The Evolutionary Foundations of the Enhanced Morphogenetic Cycle

Constraint Regulation and the Emergence of Reflexive Agency

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Abstract

This paper explains the evolutionary foundations of the enhanced morphogenetic cycle by situating it within a broader process of constraint regulation that governs the emergence and persistence of viable systems. The central proposition is that systems that proliferate and persist are those whose organisation regulates constraints on satisfiers and contra-satisfiers sufficiently to maintain viability within their environment. Satisfiers are process-maintaining causal inputs that contribute to system persistence, while contra-satisfiers are process-inhibiting causal inputs that undermine it. From this perspective, the enhanced morphogenetic cycle represents the most recent expression of a deeper evolutionary pathway. Across physical, biological, psychological, and social domains, increasing system complexity has been accompanied by the emergence of new mechanisms that reduce constraints on satisfiers and impose constraints on contra-satisfiers. These developments progressively expand the capacity of systems to maintain and reproduce themselves. In human societies, symbolic communication and cultural storage enable reflexive agency, allowing agents to recognise and deliberately modify the material, structural, and cultural constraints they face. The paper shows that the morphogenetic cycle is the form this process takes in reflexive social systems, providing a unified framework linking multiple levels of evolution and offering a causal explanation for the correspondence between social evolution and individual human development.

1. Introduction — The Morphogenetic Cycle and Its Evolutionary Question

1.1 The Morphogenetic Cycle

Margaret Archer's morphogenetic cycle provides a foundational framework for understanding the dynamic relationship between social structure and human agency (Archer, 1995; Archer, 2003). In its simplest form, the cycle describes a temporal sequence in which pre-existing structural and cultural conditions shape the actions of agents, whose subsequent interactions either reproduce those conditions (morphostasis) or transform them (morphogenesis) (Archer, 1995). The cycle can be summarised schematically as:

Structure & Culture → Agency → Structural & Cultural Reproduction or Revision

This formulation captures the essential insight that culture and structure both constrain and enable action, while human agency, in turn, reproduces or revises those structures over time.

The enhanced morphogenetic cycle developed here builds on Archer's framework by introducing a more explicit account of the nature and operation of constraints, the causal processes through which agents experience and respond to them, and the hierarchical organisation of social systems. These enhancements are summarised in Figure 1.

First, structure and culture are given strict definitions and are treated explicitly as constraints on action. Structural constraints define what agents *can* or *cannot* do, arising from the organisation of roles, relationships, and material arrangements within the system. Cultural constraints define what agents *should* or *should not* do, arising from shared norms, values, knowledge, beliefs and symbols. These cultural constraints operate causally by shaping expectations and evaluations of behaviour.

Second, the enhanced cycle explicitly recognises the role of material constraints, including time, energy, and environmental conditions. These constraints define the conditions that must be satisfied for agents to maintain viability, and therefore what agents *must* or *must not* do *in order to persist*. They operate alongside structural and cultural constraints. The inclusion of material constraints completes the triadic constraint structure: material constraints define what is required for viability, structural constraints define what actions are possible, and cultural constraints define what actions are considered appropriate.

Third, the model introduces satisfiers and contra-satisfiers as the causal inputs through which agents experience the effects of constraints. These inputs arise from material, structural, and cultural conditions. Satisfiers are process-maintaining causal inputs that contribute to the persistence of viable states, while contra-satisfiers are process-inhibiting causal inputs that undermine them. Agents experience these in the form of the satisfaction or dissatisfaction of their needs, which motivates behavioural response.

Fourth, the model incorporates the existence of multiple levels of organisation, each possessing its own emergent properties and associated forms of agency. For example, individuals operate within groups, groups within societies, and societies within wider institutional and cultural systems. Each level both constrains and enables the levels below it while remaining subject to constraints from levels above.

Fifth, the enhanced model clarifies the dual character of laws and formal rules, which operate as cultural constraints at the level at which they are created, but as structural constraints at lower levels where they define the range of permissible action.

Finally, the enhanced cycle incorporates the role of psychological defence mechanisms, which may inhibit reflexive engagement with constraints. These mechanisms can prevent agents from accurately recognising the causes of dissatisfaction, thereby stabilising existing structures even where they reduce system viability.

Taken together, these enhancements produce a more fully specified account of how agents encounter and respond to material, structural, and cultural constraints through reflexive engagement. The morphogenetic cycle thus becomes a model of constraint regulation within reflexive social systems. As the remainder of this paper will show, this process is not unique to human societies but represents the latest expression of a much deeper evolutionary pathway.

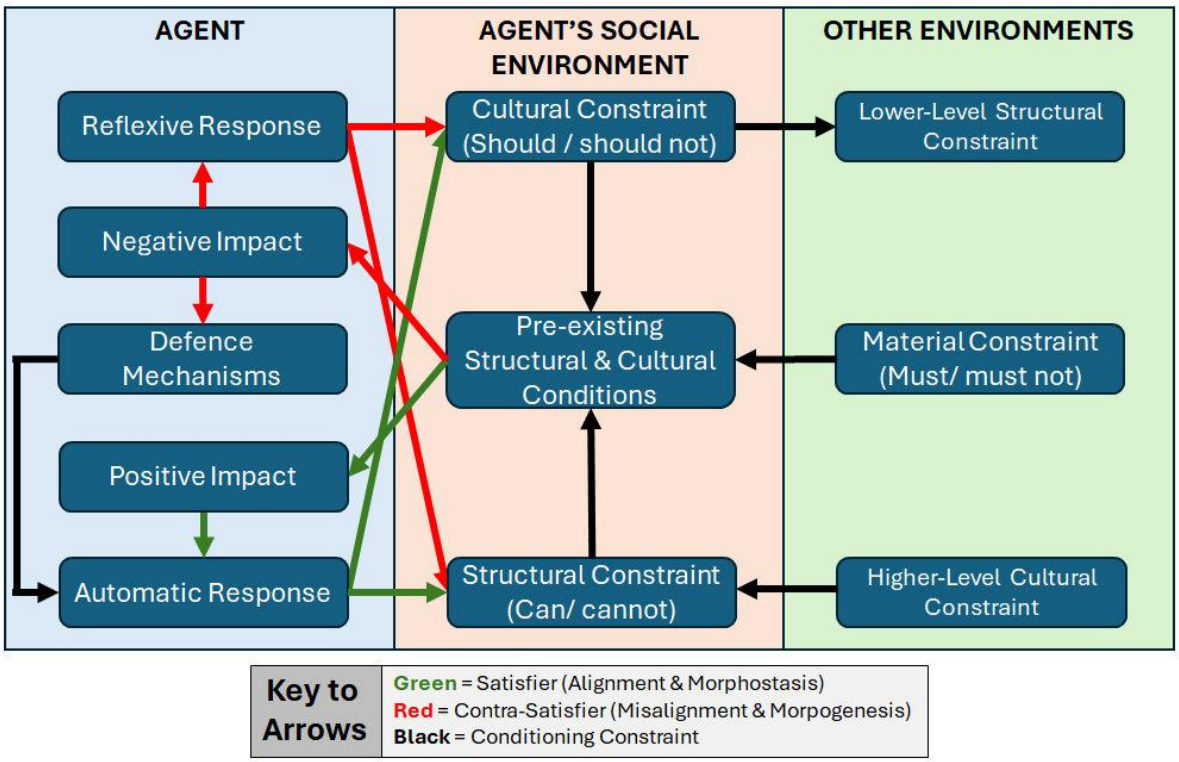

Figure 1. *The Enhanced Morphogenetic Cycle*

1.2 The Problem: Where Did the Morphogenetic Cycle Come From?

The morphogenetic cycle provides a powerful account of how modern human social systems reproduce and transform themselves through the interaction of constraints and agency. In its enhanced formulation, by distinguishing between structural, cultural, and material constraints, and by recognising the reflexive capacity of agents to respond to them, the morphogenetic cycle offers a comprehensive framework for understanding social stability and change.

However, this raises a deeper and more fundamental question. If the morphogenetic cycle accurately describes the operation of contemporary human societies, how did such a system arise in the first place? Reflexive agents capable of recognising and responding to material, structural, and cultural constraints did not exist throughout most of the history of the universe. Nor did symbolic culture, formal institutions, or the complex social organisations within which the morphogenetic cycle now operates.

This suggests that the morphogenetic cycle itself must have emerged through a developmental process. The question, therefore, is whether the morphogenetic cycle represents a phenomenon unique to human social systems, or whether it is the latest expression of a more general evolutionary pathway through which increasingly complex systems have acquired progressively more powerful means of regulating the constraints affecting their viability.

If the latter is the case, then the morphogenetic cycle may be understood not as an isolated sociological mechanism, but as part of a continuous process extending from the earliest physical systems, through living organisms and reflexive individuals, to modern human societies. The task, then, is to identify the underlying principles governing this process and to determine how the morphogenetic cycle relates to them.

The following section addresses this question by introducing the concepts of satisfiers, contra-satisfiers, and constraint regulation, and by showing how these provide a foundation for understanding the evolutionary emergence of reflexive social systems.

1.3 Thesis: The Morphogenetic Cycle as an Expression of Evolutionary Constraint Regulation

This paper argues that the morphogenetic cycle is the most recent expression of a universal evolutionary process through which systems regulate constraints on satisfiers and contra-satisfiers, understood more generally as enabling and inhibiting causal inputs, required for their viability. Systems persist and proliferate only insofar as their organisation reduces constraints on process-maintaining causal inputs and imposes constraints on process-inhibiting causal inputs. Over time, new forms of organisation emerge that regulate these constraints more effectively, allowing increasingly complex systems to maintain their viability under a wider range of conditions.

From this perspective, the morphogenetic cycle is not unique to human society but represents the form this process takes in reflexive social systems. The distinctive feature of such systems is the capacity of agents to recognise material, structural, and cultural constraints and to respond to them deliberately. Reflexive agency thus becomes a mechanism through which constraint configurations can be modified consciously, rather than solely through non-reflexive processes such as natural selection or structural drift.

The enhanced morphogenetic cycle makes this process explicit by identifying the different classes of constraint involved and the causal role of satisfiers and contra-satisfiers in motivating agency. It thereby situates the morphogenetic cycle within a continuous evolutionary sequence extending from early viability-maintaining systems to contemporary human societies.

The following sections develop this argument by first clarifying the relationship between viability, satisfiers, contra-satisfiers, and constraint regulation, and then showing how progressively more complex forms of constraint regulation have emerged over evolutionary time.

2. Viability, Satisfiers, Contra-Satisfiers, and Constraint Regulation

2.1 Viability and Needs

The starting point for understanding the emergence of the morphogenetic cycle is the concept of viability. A system is viable insofar as it persists and/or proliferates within its environment (Maturana & Varela, 1980) (Deacon, 2012). Persistence refers to the continuation of the system's organisation over time, while proliferation refers to the reproduction or replication of that organisation across multiple instances. Both are expressions of the same underlying requirement: the maintenance of the causal processes that constitute the system.

For many systems, viability depends on ongoing interactions with their environment. Such systems cannot maintain their organisation indefinitely in isolation but require continuous causal inputs to sustain the processes on which their persistence depends. These requirements give rise to needs. A need may therefore be understood as a condition that must be satisfied if a system is to remain viable.

The causal inputs that contribute to the continuation or stability of viability-maintaining processes are termed satisfiers. Satisfiers are process-maintaining causal inputs: they enable the system to persist and, in some cases, to proliferate. Conversely, contra-satisfiers are process-inhibiting causal inputs: they disrupt, degrade, or destabilise the processes on which viability depends. The viability of a system is therefore shaped both by its access to satisfiers and by its exposure to contra-satisfiers.

From this perspective, needs do not imply intention or purpose but arise as a consequence of the causal organisation of viability-maintaining systems. Systems that persist are those whose organisation enables sufficient access to satisfiers while limiting the effects of contra-satisfiers. The regulation of constraints affecting these causal inputs is thus fundamental to the maintenance of viability.

This relationship between viability, needs, satisfiers, and contra-satisfiers provides the foundation for understanding how increasingly complex systems, including human societies, emerge and evolve.

2.2 Constraint Regulation and Viability

If viability depends on access to satisfiers and exposure to contra-satisfiers, then the persistence and proliferation of systems necessarily depend on the constraints that affect these causal inputs. Constraints influence whether satisfiers can be acquired, whether contra-satisfiers can be avoided, and how effectively systems can maintain the processes on which their continued existence depends.

This leads to the following general proposition:

systems that proliferate and persist are those whose organisation regulates constraints on satisfiers and contra-satisfiers sufficiently to maintain viability within their environment.

Systems whose organisation reduces constraints on satisfiers improve their access to the causal inputs required for persistence. At the same time, systems whose organisation imposes constraints on contra-satisfiers limit their exposure to causal inputs that would otherwise degrade or destabilise their viability-maintaining processes.

Constraint regulation occurs through the organisation of the system itself. Boundaries, internal structures, and patterns of interaction can all influence the flow of causal inputs. For example, physical boundaries may limit the entry of harmful influences while permitting access to beneficial ones, and behavioural or structural adaptations may increase the reliability with which satisfiers are obtained. In each case, persistence follows not from intention or foresight, but from the causal consequences of organisation. Systems whose organisation results in favourable constraint configurations persist, while those whose organisation does not are more likely to degrade or disappear.

Constraint regulation is therefore not a goal-directed process but a selection process. Over time, forms of organisation that regulate constraints more effectively tend to remain, while less effective configurations do not. This principle applies across all domains in which viable systems exist and provides a basis for understanding how increasingly complex forms of organisation emerge.

The following section shows how new emergent properties alter constraint configurations and thereby enable new forms of viability.

2.3 Emergence as Constraint Regulation

The regulation of constraints on satisfiers and contra-satisfiers does not remain fixed. Over time, new forms of organisation may arise that alter the constraint configurations affecting system viability. These changes are associated with the emergence of new properties, which modify the relationships between the system and its environment and thereby affect the causal inputs available to it.

An emergent property may be understood as a feature of a system that arises from the organisation and interaction of its components but is not present in the components considered in isolation (Simon, 1962). Such properties have causal consequences. In particular, emergent properties can alter the constraints that govern access to satisfiers and exposure to contra-satisfiers. For example, the emergence of catalytic activity can reduce energetic constraints, enabling chemical transformations that would otherwise occur too rarely to sustain organised processes. Similarly, the emergence of a nervous system can reduce constraints on coordination by allowing rapid transmission of information within an organism, thereby improving its ability to obtain satisfiers and avoid contra-satisfiers. In each case, the emergent property alters the constraint configuration affecting viability.

In this way, emergence can enable new capabilities and new forms of viability. Systems possessing emergent properties that regulate constraints more effectively may persist under conditions in which less organised systems cannot. The emergence of new forms of organisation therefore expands the range of environments within which viability can be maintained.

This process does not occur through foresight or design but through the persistence of systems whose emergent properties result in favourable constraint configurations. Over time, successive emergent properties may progressively transform the relationship between systems and their environments, enabling increasingly complex forms of organisation to arise.

Understanding emergence in terms of constraint regulation provides a framework for examining the evolutionary sequence through which progressively more powerful forms of viability-maintaining organisation have developed. The following section applies this framework to the evolution of living systems and the eventual emergence of reflexive social systems.

Understanding emergence in terms of constraint regulation provides a framework for examining the evolutionary sequence through which progressively more powerful forms of viability-maintaining organisation have developed. This sequence is summarised in Figure 2.

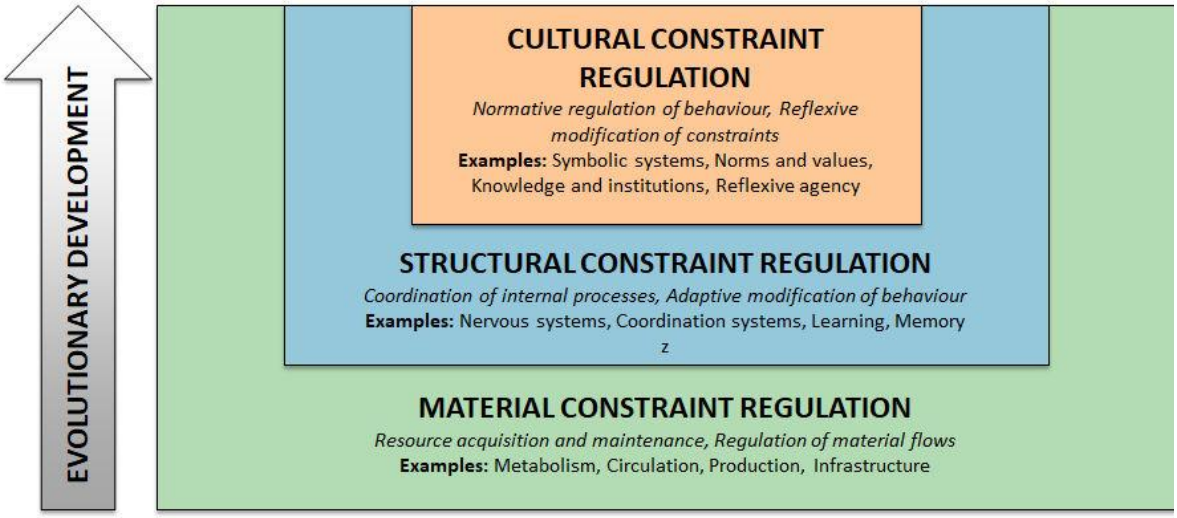

Figure 2. *The Constraint Regulation Pathway.*

Constraint regulation develops cumulatively through evolutionary time, with each higher level emerging within and remaining dependent upon lower levels. Material constraint regulation defines the conditions required for viability, structural constraint regulation defines the space of possible actions, and cultural constraint regulation defines the normative evaluation of action. Higher levels do not replace lower ones but extend the capacity of systems to regulate the constraints affecting their persistence.

The following section applies this framework to the evolution of living systems and the eventual emergence of reflexive social systems.

3. Constraint Regulation in Biological Evolution

3.1 Regulation of Material Constraints: The Emergence of Living Systems

The earliest viable systems faced fundamental material constraints affecting their persistence. In the absence of sustained energy and material flows, physical and chemical processes tend toward increasing entropy (dispersion) and toward thermodynamic equilibrium (a state in which gradients are eliminated) and organised structures cannot be maintained over time (Prigogine, 1980). For systems to persist over time, their organisation must regulate the flow of causal inputs in ways that counteract these tendencies. The emergence of living systems represents a major transition in the regulation of such material constraints (Maynard Smith & Szathmáry, 1995).

Prior to the emergence of living systems, early chemical organisation began to regulate material constraints through the development of catalytic processes. *Catalysis* reduced energetic constraints on chemical transformation, enabling reactions to occur more readily under prevailing conditions. The emergence of *autocatalysis* extended this process, as certain reaction networks began to generate components that facilitated their own continuation, giving rise to self-amplifying dynamics that resemble a primitive

form of reproduction. In *autocatalytic sets*, networks of mutually reinforcing reactions stabilised production processes, increasing the persistence, and thereby the potential prevalence, of organised chemical systems. These developments altered constraint configurations by improving access to enabling causal inputs and increasing the reliability with which viability-maintaining processes could be sustained. However, such systems remained vulnerable to the dispersion of components and variation in environmental conditions, which disrupted the proximity and stability required for ongoing reactions. As a result, their persistence was limited, and they lacked the discrete replication and lineage continuity characteristic of later living systems.

Another key early development was the emergence of *compartmentalisation*, in which chemical processes became enclosed within bounded regions, such as mineral compartments or lipid vesicles, i.e., small, self-forming membrane-bound structures in which lipid molecules arrange themselves into a spherical boundary separating an internal environment from the external surroundings.

Compartmentalisation altered constraint configurations by maintaining the proximity of interacting components and stabilising the conditions required for ongoing reactions. This reduced the constraints imposed by the dispersion of components and variation in environmental conditions, allowing more reliable continuation of viability-maintaining processes.

A further development was the emergence of *metabolism*, in which systems actively incorporated external causal inputs and transformed them into forms that sustained their own organisation. Metabolism regulated material constraints by enabling systems to counteract degradation through continuous exchange with their environment.

However, this also introduced a fundamental dependency: the persistence of the system now required a continuous supply of specific causal inputs to sustain its internal processes. Needs emerged at this point as an intrinsic feature of viability, as the continuation of those processes depended on ongoing access to satisfiers rather than initial conditions alone.

Finally, the emergence of *replication* provided a further mechanism for regulating material constraints, particularly those associated with finite lifespan and structural degradation. Through replication, the organisation of the system could persist beyond the duration of any individual instance. This allowed viable configurations to proliferate, increasing their likelihood of continued existence.

Together, compartmentalisation, metabolism, and replication represent successive emergent properties that progressively enhanced the regulation of material constraints. These developments enabled the persistence and proliferation of living systems under conditions that would otherwise have led to their degradation or disappearance. At the

same time, they established the fundamental relationship between viability and needs that characterises all living systems.

The regulation of material constraints therefore provided the foundation upon which more complex forms of constraint regulation could emerge. The following section examines how the evolution of nervous systems introduced new mechanisms for regulating structural constraints through behavioural coordination.

3.2 Regulation of Structural Constraints: Nervous Systems and Learning

While metabolism and replication enabled living systems to regulate material constraints affecting their viability, their behavioural responses to environmental conditions remained limited. The emergence of nervous systems introduced a new form of organisation that altered the regulation of structural constraints by enabling more effective coordination of internal processes and interactions with the environment.

Nervous systems allowed signals concerning environmental conditions and internal states to be transmitted rapidly within the organism. This reduced constraints on coordination by enabling timely and coherent behavioural responses. As a result, organisms could regulate their access to satisfiers and limit their exposure to contra-satisfiers more effectively than systems whose responses depended solely on slower chemical processes. Behaviour thus became a primary mechanism for the regulation of structural constraints.

A further development was the emergence of *learning*, in which patterns of neural organisation were modified as a result of experience (Hebb, 1949) (Friston, 2010). Learning altered structural constraint configurations by enabling behavioural responses to be adjusted over time. Systems were no longer limited to behavioural patterns specified solely by inherited organisation but could modify their own behavioural organisation in ways that improved their viability under local conditions. In this sense, learning enabled systems to regulate structural constraints affecting their own behaviour.

The emergence of *self-representation* extended this capability further. By maintaining internal representations of their own state and their relationship to the environment, systems could integrate past experience with present conditions to guide future action. This enabled more flexible and coherent regulation of behavioural structure.

These developments mark the emergence of *agency* in its functional form. Agency may be understood here as the capacity of a system to regulate structural constraints on its own behaviour in ways that affect its viability. This represents a functional form of agency, prior to the emergence of reflexive agency associated with the regulation of cultural constraints. Behaviour was no longer determined solely by fixed structural

organisation but became subject to modification through processes occurring within the system itself.

The regulation of structural constraints through nervous systems, learning, and self-representation enabled organisms to maintain viability under a wider range of conditions than would otherwise have been possible. At the same time, these developments provided the foundation for the later emergence of symbolic communication and reflexive agency, through which cultural constraints could also be regulated.

3.3 Regulation of Cultural Constraints: Symbolic Communication and Reflexive Agency

The emergence of nervous systems, learning, and self-representation enabled organisms to regulate structural constraints affecting their behaviour. However, behavioural regulation at this stage remained limited to the modification of internal structures through individual experience. A further major transition occurred with the emergence of *symbolic communication*, which enabled systems to regulate behaviour through shared symbolic representations (Tomasello, 2008).

Symbolic communication enabled organisms to represent objects, actions, and relationships in a form that could be transmitted between individuals and preserved beyond immediate experience. This altered constraint configurations by allowing behavioural regulation to occur not only through individual learning but also through socially transmitted symbolic systems. These symbolic systems gave rise to shared norms, values, beliefs, and bodies of knowledge that defined patterns of behaviour considered appropriate or inappropriate within a given social context. These developments introduced a new class of constraint, i.e., cultural constraints, which define what agents should and should not do.

Cultural constraints regulate behaviour by influencing how agents evaluate potential actions. Through symbolic communication, agents acquire shared frameworks of meaning that shape how they interpret satisfiers and contra-satisfiers and guide their responses to them. This enables behavioural coordination at a level not possible through individual learning alone.

The emergence of *reflexive agency* extended this process further. Reflexive agents are capable of recognising cultural constraints and evaluating their own behaviour in relation to them. This enables agents not only to modify their behaviour in response to immediate structural and material conditions but also to regulate their behaviour in accordance with shared norms, values, beliefs, and other cultural expectations. Behaviour thus becomes subject to cultural evaluation as well as structural and material constraint.

This marks the emergence of the “Should” as a distinct dimension of constraint regulation. Systems capable of reflexive agency can regulate their own behaviour in relation to cultural constraints, thereby altering the constraint configurations affecting their viability.

The regulation of cultural constraints through symbolic communication and reflexive agency provides the foundation for the enhanced morphogenetic cycle. Through reflexive engagement with material, structural, and cultural constraints, agents participate in the reproduction and transformation of the social systems in which they exist. The enhanced morphogenetic cycle may therefore be understood as the form that constraint regulation takes in reflexive social systems.

4. Constraint Regulation in Social Evolution

4.1 Social Assembly

The emergence of reflexive agency created the conditions for a further major transition: the formation of persistent social groups. Early hominids did not exist solely as isolated individuals but increasingly formed loosely coupled social assemblies, commonly in the form of small bands. These groups did not constitute tightly integrated organisms in a biological sense, since each individual remained physically autonomous and capable of independent action. Nevertheless, their association had important consequences for the regulation of material constraints affecting viability.

The formation of social groups altered constraint configurations by enabling cooperative access to satisfiers and collective limitation of contra-satisfiers. Through coordinated activity, individuals could obtain resources that would have been difficult or impossible to secure alone. Cooperative hunting, shared food distribution, and collective care of offspring improved the reliability with which satisfiers were acquired. At the same time, group living imposed constraints on contra-satisfiers by enabling collective vigilance and defence against predators and environmental threats. These developments reduced the material constraints affecting individual survivability.

Social assembly also enabled the sharing of experiential knowledge through symbolic communication. Information about resource locations, environmental dangers, and effective behavioural strategies could be transmitted between individuals and across generations. This further improved the regulation of material constraints by increasing the effectiveness and reliability of behavioural responses.

Importantly, these early social groups remained only loosely integrated. Their viability depended on the continued participation of individual agents whose behaviour was regulated through reflexive engagement with material, structural, and cultural constraints. Social assembly therefore represents an emergent form of organisation in

which constraint regulation began to operate at the collective level, while remaining grounded in the agency of individual members.

The formation of hominid bands thus constituted a significant extension in the regulation of material constraints, enabling more stable and resilient forms of viability than were possible for isolated individuals. At the same time, persistent social assembly created the conditions for further emergent developments, including the differentiation of roles and the more complex organisation of satisfier production and distribution. The following section examines how such social functional differentiation introduced new mechanisms for regulating material, structural, and cultural constraints within increasingly complex social systems.

4.2 Social Functional Differentiation

While social assembly improved the regulation of material constraints through cooperation, early hominid groups were initially characterised by a high degree of functional similarity among their members. Most individuals participated in broadly the same activities, such as foraging, tool use, and offspring care. A further major transition occurred with the emergence of social functional differentiation, in which individuals increasingly specialised in particular roles within the group.

The division of labour altered constraint configurations by improving the efficiency and reliability with which satisfiers were produced and distributed. Individuals specialising in particular activities could develop skills and knowledge that enhanced their effectiveness, thereby increasing the overall productivity of the group. This reduced material constraints on satisfier acquisition, allowing larger and more stable populations to be sustained. Cooperative interdependence became more pronounced, as individuals relied not only on their own activities but also on the specialised contributions of others.

At the same time, functional differentiation introduced new forms of structural constraint. As roles became established, they defined patterns of activity and expectation that constrained what individuals could and could not do within the social system. The organisation of the group thus began to take on a more stable structural form, with differentiated positions contributing to the maintenance of collective viability.

Functional differentiation also gave rise to more developed **cultural constraints**. Shared norms, values, beliefs, and bodies of knowledge emerged governing the performance of roles, the distribution of satisfiers, and the relationships between members of the group. These cultural frameworks defined what individuals should and should not do in particular contexts and provided a basis for coordinating behaviour within increasingly complex social systems. Cultural constraints thus became more

deeply embedded in the organisation of the group, reinforcing patterns of cooperation and stabilising role relationships over time.

Through social functional differentiation, constraint regulation became more structured and systematic. The production, distribution, and protection of satisfiers were no longer managed solely through undifferentiated cooperation but through organised patterns of specialised activity. This enabled social systems to maintain viability under conditions that would have exceeded the capabilities of less differentiated groups.

At the same time, the increasing complexity and scale of differentiated social systems introduced new challenges in coordinating material flows and maintaining cultural continuity. These challenges created the conditions for further emergent developments, including the evolution of infrastructure and the external storage of symbolic information, which provided new mechanisms for regulating constraints at the societal level.

4.3 Infrastructure and Stored Agency

As social systems grew in size and functional complexity, the regulation of constraints increasingly depended on mechanisms that extended beyond the immediate interactions of individuals. In particular, the efficient distribution of satisfiers across space and time became a critical challenge. This led to the emergence of infrastructure: persistent material arrangements such as pathways, transport routes, water systems, and later energy and communication networks, which enabled the reliable movement of resources within the social system.

Infrastructure altered constraint configurations by reducing the material constraints associated with distance, environmental variability, and temporal fluctuation. Satisfiers could be transported more efficiently from locations of production to locations of use, and contra-satisfiers such as waste could be removed more effectively. This increased the stability and scale of viable social systems, allowing larger populations to be supported and more specialised forms of functional differentiation to be sustained. Infrastructure thus performed a role analogous to circulatory systems in biological organisms, regulating the flow of causal inputs required for systemic viability.

A parallel development was the emergence of writing and other forms of external symbolic storage, which enabled information to persist independently of individual memory. Prior to this development, cultural continuity depended on direct interpersonal transmission, which limited the stability and scale of social organisation. Writing altered structural and cultural constraint configurations by preserving symbolic representations of knowledge, norms, and procedures across time and space.

Through written records and their later technological extensions, social systems acquired the capacity to store and transmit what may be understood as stored agency:

the capacity for past agents to influence future action through persistent symbolic structures. Laws, technical instructions, administrative records, and scientific knowledge could guide behaviour long after their originators were no longer present. This stabilised cultural constraints by maintaining normative continuity and stabilised structural constraints by preserving patterns of organisation and coordination.

The combined emergence of infrastructure and stored agency enabled social systems to regulate material, structural, and cultural constraints with far greater reliability and precision than had previously been possible. These developments supported the persistence of increasingly complex forms of social organisation and created the conditions for a further major transition: the capacity of social systems to reflect upon and deliberately modify their own organisation. The following section examines the emergence of this capacity in the form of reflexive societal self-modification.

4.4 Reflexive Societal Self-Modification

The emergence of infrastructure and stored agency enabled social systems to stabilise the regulation of material, structural, and cultural constraints across extended spatial and temporal scales. A further major transition occurred when social systems acquired the capacity not only to preserve and reproduce existing constraint configurations, but also to examine and deliberately modify them. This development is most clearly expressed in the emergence of science, governance, and formal planning.

Science provided systematic methods for investigating the causal structure of the natural and social world (Popper, 1959). By generating reliable knowledge about the relationships between actions and their consequences, scientific activity enabled social systems to regulate material constraints more effectively by improving their understanding of causal relationships. For example, advances in agriculture, medicine, and engineering altered constraint configurations by increasing access to satisfiers and reducing exposure to contra-satisfiers. Science thus extended the capacity of social systems to modify the conditions affecting their viability.

At the same time, the emergence of formal governance introduced new mechanisms for regulating structural and cultural constraints. Legal systems, administrative institutions, and formal decision-making processes enabled societies to define and enforce rules and norms governing behaviour at scale. These structures provided a means through which social systems could alter their own organisation, redefining what agents could and could not do, and what they should and should not do, within the social order.

Planning further extended this capacity by enabling the deliberate design and implementation of structural and material arrangements intended to achieve specific outcomes. Through planning, societies could anticipate future conditions and modify infrastructure, institutions, and practices accordingly. This altered constraint configurations proactively, rather than solely in response to immediate pressures.

Together, science, governance, and planning represent the emergence of reflexive societal self-modification: the capacity of a social system to regulate its own structural and cultural constraints through the reflexive agency of its members. In this process, societies become capable of examining the conditions affecting their viability and deliberately modifying the organisation through which those conditions are regulated.

This development represents the societal-level expression of the enhanced morphogenetic cycle. Material, structural, and cultural constraints condition the actions of agents, whose reflexive engagement leads to the reproduction or transformation of those constraints over time. The morphogenetic cycle thus becomes not only a feature of individual social interaction but a property of society as a whole, operating across extended temporal and organisational scales.

Reflexive societal self-modification represents the most recent stage in the evolutionary sequence described here. It is through this capacity that modern human societies regulate the constraints affecting their continued persistence and proliferation through the regulation of satisfiers and contra-satisfiers, and it is within this context that the enhanced morphogenetic cycle finds its fullest expression.

5. The Evo-Socio Correspondence

5.1 The Evolutionary Correspondence Between Human Organisms and Human Societies

The evolutionary sequence described in the preceding sections gives rise to a systematic correspondence between the organisation of human organisms and that of human societies. This correspondence is not metaphorical, but arises because both are viability-maintaining systems whose persistence depends on regulating constraints on satisfiers and contra-satisfiers. As each system increases in complexity, new emergent properties alter constraint configurations, enabling new forms of viability. Because both follow this same constraint regulation pathway, they develop functionally analogous mechanisms.

In the case of the human organism, viability depends on processes that regulate material constraints through metabolism and internal distribution, structural constraints through nervous system coordination and learning, and behavioural regulation through reflexive agency. In the case of human society, viability likewise depends on processes that regulate material constraints through economic production and infrastructure, structural constraints through communication and institutional organisation, and cultural constraints through symbolic systems, stored knowledge, and governance. These parallels are summarised in Table 1.

Table 1. Evolutionary correspondence between human organisms and human societies

Constraint regulation function	Human organism	Human society
Material satisfier production	Metabolism	Economic production
Material satisfier distribution	Circulatory system	Infrastructure
Structural coordination	Nervous system	Communication systems
Structural adaptation	Learning	Cultural learning
Stored structural and cultural continuity	Memory	Writing and stored knowledge
Reflexive constraint regulation	Reflexive agency	Science, governance, and planning

In each case, the emergent property alters constraint configurations in ways that improve the system's capacity to maintain viability. Metabolism enables the organism to regulate material requirements, while economic production performs the same function at the societal level. Circulatory systems distribute satisfiers within the organism, while infrastructure distributes satisfiers within society. Nervous systems coordinate behaviour within the organism, while communication systems coordinate behaviour within society. Memory preserves structural adaptations within the organism, while writing preserves structural and cultural continuity within society. Finally, reflexive agency enables the organism to regulate its own behaviour in light of perceived constraints, while science, governance, and planning enable society to regulate its structural and cultural constraints.

This correspondence arises because both human organisms and human societies emerge through the progressive regulation of material, structural, and cultural constraints affecting their viability. As new forms of organisation arise, they enable more effective constraint regulation, allowing increasingly complex systems to persist and proliferate. The enhanced morphogenetic cycle represents the form this process takes in reflexive social systems, just as reflexive cognition represents its expression at the level of the individual organism.

This correspondence provides a foundation for explaining why the morphogenetic cycle has the structure that it does. It reflects not an arbitrary sociological construct, but the latest stage in a continuous evolutionary process through which viable systems acquire progressively more powerful means of regulating the constraints affecting their continued existence.

5.2 Explanation of the Evo-Socio Hypothesis

The evo-socio hypothesis proposed here is that the correspondence between the evolutionary development of human organisms and that of human societies arises from shared constraint conditions affecting their viability. Both types of system persist only insofar as their organisation regulates material, structural, and cultural constraints sufficiently to maintain access to satisfiers and limit exposure to contra-satisfiers. The observed parallels therefore reflect common causal conditions, rather than metaphorical resemblance or historical coincidence.

In both organisms and societies, viability depends on the regulation of material constraints affecting the production and distribution of causal inputs, structural constraints affecting the coordination of internal processes, and, at higher levels of complexity, cultural constraints affecting behaviour through symbolic regulation. These constraints create selective conditions favouring forms of organisation that regulate them more effectively. Over time, systems possessing emergent properties that improve constraint regulation persist and proliferate, while those that do not are less likely to endure.

Because human societies are composed of human agents, and those agents themselves are viability-maintaining systems, social organisation develops under constraint conditions that are continuous with those that shaped the evolution of the organism. As a result, emergent social structures that regulate material flows, coordinate collective activity, preserve organisational continuity, and enable reflexive self-modification perform functions analogous to those performed by metabolism, nervous systems, memory, and reflexive cognition in individual organisms. These similarities reflect shared functional requirements arising from constraint regulation, not shared physical structure.

The evo-socio hypothesis therefore provides a causal explanation for the structural correspondence identified above. Both human organisms and human societies represent successive stages in a continuous evolutionary sequence in which increasingly complex systems emerge through progressively more effective regulation of constraints on satisfiers and contra-satisfiers. The morphogenetic cycle is the form this process takes in reflexive social systems, just as reflexive cognition is its expression at the level of the individual organism.

Understanding the evo-socio correspondence in these terms clarifies why social systems possess structural, cultural, and reflexive properties analogous to those found in individual human agents. These properties arise because both types of system are shaped by the same underlying requirement: the regulation of constraints necessary for continued viability.

This correspondence is developed further in a subsequent paper, where its implications for social theory and systems modelling are examined in greater detail.

6. The Enhanced Morphogenetic Cycle as the Latest Expression of This Evolutionary Process

The evolutionary sequence described in the preceding sections provides the foundation for understanding the morphogenetic cycle as the most recent expression of constraint regulation in viable systems. Figure 1 illustrates the enhanced morphogenetic cycle as it operates in reflexive social systems. In this framework, the cycle represents the

integrated regulation of material, structural, and cultural constraints through reflexive agency.

In reflexive social systems, agents are capable of recognising these different classes of constraint and responding to them deliberately. Reflexive agency enables agents to evaluate their conditions in relation to their needs and to act in ways that reproduce or modify the constraint configurations affecting their viability. Through these actions, agents participate in the ongoing regulation of the social systems in which they exist.

The morphogenetic cycle therefore represents the coordinated operation of constraint regulation across all three domains. Material, structural, and cultural constraints condition the actions of agents, whose reflexive engagement leads to the reproduction or transformation of those constraints over time. In this way, social systems acquire the capacity to regulate their own organisation through the agency of their members.

The enhanced morphogenetic cycle makes explicit the causal structure of this process by identifying the distinct classes of constraint involved and the role of satisfiers and contra-satisfiers in mediating the relationship between constraint and agency. It therefore provides a model of how constraint regulation operates in reflexive social systems.

From this perspective, the morphogenetic cycle is not an isolated sociological phenomenon but the latest stage in a continuous evolutionary process through which viable systems progressively acquire the capacity to regulate the constraints affecting their continued persistence and proliferation.

7. Implications

7.1 Implications for Social Theory

Understanding the morphogenetic cycle as the latest expression of an evolutionary process of constraint regulation provides a deeper foundation for social theory. Rather than treating structure, culture, and agency as phenomena unique to human society, this perspective situates them within a continuous sequence of emergent developments through which viable systems progressively acquired new capacities to regulate the constraints affecting their persistence and proliferation. This situates the core concepts of social theory within an evolutionary framework, linking them to general principles governing the emergence and stability of organised systems.

From this standpoint, agency can be understood as an emergent capacity that arises when systems acquire the ability to regulate structural constraints on their own behaviour. Agency is not an irreducible or mysterious property but an emergent consequence of the evolution of nervous systems, learning, and self-representation. Reflexive agency, in particular, emerges when systems become capable of recognising

and responding to cultural constraints through symbolic communication. This clarifies the origin of agency while preserving its causal significance within social processes.

Similarly, culture may be understood as an emergent form of constraint regulation that operates through symbolic systems. Cultural norms, values, and beliefs are not merely interpretive frameworks but causal structures that regulate behaviour by defining what agents should and should not do. The emergence of symbolic communication enabled these cultural constraints to persist beyond individual experience and to shape the organisation of social systems across generations. Culture thus represents a distinct level of organisation within the broader evolutionary sequence.

This perspective also clarifies the relationship between structure and culture. Both are forms of constraint that regulate behaviour, differing primarily in their mode of operation. Structural constraints regulate behaviour by defining what actions are possible within a given system, while cultural constraints regulate behaviour by defining what actions are appropriate. Their interaction, mediated through reflexive agency, constitutes the morphogenetic cycle.

By situating structure, culture, and agency within a unified evolutionary framework, the enhanced morphogenetic cycle provides a causal explanation for their emergence and operation. Social theory can therefore be understood not as a separate domain governed by fundamentally different principles, but as the study of a particular class of viability-maintaining systems whose organisation has evolved to regulate material, structural, and cultural constraints through reflexive agency.

7.2 Implications for Understanding Societal Viability

Viewing social systems through the framework of constraint regulation provides a clearer basis for understanding societal viability. Just as individual organisms persist only insofar as they regulate constraints on satisfiers and contra-satisfiers, societies persist only insofar as their organisation enables the effective regulation of material, structural, and cultural constraints affecting their continued existence. Social stability is therefore not a static condition but an ongoing process in which constraint configurations must be continuously reproduced or adapted in response to changing conditions.

At the material level, societies must maintain reliable access to the causal inputs required for their functioning, including energy, resources, and environmental conditions necessary for human life. Failures in the regulation of these constraints, such as disruptions to production, distribution, or environmental stability, can undermine the satisfiers on which social organisation depends, leading to instability or decline.

At the structural level, societies must maintain patterns of organisation that enable coordinated activity. If structural constraints become misaligned with material conditions or with the needs of the population, the effectiveness of collective action may be reduced. This can impair the ability of the social system to regulate material constraints, further weakening its viability.

At the cultural level, societies must maintain constraints that support cooperation and guide behaviour in ways consistent with systemic viability. Cultural constraints influence how agents interpret their conditions and respond to them. If cultural constraints fail to support effective responses to material and structural challenges, or if they inhibit reflexive recognition of emerging constraints, the capacity of the society to adapt may be diminished.

Because social systems depend on the reflexive agency of their members to regulate these constraints, societal viability is closely linked to the capacity for accurate recognition and effective response. When agents are able to recognise material, structural, and cultural constraints and act in ways that regulate them appropriately, social systems can maintain stability and adapt to changing conditions. Conversely, when constraint regulation becomes ineffective, whether through material disruption, structural rigidity, or cultural processes that inhibit reflexive engagement, societies may experience increasing instability.

Societal persistence is therefore not guaranteed but depends on the continued effectiveness of constraint regulation across multiple domains. Stability and change may therefore be understood as outcomes of the ongoing process through which social systems regulate the constraints affecting their viability.

7.3 Implications for Future Evolution

Understanding the morphogenetic cycle as a process of constraint regulation has important implications for future evolution. With the emergence of reflexive societal self-modification, the regulation of material, structural, and cultural constraints is no longer shaped solely by non-reflexive processes such as natural selection, but increasingly by the deliberate actions of reflexive agents operating within social systems. This represents a significant transition in evolutionary dynamics, as societies acquire the capacity to examine and modify the constraint configurations affecting their own viability.

At the societal level, this process takes the form of **cultural morphogenesis**, in which cultural constraints, i.e., norms, values, beliefs, knowledge, and symbolic systems, are progressively reproduced or transformed through reflexive engagement. Cultural morphogenesis may be understood as cultural evolution: the cumulative modification of symbolic and institutional structures over time (Boyd & Richerson, 1985) (Odling-Smee, Laland & Feldman, 2003). Through science, governance, education, and other

forms of collective reflexivity, societies alter the cultural and structural conditions that shape behaviour, thereby influencing the trajectory of their own development.

Importantly, cultural morphogenesis can also alter the material and selective environments within which biological evolution occurs. By modifying patterns of behaviour, resource use, and environmental interaction, cultural developments may create new selection pressures affecting human populations. Over longer timescales, such changes can influence biological evolution itself. In this way, cultural evolution does not replace biological evolution but becomes an additional pathway through which the constraint configurations affecting viability are transformed.

Reflexive societal constraint regulation therefore represents a continuation of the evolutionary process by new means. The capacity of social systems to generate and preserve knowledge, to reflect upon their own organisation, and to deliberately modify their structural and cultural constraints introduces new possibilities for adaptation and transformation. At the same time, this capacity introduces new risks, as ineffective or maladaptive constraint regulation may undermine societal viability.

Future evolution will thus be shaped increasingly by the interaction between biological inheritance and culturally mediated constraint regulation. The morphogenetic cycle provides a framework for understanding this process by describing how reflexive agents participate in the ongoing reproduction and transformation of the constraint configurations affecting their collective viability.

8. Conclusion

This paper has argued that the enhanced morphogenetic cycle is not a phenomenon unique to human society, but the latest stage in a continuous evolutionary process through which viable systems progressively regulate constraints on satisfiers and contra-satisfiers. By situating the morphogenetic cycle within this broader framework, its structure and operation can be understood as the outcome of a long sequence of emergent developments extending from early living systems to contemporary reflexive societies.

The analysis established viability as the fundamental condition governing the persistence and proliferation of systems, and identified satisfiers and contra-satisfiers as the causal inputs that maintain or undermine that viability. From this perspective, the organisation of viable systems can be understood in terms of their capacity to regulate the constraints affecting these inputs. Emergent properties such as compartmentalisation, metabolism, nervous systems, symbolic communication, and infrastructure were shown to alter constraint configurations in ways that enabled new forms of viability.

Within this sequence, the emergence of reflexive agency introduced the capacity for systems to recognise and deliberately modify the material, structural, and cultural constraints affecting their own organisation. The morphogenetic cycle represents the form this process takes in reflexive social systems, as agents reproduce or transform the constraint configurations that condition their behaviour.

Understanding the morphogenetic cycle in these terms provides a unified explanation for the emergence of biological, psychological, and social organisation. It clarifies the origin of agency, the role of culture, and the basis of social stability and change, while situating human society within a continuous evolutionary process governed by constraint regulation. The enhanced morphogenetic cycle therefore offers both a model of social morphogenesis and a framework for understanding the broader evolutionary context in which reflexive social systems have emerged.

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Appendix A: Evolutionary Stages in the Constraint Regulation Pathway

This table provides a summary of the evolutionary sequence described in the main text in terms of successive emergent properties and their effects on constraint regulation. It illustrates how increasingly complex forms of organisation emerged through progressive modification of material, structural, and cultural constraint configurations. The morphogenetic cycle represents the latest stage in this sequence.

Table A1. Evolutionary stages in the constraint regulation pathway

Stage	Emergent property	Constraint class primarily affected	Constraint regulation function	Resulting capability
1	Catalysis	Material	Reduces energetic constraints on chemical transformation	Enables reliable chemical processes
2	Autocatalysis	Material	Reduces constraints on the continuation of production processes	Enables self-sustaining chemical networks
3	Autocatalytic sets	Material	Stabilises self-sustaining production networks	Enables persistent chemical organisation
4	Compartmentalisation	Material	Reduces dispersion of components and environmental interference	Enables stable internal environments
5	Metabolism	Material	Regulates acquisition and use of external satisfiers	Needs emerge
6	Replication	Material	Regulates constraints on lineage continuity	Enables persistence beyond individual lifespan
7	Cellular coupling	Structural	Enables coordination between interacting units	Enables multicellular organisation
8	Cellular differentiation	Structural	Enables functional specialisation within multicellular systems	Improves efficiency and survivability
9	Organism reproduction	Material / Structural	Stabilises developmental organisation	Enables complex organism persistence
10	Nervous system	Structural	Regulates behavioural coordination	Enables adaptive behaviour
11	Learning	Structural	Modifies behavioural organisation	Enables behavioural adaptation

12	Self-representation	Structural	Enables internal modelling of self and environment	Enables functional agency
13	Symbolic communication	Cultural	Enables shared symbolic constraint regulation	Enables normative coordination
14	Reflexive agency	Cultural	Enables reflexive regulation of cultural constraints	Enables morphogenetic action
15	Social assembly	Material	Enables cooperative regulation of material constraints	Improves survivability
16	Social functional differentiation	Structural	Enables functional differentiation of roles	Improves social efficiency
17	Infrastructure	Material	Enables reliable resource distribution	Enables large-scale societies
18	Stored agency (writing, knowledge storage)	Cultural	Enables continuity and accumulation of constraint regulation	Enables cultural accumulation
19	Governance, science, planning	Cultural / Structural	Enables deliberate regulation of structural and cultural constraints	Enables societal self-modification
20	Reflexive social systems	Integrated	Integrates regulation of material, structural, and cultural constraints	Morphogenetic cycle fully expressed

Appendix B: Definitions and Propositions for Constraint Regulation and Morphogenesis

These definitions and propositions provide a formal framework for understanding the morphogenetic cycle as part of a universal evolutionary process of constraint regulation governing the persistence and proliferation of viable systems.

Definitions and propositions referenced from the General Systems Theory (GST) and earlier Social Systems Theory (SST) papers retain their original numbering. New definitions introduced in this paper are numbered sequentially, e.g., D2.x or P2.y.

Definitions

System (Defined in the GST Series)

A system is an organised set of components and processes whose interactions produce identifiable properties and whose organisation may persist over time.

Emergent Property (Defined in the GST Series)

An emergent property is a property arising from the organisation of a system that alters constraint configurations affecting system viability.

Viability (Defined in the GST Series)

Viability is the capacity of a system to persist and/or proliferate through the continuation of its organisation.

D1.1 – Morphogenetic Cycle (Defined in SST 01)

The Morphogenetic Cycle is a temporally sequenced process through which social structures and cultural systems condition social interaction, and through which the outcomes of that interaction either reproduce existing arrangements (morphostasis) or transform them (morphogenesis).

D1.2 – Morphostasis (Defined in SST 01)

Morphostasis refers to the reproduction or maintenance of existing structural and cultural arrangements through social interaction.

D1.3 – Morphogenesis (Defined in SST 01)

Morphogenesis refers to the elaboration, modification, or transformation of structural and cultural arrangements arising from social interaction.

D1.4 – Material Constraint (Defined in SST 01)

A material constraint is a constraint arising from physical, energetic, or environmental conditions that define the conditions required for a system to maintain viability.

D1.5 – Structural Constraint (Defined in SST 01)

A structural constraint is a constraint arising from the organisation of a system that affects what actions or processes can or cannot occur.

D1.6 – Cultural Constraint (Defined in SST 01)

A cultural constraint is a constraint arising from shared symbolic systems (including norms, values, beliefs, knowledge, and symbols) that affects what agents should or should not do.

D1.7 – Need (Defined in SST 01)

A need is a condition that must be satisfied for the continuation of processes required to maintain system viability. Needs arise when viability depends on ongoing causal inputs.

D1.8 – Satisfier (Defined in SST 01)

A satisfier is a process-maintaining causal input that contributes to the persistence or proliferation of a system. Different satisfiers may fulfil the same underlying need depending on context.

D1.9 – Contra-satisfier (Defined in SST 01)

A contra-satisfier is a process-inhibiting causal input that degrades, destabilises, or prevents the persistence or proliferation of a system.

D2.1 – Constraint

A constraint is any condition that alters the probability, availability, or effectiveness of causal inputs (satisfiers and contra-satisfiers) affecting system viability.

D2.2 – Constraint Regulation

Constraint regulation is the process by which systems alter constraint configurations affecting access to satisfiers and exposure to contra-satisfiers.

This may involve:

- Constraint reduction on satisfiers
- Constraint imposition on contra-satisfiers

D2.3 – Agency

Agency is the capacity of a system to regulate structural constraints affecting its own behaviour in ways that affect its viability.

D2.4 – Reflexive Agency

Reflexive agency is the capacity of a system to recognise and deliberately regulate material, structural, and cultural constraints affecting its own viability.

Propositions

The propositions developed in SST Paper 1 may be understood as domain-specific expressions of the more general principles of constraint regulation described here.

P2.1 – Viability Constraint Proposition

Systems persist and proliferate only insofar as their organisation regulates constraints on satisfiers and contra-satisfiers sufficiently to maintain viability.

P2.2 – Needs Emergence Proposition

Needs emerge when the persistence of a system depends on ongoing access to satisfiers required for the continuation of viability-maintaining processes.

P2.3 – Constraint Regulation Proposition

Systems whose organisation reduces constraints on satisfiers and imposes constraints on contra-satisfiers are more likely to persist and proliferate.

P2.4 – Emergence Proposition

Emergent properties persist when they alter constraint configurations in ways that improve system viability.

P2.5 – Evolutionary Constraint Regulation Proposition

Evolutionary development proceeds through the successive emergence of properties that enable increasingly effective constraint regulation.

P2.6 – Agency Emergence Proposition

Agency emerges when systems acquire the capacity to regulate structural constraints affecting their own behaviour.

P2.7 – Reflexive Agency Proposition

Reflexive agency emerges when systems acquire the capacity to recognise and regulate cultural constraints, and thereby to modify structural and material constraints affecting their own viability.

P2.8 – Social Emergence Proposition

Social systems emerge when constraint regulation occurs through coordinated interaction between multiple agents.

P2.9 – Cultural Evolution Proposition

Cultural morphogenesis enables the cumulative modification of cultural constraints affecting system viability.

P2.10 – Evo-Socio Correspondence Proposition

Human organisms and human societies exhibit corresponding organisational properties because both emerged through the progressive regulation of material, structural, and cultural constraints affecting viability.

P2.11 – Morphogenetic Cycle Evolution Proposition

The morphogenetic cycle is the latest evolutionary expression of constraint regulation in reflexive social systems.

P2.12 – Societal Viability Proposition

Societal stability depends on the continued effectiveness of constraint regulation affecting satisfiers and contra-satisfiers. Failure of constraint regulation leads to instability or decline.

P2.13 – Cultural-Biological Evolution Coupling Proposition

Cultural morphogenesis may alter the selective environments affecting biological evolution.

P2.14 – Universal Constraint Regulation Proposition

The regulation of constraints on satisfiers and contra-satisfiers is a universal principle governing the persistence and proliferation of viable systems.