GST 92 — Investigating Emergence

Formal Description

An investigation of emergence evaluates whether the causal organisation of participating components establishes and maintains a capability to produce or accept physical transfers unavailable to those components independently. The investigation identifies a candidate capability and its transfers, reconstructs the causal process, examines the components and their independent capabilities, tests dependence upon their organisation, considers alternative explanations, and evaluates the evidence.

A conclusion of emergence must distinguish genuine causal novelty from aggregation, improved performance, activation of an existing capability, causal integration and a change in the observer's knowledge. The method is an investigative guide, not an automatic proof.

Plain English Explanation

Suppose we observe an assembly doing something that its separate components do not appear able to do. How can we find out whether a genuinely new capability has emerged? We need to trace what happens physically, rather than relying on the appearance of the finished assembly.

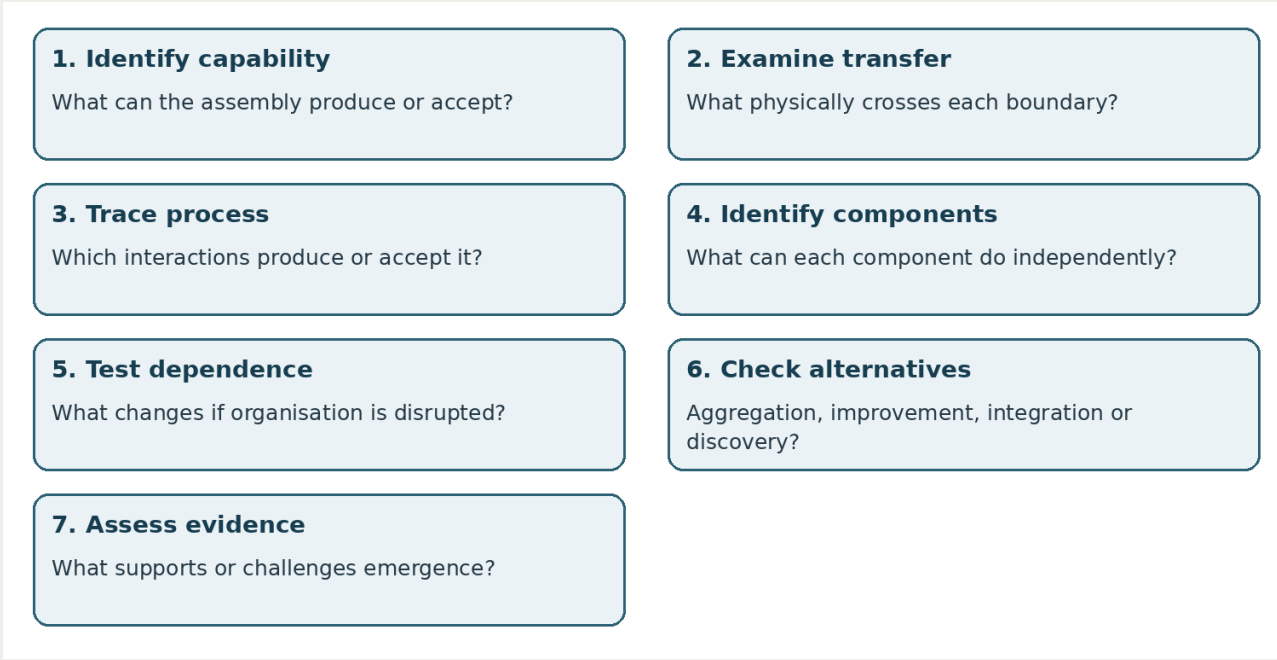
Begin by stating precisely what the assembly can do. Identify what it produces or accepts and what physical entity, energy or embodied information is transferred. Follow the transfer through the causal process: what does each component do, and what passes between components? Distinguish transfers within the assembly from those crossing its boundary.

Next, ask what each participating component could do independently. Does the capability depend on their organisation? What happens if a connection is removed, a component is isolated, or a constraint is changed? A carefully chosen comparison or intervention can be more informative than merely watching the assembly operate.

Finally, consider other explanations. Perhaps existing outputs have simply been added together, an old capability has become more efficient, or a previously inactive capability is now exercised. An existing transfer may have become internal, mediated or suppressed. Or perhaps we have discovered something that was present all along.

The outcome need not be a simple yes or no. We may find strong evidence for emergence, evidence against it, or insufficient evidence to decide. The important skill is to explain which causal relationships support the conclusion and what further tests would be useful.

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Seven questions for investigating a suspected emergent capability. The diagram is a guide to investigation, not a claim that physical causal processes occur in this order.

Examples

A thermostat-controlled heating arrangement. A heater transfers energy to its surroundings; a temperature sensor produces an electrical signal; and a controller changes the power supplied to the heater. To investigate the capability to maintain temperature within a chosen range, trace the energy and signal transfers, test what each component can do alone, and examine what happens when the feedback connection is removed. The question is whether the organised arrangement establishes a capability unavailable to the components independently.

A chemical reaction complex. Two molecules may temporarily interact in a configuration that enables a reaction pathway unavailable to either molecule separately. Identify the transferred entities and energy exchanges, compare the interacting and separate molecules, and determine whether the proposed capability depends on the short-lived organisation. The duration of the complex does not by itself settle whether emergence occurs.

A coordinated emergency response. Several people and communication devices may jointly identify incidents, allocate tasks and direct assistance. Trace spoken, electronic and material transfers between participants. Compare the collective capability with what individuals and devices could achieve independently, while considering whether the apparent improvement is simply increased capacity or a genuinely new organised capability.

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Provenance and Links

This module draws on the investigative procedure in *A Causal Account of Emergence* (Challoner, 2026) and on the treatment of components, assembly, causal processes and physical transfers in *Causal Assembly Theory* (Challoner, 2026). Related concepts include emergence, causal integration, transfer internalisation, transfer mediation, capability suppression and latent causal potential.

The method is consistent with the wider scientific practice of testing causal explanations by comparison, intervention and examination of alternative hypotheses. The proposed criteria for emergence remain open to refinement through cross-domain case studies.

Practical Exercise

Investigate a pedestrian crossing with a push-button, traffic signals and a controller. Its apparent capability is to coordinate traffic stopping and pedestrian crossing in response to a request. Do not assume at the outset that the capability is emergent.

Apply the seven questions in the diagram. Identify the physical transfers involved (including electrical signals, light and the movements of road users); identify what the components can do independently; and propose one intervention that would test whether the capability depends on their organisation. Distinguish internal from external transfers.

Consider at least two alternative explanations for the observed behaviour. Conclude whether the available evidence supports emergence, does not support it, or is insufficient. Explain what additional evidence would change your assessment.

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