GST 32 – Causal Compression

Formal Description

Causal compression is the representation of recurring causal organisations in simplified conceptual form. It enables complex patterns of interaction, transfer, constraint, and transformation to be communicated, compared, and reasoned about without requiring every underlying causal relationship to be represented explicitly.

Plain English Explanation

Once people begin to understand why things happen, they face a new problem.

The causal relationships responsible for most events are often extremely complex. A single outcome may depend upon hundreds or thousands of interacting causes. If every causal relationship had to be described in detail, communication and reasoning would quickly become impossible.

To overcome this difficulty, humans develop causal compressions.

A causal compression is a concept that represents a recurring causal organisation. Instead of describing every individual interaction, the concept summarises the overall pattern.

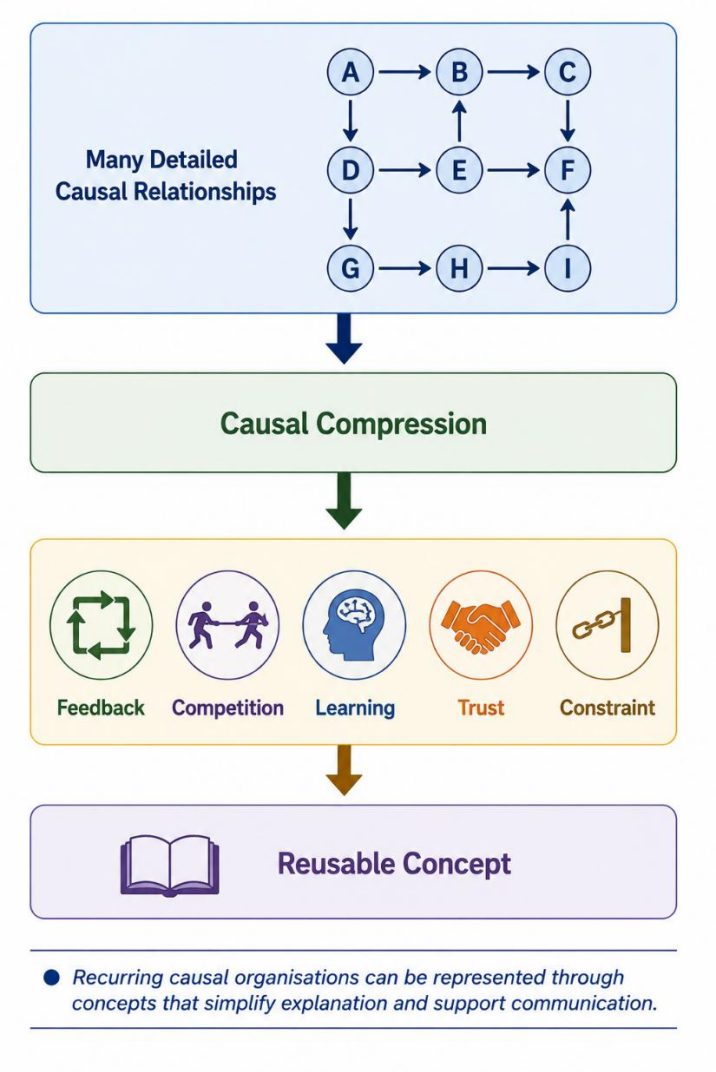
For example, feedback is a causal compression. The concept represents a recurring organisation in which information about the state of a system influences future behaviour. Likewise, competition compresses recurring situations in which multiple entities pursue similar goals using limited resources. Learning compresses recurring processes in which behaviour changes as a result of experience.

These concepts do not refer to particular objects or entities. Rather, they represent recurring patterns of causation that can appear in many different contexts.

The same causal compression may therefore be useful across multiple disciplines. Feedback occurs in engineering, biology, psychology, economics, and social systems. Competition occurs in ecosystems, markets, political systems, and sporting contests. Although the details differ, the underlying causal organisation remains recognisable.

Much of science and systems theory depends upon causal compression. Scientific concepts frequently represent recurring causal structures that help explain large numbers of observations using relatively small numbers of ideas.

Causal compression therefore enables understanding to be communicated, compared, and applied across different situations. It transforms complex explanations into concepts that can be used for reasoning, prediction, and intervention.



Example 1 – Feedback
A thermostat continuously measures temperature and adjusts heating output. Rather than describing every individual interaction, the concept of feedback compresses the recurring causal organisation.

Example 2 – Competition
Animals competing for food, businesses competing for customers, and political parties competing for votes all exhibit similar causal patterns despite occurring in different domains.

Example 3 – Learning
Humans, organisations, and artificial intelligence systems all modify future behaviour based upon past experience. The concept of learning compresses this recurring causal organisation.

Example 4 – Trust
Trust influences communication, cooperation, and decision-making across families, businesses, communities, and nations. The concept compresses a recurring pattern of causal relationships affecting social behaviour.

Provenance and Links

The concept of causal compression draws upon systems theory, information theory, complexity science, and cognitive psychology.

Relevant contributors include:

- Claude Shannon – information and communication.
- Herbert Simon – complexity and cognitive simplification.
- Gregory Bateson – patterns, information, and relationships.
- Ludwig von Bertalanffy – systems and interactions.
- Jay Forrester – causal feedback structures and system dynamics.
- Donella Meadows – leverage, feedback, and system behaviour.

Related topics include causality, systems science, feedback, constraints, modelling, explanation, prediction, and intervention.

Practical Exercise

Choose a situation that involves many interacting causes.

Examples might include:

- traffic congestion,
- a successful business,
- a sporting competition,
- a social media platform,
- a school or workplace.

1. Describe some of the individual interactions that occur.
2. Identify any recurring causal patterns.
3. Create simple concepts or labels that could represent each pattern.
4. Explain what information is retained by the compression.
5. Explain what information is omitted.

Reflect on how the compressed concept helps understanding while also hiding some of the underlying complexity.