

Opacity as an Emergent Property: From Natural to Artificial Systems

Opacidad como propiedad emergente: de sistemas naturales a sistemas artificiales

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Trujillo — Lima, Perú

May 2026

This paper is the fifth in a series of independent preprints deposited in Zenodo. It connects with the conceptual frameworks developed in Ravello Joo (2026a, 2026b, 2026c, 2026d). No external funding was received. The author declares no conflict of interest.

Abstract

Keeping a secret is no longer viable. The relevant question became how persistent systems manage the boundary between revelation and concealment. Biology solved this problem long before corporate strategy did.

Opacity is not a moral category or a deliberate choice. It is an emergent property of any system that persists. Cell membranes do not hide information — they regulate selective permeability. A flame maintains coherence precisely because it does not release all its internal energy at once. Tesla opened its patents in 2014 while its real competitive advantage had already migrated to fleet driving data no patent can transfer. Google released TensorFlow as open source in November 2015 while its tensor processing units had been running in internal datacenters since that same year, publicly announced only in May 2016. Meta releases prior versions of its models while continuing to develop capabilities it does not publish. The pattern holds across systems with no apparent relationship.

That consistency has structure. The Dynamic Coherence Model (DCM) formalizes it: $\Omega = V/(M+I)$, where V is verifiable revelation, M is excess concealment beyond what coherence requires, and I is managed uncertainty — what the system acknowledges as unresolved. The model operates as a dynamic corridor, not a maximization function. Preliminary explorations using Monte Carlo methods suggest stable operational regions within that corridor. Full quantitative validation is reserved for subsequent work.

Opacity does not eliminate information. It distributes access to it asymmetrically. Systems that reveal everything reach equilibrium with their environment. Thermodynamic equilibrium is the death of the system.

Four prior papers in this series documented the symptoms — thermodynamic collapse of the digital ecosystem, simultaneous failure of established knowledge regimes, the irrevocability of biometric data as a new asymmetry frontier. This paper documents the mechanism underneath. The mechanism did not wait to be discovered. It only waited to be recognized.

Provisional by design.

Keywords: systemic opacity, Dynamic Coherence Model, DCM, revelation gradient, selective revelation regulation, managed uncertainty, systemic overprotection, dynamic coherence, persistent systems, informational asymmetry, dissipative informational structures, differential revelation

Resumen

La opacidad no es ocultamiento ni transparencia. Es la regulación selectiva de revelación que permite a un sistema mantener coherencia interna frente a su entorno. Se trata de una propiedad emergente de cualquier sistema que persiste.

Las membranas celulares no ocultan información: regulan permeabilidad selectiva. Una llama mantiene su estructura porque no libera toda su energía interna de golpe. Tesla abrió patentes mientras su ventaja real migraba a datos operativos. Google liberó TensorFlow mientras sus TPUs operaban internamente. Meta publica versiones anteriores mientras retiene capacidades frontier. El patrón es consistente en sistemas sin relación aparente.

El Modelo de Coherencia Dinámica (MCD) lo formaliza: $\Omega = V/(M+I)$, donde V es revelación verificable, M es sobreprotección excedente e I es incertidumbre gestionada. El modelo opera como corredor dinámico, no como función de maximización. Exploraciones preliminares mediante métodos Monte Carlo sugieren regiones estables. La validación cuantitativa completa queda para trabajos posteriores.

La opacidad no elimina información: distribuye asimétricamente el acceso a ella. Los sistemas que revelan todo alcanzan equilibrio termodinámico. Ese equilibrio es muerte sistémica.

Cuatro trabajos anteriores documentaron los síntomas. Este documenta el mecanismo subyacente. El mecanismo no esperó a ser descubierto. Solo esperó a ser reconocido.

Provisional por diseño.

Palabras clave: opacidad sistémica, Modelo de Coherencia Dinámica, MCD, gradiente de revelación, regulación selectiva de revelación, incertidumbre gestionada, sobreprotección sistémica, coherencia dinámica, sistemas persistentes, asimetría informacional, estructuras disipativas informacionales, revelación diferencial

1. The problem

Keeping absolute secrets became unviable. Not even organizations with the largest counterintelligence budgets can guarantee it sustainably. The AI-advanced user tandem raised the cost and reduced the viability of classical secrecy.

The adaptive response was to move from secrecy to opacity: not hiding everything, but regulating how much and what gets revealed.

2. The definition

Reveal enough so that what you do not reveal stays invisible.

In this work, opacity means selective regulation of revelation. It is not privacy — privacy tries to hide. It is not transparency — transparency exposes everything. Opacity regulates the gradient between both, and that regulation is not a moral decision: it is an emergent property of systems that persist

over time.

Opacity does not eliminate information. It distributes access to it asymmetrically. It does not imply deliberate falsification — it implies differential regulation of access, resolution, and exposure.

3. Natural systems

Biology solved this before any corporate strategist. The cell membrane is not a wall — it is a selective filter that decides what enters, what exits, and what it blocks. Every cell contains the full genetic information of the organism but expresses only what the context requires.

Thermodynamics confirms the same principle from another angle. A flame reveals light and heat — but what keeps it coherent is what it does not reveal: an internal organization of thousands of simultaneous reactions. If it released all its internal energy at once, it would be an explosion, not a flame.

A system that reveals everything reaches equilibrium with its environment. Thermodynamic equilibrium is the death of the system — maximum entropy, zero difference, zero activity. The coffee that reaches room temperature ceased to be a system.

Persistence requires gradients. Opacity regulates informational gradients the same way membranes regulate chemical gradients. A system that eliminates that difference reaches equilibrium with its environment — and complete equilibrium is indistinguishable from systemic death.

Opacity is not concealment. It is the condition of coherence.

4. Human systems

The boom in Peruvian gastronomy is a studied case in gastrodiploacy (Wilson, 2011). The public narrative emphasized openness, technique exchange, and collaboration among chefs. The precise coordination mechanism that made that expansion possible remained opaque. That managed uncertainty — more than the openness itself — functioned as the engine of continuous participation. Opacity was not the movement's limit. It was its condition of possibility.

5. Technological systems

Three companies, three historical gestures of openness, three mechanisms protecting what actually matters.

Tesla, 2014. Elon Musk published "All Our Patent Are Belong To You" on June 12, 2014. The patent opening coincided with an observable shift of competitive advantage toward assets not transferable under that regime: fleet operational data, vertical integration, and proprietary software. The driving dataset accumulated by millions of vehicles in real-road conditions could not be transferred through the patent regime Tesla chose to open.

Google, 2015. TensorFlow was released as open source on November 9, 2015. Google's tensor processing units had been running in internal datacenters since that same year — Jouppi et al. (2017) confirm it explicitly: "a custom ASIC deployed

in datacenters since 2015." The public announcement came at Google I/O, May 2016. The software framework was revealed after the real advantage had already migrated to proprietary hardware no one else had.

Meta, 2023–2024. Llama 1 in February 2023. Llama 2 in July 2023. Llama 3 in April 2024. The pattern speaks for itself.

This is not corporate hypocrisy. It is opacity functioning exactly as it should.

6. Language models

Language models tend to produce convergent recommendations about themselves and their peers. This convergence reflects partially shared infrastructure and corpus. What remains opaque is the actual infrastructure, proprietary optimizations, and unpublished frontier versions. Selective revelation functions here as a competitive positioning mechanism, not a declaration of transparency.

7. The formalization

The pattern converges across unrelated systems. The cell membrane, the flame, the Peruvian gastronomy boom, the major tech companies, the language models. All exhibit functional convergence toward selective revelation mechanisms.

That mechanism has structure. And if it has structure, it can be formalized.

The operative question is not what opacity is. It is how to calibrate it deliberately.

The Dynamic Coherence Model (DCM) proposes an answer — not as a linear maximization function but as a dynamic operational corridor. Systemic coherence emerges within stable ranges, not at absolute extremes.

$$\Omega = V / (M + I)$$

Ω represents the dynamic coherence index of the system. Where:

V — Revelation: what the system delivers verifiably to the exterior. Not everything it knows — what it chooses to show.

M — Overprotection: what the system conceals beyond what coherence requires. Excess M does not produce security — it produces dogma, and at its limit, structural falsehood. A lie does not require intent. It requires sufficient overprotection.

I — Managed uncertainty: what the system acknowledges as unresolved and administers without pretending premature resolution. I is not ignorance — it is the system's operational floor. Without I, the system is static, suspicious, or unreachable. With calibrated I, the system is improvable and therefore credible.

Preliminary explorations using Monte Carlo methods suggest stable operational regions within dynamic corridors of revelation, overprotection, and uncertainty. Full quantitative formalization and methodological validation of the model will be developed in subsequent work.

Language model hallucinations do not occur because the model does not know. They occur because the model does not know that it does not know. Structural absence of I.

8. From observed pattern to conscious operation

The systems described in this work did not learn opacity. They exhibit it because the ones that did not no longer exist. The cell membrane did not choose to be a selective filter — systems that released everything or blocked everything collapsed before there was any record of them. Tesla, Google, and Meta did not consciously design their openness gestures as differential protection mechanisms — they operated under the same selective pressures as any system that needs to survive in a competitive environment.

Documenting that pattern across unrelated systems does not produce a new tool. It produces visibility into a mechanism that was already operating. The difference between a system that applies opacity under selective pressure and one that applies it consciously is the same difference that Metacognition 2.0 (Ravello Joo, 2026a) identified between the agent classified by default and the agent who deliberately designs the signals that systems process about them.

Prior papers in this series documented symptoms: the thermodynamic collapse of the digital ecosystem (Ravello Joo, 2026c), the simultaneous failure of established knowledge regimes (Ravello Joo, 2026d), the irrevocability of biometric data as a new asymmetry frontier (Ravello Joo, 2026b). This paper documents the underlying mechanism: opacity is not what systems apply to survive those problems. It is the structural condition that surviving systems exhibit consistently, regardless of the specific problem they face.

The Dynamic Coherence Model does not propose a path. It formalizes a structure that already exists. $\Omega = V/(M+I)$ is not the equation of a strategy — it is the operational description of what persistent systems do. The agent who deliberately calibrates that ratio does not acquire an artificial advantage. They recover alignment with a mechanism that natural systems never lost and that human systems abandoned when they confused transparency with trust and privacy with security.

Opacity predates the contemporary information problem. The systems that will persist in the ecosystem described in prior work will not be those that produce the most signal nor those that protect the most information — they will be those that best regulate the gradient between both. That does not require adopting a model. It requires recognizing that the mechanism was already operating.

The mechanism did not wait to be discovered. It only waited to be recognized.

Limitations

The cases presented are illustrative, not formal empirical validation. This work proposes a hypothesis of functional convergence observed across heterogeneous systems — it does not assert causal identity between them. The model's parameters require independent validation with field data.

The philosophical origin of the DCM — the structure of truth as the condition of opacity, the emergence of I from the limits of classical binary logic — is under formal development as a separate work.

Prior papers in this series developed the operational framework (Ravello Joo, 2026a, 2026b) and the systemic diagnosis (Ravello Joo, 2026c, 2026d). The condition of the observer who consciously applies this principle — and the epistemological declaration that position requires — is the subject of

subsequent work in this series.

Provisional by design.

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