GST 93 — How Assemblies Form and Persist

Formal Description

This module explains how assemblies form and why they persist. Its central distinction is between the processes establishing organised component participation and the interactions and constraints maintaining it. Separating these questions helps connect familiar forms of organisation with the physical mechanisms that make them possible.

Formation requires suitable entities to encounter one another under conditions permitting assembly. Concentration, orientation, movement and timing can affect these opportunities. Environmental flows, surfaces and boundaries can bring entities together or retain them within a region. These circumstances enable or constrain assembly, but relevant interactions must still establish component relationships.

Physical interactions can establish, maintain, transform or disrupt assemblies. Electromagnetic interactions underlie chemical bonding and many contact interactions. The strong interaction contributes to nuclear binding, while gravity maintains bound astronomical relationships. Weak interactions can transform participating particles and thereby contribute to formation or breakdown; they are not a general binding mechanism.

Agents can also select, transport and organise components. Their activity directs physical interactions rather than introducing a separate fundamental form of causality. Existing biological organisation can likewise produce and position components without conscious intention. Deliberate construction is therefore just one route to assembly, rather than a requirement for it.

Energy transfers can allow entities to enter bound arrangements. Assembly may release energy to the surroundings, may require an initiating input to cross an energetic barrier, or involve both. A resulting assembly may persist because separation requires energy unavailable under prevailing conditions, or because a barrier restricts access to a different arrangement. However, at quantum scales, a particle may sometimes pass through an energetic barrier without acquiring enough energy to go over it. This is called quantum tunnelling. It opens a possible route for change while conserving energy.

Persistence can also involve configurational constraints. Interlocking or surrounding structures can obstruct component movement, with physical interactions enforcing that restraint. Other assemblies require continuing inputs, repair or coordinated activity. Formation and persistence can, therefore, involve different mechanisms, although the same interactions can also perform both roles.

Where one component causally constrains, enables or influences another, they are causally coupled. Coupling may be direct or indirect, intermittent or one-way. Organisation can therefore persist through a network without every component interacting continuously with every other.

By the end of the module, the learner should be able to distinguish formation from maintenance, explain environmental and agentic contributions, and identify binding, energetic barriers, configurational retention and continuing-input maintenance in contrasting cases.

© John A Challoner, 2026.

Plain English Explanation of Formation and Maintenance

Return to the drainage work introduced in the previous module. The replacement pipes have been joined and supported. To explain the assembled pipework, we need to answer two questions: what established the connections, and what now keeps them effective?

During installation, people selected the sections, aligned their ends and used tools to make the joints. Afterwards, the tools were removed and the installers left. The pipework did not therefore become disconnected. The joints, supports and surrounding structures continued to restrict movement and preserve the route.

Closing a zip provides an even simpler example. Moving the slider brings the teeth into an interlocking arrangement. Once the slider stops, their shapes and contact interactions resist separation. So, continued movement of the slider is unnecessary for the closed part to remain assembled.

The distinction is between roles, rather than necessarily between different kinds of interaction. In some cases, interactions that establish an assembly continue to maintain it. In others, the formation process ends and different relationships maintain the result. We should identify what happens in each case rather than assume that either pattern applies universally.

Suitable encounters are also important. Imagine dissolved ions in water as evaporation increases their concentration. Under suitable conditions, ions can become incorporated into a growing salt crystal. Evaporation helps establish the circumstances for growth; interactions involving the ions establish the crystal lattice. The crystal can remain after evaporation has ended.

Other environmental circumstances may prevent assembly. Compatible entities may be too dispersed, wrongly oriented or available at different times. Alternatively, a channel may direct them towards one another. This is why increasing the number of encounters can promote assembly without guaranteeing that every encounter produces incorporation.

An agent can deliberately create suitable conditions, but the distinction between formation and maintenance also applies without an agent. A builder positions and joins materials; a bird collects and interweaves nesting material. Both establish physical structures. The bird’s involvement makes the cause agentic.

Biological assembly can be illustrated by a developing leaf. Cells divide, grow and become organised into tissues. Continuing cellular activity and supplies from the plant then contribute to maintenance. Growth and maintenance can occur together, so assembly need not be confined to an entity’s beginning.

We therefore need to ask more than who or what brought the components together. We also need to identify what keeps them participating, whether that requires continuing activity, and what change would allow the organisation to break down.

© John A Challoner, 2026.

Plain English Explanation of Energy and Retention

Why can some assemblies remain in place after their formation process ends? One reason is binding. A bound arrangement can have lower energy than the corresponding separated components. Separating those components then requires an appropriate interaction supplying sufficient energy.

An electron bound in an atom provides an example. Removing it from that atom requires sufficient energy to be transferred through an appropriate interaction. The atom does not need a continual external energy supply simply to retain that bound electron.

Formation must also be explained. When initially separate entities form a lower-energy bound arrangement, the released energy must go somewhere. It may pass to another entity or leave as radiation. Merely bringing the entities close together does not explain how that energy is redistributed. The next module follows one molecular example in detail.

An initiating energy input can be necessary even when the completed change releases energy overall. This is because the route to the new arrangement may pass through an energetic barrier. The energy needed to reach that barrier and the energy difference between the starting and finishing arrangements are separate questions.

Alternatively, an assembly may occupy an arrangement that is stable against small disturbances even though a different arrangement has lower energy. In energy-landscape terms, it lies in a local minimum. A barrier can delay its escape. It may therefore persist until a suitable interaction provides a route out, after which further change can release stored energy.

The barrier is an energetic requirement along a route of change, rather than necessarily a material wall. At quantum scales, tunnelling can allow a transition through a barrier that would prevent classical passage. Persistence therefore depends upon the states, interactions and timescales involved, rather than upon the presence of a barrier alone.

Configurational retention provides another contribution. The interlocked teeth of a zip resist movement because other teeth obstruct the route of separation. A retained component cannot simply pass through the material around it. Such restraint is enforced through physical interactions; configuration is not an additional fundamental force.

These contributions can operate together. A component may be bound to neighbouring material while surrounding structures also restrict its movement. Conversely, removing a retaining structure or supplying energy may permit separation. Disassembly can require energy, release energy, or involve an initiating input followed by energy release.

Finally, an open system can contain both relatively persistent structures and activities requiring continuing inputs. A plant's molecular structures can remain between transfers, while its living organisation requires continuing supplies and maintenance. The persistence of some parts does not remove the input requirements of the whole.

© John A Challoner, 2026.

Formation

What establishes component relationships?

Maintenance

What keeps those relationships effective?

Two Questions About the Same Assembly

The mechanisms may differ or overlap. A closed zip illustrates the distinction: slider movement establishes interlocking, while the teeth's shapes and contact interactions subsequently resist separation.

Examples

Social organisation. Residents establish a flood-response group through agreement, communication arrangements and allocated responsibilities. The founding meeting can end, while later participation, training and coordination maintain the organisation. If contact details become obsolete or members stop participating, then the group's effective organisation may deteriorate.

Causal coupling. One resident's warning can enable another to close a flood gate. The relevant relationship need not operate in both directions. Nor must every resident contact every other: messages may pass through coordinators. Intermittent communication can maintain readiness, even when no flood-response operation is active.

Epistemic organisation. An investigator connects rainfall records, measured flows and evidence of infiltration in an explanation of sewer overload. Cognitive activity establishes the explanation; memory and written or digital records support its retention. New evidence can lead to revision. The represented explanatory relationships must be distinguished from physical interactions involving brains and records.

Physical persistence. A gravitationally bound pair of stars can remain organised while its members move relative to one another. Fixed positions and direct contact are therefore unnecessary. How initially unbound objects become bound requires a separate account of the formation process and its energy transfers.

Across these examples, persistence does not mean permanence or complete inactivity. It means that sufficient organisation remains through time. The useful questions are what established that organisation, what maintains it, and what would allow it to change or break down.

© John A Challoner, 2026.

Provenance and Links

This module draws upon *Causal Assembly Theory: Assembly and Disassembly as Causal Processes* and its distinction between the causes of formation and the causes of maintenance (Challoner, 2026a). It develops the account introduced in *Foundational Causality*, in which physical transfers connect sources and recipients (Challoner, 2026b).

Causal Assembly Theory brings environmental circumstances, physical interactions and agentic action into a common explanation of organised component participation. Environmental conditions affect opportunities for interaction, while agents can direct the transfers and arrangements involved. These contributions can be distinguished without treating them as mutually exclusive alternatives.

This module distinguishes the processes that bring an assembly into being from the interactions, arrangements and recurring activities that keep it intact. The next module, GST 94, illustrates that distinction using a hydrogen molecule. GST 95 then examines how components cease to participate in an assembly and how their release can be linked to assembly elsewhere.

The physical examples introduce binding, energy redistribution and barriers without attempting a full account of atomic, nuclear or gravitational processes. The following molecular case develops one specified route in detail, and a later module examines gravitational binding. Fuller use of energy landscapes remains a future development of the theory.

The zip, crystal, leaf, flood-response group and retained explanation apply the same causal questions across different domains. They do not imply that the mechanisms in those domains are identical. The broader hypotheses generated by the theory require testing through investigation of the relevant interactions, transfers and organisational relationships.

The author's developing papers and course materials can be found through Rational Understanding. This module prepares for later discussions of disassembly, transfer timing, causal networks and capabilities that remain available between occasions of activity.

Challoner, J. A. (2026a). Causal assembly theory: Assembly and disassembly as causal processes. Rational Understanding. https://rational-understanding.com/efgst/

Challoner, J. A. (2026b). Foundational causality. Rational Understanding. https://rational-understanding.com/efgst/

© John A Challoner, 2026.

Practical Exercise

Compare two assemblies: a closed zip and a residents' flood-response group. Treat the group as a hypothetical case in which residents have agreed roles, established a contact list and practised their procedures. Your task is to explain formation, maintenance and possible breakdown in each case.

First, identify the components and the relationships through which they participate. Then describe what establishes those relationships. For the zip, consider the slider's movement. For the group, consider communication, agreement and the allocation of responsibilities. Explain why a list of components alone would not answer the formation question.

Now identify what maintains each assembly after its initial formation. What continues when the slider stops or the founding meeting ends? Which relationships remain effective without repeating the original activity, and which require further activity or inputs?

For each case, describe one change that would permit disassembly or loss of effective organisation. Explain which maintaining interaction or constraint is altered. Avoid assuming that a failure of one function necessarily destroys every part of the assembly.

Next, consider a salt crystal growing as water evaporates. Distinguish the environmental change favouring growth from the interactions incorporating ions into the lattice. Explain why ending evaporation need not immediately destroy the crystal. What change in the surrounding conditions might instead favour its dissolution?

Use the flood-response example to draw a small communication network. Include a warning passing through a coordinator to another resident. Mark a one-way relationship and an indirect connection. Explain why neither continuous communication nor a direct connection between every pair is necessary for the organisation to persist. Also, explain why intermittent communications are neessary.

Finally, explain the difference between these energetic statements: separating components requires energy; reaching a different arrangement requires crossing an energy barrier. Can an initiating input be followed by energy release? In your answer, distinguish the route of change from the energy difference between its initial and final arrangements.

Conclude with a short account of an assembly from your own experience. Identify its formation process, its maintenance requirements and a possible route to breakdown. If you describe an open system, then distinguish structures that persist between transfers from activities that depend upon continuing inputs.

© John A Challoner, 2026.