GST 114 — Emergence and Evolutionary Change

Formal Description

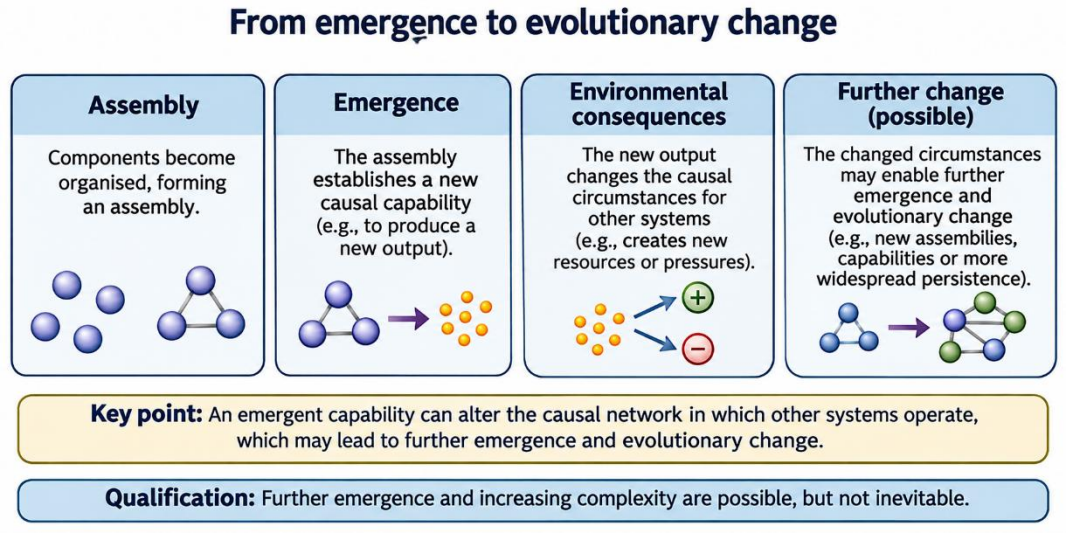
An emergent capability may change the causal circumstances experienced by other entities through the physical transfers it produces or accepts. Its outputs can enable, constrain or disrupt causal interactions, affecting the persistence, proliferation, assembly and disassembly of other systems. These effects may create opportunities for further emergence, but neither increasing complexity nor further emergence is inevitable. The proposed general evolutionary pathway described below is a hypothesis; its operation must be investigated in each physical domain.

Plain English Explanation

When a system develops a new capability, the consequences need not stop at its boundary. What it produces may enter the environment and affect other entities. Some may already be able to accept that output; others may subsequently acquire ways of using it. The effects can be helpful, harmful or irrelevant, depending on the receiving system and circumstances.

Imagine an organism that begins releasing a substance into its surroundings. Other organisms might use it as a resource, be harmed by it, or be unaffected. Those interactions can alter which organisms survive or reproduce and may change the opportunities for new assemblies and capabilities to arise.

The important distinction is between how an emergent capability is established within an assembly and what happens afterwards because that capability is exercised. Evolutionary consequences arise through further causal interactions, not simply because emergence has occurred. Nor is evolution necessarily a march towards greater complexity.



The diagram shows one possible route from an emergent capability to changes in other systems. The arrows indicate possible causal connections, not a fixed or unavoidable progression. Outputs may also produce several effects at once, including feedback to the originating system.

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Examples

Oxygen-producing photosynthesis. Early oxygen-producing organisms released oxygen into their surroundings. Over geological time, this changed chemical and ecological conditions. Oxygen was harmful to some organisms but for others enabled metabolic opportunities. The broader changes involved many interacting processes; they were not the inevitable result of one isolated event.

The evolution of vision. Early light-sensitive arrangements could detect illumination. Later organisational changes enabled direction sensing and, in some lineages, more detailed imaging. Some stages established distinct capabilities, while others improved existing ones. Those capabilities could change how organisms found resources, avoided danger and interacted with one another.

A social example: digital communication. Organisations that develop new ways of exchanging physically embodied information can change how other organisations coordinate, compete and respond. The consequences depend on how people and institutions adopt and use the technology; they may include benefits and contra-effects.

Provenance and Links

This module develops the account of the evolutionary consequences of emergence in *A Causal Account of Emergence* (Challoner, 2026) and builds upon *Causal Assembly Theory: Assembly and Disassembly as Causal Processes* (Challoner, 2026). It connects the causal explanation of emergence with established biological mechanisms such as inheritance and natural selection, while treating the proposed wider cross-domain evolutionary pathway as a hypothesis requiring further investigation. Related concepts include causal transfers, environmental change, persistence, proliferation and further emergence.

Practical Exercise

Consider three cases not developed in the examples above: (a) a beaver colony builds a dam that changes water flow; (b) a manufacturer introduces a new reusable packaging system; (c) a species develops a chemical defence against predators.

For each case, identify a capability and the physical transfers involved. Trace at least two possible consequences for other entities or systems, including one potentially beneficial and one potentially harmful consequence. Explain how those effects might alter persistence, proliferation, assembly or disassembly. Identify any further emergent capability that might become possible, and distinguish that possibility from an inevitable outcome. Finally, state what observations would be needed to test your proposed causal pathway.

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