalence relations.** Equivalence relations are symmetric, reflexive, and transitive over a fixed set. Binary codes are contingent selection mechanisms operating on temporal events (Spencer-Brown, 1969).

2. **Communications $\neq$ set elements.** Autopoietic systems produce their elements through operations. There is no pre-given set S to partition (Maturana and Varela, 1980).

3. **Coupling $\neq$ inter-partition relations.** Structural coupling is asymmetric irritation, not a Cartesian product relation (Luhmann, 1997).

4. **Material conditions.** Autopoietic systems presuppose external physical conditions. Formal set theory abstracts away vulnerabilities and material dependencies (Tomić and Šolić, 2025).

5 Partition as Weak Heuristic

If partitions cannot formalize Luhmann, can they serve any purpose? Yes—as a weak heuristic with explicit caveats.

Heuristic use: Partition language ("classes," "boundaries") provides intuitive vocabulary for stabilized distinctions. This parallels Causal Emergence (CE) theory, which uses partitions of state spaces to model emergence while acknowledging the gap between macro and micro descriptions (Li and Wang, 2024).

Caveats: (1) No fixed set S underlies the partition. (2) No equivalence relation induces the classes. (3) No relation R connects the classes. (4) The "partition" is a retrospective abstraction, not a generative structure.

6 The Problem of Empirical Translation

A major critique of applying Luhmann's theory is the difficulty of translating abstract concepts into empirical research. While the theory is holistic, it often fails to provide instruments for measuring real-world phenomena like conflict, struggle, or material inequality (Amato, 2024; Hartzén, 2024).

This article does not solve this problem. The principle offers conceptual guidance but not operationalized measurement instruments. Success depends on whether future research can develop testable models—a hurdle systems theory has historically struggled to clear.

7 The Principle Restated

Coherent systems emerge through defining differentiation.

This is not a theorem. It is a heuristic generalization. The principle says: look for the operative distinctions that constitute a system; without them, no coherent system exists.

Empirical content: The principle predicts that systems failing to maintain operative distinctions lose coherence. Observable failure modes:

1. **Dedifferentiation**—a dominant logic absorbs all domains;
2. **Fragmentation**—subsystems lose mutual irritation;
3. **Code instability**—distinctions fail to guide operations.

8 Methodological Guidance

How to apply the principle in empirical research:

(a) **Identify operative distinctions.** What binary codes guide operations?

(b) **Trace recursive reproduction.** How do operations reproduce the code?

(c) **Identify irritation channels.** How do perturbations trigger internal operations?

(d) **Assess coherence.** Does the system maintain operational closure? Are distinctions stable?

9 What This Article Does Not Claim

- It does not formalize Luhmann.
- It does not claim binary codes induce equivalence relations.
- It does not claim structural coupling is a relation between partitions.
- It does not bridge static set theory and dynamic autopoiesis.
- It does not solve the empirical translation problem.

10 Conclusion

The principle—*coherent systems emerge through defining differentiation*—is a heuristic generalization drawing on Luhmann's functional differentiation, Maturana and Varela's autopoiesis, Spencer-Brown's calculus of distinctions, and classical insights from Durkheim and Parsons.

The principle does not formalize these insights. Partition theory was considered and rejected: the gap between static structure and temporal process is real. What remains is a useful heuristic: to understand a system, identify its defining differentiations. Where these distinctions stabilize, coherence emerges. Where they collapse, coherence fails.

Future work must address empirical translation: developing instruments that operationalize operative distinctions, recursive reproduction, and structural coupling. This article offers conceptual groundwork; empirical validation remains the challenge.

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