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Causonomy

A Formal Science of Failure and Causation

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EXECUTIVE SUMMARY

Every organisation depends on problem solving — yet until now, problem solving has had no formal scientific foundation. Root cause analysis, fault trees, Six Sigma, and expert judgement are all *methods*: useful but incomplete, because they operate in an open, unbounded space of possible causes. Completeness can never be guaranteed. Conclusions remain contingent on who is in the room.

Causonomy changes this. It establishes problem solving as a *science* — one with a precisely defined object, a finite domain, and necessary relations that hold regardless of industry or domain. The practical result: for any observed failure in any operation, the complete set of possible causes is **known in advance**, and reasoning proceeds by **elimination** rather than by hypothesis generation.

> **Causonomy transforms problem solving from an open-ended search into a deterministic, auditable process — reducing dependence on expertise and guaranteeing completeness.**

THE PROBLEM CAUSONOMY SOLVES

Today, when something goes wrong, investigators face a space of causes that is effectively unlimited. The process looks like this:

- Brainstorm possible causes — limited by the experience of who is present
- Gather evidence to support or reject each hypothesis
- Reach a conclusion that different teams may reach differently
- Implement a fix — which may not address the true root cause

This is problem solving as a *craft*. The result is variability between analysts, recurring failures, and investigations that never fully close. The deeper problem is structural: **failure has never been formally defined as a closed, enumerable object.**

Causonomy begins by doing exactly that.

HOW THE SCIENCE WORKS

Step 1 — Define Failure Precisely

A failure — called a **Negative Outcome (NO)** — is defined as the measurable deviation between what a process is *required* to produce and what it actually produces at a defined activity boundary. This is not a narrative; it is a measurable relation between two states.

Step 2 — Close the Failure Space

Any activity can fail in a finite number of ways. Causonomy derives these from first principles: forms (outputs of activities) vary only in *structure* and *quantity*; activities vary only in *existence*, *magnitude*, and *time*. Combining these dimensions with six universal activity types yields exactly **72 Negative Outcomes** — the complete, closed surface of observable failure. Every real-world problem, however complex, maps onto one of these 72 positions.

Step 3 — Close the Cause Space

Causes arise from the failure of necessary conditions that support any activity. These conditions always belong to four types — Process, Organisation, Tools, Data — each of which can fail in three modes: absent, insufficient, or mistimed. Combining 72 failures with 12 support-failure modes yields **864 operational causal positions**. Root causes are further traced to the governing layer — the specifications, plans, constraints, and authorisations that define what must happen — yielding **1,152 root-cause positions**.

72	864	1,152	4
Negative Outcomes (observable failures)	Operational causal positions	Root-cause positions (governing level)	Reasoning operations (one framework)

THE STRUCTURAL REDUCTION MATRIX

Not every cause can produce every failure. The **Structural Reduction Matrix (SRM)** is the engine that connects governing defects to observable outcomes. A cause is admissible for a given failure only when two structural conditions are simultaneously met:

- **Projection:** the type of governing defect is compatible with the type of deviation observed.
- **Connectivity:** a path exists in the system through which the defect can reach the activity boundary where the failure occurs.

This double filter eliminates the majority of the 864 causal positions immediately — before any evidence is collected. What remains is a small, system-specific set of admissible causes. Investigation then proceeds by verification against evidence, not by brainstorming.

> **The SRM determines, a priori, which causes are structurally possible for a given failure in a given system. Investigators do not generate hypotheses — they eliminate impossibilities.**

FOUR OPERATIONS — ONE FRAMEWORK

All four core problem-solving activities are traversals of the same structure. No additional machinery is required for any of them.

Operation	Direction	What it delivers
Diagnosis	Failure → Causes	The complete set of admissible root causes for a known failure, reduced by evidence.
Prediction	Cause → Failures	All failures that a known governing defect can structurally produce — before they occur.
Stress Testing	System → All Failures	The full exposure map of a system: every failure its governing structure permits.
Preventive Design	Structure → Fewer Failures	Modification of governing forms so that certain failures become structurally impossible.

WHY THIS IS A SCIENCE, NOT JUST A METHOD

Causonomy satisfies the criteria that distinguish a science from a collection of methods. The comparison below shows how it differs structurally from existing approaches, which all share a common limitation: an open, unbounded domain.

Property	Existing Methods (RCA, FMEA, Five Whys…)	Causonomy
Failure space	Open / context-dependent	Closed — 72 NOs
Cause space	Open / expertise-dependent	Closed — 864 positions
Completeness	Cannot be guaranteed	Guaranteed by structure
Reasoning mode	Hypothesis generation	Elimination within finite set
Expert dependence	High — shapes the domain	Low — structure is pre-defined
Reproducibility	Varies by analyst	Deterministic under same inputs
Domain	Domain-specific tools needed	Universal — same structure applies everywhere
Falsifiability	Not formally stated	Explicit — testable structural claims

WHAT THIS MEANS IN PRACTICE

For Diagnosis and Incident Investigation

When a failure occurs, investigators classify it as one of 72 Negative Outcomes. The SRM immediately returns the complete admissible set of governing defects. Evidence is then used to eliminate — not to suggest. The process terminates when all positions but one are excluded. **Completeness is structural, not a function of how experienced the team is.**

For Risk and Exposure Management

Given the governing forms in a system — its specifications, plans, constraints, authorisations, and verification procedures — stress testing enumerates every failure the system structurally permits. This includes failures that have never occurred but are latent in the design. Risk assessment shifts from looking at history to examining structure.

For System Design and Governance

Preventive design does not attempt to reduce the frequency of failure. It eliminates the structural conditions under which certain failures are possible. When a governing form — a specification, a plan, an authorisation procedure — is corrected or made complete, the failures it permitted are removed from the admissible space entirely. **Prevention becomes a design activity, not a reactive one.**

For Operational Consistency and Standardisation

Because the causal structure is universal, the same framework applies across every part of the organisation and every domain — manufacturing, logistics, finance, healthcare, software delivery. Different teams no longer need different methods. Expertise is still needed to interpret domain-specific evidence; it is no longer needed to *define* the space of possible causes.

> **Organisations that adopt Causonomy move from a culture of investigation to a culture of structural prevention — knowing their exposure before failures occur.**

KEY CONCEPTS AT A GLANCE

Concept	Plain-language meaning
Negative Outcome (NO)	A measurable gap between what a process must produce and what it actually produces. There are exactly 72.
Deviation grammar	The 12 ways any form or activity can deviate — derived from first principles, not from observation.
POTD (supports)	The four necessary conditions for any activity: Process, Organisation, Tools, Data.
EMT (failure modes)	The three ways any support can fail: absent (Existence), insufficient (Magnitude), or mistimed (Time).
Governing form	Any artefact that defines what must happen: specifications, plans, requests, constraints, authorisations, verification criteria.
MNAD	The network of activities and form-flows in a system — the map along which defects propagate.

Concept	Plain-language meaning
Structural Reduction Matrix	The mapping that determines which governing defects can produce which failures in a specific system.
Admissible set	The finite list of causes that are structurally possible for a given failure. Investigation eliminates within this set.

THE BOTTOM LINE FOR LEADERS

Problem solving has long been treated as a skill — something you get better at through experience, training, and the right people in the room. Causonomy shows that it is also a domain with a fixed, discoverable structure.

The implications are significant:

- **Investigations become auditable.** The complete set of causes considered is determined by structure, not by who was present.
- **Gaps become visible.** If a cause falls outside the admissible set, it cannot produce the failure — no matter how plausible it seems.
- **Prevention becomes precise.** Governing defects that admit failures can be identified and corrected before incidents occur.
- **Knowledge scales.** The framework is the same across every function and domain. New teams start from structure, not from scratch.

Causonomy does not replace domain expertise. It provides the structure within which expertise operates — and guarantees that the space of causes considered is always complete.

This brief summarises the full paper: *Causonomy: A Formal Science of Failure and Causation in Normative Systems*, Pascal Etcheber, April 2026. The paper contains formal proofs, derivations, and a worked diagnostic example.