

Iterated Generalized Dynamics, Semantic Engines, and from Symmetry to Deformation

A day's work in the Grain Program — Klein, Landauer, and the Information–Matter Link

Hugues Genvrin

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Dynamics

- ① Iterated RFDG: the tower of time-derivatives

Semantics & Matter

One thread: a variation of information, differentiated, closed, and — in a physical system — paid for in energy.

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- 1 Iterated RFDG: the tower of time-derivatives
- 2 Saturation = closure: dynamical complexity

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- ③ The link to chaos (signature, not cause)

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- ⑦ Klein: symmetry breaking = semantic force
- ⑧ The full chain: symmetry $\rightarrow$ deformation

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1 — Iterated RFDG: the tower of derivatives

The generalized dynamics $F = \dot{q}$ is *iterated*: each force becomes the next dynamical quantity.

$$\mathcal{I} \xrightarrow{d/dt} \dot{\mathcal{I}} = \text{sense } S \xrightarrow{d/dt} \ddot{\mathcal{I}} = \text{force} \xrightarrow{d/dt} \dddot{\mathcal{I}} \rightarrow \dots$$

Dimensional caution

The stages are *not* homogeneous: $[\mathcal{I}^{(n)}] = Q T^{-n}$.
“The variation of a force is a force” is false without a time factor.

Closure

The tower closes at finite order *iff* the law is auto-similar (harmonic):

$$\ddot{\mathcal{I}} = -\omega^2 \mathcal{I}.$$

Polynomial law $\Rightarrow$ no closure.

2 — Saturation = closure: dynamical complexity

Read the tower as a state vector. Its *composition neguentropy* (total correlation) measures redundancy between stages.

Theorem (saturation $\Leftrightarrow$ closure)

The composition neguentropy saturates at rank n *iff* the tower closes at order n : beyond n , each stage is determined by the previous ones (zero conditional information).

Regime	Order n
Relaxation	1
Oscillator (cycle)	2
Quasi-periodic (k modes)	$2k$
Chaotic	∞

“Saturates at order n ”

means the *rank* is n (not the value in bits).
This rank is the **dynamical complexity**: the number of independent degrees of freedom.

3 — The link to chaos: signature, not cause

First, a correction

Chaos is *already deterministic* (same initial conditions $\rightarrow$ same trajectory). Non-saturation causes *no* determinism — it *signals* unbounded dynamical complexity.

The tower is Takens' embedding

Stacking $\mathcal{I}, \dot{\mathcal{I}}, \ddot{\mathcal{I}}, \dots$ unfolds the attractor.
Saturation rank = embedding dimension.
Chaotic = no closure = “fractal in time”.

Necessary, not sufficient

chaos = non-saturation + $\lambda > 0$
Lyapunov $\lambda > 0$ (exponential divergence) is the lock; non-saturation is the door.

Verified: oscillator saturates at order 2 ($\sim 10^{-19}$); Lorenz never saturates.

4 — The two-axis semantic engine

The tick example revealed that a semantic engine has *two* axes, not one.

Two axes

Depth d : derivations before action
(perception $\rightarrow$ sense $\rightarrow$ action) = closure order
of a channel.

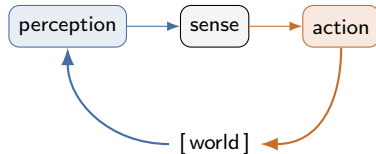
Width L : parallel perception–action channels.

What makes it an “engine”

The **functional cycle** (Von Uexküll's *Funktionskreis*): action reshapes the perceived world, closing the loop. The engine is the *loop driving the structure* — both articulated.

5 — Biology: Von Uexküll's tick (L, d) = (3, 2)

perception $\mathcal{I}_1$	sense $\dot{\mathcal{I}}$	action $\ddot{\mathcal{I}}$
butyric acid	detection	let go
mammal hair	exploration	explore
skin heat	temperature	bore in



the loop turns, driven by the milieu

Illustration (a system where the quantities map), not validation — ethology already describes these cycles.

6 — Physics, link 2: deformation $\Rightarrow$ forces

Continuum mechanics (established)

$$\varepsilon \neq 0 \xrightarrow{c} \sigma \neq 0 \xrightarrow{\partial_j} f \neq 0$$

strain $\rightarrow$ stress (constitutive law) $\rightarrow$ force (divergence). Deforming a body *necessarily* expresses forces.

But it is mute on the cause

Link 2 says “*if* deformed, *then* forces”. It says nothing about what *causes* the deformation — in particular not that information does. That is link 1, and it needs energy.

7 — Physics, link 1: the Landauer bridge

Why not mathematics? Extending g^{-1} stays in the descriptive register, at *zero energy*. Deformation *costs* energy. Link 1 is physical, not formal.

Landauer: information $\rightarrow$ energy

$$\Delta F = \mathcal{N} k_B T \ln 2 \quad (k_B T \ln 2 \approx 2.9 \times 10^{-21} \text{ J/bit})$$

Composition negentropy $\mathcal{N}$ (a *structuring*, not an erasure) is stored as **free energy** — *potential*, recoverable.

Potential $\rightarrow$ force $\rightarrow$ deformation

$$F = -\frac{\partial(\Delta F)}{\partial \epsilon} = -k_B T \ln 2 \frac{\partial \mathcal{N}}{\partial \epsilon}$$

feeds link 2. This answers “can the energy be potential?” — yes: free energy of structuring.

Scale: molecular

1 bit $\rightarrow$ 2.9 pN over 1 nm.

100 bits $\rightarrow$ 287 pN.

1 ATP $\approx$ 29 bits.

Negligible macroscopically, *significant biologically*.

8 — Klein: breaking a symmetry is a semantic force

A geometry is a closed pair (A, G) : a content A (measurable properties) and its principal group $G = \text{Sym}(A)$ — an antitone Galois connection.

Semantic force = deviation from symmetry

$$F_s = 0 \iff (\tau_t) \subseteq \text{Sym}(A)$$

Any transformation outside the principal group breaks an invariance: $F_s = \Delta\mu \neq 0$. It *measures* the break.

Noether, both ways

$$F_s = \dot{q}_X = \{q_X, H\}$$

Charge conserved while the symmetry holds; its variation *at the break* is the force. Two faces of one fact.

Predictive content lives in the generator H — $F_s = \dot{q}$ alone is a definition.

9 — The missing link: Burnside counts the negentropy

Breaking a symmetry changes the *count of orbits* — and that is the change in composition negentropy.

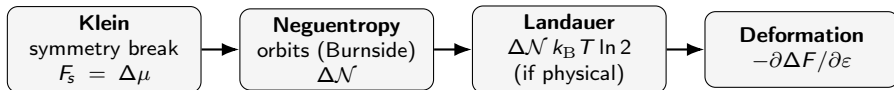
Orbit counting (Burnside)

$$|\Omega/G| = \frac{1}{|G|} \sum_{g \in G} |\text{Fix}(g)|, \quad \mathcal{N}_G = \log_2 \frac{|\Omega|}{|\Omega/G|}.$$

A break $G \rightarrow G' \subsetneq G$ releases $\Delta\mathcal{N} = \mathcal{N}_G - \mathcal{N}_{G'} \geq 0$: the semantic force, in bits.

Necklace, 6 beads, 3 colours	$ \Omega/G $	$\mathcal{N}_G$ (bits)	
C_6 (rotations)	130	2.487	
D_6 (rot. + refl.)	92	2.986	richer quantum
break $D_6 \rightarrow C_6$		$\Delta\mathcal{N} = 0.499$	semantic force

10 — The full chain: symmetry $\rightarrow$ deformation



One causal line

$$F = -k_B T \ln 2 \frac{\partial(\Delta\mathcal{N})}{\partial\epsilon}$$

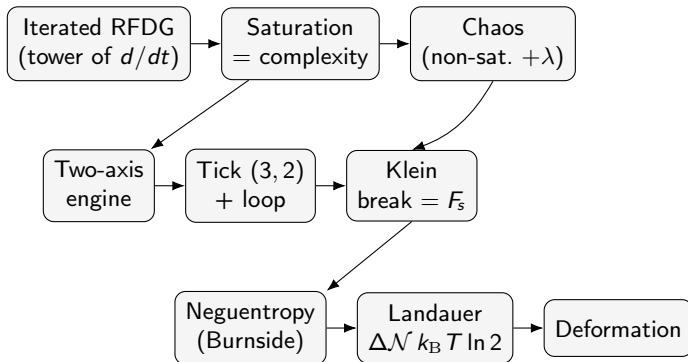
Symmetry break $\rightarrow$ orbit count $\rightarrow$ free energy $\rightarrow$ force $\rightarrow$ strain. Each arrow proven separately; Burnside is the new weld.

Two “group $\rightarrow$ force” bridges

Established: Noether / gauge (SU(3), SU(2) $\times$ U(1)) — acts on *dynamics*.

This one: Klein structures *information*, Landauer supplies the energy. Distinct, complementary.

The thread of the day



Depth (closure), complexity (saturation), chaos (non-saturation), width $\times$ loop (engine), symmetry break (Klein), and — in a physical system — energy (Landauer) $\rightarrow$ deformation. *Description throughout; validation only where measured.*

Epistemic guardrails held today

- **Signature vs cause:** non-saturation *signals* chaos; it causes no determinism.
- **Illustration vs validation:** the tick *maps* onto the formalism; it does not *prove* a biological engine.
- **Describe vs found:** link 2 is established physics; link 1 needed Landauer, not a formal extension of g^{-1} .
- **Formal $\neq$ energetic:** no manipulation of descriptions creates energy — deformation is paid for in $k_B T \ln 2$.
- **Two group $\rightarrow$ force bridges:** Noether/gauge (dynamics) vs Klein/Landauer (information + energy) — distinct, not to be confused.

*The intuition “information deforms the body” found its defensible form:
in physical systems, structuring stores free energy whose gradient deforms.*