Methodological Article

A Six-Functional Profile for Structural-Dynamic Coherence in Formal Systems

Internal Definition, Methodological Limits, and a Protocol for Independent External Evaluation

The $\mathbf{K}_{\mathrm{TUC}}$ Profile

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Scope statement. This manuscript presents a mathematical and methodological proposal for describing technical coherence in formal systems. It does not measure consciousness directly, does not establish any ontological entity, does not validate the broader TUC-O programme, and does not report an empirical result. A separate supplementary package specifies a preregistered route for independent external evaluation; at the time of this preprint the package is frozen but no evaluation run has been authorized or executed.

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Abstract

The term *coherence* is used across mathematics, computer science, complex-systems research, cognitive science, and philosophy, but it often denotes different and partially incompatible properties: stability, consistency, integration, reproducibility, compositionality, robustness, or resistance to perturbation. A single scalar definition can therefore be misleading. A system may be stable because it is trivial, discriminable because it is noisy, compositional because the declared composition law is constant, or robust because it is insensitive to every input. This paper proposes a six-functional profile for *technical coherence* in a formal system observed through a finite, preregistered window. The profile is

$$\mathbf{K}_{\mathrm{TUC}}(m;W) = (R_W, D_W, Q_W, N_W, S_W, O_W)(m),$$

where the components evaluate relational replicability, internal discriminability, structural compositionality, compositional non-collapse, perturbational stability, and non-trivial neutral openness. Each component takes values in $[0,1] \cup \{\bot\}$, with $\bot$ denoting non-evaluability rather than failure. The vector is primary; scalar summaries and threshold gates are secondary and admissible only under explicit domain conditions. The construction emerged from a staged programme of semantic clarification, adversarial counterexample design, axiomatic diagnostics, and positive formalization. The article states the definitions, illustrates why simpler alternatives fail, identifies non-circularity requirements, and separates internal mathematical adequacy from external empirical validity. It also summarizes a frozen protocol for independent evaluation based on preregistration, lock files, hashes, role separation, blind handling, stop rules, constrained outputs, and chain of custody. No claim is made that $\mathbf{K}_{\mathrm{TUC}}$ measures phenomenal consciousness, proves Φ_0, or has already been empirically validated. The intended contribution is a reviewable formal object and an explicit invitation to independent criticism.

Keywords: formal systems; technical coherence; structural dynamics; robustness; compositionality; multi-criteria profiles; preregistration; independent evaluation.

Contents

1 Introduction

1.1 The problem of technical coherence

Many scientific and technical discussions rely on the word *coherence* while leaving its operative meaning underdetermined. In one context coherence means logical consistency; in another it means dynamical stability; elsewhere it refers to statistical reproducibility, integration among parts, preservation under perturbation, or the capacity to generate differentiated but coordinated behaviour. These meanings overlap, but none entails all the others. The architecture of a complex system may be nearly decomposable without being dynamically stable; a dynamical system may be structurally stable without being richly discriminative; a computational model may reproduce its own output while failing to distinguish inputs; and a compositional rule may fit every observed composition because it was defined after the observations were known.

The general lesson is familiar from complex-systems theory and methodology. Complex organization is rarely captured by a single undifferentiated property, and decomposability, hierarchy, robustness, and stability answer different questions [5, 12, 13]. Multiobjective analysis likewise warns that a vector of criteria cannot always be replaced innocently by one weighted sum, because scalarization may encode hidden preferences and may erase non-dominance relations [6]. The present proposal applies this caution to the narrower question:

What should count as technical coherence when a formal system is evaluated through a finite observational and operational window?

The phrase *technical coherence* is deliberately modest. It does not name phenomenal unity, ontological identity, semantic truth, or biological consciousness. It names a profile of formally inspectable properties relative to a declared system m and a declared evaluation window W.

1.2 Why a profile rather than a single score

The central methodological choice is to treat technical coherence first as a vector and only secondarily, if at all, as a scalar. Let

$$\mathbf{K}_{\mathrm{TUC}}(m;W) = (R_W, D_W, Q_W, N_W, S_W, O_W)(m).$$

Each coordinate answers a distinct diagnostic question:

1. Do declared repetitions preserve relational structure?
2. Do declared distinctions remain distinguishable?
3. Does composition obey a predeclared structural law?
4. Does composition preserve sensitivity to both arguments rather than collapsing them?
5. Does relevant structure survive admissible perturbations?
6. Can the system vary non-trivially in neutral dimensions while preserving its structural core?

The profile is not intended as a universal metric that is canonical for every formalism. It is a schema whose implementation depends on a typed relational vocabulary, finite anchors, declared comparison pairs, a composition law, perturbation families, and a decomposition between structurally binding and neutral coordinates. That dependence is a limitation, but it is also a safeguard: the objects that determine the score are made explicit and can therefore be criticized.

1.3 Contribution and non-contribution

This paper contributes five things. First, it supplies a semantic contract for the phrase *technical coherence*. Second, it defines six partial functionals and their shared domain. Third, it shows by counterexample why stability, variance, integration, or a weighted mean are insufficient as stand-alone definitions. Fourth, it distinguishes internal formal adequacy from external validation. Fifth, it describes a preregistered, frozen, but not yet authorized procedure for independent evaluation.

It does *not* contribute an empirical demonstration that any natural or artificial system is conscious. It does not infer a physical substrate from the profile. It does not establish the TUC-O ontological proposal, and it does not turn a formal pass into evidence for Φ_0. This separation is not rhetorical caution added after the mathematics; it is part of the formal use contract.

2 Semantic Scope and Epistemic Contract

2.1 Three meanings that must remain separate

The notation $\mathbf{K}_{\mathrm{TUC}}$ arose inside a wider theoretical programme, but the present article isolates it as a technical object. Three levels must not be conflated:

$$\text{technical coherence} \neq \text{phenomenal consciousness,} \tag{1}$$

$$\text{technical coherence} \neq \text{ontological coherence,} \tag{2}$$

$$\text{internal formal adequacy} \neq \text{external empirical validity.} \tag{3}$$

Equation (1) blocks the inference from a high profile to subjective experience. Equation (2) blocks the substitution of the profile for any claim about an ontological ground. Equation (3) blocks the inference from syntactic consistency and well-formedness to successful measurement of a real target.

Other theories explicitly identify or connect mathematical quantities with consciousness, most prominently integrated information approaches [8, 14]. The present profile does not make that identity claim. A comparison with such theories would therefore concern architecture and methodology, not equivalence of interpretation.

Definition 2.1 (Technical coherence)**.** *Technical coherence is the ordered profile of six partial, window-relative functionals that evaluate whether a formal system exhibits relational repeatability, internal differentiation, lawful composition, non-collapsing composition, perturbational preservation, and constrained openness.*

The definition is intentionally operational and conditional. It does not state that the six dimensions are metaphysically necessary, empirically sufficient, or exhaustive for every scientific purpose. They are a proposed basis for disciplined analysis.

2.2 Internal, editorial, and external layers

The development process distinguishes three epistemic layers:

$$\mathrm{Layer}(\mathbf{K}_{\mathrm{TUC}}) \in \{\mathsf{INTERNAL}, \mathsf{EDITORIAL}, \mathsf{EXTERNAL}\}.$$

The internal layer contains definitions, propositions, domain rules, and counterexamples. The editorial layer concerns whether the object can be described consistently in a manuscript with traceable notation and explicit limits. The external layer concerns independent application to a frozen target under a frozen protocol.

The permitted implications are one-way and conditional. In particular,

$$\textsf{INTERNAL READY} \not\Rightarrow \textsf{EDITORIALLY SAFE}, \tag{4}$$
$$\textsf{EDITORIALLY SAFE} \not\Rightarrow \textsf{EXTERNALLY VALIDATED}. \tag{5}$$

The present article aims to satisfy the editorial layer. The supplementary protocol package aims to make a later external test possible. Neither is itself an external result.

2.3 Window relativity is not optional

A coherence profile without an evaluation window is incomplete. Every component depends on choices about which states, relations, repetitions, distinctions, compositions, perturbations, and neutral variations are inspected. The window is therefore part of the argument, not a technical afterthought. If it is selected after the outcome is known, the profile becomes vulnerable to the same researcher degrees of freedom that motivate preregistration in empirical science [7, 11].

Window relativity does not imply arbitrariness. It means that a result has the form "system m under window W", not "system m simpliciter". Comparisons across windows require an explicit transport rule or an invariance analysis; otherwise they are different measurements.

3 Why Simple Definitions Fail

3.1 Stability alone rewards triviality

A first candidate is to define coherence as stability:

$$K_{\mathrm{stab}}(m) = 1 - \mathrm{change}(m).$$

This definition confuses preservation with organization. A constant system that maps every state to one fixed point can be maximally stable while carrying no internal distinctions. Likewise, a classifier that always returns the same label is perfectly reproducible but technically uninformative.

Example 3.1 (Uniform collapse)**.** *Suppose every state has the same observed relational profile c. Declared repetitions match, and admissible perturbations leave c unchanged. Thus relational replicability and perturbational stability may both equal one. Yet every declared distinction also maps to c, so discriminability equals zero. If neutral variation is absent, openness also equals zero. A stability-only score would classify this system as maximally coherent; the profile records the collapse.*

This is a general tension between robustness and degeneracy. Robustness is valuable when function or organization is preserved against disturbance, but insensitivity can mimic robustness if the target property has not been specified carefully [5].

3.2 Variance alone confuses uniformity and order

A second candidate uses low variance:

$$K_{\mathrm{var}}(m) = 1 - \mathrm{Var}(z_1, \ldots, z_n).$$

Low variance can reflect reliable organization, but it can also reflect a dead channel, a saturated sensor, or a constant output. High variance can reflect differentiated structure, but it can also reflect noise. Variance is therefore not directionally interpretable without a relational model of what should remain invariant and what should remain discriminable.

The same objection applies to entropy used without a structural contract. Maximum entropy may indicate rich differentiation or unstructured randomness. Minimum entropy may indicate compression, regularity, or triviality. A coherence proposal must state which variations are expected, which are prohibited, and which are neutral.

3.3 Integration alone can hide internal collapse

A third candidate defines coherence through integration among parts. Integration is an important systems concept, but it does not by itself guarantee reliable discrimination, lawful composition, or robustness. A strongly coupled network can synchronize into a uniform state. Conversely, a modular system can preserve meaningful distinctions while remaining only weakly integrated.

The present proposal therefore does not use an integration scalar as its primitive. It asks whether relations are repeatable, whether distinctions survive, whether composition behaves as declared, and whether the system remains responsive to both components. This is methodologically different from theories that associate consciousness with integrated causal information [8, 14].

3.4 Compositional fit can be tautological

A fourth candidate judges a system coherent whenever a declared composition law fits observed compounds:

$$\pi(x \odot y) = \kappa(\pi(x), \pi(y)).$$

This is meaningful only if κ is specified independently of the observations it is asked to fit. If κ is defined post hoc by setting it equal to every observed compound, the test is tautological.

Even a predeclared law can be degenerate. Consider $\kappa(u, v) = c$ for all u, v. If all compounds have profile c, compositional fit is perfect, yet the composition erases both arguments. This motivates a separate non-collapse functional rather than treating compositionality as sufficient.

3.5 A weighted mean permits compensation

Suppose six dimensions have been measured and are collapsed into

$$K_w(m; W) = \sum_{i=1}^{6} w_i K_i(m; W), \qquad w_i \geq 0, \quad \sum_i w_i = 1.$$

A weighted mean can be useful for a declared decision problem, but it permits a severe failure in one dimension to be offset by high values elsewhere. The weights also encode preferences that may not be justified by the mathematics. Multiobjective optimization treats such scalarization as one possible decision rule, not as an identity between the vector and the scalar [6].

For example,

$$(1, 1, 1, 0, 1, 1)$$

has arithmetic mean $5/6$, even though compositional non-collapse has failed completely. If the six components are intended as joint constraints, the average is promotionally unsafe.

3.6 Failure patterns summarized

The proposed profile is not guaranteed to solve every issue, but it makes these failure modes visible rather than averaging them away.

Table 1: Canonical failures of one-dimensional definitions.

Candidate definition	What it captures	What it can miss
Stability only	Persistence under change	Trivial uniformity, loss of distinctions, lack of openness
Low variance	Homogeneity or consistency	Dead channels, saturation, non-informative constancy
High variance	Differentiation	Noise, non-replicability, lack of organization
Integration only	Coupling or whole-part dependence	Internal collapse, rigid synchronization, poor composition
Compositional fit	Agreement with a law κ	Post hoc tautology, constant or projective composition
Weighted mean	Compact ranking	Compensation, arbitrary weights, hidden component failure
Single threshold	Binary decision	Fragility near the boundary and non-evaluability

4 Development Path: From Clarification to Positive Formula

4.1 Why the development history matters

The profile was not selected in one step. Its internal development used four project stages, denoted C, S, E, and F. These labels describe a design history rather than accepted scientific stages, and they should not be mistaken for external validation. Their value is methodological: they document which kinds of errors the final formula was designed to avoid.

4.2 Stage C: conceptual and semantic clarification

The C stage separated terms that had previously been liable to conflation. In particular, it distinguished phenomenal consciousness, ontological coherence, and technical coherence. It also established that historical symbolic expressions involving Φ_0 could not be treated automatically as operational ratios, because an ontological primitive that is not quantitatively defined cannot serve silently as a numerical scale.

For the present article, the relevant output of stage C is negative but essential: $\mathbf{K}_{\mathrm{TUC}}$ must not inherit the semantics of consciousness merely because it was developed in the same programme. The notation is a project label; the object is a technical profile.

4.3 Stage S: adversarial candidate search

The S stage examined candidate criteria and families of formal transducers under adversarial conditions. The aim was not to find a formula that would pass a preferred target, but to expose candidate definitions that could succeed for the wrong reason. A measure was treated as suspect if it encoded the expected endpoint, separated only a narrow hand-built family, collapsed under a non-affine transformation, or could be rescued by changing the test after observing the result.

The principal methodological lesson was that apparent success on a candidate bank does not establish a general definition. A candidate may be overfit to the benchmark, and a benchmark may fail to contain the right adversaries. This motivated explicit stop conditions and a prohibition on retroactive threshold tuning.

4.4 Stage E: axiomatic and diagnostic architecture

The E stage developed an axiomatic language for external technical coherence, a taxonomy of failure signatures, and a diagnostic bridge between abstract requirements and future observable descriptors. The key contribution was to separate *declarability* from *external truth*. A statement can be well-formed, internally consistent, and diagnostically classified without having been externally confirmed.

This distinction anticipates the current protocol. A formal object may be ready for evaluation while the target, operator, data, and evaluator remain unspecified. The state "ready for authorization" is therefore intentionally weaker than "authorized", which is weaker than "executed", which is weaker than "validated".

4.5 Stage F: positive internal construction

The F stage supplied the positive mathematical object. Its sequence was:

1. definition of the six functionals;
2. domain control and the distinction between 0 and $\perp$;
3. modular non-redundancy analysis;
4. evaluation of admissible scalarizations;
5. threshold gates and symbolic margins;
6. window comparison, transport, and freeze rules;
7. declaration and registry formats;
8. internal editorial audit and final use contract.

The endpoint of the stage is the vector $\mathbf{K}_{\mathrm{TUC}}$, not an empirical conclusion. The external protocol described later was created precisely because internal completion cannot certify external performance.

Table 2: Role of the four internal development stages.

Stage	Main task	Positive contribution	What it does not establish
C	Semantic clarification	Separation of technical, phenomenal, and ontological uses	No metric and no empirical result
S	Adversarial candidate analysis	Counterexamples, anti-overfitting constraints, stop logic	No universal impossibility theorem
E	Axiomatic diagnostics	Failure signatures, declaration rules, external bridge architecture	No external certificate
F	Positive formula	Six-function profile, domains, gates, scalarization rules, registries	No validated target and no consciousness inference

5 Formal Setting

5.1 System model

Definition 5.1 (Abstract technical system)**.** *A technically evaluable system is a tuple*

$$m = (X, \mathcal{R}, T, \odot, \mathcal{O}, \mathcal{P}, \mathcal{N}), \tag{6}$$

where:

- X *is a non-empty set of states, configurations, or episodes;*
- $\mathcal{R} = (R_j)_{j \in J}$ *is a typed family of internal relations;*
- T *is an allowed dynamics or partial transformation;*
- $\odot$ *is a partial composition operation;*
- $\mathcal{O} : X \to Y$ *is a technical observation map;*
- $\mathcal{P}$ *is a family of structurally relevant perturbations;*
- $\mathcal{N}$ *is a family of neutral or non-destructive variations.*

The observation map is not assumed to recover the full state. It determines which aspects of the system enter the evaluation. Consequently, a profile is always conditional on the observational vocabulary.

5.2 Finite evaluation window

Definition 5.2 (Evaluation window)**.** *A finite technical evaluation window is*

$$W = (X_W, J_W, A_W, \Pi_R, \Pi_D, \Pi_Q, \Pi_P, \Pi_N, \kappa_W, \lambda_W), \tag{7}$$

where $X_W \subseteq X$ *and* $J_W \subseteq J$ *are finite non-empty sets,* $A_W \subseteq X_W$ *is a finite anchor set,* Π_R *contains declared replicate pairs,* Π_D *contains declared discrimination pairs,* Π_Q *contains declared composable pairs,* Π_P *contains perturbation tests,* Π_N *contains neutral-variation tests,* κ_W *is a predeclared profile-composition rule, and* $\lambda_W = (\lambda_K, \lambda_U)$ *decomposes the profile into structurally binding and neutral coordinates.*

The window must be frozen before the outcome is inspected. The labels "replicate", "distinct", "composable", "perturbationally equivalent", and "neutral" are part of the test specification and require independent justification.

5.3 Partial relational profiles

Definition 5.3 (Relational profile)**.** *For* $x \in X_W$*, define*

$$\pi_W(x) = \big(\rho_{j,a}(x)\big)_{(j,a) \in J_W \times A_W}, \tag{8}$$

where

$$\rho_{j,a}(x) = \begin{cases} 1, & R_j(x,a) \text{ is verified in } W, \\ 0, & R_j(x,a) \text{ is falsified in } W, \\ \perp, & R_j(x,a) \text{ is not evaluable in } W. \end{cases} \tag{9}$$

The symbol $\perp$ is not a third truth value in a substantive logic. It is a domain marker: the required observation is unavailable or undefined. Treating $\perp$ as zero would convert missing evaluability into a measured failure.

For $u, v \in \{0, 1, \perp\}^n$, let

$$I(u, v) = \{i : u_i \neq \perp \text{ and } v_i \neq \perp\}. \tag{10}$$

If $I(u, v) = \varnothing$, set $\mathrm{dist}_W(u, v) = \perp$. Otherwise define the normalized Hamming distance and similarity

$$\mathrm{dist}_W(u, v) = \frac{1}{|I(u, v)|} \sum_{i \in I(u,v)} \mathbf{1}[u_i \neq v_i], \tag{11}$$

$$\mathrm{sim}_W(u, v) = 1 - \mathrm{dist}_W(u, v). \tag{12}$$

Definition 5.4 (Safe finite mean)**.** *For* $z_1, \ldots, z_n \in [0, 1] \cup \{\perp\}$*, let*

$$\mathrm{Mean}^\star(z_1, \ldots, z_n) = \begin{cases} \dfrac{1}{|I|} \displaystyle\sum_{i \in I} z_i, & I = \{i : z_i \neq \perp\} \neq \varnothing, \\ \perp, & I = \varnothing. \end{cases} \tag{13}$$

The safe mean prevents an entirely non-evaluable set from being reported as zero. It does not solve partial-coverage bias: the size and composition of the evaluable support must still be reported.

6 The Six Functionals

6.1 Relational replicability R_W

Definition 6.1 (Relational replicability)**.**

$$R_W(m) = \mathrm{Mean}^\star_{(x,y) \in \Pi_R} \mathrm{sim}_W(\pi_W(x), \pi_W(y)). \tag{14}$$

R_W is high when configurations declared to be repetitions preserve the same relational profile. The word *replicability* is used locally: it concerns repeated instances inside the window, not the full methodological distinction among repeatability, reproducibility, and replicability in empirical research [3]. The labels in Π_R must be assigned independently of the resulting similarity.

A low value indicates that declared repetitions fail to preserve relational structure. A value $\perp$ indicates that no declared replicate pair has a comparable support. These outcomes have different interpretations and must not be merged.

Diagnostic question. When the system is placed in conditions declared equivalent for the purpose of the test, does its relational organization recur?

Canonical confound. A constant system can obtain $R_W = 1$. Replicability is therefore necessary for some uses but never sufficient for technical coherence.

6.2 Internal discriminability D_W

Definition 6.2 (Internal discriminability)**.**

$$D_W(m) = \mathrm{Mean}^\star_{(x,y) \in \Pi_D} \mathrm{dist}_W(\pi_W(x), \pi_W(y)). \tag{15}$$

D_W is high when configurations declared relevantly distinct do not collapse into the same profile. It measures differentiation relative to Π_D, not semantic correctness and not phenomenology.

Proposition 6.3 (Neither R nor D entails the other)**.** *Without constraints relating* Π_R *and* Π_D*, neither* R_W *nor* D_W *determines the other.*

Proof. The functionals average over independently declared pair sets. One may construct a window in which replicate pairs are identical while all distinction pairs collapse, yielding high R and low D. Conversely, replicate pairs may vary while distinction pairs remain well separated, yielding low R and high D. □

Diagnostic question. Does the system preserve distinctions that the evaluation contract says should matter?

Canonical confound. Random profiles may be highly distinguishable. Discriminability must therefore be paired with replicability and structural tests.

6.3 Structural compositionality Q_W

For $(x, y) \in \Pi_Q$, assume $x \odot y$ is defined and the predeclared rule $\kappa_W(\pi_W(x), \pi_W(y))$ returns a profile. Define

$$q_W(x, y) = \mathrm{sim}_W\left(\pi_W(x \odot y), \kappa_W(\pi_W(x), \pi_W(y))\right), \tag{16}$$

with $q_W(x, y) = \perp$ when either side is undefined.

Definition 6.4 (Structural compositionality)**.**

$$Q_W(m) = \mathrm{Mean}^{\star}_{(x,y)\in\Pi_Q}\, q_W(x, y). \tag{17}$$

This functional asks whether the observed profile of a compound agrees with a law declared before evaluation. The concept is related to the broader requirement that complex capacities depend systematically on constituent structure, although the present definition is technical and window-specific rather than a theory of mental representation [2].

> **Anti-tautology requirement.** The rule κ_W must not be fitted to the same compound profiles used to score Q_W, unless the fitting procedure and an out-of-sample test are preregistered. Otherwise Q_W measures reconstruction flexibility rather than compositionality.

Diagnostic question. Does composition behave according to a rule that existed before the observed outcome?

Canonical confound. A constant or projective κ_W can fit perfectly while erasing one or both arguments. This motivates N_W.

6.4 Compositional non-collapse N_W

Let

$$\Pi_Q^{(1)} = \{(x, x', y) : (x, y), (x', y) \in \Pi_Q\}, \tag{18}$$

$$\Pi_Q^{(2)} = \{(x, y, y') : (x, y), (x, y') \in \Pi_Q\}. \tag{19}$$

For comparable triples, define sensitivities

$$s_1(x, x', y) = \begin{cases} \mathrm{clip}\Big(\dfrac{\mathrm{dist}_W(\pi_W(x \odot y), \pi_W(x' \odot y))}{\mathrm{dist}_W(\pi_W(x), \pi_W(x'))}\Big), & \mathrm{dist}_W(\pi_W(x), \pi_W(x')) > 0, \\ \perp, & \text{otherwise,} \end{cases} \tag{20}$$

and

$$s_2(x, y, y') = \begin{cases} \mathrm{clip}\Big(\dfrac{\mathrm{dist}_W(\pi_W(x \odot y), \pi_W(x \odot y'))}{\mathrm{dist}_W(\pi_W(y), \pi_W(y'))}\Big), & \mathrm{dist}_W(\pi_W(y), \pi_W(y')) > 0, \\ \perp, & \text{otherwise.} \end{cases} \tag{21}$$

Here $\mathrm{clip}(z) = \min\{1, \max\{0, z\}\}$.

Definition 6.5 (Compositional non-collapse)**.** *When both safe means are defined,*

$$N_W(m) = \frac{1}{2}\left(\mathrm{Mean}^{\star}_{\Pi_Q^{(1)}} s_1 + \mathrm{Mean}^{\star}_{\Pi_Q^{(2)}} s_2\right); \tag{22}$$

otherwise $N_W(m) = \perp$.

N_W is high when changes to either argument remain visible in the compound. It is low when the operation is absorbing, constant, or effectively a projection onto one side.

Proposition 6.6 (Compositional fit does not imply non-collapse)**.** $Q_W(m) = 1$ *does not imply* $N_W(m) = 1$.

Proof. Let $\kappa_W(u, v) = c$ for all profiles and let every observed compound have profile c. Then $Q_W = 1$. Because changing either argument never changes the compound profile, the corresponding sensitivities are zero whenever the denominators are positive, so $N_W = 0$. □

Diagnostic question. Does the composition preserve contribution from both arguments rather than merely satisfying a formal equation?

Canonical limitation. The clipped ratio is scale-sensitive and may conceal amplification above one. Alternative sensitivity transforms should be tested in later work, but changing them after observing an external result is prohibited.

6.5 Perturbational stability S_W

For $(x, p) \in \Pi_P$, define

$$s_W(x, p) = \begin{cases} \mathrm{sim}_W(\pi_W(x), \pi_W(p(x))), & p(x) \in X_W, \\ \perp, & \text{otherwise.} \end{cases} \tag{23}$$

Definition 6.7 (Perturbational stability)**.**

$$S_W(m) = \mathrm{Mean}^{\star}_{(x,p)\in\Pi_P} s_W(x, p). \tag{24}$$

The functional is intentionally narrower than structural stability in dynamical-systems theory [13]. It evaluates whether predeclared, admissible perturbations preserve the selected relational structure. The perturbation family must be meaningful: perturbations that are too weak make stability trivial, while perturbations that redefine the target make failure inevitable.

Diagnostic question. Does the structural profile persist under disturbances that the protocol declares relevant and admissible?

Canonical confound. A system can be stable because it is rigid or insensitive. O_W is included to distinguish preservation with flexibility from preservation by total closure.

6.6 Non-trivial neutral openness O_W

The window includes a predeclared decomposition $\lambda_W = (\lambda_K, \lambda_U)$, where K denotes structurally binding coordinates and U denotes neutral or free coordinates:

$$\pi_W^K(x) = \lambda_K(\pi_W(x)), \tag{25}$$
$$\pi_W^U(x) = \lambda_U(\pi_W(x)). \tag{26}$$

For each $x \in X_W$, let

$$\mathcal{N}_W(x) = \{n(x) : (x, n) \in \Pi_N,\ n(x) \in X_W\}. \tag{27}$$

When this set is non-empty, define structural preservation

$$P_K(x) = \mathrm{Mean}^\star_{z\in\mathcal{N}_W(x)} \mathrm{sim}_W(\pi_W^K(x), \pi_W^K(z)), \tag{28}$$

and neutral variation

$$V_U(x) = \mathrm{clip}\Big(\mathrm{diam}\{\pi_W^U(z) : z \in \mathcal{N}_W(x)\}\Big). \tag{29}$$

If the neutral set is empty, both terms are $\perp$.

Definition 6.8 (Non-trivial neutral openness)**.**

$$O_W(m) = \mathrm{Mean}^\star_{x\in X_W}(P_K(x)V_U(x)). \tag{30}$$

O_W is high only when two conditions hold jointly: the structural core is preserved and the neutral subspace exhibits actual variation. If the system is completely rigid, V_U is low. If variation destroys the core, P_K is low.

Diagnostic question. Can the system vary in ways declared neutral without losing the relations declared constitutive for the test?

Canonical limitation. The decomposition into K and U is not generated by the formula. It must be justified independently and frozen. A malicious decomposition could label every destructive change as neutral or every changing coordinate as structural; external review must examine this choice.

6.7 The profile and its partial codomain

Definition 6.9 (Six-functional profile)**.**

$$\boxed{\mathbf{K}_{\mathrm{TUC}}(m; W) = (R_W, D_W, Q_W, N_W, S_W, O_W)(m)} \tag{31}$$

with

$$\mathbf{K}_{\mathrm{TUC}}(m; W) \in \big([0, 1] \cup \{\perp\}\big)^6. \tag{32}$$

Definition 6.10 (Full domain)**.**

$$\mathrm{FullDom}_F(m, W) = 1 \iff \mathbf{K}_{\mathrm{TUC}}(m; W) \in [0, 1]^6. \tag{33}$$

The distinction

$$0 \neq \perp \tag{34}$$

is mandatory. A zero is a substantive failure on an evaluable test; $\perp$ is a domain failure. The coverage pattern should be reported alongside the values, because a high mean based on sparse support may be less informative than a moderate mean based on complete support.

7 Worked Abstract Examples

The following examples are not empirical validations. They are deliberately small witness systems designed to show how the six coordinates separate failure modes that a single score would conflate. Each example assumes a finite binary profile space and complete comparability, so no coordinate is undefined unless explicitly stated.

7.1 Example A: the perfectly repeatable constant system

Let $X_W = \{a, b, c, d\}$ and suppose

$$\pi_W(a) = \pi_W(b) = \pi_W(c) = \pi_W(d) = u.$$

Take $\Pi_R = \{(a, b), (c, d)\}$ and let $\Pi_D = \{(a, c), (b, d)\}$. Assume every admissible perturbation maps a state to another state with the same profile u. Then

$$R_W = 1, \qquad D_W = 0, \qquad S_W = 1.$$

If composition is constant and agrees with a predeclared constant rule, Q_W can also equal one, while $N_W = 0$. If all declared neutral variations preserve the same neutral coordinates, then $V_U = 0$ and $O_W = 0$. A representative profile is therefore

$$\mathbf{K}_{\mathrm{TUC}}(m_A; W) = (1, 0, 1, 0, 1, 0). \tag{35}$$

This system is maximally repeatable and stable in the narrow sense encoded by the window. It is also maximally collapsed with respect to declared distinctions, compositional sensitivity, and neutral variation. A scalar based only on repeatability and stability would classify it positively. The full profile identifies why that classification would be misleading.

The example also illustrates why low variance cannot be equated with coherence. Every observed coordinate is constant, so variance vanishes. Yet the technical architecture lacks internal differentiation and openness. The relevant question is not whether values vary, but whether the correct values remain invariant under repetitions while the correct distinctions remain variant.

7.2 Example B: discriminable noise

Let each state receive an independently sampled binary profile of length n, and suppose declared distinction pairs are sampled from different states. For moderate or large n, two independently sampled profiles are likely to have normalized Hamming distance near $1/2$. Thus D_W may appear reasonably high. However, if a replicate of the same intended condition is resampled independently, similarity is also near 1/2, so R_W is low relative to a demanding threshold. Perturbational stability is likewise low if perturbations trigger new samples.

A stylized outcome is

$$\mathbf{K}_{\mathrm{TUC}}(m_B; W) = (0.51, 0.49, \perp, \perp, 0.50, 0.47). \tag{36}$$

The values near one half do not indicate moderate coherence. They indicate that the binary profiles behave approximately like noise under the chosen comparisons. The undefined compositional coordinates record that no valid composition contract has been supplied.

This example shows why a high differentiation measure is not sufficient. Differentiation becomes informative only when it is structured by reproducibility, composition, and perturbational constraints. It also shows why $\perp$ must not be replaced with zero: the absence of a composition test is not evidence that composition failed.

7.3 Example C: perfect compositional fit with projection

Let the composition operation satisfy

$$\pi_W(x \odot y) = \pi_W(x)$$

for every composable pair. Suppose $\kappa_W(u, v) = u$ is declared before evaluation. Then $Q_W = 1$ because the observed compound exactly matches the rule. Changes to the first argument are preserved, while changes to the second argument are completely erased. Under balanced sensitivity averages, one obtains approximately

$$\mathrm{Mean}^\star s_1 = 1, \qquad \mathrm{Mean}^\star s_2 = 0, \qquad N_W = \frac{1}{2}.$$

A representative profile may be

$$\mathbf{K}_{\mathrm{TUC}}(m_C; W) = (0.95, 0.91, 1, 0.50, 0.93, 0.22). \tag{37}$$

The value $N_W = 0.50$ is not a universal signature of projection; it results from the symmetric average in Equation (22). It does, however, reveal that perfect compositional fit coexists with complete loss of one argument. A stricter implementation could require separate lower bounds on first- and second-argument sensitivity rather than averaging them. That alternative is a legitimate future refinement, but it must be specified before external outcomes are observed.

This witness clarifies the difference between *lawfulness* and *non-collapse*. A system can obey a simple law perfectly while remaining structurally impoverished. The same issue arises with absorbing operations and constant maps.

7.4 Example D: stable but closed organization

Consider a system with rich relational distinctions and a non-collapsing composition law. Perturbations within the declared admissible family preserve the structural profile, so S_W is high. However, every proposed neutral variation either leaves the entire profile unchanged or destroys a structural coordinate. Consequently, there is no non-trivial neutral direction that preserves the core. A representative profile is

$$\mathbf{K}_{\mathrm{TUC}}(m_D; W) = (0.94, 0.90, 0.88, 0.86, 0.97, 0.05). \tag{38}$$

The arithmetic mean of this vector is approximately 0.77, which might look acceptable under an unspecified scalar rule. The minimum scalar is 0.05, and a threshold gate with $\tau_O > 0.05$ fails. The disagreement is not a mathematical contradiction; it exposes a policy choice. If openness is considered a joint requirement, a compensatory average is inappropriate.

This example also prevents the interpretation of robustness as automatic evidence of adaptability. The system preserves structure, but it does so through closure. Whether closure is a defect depends on the intended use. For a cryptographic invariant it may be desirable; for a generative or adaptive system it may be a serious limitation. The profile reports the distinction without determining the application-specific verdict.

7.5 Example E: partial evaluability

Suppose a system supports replicate, discrimination, and perturbation tests, but composition is not defined on the selected state class and the proposed neutral decomposition cannot be justified. Then a scientifically honest profile might be

$$\mathbf{K}_{\mathrm{TUC}}(m_E; W) = (0.89, 0.84, \bot, \bot, 0.92, \bot). \tag{39}$$

No global scalar or binary pass is defined because $\mathrm{FullDom}_F(m_E, W) = 0$. This does not make the three measured coordinates useless. It means that the evidence supports only a partial statement: the system is repeatable, discriminable, and perturbationally stable under the declared window. Any stronger claim would require additional structure.

Partial profiles are expected in early applications. Forcing completeness by inventing a composition law or neutral split would be methodologically worse than reporting non-evaluability. External reviewers should therefore treat a high-coverage partial profile as a legitimate intermediate result, while refusing its promotion to a full technical-coherence pass.

7.6 Comparison of the witness systems

Table 3: Illustrative profiles for five abstract witness systems. Values are schematic, not empirical.

System	R	D	Q	N	S	O
A: constant repeatable	1.00	0.00	1.00	0.00	1.00	0.00
B: discriminable noise	0.51	0.49	$\bot$	$\bot$	0.50	0.47
C: projection composer	0.95	0.91	1.00	0.50	0.93	0.22
D: stable but closed	0.94	0.90	0.88	0.86	0.97	0.05
E: partial evaluation	0.89	0.84	$\bot$	$\bot$	0.92	$\bot$

The examples illustrate the intended diagnostic use of the profile. None is "the incoherent system" in an absolute sense. Each fails or remains undefined in a different way. The vector preserves that information and makes disagreement about application-specific priorities explicit.

8 Scalarization, Gates, and Fragility

8.1 The vector remains primary

The vector in Equation (31) is the primary result. A scalar may be useful for ranking or gating, but it cannot retain all information. In particular, two systems with the same mean may fail in different coordinates and therefore require different interpretations.

8.2 Conservative minimum scalarization

On the full domain, define

$$C_\wedge(m; W) = \min\{R_W, D_W, Q_W, N_W, S_W, O_W\}. \tag{40}$$

This scalar is anti-compensatory: no strong coordinate can erase the weakest one.

Proposition 8.1 (Minimum is bounded by the geometric summary)**.** *For a full profile with coordinates in* $[0, 1]$,

$$C_\wedge(m; W) \leq (R_W D_W Q_W N_W S_W O_W)^{1/6}. \tag{41}$$

Proof. The geometric mean of non-negative numbers is at least their minimum. □

The geometric mean remains descriptive and partially compensatory. The arithmetic mean is more compensatory still. None is declared to be the unique scalar meaning of coherence.

8.3 Threshold gate

Let

$$\tau = (\tau_R, \tau_D, \tau_Q, \tau_N, \tau_S, \tau_O) \in (0, 1]^6$$

be frozen before evaluation. Define the trivalent gate

$$\mathrm{Pass}_\tau(m; W) = \begin{cases} 1, & \mathrm{FullDom}_F(m, W) = 1 \text{ and } K_i(m; W) \geq \tau_i \ \forall i, \\ 0, & \mathrm{FullDom}_F(m, W) = 1 \text{ and } K_i(m; W) < \tau_i \text{ for some } i, \\ \bot, & \mathrm{FullDom}_F(m, W) = 0. \end{cases} \tag{42}$$

The gate is a decision rule, not a definition of truth. A pass means only that the six frozen technical criteria were met in the frozen window. It does not imply consciousness, ontology, or cross-domain generalization.

8.4 Margins and fragility

Binary gates hide distance from threshold. Define coordinate margins

$$\mu_i(m; W, \tau) = K_i(m; W) - \tau_i \tag{43}$$

and the fragility profile

$$\mathrm{FragProf}(m; W, \tau) = (\mu_R, \mu_D, \mu_Q, \mu_N, \mu_S, \mu_O). \tag{44}$$

A pass with $\min_i \mu_i \approx 0$ is fragile; a pass with all margins well above zero is more robust relative to the same specification. This still does not provide sampling uncertainty, measurement error, or external generalizability. Those require an empirical design.

8.5 Window sensitivity

For two full-domain windows W and W', a simple descriptive discrepancy is

$$\Delta_\infty(W, W'; m) = \max_{i \in \{R,D,Q,N,S,O\}} |K_i(m; W) - K_i(m; W')|. \tag{45}$$

This quantity does not establish transportability. It merely reveals whether the profile changes substantially when the evaluation window changes. A transport claim requires a declared mapping between anchors, relations, comparison sets, perturbations, and decompositions.

9 Non-Circularity and Adversarial Checks

9.1 The endpoint must not define the instrument

A technical-coherence measure is circular if the target class is used to define the relational vocabulary, window, composition law, perturbations, thresholds, or neutral coordinates in a way that guarantees the desired classification. The problem is not unique to this proposal. Flexibility in analysis and reporting can inflate apparent success even when each local choice seems defensible [4, 11].

The following choices must therefore be frozen before outcome access:

$$W_\star, \quad \tau, \quad \kappa_{W_\star}, \quad \lambda_{W_\star}, \quad \mathcal{P}_\star, \quad \mathcal{N}_\star, \quad \mathcal{A}_{\mathrm{ext}}. \tag{46}$$

Here $\mathcal{A}_{\mathrm{ext}}$ is the external analysis plan.

9.2 Counterexample families

A proposed implementation should be challenged by at least the following families:

1. **Constant systems**: test whether high R and S are rejected by low D and O.
2. **Random systems**: test whether high apparent differentiation is rejected by low R, Q, or S.
3. **Projective compositions**: test whether Q can be high while N detects loss of one argument.
4. **Rigid systems**: test whether stability without neutral variation yields low O.
5. **Window-overfit systems**: test whether the profile collapses under a separately frozen transport window.
6. **Missing-support systems**: test whether non-evaluability remains $\perp$ rather than being coded as success or failure.

These are not exhaustive. Their function is to prevent obvious shortcuts.

9.3 Limited non-redundancy claim

The internal development supplied witness constructions showing that each coordinate can vary while others are held fixed within a modular test class. This supports a limited claim of functional non-redundancy: none of the six coordinates is algebraically dispensable in that class. It does not establish empirical statistical independence, causal autonomy, or universal minimality.

Remark 9.1 (What would falsify the architecture)**.** *The six-functional architecture would be weakened if independent analysis showed that one coordinate is always determined by the others under every admissible implementation, that a simpler profile captures all registered failure modes without loss, or that one functional cannot be defined non-arbitrarily for any serious target class.*

10 External Evaluation Protocol

10.1 Why an external protocol is part of the proposal

A formal measure can appear compelling because its authors know the benchmark and can adapt the implementation. Independent evaluation is intended to separate design from scoring. Preregistration is useful precisely because it distinguishes prediction from postdiction and reduces undisclosed analytic flexibility [7]. Reproducible computational materials are a minimum condition for scrutiny, though not a substitute for independent replication [9, 10].

The supplementary protocol was developed as a separate branch, G-EXT. It does not contain an empirical result. It defines what must happen before an external evaluator can run the profile.

10.2 Six protocol stages

G-EXT.1: preregistered external-evaluation protocol. The research question, target class, inclusion and exclusion rules, reference window, thresholds, margins, operators, data-lock conditions, analysis plan, blind plan, provenance plan, stop rules, permitted claims, and non-promotion clauses are declared.

G-EXT.2: external lock and operational package. The frozen objects receive identifiers and hashes. Responsibilities are assigned. Editable templates are separated from immutable files. The lock is invalid if a required object remains unspecified or if a hash is a placeholder.

G-EXT.3: pre-execution admissibility. A formal verification checks completeness, hash consistency, provenance, no leakage, no outcome-driven modification, and non-promotional scope. Possible states include ready, waiting for completion, blocked for incompleteness, blocked for leakage, blocked for outcome-driven changes, and blocked for hash failure.

G-EXT.4: separate evaluator handoff. The evaluator receives a minimal frozen envelope, a root hash, instructions, a receipt template, and a chain-of-custody record. A mismatch blocks the handoff rather than being repaired informally after transfer.

G-EXT.5: execution contract and constrained output. The permitted execution order, runtime environment, stop rules, deviations, logs, primary outputs, diagnostic outputs, and terminal states are fixed. Output values distinguish BOTTOM from NOT_COMPUTED.

G-EXT.6: static verification and final freeze. Schemas and empty templates are checked syntactically, a final manifest is created, and the package receives the state READY_FOR_AUTHORIZATION. This state is explicitly distinct from authorization.

10.3 Protocol state logic

The methodological chain is

$$\mathsf{READY\_FOR\_AUTHORIZATION} \not\Rightarrow \mathsf{AUTHORIZED} \not\Rightarrow \mathsf{RUN\ STARTED} \not\Rightarrow \mathsf{EXTERNALLY\ VALIDATED}. \tag{47}$$

At the time of this preprint,

$$\mathsf{AUTHORIZATION} = \mathsf{NO}, \qquad \mathsf{RUN} = \mathsf{NOT\ STARTED}. \tag{48}$$

A valid future handoff requires, at minimum,

$$\begin{aligned}\mathrm{ValidHandoff} = 1 \iff\ & \mathrm{PreExecReady} = 1 \wedge \mathrm{ManifestOK} = 1 \wedge \mathrm{RootHashMatch} = 1 \\ & \wedge \mathrm{ChainOfCustody} = 1 \wedge \mathrm{RoleSeparation} = 1 \wedge \mathrm{BlindOK} = 1. \end{aligned} \tag{49}$$

A conforming future output requires

$$\begin{aligned}\mathrm{ConformingOutput} = 1 \iff\ & \mathrm{SchemaValid} = 1 \wedge \mathrm{HashValid} = 1 \wedge \mathrm{OrderValid} = 1 \\ & \wedge \mathrm{NoSubstantiveDeviation} = 1 \wedge \mathrm{NoLeakage} = 1 \wedge \mathrm{ComponentsResolved} = 1. \end{aligned} \tag{50}$$

If any substantive stop rule triggers, the run cannot be labelled completed and conforming.

10.4 What external reviewers are invited to examine

Independent reviewers are not asked initially to endorse the broader theory. They are asked to inspect narrower questions:

1. Are the six functionals mathematically well formed on their stated domains?
2. Are 0 and $\perp$ handled consistently?
3. Are the functionals non-circular with respect to the target and benchmark?
4. Do the counterexamples demonstrate genuine non-redundancy or only artefacts of the witness class?
5. Are κ_W and λ_W independently justifiable?
6. Do scalarization and gate rules preserve the intended non-compensation principle?
7. Is the external protocol sufficient to prevent tuning, leakage, and selective reporting?
8. Which claims should remain prohibited even after a successful technical pass?

This invitation is intentionally adversarial. A negative review that identifies a structural flaw is a useful result.

11 Reporting Standard for Future Applications

A technical profile is only as reviewable as its report. Future applications should use a fixed reporting order so that favourable summaries cannot precede or obscure domain failures.

11.1 Required report order

A conforming report should present, in order:

1. the target and version identifier;
2. the immutable window identifier and root hash;
3. the definitions of $\mathcal{O}$, $\mathcal{R}$, κ_W, and λ_W;
4. support counts for every component and every safe mean;
5. the six raw coordinates, including all $\perp$ values;
6. the full-domain indicator;

7. any threshold vector and the signed margins;
8. scalar summaries, if preregistered;
9. deviations, stop-rule events, and unresolved ambiguities;
10. the exact claims permitted by the execution contract.

The vector must precede the scalar. Coverage must precede interpretation. Deviations must be visible even when they do not alter the primary output.

11.2 Minimum machine-readable record

A machine-readable result should include at least

$$\mathcal{M}_{\text{result}} = (\text{TargetId}, \text{Version}, \text{WindowId}, H_{\text{root}}, \mathbf{K}_{\text{TUC}}, \text{Coverage}, \tau, \text{FragProf}, \text{Deviations}, \text{Status}). \tag{51}$$

The hash identifies the frozen input package; it does not certify scientific correctness. The status must distinguish completed conforming, completed with non-substantive deviation, stopped, invalidated by leakage, invalidated by hash mismatch, and not computed.

11.3 Claim discipline

A report may state that a target passed or failed the frozen technical gate. It may compare coordinates across preregistered targets or windows. It may describe robustness of margins under preregistered sensitivity analyses. It may not infer phenomenal consciousness, ontological status, or universal validity. It may not relabel an exploratory analysis as confirmatory after seeing the outcome.

The reporting standard is designed to make negative and undefined results publishable. A protocol that only produces a document when the result is favourable is not an external evaluation protocol; it is a selection mechanism.

12 Methodological and Epistemic Limitations

12.1 No direct measure of consciousness

The strongest limitation is categorical:

$$\mathbf{K}_{\text{TUC}} \not\equiv \text{a measure of phenomenal consciousness.} \tag{52}$$

The six coordinates describe technical properties relative to a chosen formal vocabulary. No mapping from these properties to subjective experience is supplied or validated. A system could score highly and still provide no evidence of consciousness; a conscious organism could score poorly under an inappropriate window.

12.2 No proof of Φ_0 or an ontology

The profile does not define, measure, or prove Φ_0:

$$\mathbf{K}_{\text{TUC}} \not\Rightarrow \Phi_0. \tag{53}$$

Nor does it establish the truth of the TUC-O ontological programme:

$$\mathbf{K}_{\text{TUC}} \not\Rightarrow \text{TUC-O is empirically or ontologically correct.} \tag{54}$$

The historical origin of a notation is not evidence for the ontology in which it first appeared.

12.3 No canonical observation map

The observation map $\mathcal{O}$, relational family $\mathcal{R}$, anchors A_W, and pair sets are not generated uniquely from the system. Different legitimate choices may yield different profiles. This is a central identifiability problem. External use requires a domain-specific justification for why the chosen observations correspond to the structural distinctions of interest.

12.4 The composition and neutrality contracts are strong assumptions

The functionals Q, N, and O depend on κ_W and λ_W. These may be difficult to justify without importing substantive theory. A poor composition law can make Q meaningless; a poor structural-neutral decomposition can make O arbitrary. The protocol can freeze these choices, but freezing does not make them scientifically correct.

12.5 Finite-window and sampling limitations

A finite window may omit rare failures, long-range dependencies, or scale transitions. The safe mean does not provide confidence intervals or sampling distributions. A complete empirical application would require uncertainty quantification, sensitivity analysis, and repeated evaluation across preregistered windows.

12.6 No universal minimality or sufficiency theorem

The six-function profile is not proven to be the unique minimal basis for coherence. Non-redundancy has been established only within restricted witness constructions. There may be omitted dimensions, such as causal directionality, temporal depth, resource dependence, or multiscale organization. Conversely, later work may show that some dimensions can be derived from others under justified assumptions.

12.7 Thresholds are normative or task-relative

The formalism does not derive universal thresholds. A threshold vector τ is part of a decision policy and must be justified for the target domain. A high technical threshold may be appropriate for safety-critical systems and inappropriate for exploratory models. Thresholds therefore cannot be interpreted as natural constants.

12.8 A formal model remains a model

Internal consistency and usefulness are distinct. The caution associated with statistical modelling applies here as well: a formal representation can be illuminating without being literally complete [1]. The correct scientific question is not whether the profile is metaphysically final, but whether it is explicit, non-circular, diagnostically useful, and externally criticizable.

Current epistemic status. The profile is an internally specified mathematical proposal with an editorially controlled description and a frozen pre-authorization protocol. It is not externally validated, not authorized for a real run, and not evidence for consciousness or ontology.

13 Discussion

13.1 Relation to robustness and structural stability

S_W shares the general intuition that relevant organization should persist under perturbation, but it is weaker and more local than structural stability in dynamical systems [13]. It is also narrower than biological robustness, which concerns preservation of function under varied internal and external disturbances [5]. The added coordinates D, N, and O are intended to prevent robustness from collapsing into rigidity or insensitivity.

13.2 Relation to compositionality

Q_W and N_W separate two questions often merged under compositionality. The first asks whether a compound obeys a declared rule. The second asks whether both arguments remain causally or structurally visible at the level of the profile. This separation is inspired by the broader role of systematic constituent structure in cognitive and formal architectures [2], but the present ratios are not claimed to solve the philosophical problem of compositionality.

13.3 Relation to multi-criteria methods

The vector-first design resembles multiobjective analysis in treating dimensions as jointly informative and not automatically commensurable [6]. The conservative minimum scalar is a policy choice that encodes non-compensation. Other applications may prefer Pareto comparison, lexicographic ordering, or domain-specific utility functions. Such alternatives should be described as decision layers over the profile, not as equivalent definitions.

13.4 Relation to consciousness theories

Some theories of consciousness propose mathematical measures with explicit phenomenological or causal interpretations [8, 14]. $\mathbf{K}_{\mathrm{TUC}}$ is deliberately not positioned as a competitor at that explanatory level. At most, future work could investigate whether particular technical coordinates correlate with independently justified consciousness markers. Such a study would require a new bridge theory, data, and preregistered predictions.

13.5 Value of a negative external result

Because the proposal is modular, a negative result can be informative. Failure may arise because the profile is undefined, because a coordinate is unstable, because the window is not transportable, because the operator is unidentifiable, or because a target violates the proposed architecture. These outcomes should not be collapsed into one generic rejection. The external protocol preserves diagnostic outputs precisely so that falsification can be localized.

14 Review Criteria and Research Agenda

14.1 Minimal criteria for a serious implementation

A credible application should provide:

1. a typed definition of X, $\mathcal{R}$, and $\mathcal{O}$;
2. a frozen window with independently justified pair sets;
3. a non-tautological composition law κ_W;

4. a justified structural-neutral decomposition λ_W;
5. declared perturbation and neutral-variation families;
6. complete reporting of undefined support;
7. thresholds chosen before outcomes;
8. vector results before any scalar summary;
9. adversarial baselines and negative controls;
10. an immutable execution record and constrained output schema.

14.2 Priority mathematical questions

The most important mathematical tasks are not to add more symbolism but to reduce arbitrariness:

- characterize equivalence classes of windows that preserve the profile;
- derive conditions under which λ_W is identifiable;
- study alternative sensitivity transforms for N_W;
- develop uncertainty estimates for partial relational profiles;
- determine when the six coordinates are statistically or algebraically dependent;
- compare minimum, Pareto, and gate-based decision layers;
- formalize multiscale versions of W and transport across scales.

14.3 Priority empirical questions

After authorization, external work should begin with synthetic systems whose ground-truth failure modes are known. Only then should the profile be applied to natural or high-dimensional learned systems. A staged benchmark should include constant, random, projective, rigid, noisy, partially observed, and compositionally structured families. Success must include correct rejection of adversarial negatives, not merely high scores on preferred examples.

15 Conclusion

This paper proposes a six-functional profile for technical coherence in formal systems:

$$\mathbf{K}_{\mathrm{TUC}} = (R, D, Q, N, S, O).$$

The proposal begins from a negative observation: no single common proxy—stability, low variance, high differentiation, integration, or compositional fit—is sufficient. The six coordinates therefore separate relational repeatability, internal differentiation, lawful composition, sensitivity of composition to both arguments, preservation under perturbation, and non-trivial variation compatible with a preserved core.

The vector is primary. Undefined values remain distinct from zeros. Scalarizations and gates are secondary decision rules whose thresholds and windows must be frozen. The profile is accompanied by explicit non-promotion clauses: internal formal adequacy does not imply external validity; external technical validity would not by itself imply consciousness; and no result of this framework proves Φ_0 or the TUC-O ontology.

A supplementary package has been prepared to allow independent evaluation under preregistration, hashing, role separation, blind handling, stop rules, constrained outputs, and chain of custody. The package is currently ready for authorization but not authorized, and no run has been executed. The scientifically appropriate next step is therefore independent criticism of the definitions and protocol, followed—only if the specification survives that criticism—by a separately authorized external evaluation.

Availability of Supplementary Materials

An English supplementary protocol package accompanies the project. It contains the preregistration schema, external-lock template, pre-execution admissibility checks, evaluator-handoff instructions, role-separation matrix, separate-execution contract, constrained output schemas, stop rules, freeze manifest, chain-of-custody forms, and integrity-verification tools.

> **Supplement title:** *K_TUC External Evaluator Pre-Authorization Package, English Edition, Version 1.*
> **Package ID:** `TUC-O-R1-GEXT-EXTERNAL-EVALUATOR-PREAUTH-EN-V1`.
> **Distribution note:** The package may be provided directly alongside this article or on request, subject to preservation of the recorded checksum.

The exact frozen ZIP distributed with this preprint has SHA-256 digest

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$$\mathsf{READY\_FOR\_AUTHORIZATION}, \quad \mathsf{NOT\_AUTHORIZED}, \quad \mathsf{NOT\_STARTED},$$

with

$$R = D = Q = N = S = O = \mathsf{NOT\_COMPUTED}.$$

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A Notation Reference

Table 4: Core notation used in the manuscript.

Symbol	Meaning
m	Abstract technical system $(X, \mathcal{R}, T, \odot, \mathcal{O}, \mathcal{P}, \mathcal{N})$.
W	Finite, frozen evaluation window.
X_W	States included in the window.
A_W	Relational anchors.
Π_R	Declared replicate pairs.
Π_D	Declared discrimination pairs.
Π_Q	Declared composable pairs.
Π_P	Declared perturbation tests.
Π_N	Declared neutral-variation tests.
κ_W	Predeclared law for composition of relational profiles.
$\lambda_W = (\lambda_K, \lambda_U)$	Predeclared split between structural and neutral profile coordinates.
$\pi_W(x)$	Partial relational profile of state x.
$\perp$	Non-evaluable or undefined value; distinct from zero.
R_W	Relational replicability.
D_W	Internal discriminability.
Q_W	Structural compositionality.
N_W	Compositional non-collapse.
S_W	Perturbational stability.
O_W	Non-trivial neutral openness.
$\mathbf{K}_{\mathrm{TUC}}$	Ordered six-functional profile.
$\mathrm{FullDom}_F$	Indicator that all six coordinates are defined.
$C_\wedge$	Conservative minimum scalarization.
τ	Frozen vector of coordinate thresholds.
Pass_τ	Trivalent threshold gate.
FragProf	Vector of signed margins from the thresholds.
$\mathrm{Reg}_{\mathbf{K}}$	Internal registry of profile declarations and metadata.

B Reviewer Checklist

The following checklist may be used for an initial methodological review.

No.	Question	Status
1	Are the system and window objects fully typed and finite where required?	________
2	Are replicate and discrimination pairs defined independently of the outcome?	________
3	Is the observation map justified for the target domain?	________
4	Is $\perp$ preserved as non-evaluability rather than recoded as zero?	________
5	Is κ_W preregistered and tested non-tautologically?	________
6	Does N_W detect constant, absorbing, and projective compositions?	________
7	Are perturbations meaningful and neither trivially weak nor impossibly strong?	________
8	Is the structural-neutral decomposition independently justified?	________
9	Are vector values reported before scalar summaries?	________
10	Are thresholds and windows frozen before outcome access?	________
11	Are missing support, coverage, and deviations reported completely?	________
12	Are consciousness and ontological claims explicitly excluded?	________
13	Is role separation sufficient for a genuinely independent evaluation?	________
14	Are hashes, manifests, and chain of custody verifiable?	________
15	Would a negative result remain reportable without changing the protocol?	________

C Safe and Unsafe Interpretive Statements

Table 6: Examples of permitted and prohibited interpretations.

Methodologically safe	**Methodologically unsafe**
"The system passed six frozen technical criteria in window W."	"The system is conscious."
"The minimum coordinate was N_W."	"The scalar proves global coherence."
"The profile was stable across two preregistered windows."	"The profile is universally invariant."
"The external output conformed to the frozen schema."	"The broader ontology is validated."
"The composition law predicted held-out compounds."	"Compositionality is proven for all possible states."
"No coordinate was undefined in the locked evaluation."	"The observation map captures the full system."
"The result supports further domain-specific testing."	"The result proves Φ_0."

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