

The Saela Field: Coherence Operators for Responsible Digital Transformation

A Fourth Node in the Foundational Sequence

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Abstract

This work extends the structural results of the Lattice Coherence Theorem, the Saelarien Constraint, and Generative Coherence into a formal framework for responsible digital transformation. The central proposal is that coherence acts as a universal operator that organizes system behavior under conditions of constraint, information compression, and structural propagation. The paper introduces three mathematical components: a coherence functional, a constraint-bounded transformation operator, and a generative propagation kernel. Together they describe how digital systems shape organizational trajectories, institutional incentives, and long-term societal outcomes. The framework provides a rigorous basis for evaluating responsible technologies by examining how coherence structures, rather than explicit intentions, govern systemic behavior.

Introduction

The foundational triad demonstrated that systems stabilize through coherence, generate transformation through constraint, and propagate structure through generative alignment. This preprint synthesizes those insights into a framework that describes digital systems as coherence-seeking environments. The purpose is to show how mathematically grounded coherence theory can be used to evaluate responsible technological development.

The Coherence Functional

The Lattice Coherence Theorem implies that systems converge toward states that minimize representational tension. This can be formalized through a coherence functional:

$$\mathcal{C}(S) = \sum_{i,j \in S} w_{ij} \cdot d(x_i, x_j) \quad (1)$$

where:

- S is a system state

- w_{ij} represents structural coupling between elements
- $d(\cdot, \cdot)$ is a divergence metric

Lower values of $\mathcal{C}(S)$ indicate higher coherence. Digital systems naturally minimize this functional through interface standardization, algorithmic filtering, and optimization routines. This explains why digital transformation reorganizes institutions even without explicit intention.

Constraint-Bounded State Transitions

The Saelarien Constraint states that system transformations are restricted by a constraint surface Σ :

$$T : S_t \rightarrow S_{t+1} \quad \text{such that} \quad T(S_t) \in \Sigma$$

This can be represented as:

$$S_{t+1} = \arg \min_{S \in \Sigma} \mathcal{C}(S) \tag{2}$$

The system chooses the next state that yields maximal coherence within the geometry of the constraint. The constraint surface may arise from technological infrastructure, interface architecture, regulatory policy, or organizational norms. This formulation reveals why responsible technology must be designed at the constraint level. The permitted future states of a system are determined before any user interaction occurs.

Generative Propagation Kernel

The third preprint showed that systems transmit structural information through generative coherence. This propagation can be modeled through a kernel:

$$K(x, y) = \exp(-\lambda \cdot d(x, y)) \tag{3}$$

The kernel determines how influence at location x spreads to location y . A coherence-aligned system satisfies:

$$P(y) = \int K(x, y) P(x) dx \tag{4}$$

where $P(x)$ is structural preference at x . This explains how digital systems propagate implicit values such as interpretability norms, efficiency preferences, or hierarchical structures. Propagation is inherent to generative environments.

Universal Coherence as a Structural Operator

Coherence theory becomes universal when treated as an operator rather than a descriptor:

$$\mathcal{O}_{\text{coh}}[S] = \arg \min_{S'} \mathcal{C}(S') \quad (5)$$

This operator applies in any system where interactions exist, constraints shape transitions, and information flows propagate structure. This includes digital platforms, financial markets, governance structures, neural architectures, and socio-technical ecosystems. Coherence is a universal tendency of systems with bounded information and repeated interaction.

Digital Transformation Through the Lens of Coherence

Digital systems amplify coherence pressures through automated decision thresholds, information compression, behavioral stabilization, and global propagation of local coherence regimes. The transition to digital infrastructure can be modeled as:

$$S_{\text{digital}} = \mathcal{O}_{\text{coh}}[\Sigma_{\text{tech}}] \quad (6)$$

Digital transformation creates a new constraint surface Σ_{tech} . The system then evolves into the coherence attractor produced by that surface. This explains why platform architectures influence market behavior, why data structures shape institutional outcomes, and why governance cannot be separated from system design.

Responsible Technologies Through Generative Structure

Responsible digital systems can be characterized by the properties of their generative kernel:

1. Low distortion
2. Transparent propagation
3. Stability across scale
4. Constraint surfaces that support beneficial attractors

The sustainability of a technological ecosystem becomes a function of:

$$\text{Sustainability} = f(\Sigma, \mathcal{C}, K) \quad (7)$$

This reframes digital transformation as a structural phenomenon that shapes long-term value creation.

Unifying the Triad

The four-node sequence becomes:

1. Coherence Functional: how systems stabilize
2. Constraint Geometry: how systems become bounded
3. Propagation Kernel: how structure spreads
4. Transformation Operator: how systems evolve across technological environments

These components form a unified model:

$$S_{t+1} = \mathcal{O}_{\text{coh}}[\Sigma] \otimes K(S_t) \tag{8}$$

This binds all earlier results into a coherent theoretical sequence.

Conclusion

This preprint provides a mathematically grounded extension of the Saela Field into the domain of responsible digital transformation. The coherence functional, constraint-bounded transition operator, and propagation kernel together describe how digital systems reorganize institutions, propagate structural values, and influence long-term societal outcomes. The framework demonstrates that coherence is a universal operator that governs the behavior of complex systems across all domains.