



CIVILIZATIONAL CYBERNETICS

Toward Dynamic Steering of Human Societies within the Earth System

1. Definition

Civilizational cybernetics refers to the set of observation, modeling, decision, and regulation mechanisms that enable a civilization to steer itself in order to maintain its conditions of existence and guide its evolutionary trajectory.

It applies the principles of cybernetics — feedback, regulation, and adaptation — at the scale of the **human socio-ecological superorganism**.

2. An Unprecedented Historical Urgency

Humanity has entered a pivotal period in its history.

2.1 Transition to the Anthropocene

Human activities now alter the fundamental balances of the Earth system:

- climate disruption,
- biodiversity collapse,
- disturbance of biogeochemical cycles,
- land artificialization,
- ocean acidification.

Humanity has become a geophysical force.

2.2 Crossing Planetary Boundaries

Several critical biophysical thresholds are being exceeded, leading to:

- ecological instability,
- irreversible tipping effects,
- accelerating feedback loops.

This is no longer a set of isolated impacts but a problem of **global systemic regulation**.

2.3 Emergence of Global Systemic Risks

Contemporary crises are interdependent:

- climate,
- energy,
- food systems,
- finance,
- migration,
- political instability.

Their interactions generate nonlinear and unpredictable dynamics.

Without appropriate steering instruments, civilization is navigating complexity it can no longer master.

3. Scientific and Conceptual Foundations

Civilizational cybernetics emerges from the convergence of several fields:

Cybernetics

→ regulation through feedback and information flows.

Systems theory

→ understanding open and interdependent systems.

Complexity sciences

→ nonlinear dynamics and self-organization.

Systems ecology

→ Earth system stability and planetary boundaries.

Collective intelligence

→ distributed cognition and large-scale cooperation.

4. Fundamental Principle: the Steering Loop

All cybernetic systems rely on a continuous adaptive loop:

Observe → **Model** → **Decide** → **Act** → **Adjust**

At the civilizational scale:

Observation

- ecological, economic, and social data;
- multidimensional indicators;
- measurement of interdependencies.

Modeling

- systemic representations;
- mapping positions and trajectories;
- prospective simulations.

Decision

- coherent public policies;
- aligned organizational strategies;
- multi-scale arbitration.

Action

- regulation;
- economic incentives;
- institutional innovation.

Feedback

- evaluation of outcomes;
 - continuous adjustment;
 - collective learning.
-

5. Representing to Steer: the Role of Systemic Models

Steering complex systems requires shared representations.

Systemic mapping tools (e.g., a navigable ecosphere) make it possible to:

- locate organizations and states;
- visualize pressures on planetary boundaries;
- assess alignment with sustainability goals;
- monitor transformation trajectories.

They transform static evaluation into **dynamic navigation**.

6. Historical Attempts at Systemic Steering

Civilizational cybernetics builds upon a long lineage of efforts to understand and guide complex human systems.

6.1 Cybernetics Applied to Governance

In the early 1970s, the Cybersyn project in Chile experimented with real-time economic management using industrial data collection and decision dashboards. It demonstrated the technical feasibility of systemic steering but was interrupted by political upheaval.

6.2 Global Dynamic Modeling

Early world system simulations revealed interactions between population, resources, and pollution, highlighting the possibility of systemic collapse without regulation.

These works provided a major scientific warning but not an operational steering tool.

6.3 International Governance Architectures

International institutions, climate agreements, and the Sustainable Development Goals have strengthened global coordination but do not constitute an integrated system of dynamic regulation.

6.4 Alternative Indicators and Ecological Accounting

Numerous indicators have been developed to move beyond GDP and incorporate well-being and sustainability.

However, their dispersion prevents a coherent systemic vision.

7. Structural Obstacles to the Emergence of Civilizational Steering

Despite growing necessity, a global steering system has not emerged due to structural constraints.

7.1 Institutional Fragmentation

The world is organized into sovereign states and sectoral institutions without a global systemic regulatory body.

7.2 Cognitive Limits in the Face of Complexity

Complex systems exceed human intuition:

- delayed causality,
- nonlinear effects,
- multiple interactions.

This encourages short-term decision-making.

7.3 Conflicting Interests and Economic Incentives

Economic structures often prioritize short-term maximization over systemic viability.

7.4 Lack of Integrated Indicators

An abundance of sectoral indicators does not provide systemic navigation or synthetic vision.

Without instruments, there can be no steering.

7.5 Incompatible Time Scales

Political and economic cycles are short, while ecological dynamics unfold over decades or centuries.

7.6 Fear of Technocratic Centralization

Global steering raises concerns about surveillance, loss of sovereignty, and authoritarian drift.

This underscores the need for a distributed, transparent, and democratic architecture.

8. Levels of Steering

Civilizational cybernetics operates across interdependent scales:

Organizations

→ strategic transformation and systemic alignment.

Territories

→ local resilience and ecological planning.

States

→ policy coherence.

Global governance

→ macroeconomic and ecological coordination.

9. Operational Objectives

Implementing civilizational cybernetics enables:

- anticipation of systemic crises;
 - preservation of planetary habitability;
 - alignment of economic activity with biophysical limits;
 - guidance of policy and investment;
 - acceleration of ecological and social transitions;
 - improved coherence of multi-level decision-making.
-

10. Conditions for Success

Its implementation requires:

- integrated and verifiable indicators;
- transparent and accessible data;
- comprehensible visualization interfaces;
- participatory multi-level governance;

- an ethic of transparency and accountability;
 - a distributed architecture preventing authoritarian centralization.
-

11. Civilizational Significance

Civilizational cybernetics marks the transition:

- from fragmented governance to systemic regulation;
- from extractive economics to viable economies;
- from short-termism to sustainable trajectories;
- from an humanity unaware of its impacts to a civilization conscious of itself.

It constitutes a steering infrastructure enabling humanity to evolve toward a systemic civilization integrated within the Earth system.

12. Concise Definition

Civilizational cybernetics is the dynamic steering system that enables observation, positioning, orientation, and regulation of human activities in order to preserve Earth's habitability and ensure a sustainable evolutionary trajectory.
