TEMPORAL REVERSE ENGINEERING

A Systematic Method for Functional Analysis of Unresolved Historical Structures

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THE CENTRAL PROPOSITION

Temporal Reverse Engineering (TRE) is a first-principles method for investigating unresolved historical structures and artefacts.

When the original function of a historical structure or artefact is uncertain, TRE begins by **temporarily suspending inherited functional interpretation** while retaining the surviving physical, archaeological and environmental evidence.

The object or structure is then analysed as an unidentified physical system through its **geometry, materials, interfaces, environmental inputs, physical constraints and engineering capabilities**.

From these observations, competing physically plausible functional hypotheses are reconstructed and required to generate **testable predictions before inherited historical interpretations are reintroduced**. Those predictions are then compared with archaeological and historical evidence, subjected where possible to experimental testing, and falsified, revised or retained according to the results.

Observation -> Interpretive Suspension -> Engineering Analysis -> Functional Reconstruction -> Prediction -> Historical Comparison -> Experimental Testing -> Falsification / Revision

1. WHY TEMPORAL REVERSE ENGINEERING?

Reverse engineering normally begins with a surviving system whose design knowledge is incomplete. Historical objects create a harder version of the same problem: the designer is absent, components may be missing, materials may have changed, operating conditions may be unknown, and later cultural use may have altered the object.

TRE treats this temporal separation as a methodological constraint. The first question is therefore not *What was this called?* or *What do we already believe it was for?* It is:

> **What can the surviving physical system itself reasonably be capable of doing?**

This question does not replace historical interpretation. It creates an independent engineering line of inquiry that can later be compared with it.

2. INTERPRETIVE SUSPENSION

Interpretive Suspension is the defining methodological step of TRE:

> **The temporary withholding of inherited claims concerning an object's purpose or meaning while preserving all independently observable physical, archaeological and environmental evidence.**

Interpretation is suspended, not rejected. Measurements, provenance, stratigraphy, material composition, environmental relationships and other evidence remain available. What is withheld is the assumption that an inherited functional label must determine the engineering reconstruction.

Historical, archaeological, cultural and religious interpretations return deliberately at the **Historical Comparison** stage. This makes the suspension reversible and reduces the risk that a functional model merely reproduces the interpretation with which the investigator began.

3. THE TRE SEQUENCE

1 - Observation

Record the surviving system before proposing a function: dimensions, geometry, materials, interfaces, wear, channels, sockets, orientation, environmental relationships and missing or altered regions.

2 - Interpretive Suspension

Temporarily withhold inherited claims about purpose. Preserve evidence; suspend the functional conclusion.

3 - Engineering Analysis

Ask what the geometry, materials and interfaces permit under known physical principles. Identify inputs, outputs, loads, constraints, moving or stationary relationships and environmental coupling.

4 - Functional Reconstruction

Generate more than one physically plausible operating model. Hydraulic, structural, thermal, acoustic, mechanical, electrical, ritual-only or hybrid explanations may compete.

5 - Prediction

Require each reconstruction to predict observable consequences before searching for confirming examples: wear, residues, flow patterns, material choices, clearances, repeated interfaces, thermal behaviour, resonance or other signatures.

6 - Historical Comparison

Restore archaeological, textual, cultural and conventional interpretations. Compare them with independently generated predictions rather than using them to construct the predictions retrospectively.

7 - Experimental Testing

Where feasible, use replicas, simulations, material tests, controlled flow, vibration, loading or other measurements to determine whether the proposed capability actually exists.

8 - Falsification / Revision

Prune hypotheses that fail. Revise those that partially survive. Retain successful models as candidates, not automatically as proof of historical intent.

4. MULTIPLE HYPOTHESES, NOT A PREFERRED STORY

TRE should not be used to manufacture a single alternative explanation. When several functions fit the surviving evidence, several reconstructions should be carried forward. The useful question is not which story is most attractive, but which model makes the most discriminating predictions.

A hypothesis becomes stronger when it predicts evidence that was not used to construct it. It becomes weaker when expected signatures are absent, another model explains the observations with fewer assumptions, or experiment shows that the mechanism does not behave as predicted.

5. THE FALSIFICATION RULE

> **Failed tests prune hypotheses. Successful tests justify further investigation.**

A failed experiment is therefore not damage to TRE. It is one of the method's intended outputs. The method survives by allowing individual functional branches to fail.

Conversely, demonstrating that a reconstructed mechanism works establishes **physical capability**, not historical intent. A replica that resonates, pumps, cools, mixes or carries load does not by itself prove that historical builders designed the original for that purpose. Intent requires additional archaeological and historical evidence.

6. RELATIONSHIP TO EXISTING METHODS

TRE does not claim that reverse engineering, functional archaeological analysis, experimental archaeology, material analysis or hypothesis testing are themselves new. Archaeological research has previously developed reverse-engineering frameworks that measure geometry, form, texture, material properties and object behaviour in order to investigate function.

The proposed contribution of TRE is the **ordered protocol centred on deliberate Interpretive Suspension**: inherited function is withheld; physical capability is independently reconstructed; predictions are generated before historical interpretation is restored; and the resulting models are then compared, tested and revised.

Accordingly, the originality claim is limited: **to our knowledge, this specific ordered procedure has not previously been formalised under the name Temporal Reverse Engineering as a methodology for unresolved historical structures and artefacts.**

7. FIRST APPLICATION: P001-01

TRE emerged during an engineering examination of the lingam-yoni assembly. The investigation began by temporarily ignoring the familiar functional label and decomposing the surviving form into a central body, surrounding collector, contained basin, directed outlet and possible interfaces.

That exercise generated multiple candidate engineering functions, predictions concerning wear and missing components, and a proposal for controlled experimental testing. The resulting case study is documented separately as **P001-01 - What If We're Looking at the Wrong Part? Reverse Engineering the Lingam.**

P001-01 is not proof that TRE is valid, nor does TRE depend on the lingam-machine hypothesis being correct. It is the first worked example of the procedure. Future cases can succeed, fail or prune individual hypotheses without changing the core method.

8. SCOPE AND LIMITATIONS

TRE is most useful when original function is genuinely unresolved, surviving physical evidence is sufficient for analysis, and proposed functions can generate discriminating predictions. It is less useful where historical function is already securely documented or where the surviving object is too incomplete to constrain competing models.

Interpretive Suspension must also be temporary. A TRE analysis that never returns to archaeology and history becomes speculation rather than historical investigation.

CONCLUSION

Temporal Reverse Engineering provides a disciplined way to ask a deliberately different question of unresolved historical technology:

> **Before deciding what an object was, determine what the surviving physical system could do - then make that reconstruction face history and experiment.**

The method separates observation from inherited functional interpretation long enough to generate independent engineering predictions, while ensuring that historical context ultimately returns as part of the test.

Its success is not measured by how many unconventional hypotheses survive. It is measured by whether uncertainty is reduced: through confirmation, comparison, revision or falsification.

SELECTED PRECEDENT

Moitinho de Almeida, V. (2013). *Towards Functional Analysis of Archaeological Objects through Reverse Engineering Processes.* Doctoral thesis, Universitat Autonoma de Barcelona. This earlier framework applies reverse-engineering processes to archaeological functional analysis and is an important methodological precedent for the broader field.