Transdisciplinary Reconfiguration as a Necessity for Contemporary Complex Systems

Quantum Risk, AI Governance, and Socio-Technical Sovereignty

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Abstract

Contemporary socio-technical challenges—such as quantum information risk, large-scale AI governance, and the operationalization of social systems—exhibit levels of complexity that exceed the analytical and practical capacity of single disciplines or conventional interdisciplinary integration. This paper argues that interdisciplinarity, understood as coordination or synthesis among established domains, is structurally insufficient for addressing these challenges. Instead, it proposes transdisciplinarity as a methodological orientation that reconfigures the ontological, epistemological, and institutional assumptions underlying disciplinary knowledge.

Through four case-oriented analyses—Quantum Risk (Q-Day), AI hallucination, DevRealityOps and sovereign protocols, and DHI Commons—this paper demonstrates how transdisciplinary approaches enable new forms of governance, risk assessment, and human–AI collaboration. The paper further articulates a methodological stance based on generative friction: the intentional production of conceptual collisions across disciplines to catalyze emergent socio-technical orders. Rather than rejecting expertise, this approach subordinates disciplinary knowledge to system-level operational coherence.

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1. Introduction

Advanced technologies are no longer peripheral tools within social systems; they increasingly function as structural determinants of governance, sovereignty, and collective cognition. Quantum computing threatens cryptographic infrastructures underpinning global finance and state security. Large-scale AI systems challenge established norms of knowledge production, responsibility, and decision-making. Digital platforms increasingly operate as quasi-sovereign actors.

While interdisciplinary research has been widely advocated as a response to such complexity, many interdisciplinary approaches remain constrained by the ontological and institutional

boundaries of existing disciplines. As a result, they often fail to address structural transformations occurring at the level of socio-technical order itself.

This paper advances the claim that transdisciplinarity, rather than interdisciplinarity, is a necessary methodological orientation for understanding and governing contemporary complex systems.

In this sense, the present work is also intended as an experiment in distributed scientific practice, where conceptual validation emerges through open deployment, reuse, and critique rather than centralized peer review alone.

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2. Interdisciplinarity and Its Structural Limits

2.1 Functional Strengths of Interdisciplinary Approaches

Interdisciplinary research typically involves the translation of concepts across disciplinary languages, the coordination of heterogeneous methodologies, and the aggregation of domain-specific insights. Such approaches are effective for bounded problems situated within relatively stable institutional contexts.

2.2 Structural Constraints

Despite these strengths, interdisciplinary approaches often presuppose the stability of disciplinary ontologies, incentive structures, and institutional boundaries. Under conditions where technologies actively reshape governance, markets, and cognition, these assumptions no longer hold. The result is analytical latency: the inability of existing frameworks to keep pace with structural change.

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3. Transdisciplinarity as System-Level Reconfiguration

In this paper, transdisciplinarity is defined as an approach that treats disciplinary structures themselves as contingent and designable. Specifically, it involves re-examining ontological assumptions, repositioning epistemic commitments as variables rather than constants, and subordinating domain expertise to system-level operational coherence.

This approach does not reject expertise. Instead, expertise is repositioned as a dependent variable within a broader socio-technical system, enabling governance and design interventions that cut across conventional disciplinary boundaries.

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4. Case Applications

4.1 Quantum Risk (Q-Day) as a Multi-Temporal Structural Event

Quantum computing poses a fundamental threat to classical cryptographic systems. Q-Day is commonly framed as a technical security milestone. This paper reconceptualizes Q-Day as a

multi-temporal structural event comprising a technical rupture in cryptographic feasibility, an economic rupture in trust and contractual stability, and a geopolitical rupture in deterrence and alliance structures.

Understanding Q-Day in this way requires integration across physical, institutional, and geopolitical timescales, which cannot be achieved through single-discipline or loosely coordinated interdisciplinary analysis.

4.2 AI Hallucination as a Distributed Socio-Cognitive Phenomenon

AI hallucination is typically treated as an algorithmic defect. This paper instead frames hallucination as a form of overgeneralized meaning production within socio-technical systems. Such behavior reflects not only model limitations but also human cognitive biases, cultural priors, and institutional incentives embedded in training data and deployment environments.

This reframing does not absolve technical responsibility. Rather, it redistributes responsibility across a distributed socio-technical architecture.

4.3 DevRealityOps and Sovereign Protocols

DevRealityOps extends the logic of DevOps to social and institutional systems, treating reality itself as an operational environment subject to iterative deployment, monitoring, and revision. Within this framework, governance is approached as a protocol design problem rather than a purely normative concern.

The concept of sovereign protocols addresses the question of authority: who defines, modifies, and enforces these operational rules. Possible sovereign actors include states, platform corporations, civic commons, and AI-augmented collectives.

4.4 DHI Commons and Humans as Context Integrators

As AI systems increasingly perform execution-oriented tasks, human contributions shift toward context integration: the synthesis of ethical judgment, situational awareness, and cross-domain meaning. DHI Commons are proposed as socio-technical spaces that preserve and amplify this function.

Key human capacities include the translation between heterogeneous rationalities, real-time ethical arbitration, and the formalization of tacit knowledge.

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5. Methodology: Generative Friction and Conceptual Collision

The methodological stance adopted in this paper is explicitly non-neutral. Rather than minimizing conflict between disciplines, it intentionally generates conceptual collisions to surface hidden assumptions and catalyze emergent socio-technical orders.

The publication strategy itself forms part of the methodology: early open release, versioned iteration, and cross-domain feedback are treated as integral components of knowledge production under conditions of complexity.

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6. Related Work and Theoretical Positioning

This work builds upon scholarship in science and technology studies, complexity theory, and AI governance, while departing from them by treating disciplinary structure itself as an object of design rather than a fixed analytical lens.

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7. Limitations and Evaluation Criteria

This approach prioritizes conceptual reconfiguration over immediate empirical validation, which may limit short-term falsifiability. Evaluation of transdisciplinary interventions should therefore focus on system adaptability, governance resilience, and the reduction of epistemic blind spots rather than on narrow performance metrics.

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8. Conclusion

This paper argues that contemporary socio-technical challenges require a shift from interdisciplinary integration toward transdisciplinary reconfiguration. By treating disciplines, institutions, and epistemic assumptions as designable components of complex systems, transdisciplinary approaches enable novel forms of governance, risk management, and collective intelligence.