# The Non-Generic Realization Theorem (Axis IV / Chamber XLVIII)

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**Abstract**

Axis III established that worldline-local utility is structurally *admissible* only in irreversible DAG histories (and forbidden in trees), with operators disabled. Chamber XLVIII (Axis IV) tested whether utility is generically *realized* in admissible ensembles by brute-force scanning over large seed ranges across multiple DAG grammar families and sizes, using the canonical Axis III $G^\circ$ evaluator. The empirical result was uniform: no utility-positive baselines were found (measured $p_n = 0$ at $\ell = 1$) across all tested conditions. This motivates a formal distinction between structural permission and realized occurrence, and yields an empirical theorem: utility realization is non-generic in the tested admissible ensembles.

## 1 Context and Definitions

### 1.1 Structures

A *history structure* is a finite directed graph $G = (V, E)$ intended to represent an irreversible causal ancestry. We restrict to directed acyclic graphs (DAGs).

- **DAGness (Invariant I):** $G$ is acyclic.
- **Structural irreversibility (Invariant II):** $G$ contains at least one non-separability witness (e.g., a merge event with indegree $\geq 2$ that induces non-separable ancestry). In Chamber XLVIII this is operationalized by requiring $\mathrm{LNSAC}(G) > 0$, where LNSAC is the *Largest Non-Separable Ancestral Class* statistic.
- **Operator-free evaluation (Invariant III):** all operators are disabled; utility is evaluated without optimization, tuning, or retroactive editing.

### 1.2 Worldlines and Utility

A *worldline* $w$ is a sampled trajectory through $G$ according to the chamber's fixed sampling procedure. Let $W$ be the number of sampled worldlines per trial. The canonical Axis III utility predicate is denoted $G^\circ(w) \in \{0, 1\}$ (binary), and depends on a persistence threshold $k_{\min}$ (and any other fixed Axis III internal criteria) [3]. For a single trial (one generated DAG plus $W$ sampled worldlines), define

$$p(G) \;=\; \frac{1}{W} \sum_{i=1}^{W} G^\circ(w_i),$$

the *utility frequency* at base scale $\ell = 1$. A trial is *utility-positive* if $p(G) > 0$ (equivalently, at least one sampled worldline has $G^\circ = 1$).

### 1.3 Admissible Ensembles

Fix a grammar family $\mathcal{F}$ and generation size $N = |V|$. A *generated trial* is a pair $(G, \{w_i\}_{i=1}^{W})$ produced by:

1. generating $G$ from $\mathcal{F}$ with a seed $s$,
2. enforcing Invariants I–III (DAGness, irreversibility witness, operators disabled),
3. sampling $W$ worldlines by the chamber's fixed sampler,
4. evaluating $G^\circ$ using the canonical Axis III evaluator.

## 2 Empirical Setup (Chamber XLVIII Seed Scan)

For each condition $(\mathcal{F}, N, W)$, Chamber XLVIII performs a brute-force seed scan over a contiguous range

$$s \in \{1, 2, \ldots, S_{\max}\},$$

generating one admissible DAG per seed and computing $p(G_s)$ at base scale $\ell = 1$.

**Tested conditions.** The scan was executed for the grammar families

$$\mathcal{F} \in \{\texttt{DAG-MERGE}, \texttt{DAG-SPARSE}, \texttt{DAG-HIERARCHICAL}\},$$

for multiple sizes $N \in \{32, 128, 328, 428\}$, for $W \in \{100, 200, 300\}$, and for seed limits up to $S_{\max} = 5000$ per condition. All trials enforced Invariants I–III and used the canonical Axis III $G^\circ$ evaluator.

## 3 Non-Generic Realization Theorem

### 3.1 Statement

**Theorem 1** (Non-Generic Realization of Worldline-Local Utility; Empirical)**.** *Consider the Chamber XLVIII admissible ensembles generated by the grammar families* ***DAG-MERGE****,* ***DAG-SPARSE****, and* ***DAG-HIERARCHICAL****, with operators disabled and structural irreversibility enforced (*LNSAC $> 0$*). For each tested condition $(\mathcal{F}, N, W, S_{\max})$ listed above, the base-scale seed scan produced no utility-positive trials:*

$$\forall s \in \{1, \ldots, S_{\max}\}, \quad p(G_s) = 0.$$

*Equivalently, no sampled worldline in any tested admissible trial satisfied $G^\circ(w) = 1$ at $\ell = 1$.*

### 3.2 Interpretation (Permission vs Realization)

The theorem formalizes a sharp distinction:

- **Structural permission (Axis III):** irreversible DAG topology is necessary for utility to be admissible [3].
- **Realization (Axis IV / XLVIII result):** admissibility does not imply generic realization; in the tested admissible ensembles, realization appears non-generic (undetected under extensive scans).

Thus, utility behaves as a *highly constrained history-level phenomenon*: it may require additional correlated structure beyond mere presence of merges and DAG irreversibility [1, 2].

## 4 Quantitative Corollary: Upper Bounds on Realization Rate

For a fixed condition $(\mathcal{F}, N, W)$, define the (unknown) probability that a random admissible seed produces a utility-positive trial:

$$\theta \;=\; \Pr\big[p(G_s) > 0\big].$$

Given $S_{\max}$ independent seeds and observing zero successes, a one-sided $95\theta \;\le\; 1 - 0.05^{1/S_{\max}} \;\approx\; \frac{2.996}{S_{\max}}. For example, with\ \mathrm{S}_{\max} = 5000,$

$$\theta \;\lesssim\; 6 \times 10^{-4}.$$

This bound is conditional on the chamber's generator and sampler and does not assert universality beyond the tested ensembles.

## 5 Scope and Falsifiability

**Scope.** This theorem is explicitly empirical and conditioned on:

- the tested grammar families and generation parameters,
- the chamber's worldline sampling procedure and $W$,
- the canonical Axis III $G^\circ$ evaluator,
- enforcement of Invariants I–III.

**Falsifier.** The theorem is falsified by exhibiting a tested condition $(\mathcal{F}, N, W)$ and a seed $s$ within the scanned range such that:

$$p(G_s) > 0.$$

More generally, it is weakened by demonstrating a reproducible subset of admissible seeds with nonzero utility at base scale.

## 6 Consequences for Axis IV

Chamber XLVIII's seed scan result implies that Axis IV cannot rely on random admissible DAG generation to supply utility-positive primaries. Any RG-flow study of utility frequency requires either:

1. reusing known utility-positive histories from earlier axes,
2. conditioning the generator on stronger history-level constraints (beyond mere merges),
3. or embedding utility-bearing substructures into larger admissible DAGs without operator intervention.

## References

[1] UNNS Research Collective. Generative Asymmetry and Worldline-Local Utility in UNNS: Validation of a History-Level Mechanism Beyond Grammar Closure. February 2026.

[2] UNNS Research Collective. Worldline-Local Utility in Physics-Like Systems: A Structural Consequence of Generative Asymmetry. February 2026.

[3] UNNS Research Collective. Structural Irreversibility and the Admissibility of Worldline-Local Utility: A UNNS Monograph on Axes, Falsification, and Structural Permission. February 2026.