Not Decoration, but Design:

Spinning, Weaving, Fastening Technology, and the Integrated Textile System of the Harappan Civilisation

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Abstract

The Harappan civilisation produced a fully integrated textile technology system. This paper argues that the standard archaeological classification of Harappan textile-related artefacts — buttons as ornaments, spindle whorls as domestic implements, loom weights as craft debris — suppresses the evidential content of the material record. We read these artefacts as what they demonstrably are: components of an engineered production system with documented continuity from 2500 BCE to at least 700 CE.

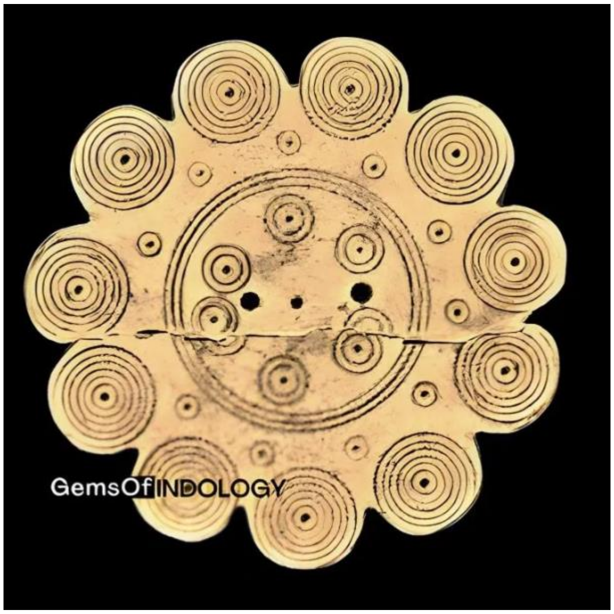
The evidentiary case rests on four interlocking bodies of evidence. First, the Lothal spinning wheel (चरखा, c. 2500 BCE) with counterweight tension-control mechanism — the earliest documented mechanised spinning apparatus, establishing that Harappan thread production operated under calibrated tension, not freehand. Second, inscribed loom weights (c. 2000 BCE), whose administrative marking places textile production within the Indus script system and therefore within an organised, regulated economy. Third, a pan-Harappan button corpus spanning circular, square, geometric, and scalloped forms across Mehrgarh, Nausharo, Rakhigarhi, and Karanpura — standardised in fastening geometry, varied in surface design, with documented quality-control rejection and direct physical evidence of textile interface. Fourth, the garment morphology record: figurines from 2500 BCE to sculpture at 700 CE showing identical garment form across 3,200 years, a continuity impossible without systematic knowledge transmission.

The paper then addresses the epistemological problem: why this system was not recognised as such. The colonial and post-colonial archaeological tradition classifies functional objects as decorative when their precise function is not immediately legible. A button becomes an ornament; a spindle whorl becomes a bead; a loom weight becomes a clay object. The classification terminates inquiry. We name this as the same move as the Griffith-Müller-Witzel tradition's reduction of functional domestic knowledge to ritual — a failure of interpretive category, not of evidence.

We conclude by establishing the full production chain: cultivation, spinning, weaving, cutting, fastening — every node archaeologically attested, every node operating under calibrated, standardised, transmissible knowledge. This is not craft. It is industrial infrastructure.

1. Introduction: The Classification Problem

In 1880, A.D. Jeffrey was granted US Patent No. 225,288 by the United States Patent Office for a two-hole disc button. The Rakhigarhi specimens from the Harappan



civilisation predate this patent by more than 3,880 years. The morphology is not merely similar — it is functionally identical: disc form, two perforations placed centrally for thread passage, standardised diameter in the fastening range. Jeffrey patented a solution that had already been engineered, standardised, mass-produced, and distributed across a civilisation spanning 1.5 million square kilometres.

This comparison is not polemical. It is diagnostic. The US patent system encodes a particular theory of invention: that a novel functional solution originates with an identifiable individual at a specific moment. The Rakhigarhi button falsifies that claim across nearly four millennia. But it does more than falsify the patent. It exposes the asymmetry in how the history of technology gets written: technologies developed in South Asia before colonial contact do not appear as inventions. They appear, when they appear at all, as precursors, proto-forms, or craft traditions — vocabulary that reserves the category of invention for the moment a European files a patent.

The colonial interpretive tradition did not only misread texts. It misread objects. When a Harappan button is catalogued as a 'fastener' and a Victorian button is patented, the asymmetry is not descriptive — it is ontological. The catalogue entry is archaeological data; the patent is invention. Same object. 3,880 years apart. Different epistemological status.

This paper dismantles that asymmetry by establishing what the Harappan textile artefact record actually shows: a fully integrated, multi-node, calibrated technology system. We proceed from fibre to thread to cloth to garment to fastening, demonstrating at each stage that the Harappan evidence documents not craft practice but industrial knowledge.

2. The Spinning System: Mechanisation and Tension Control at Lothal

The Lothal spinning wheel (चरखा), recovered from Lothal and documented in Lothal Volume II (pp. 553), dates to approximately 2500 BCE. It is a frame apparatus with spindle and counterweight — not a hand spindle operated by finger-twisting, but a mechanised device that separates the spinning and tensioning functions into distinct components.

The counterweight is the analytically critical element. Its function is to maintain constant tension on the yarn during spinning. Constant tension produces consistent thread diameter. Consistent thread diameter is not an aesthetic preference — it is a technical prerequisite for controlled weave density. Controlled weave density is what makes fabric weight predictable. Predictable fabric weight is what makes garment drape consistent. Consistent drape is what makes a stable garment form — the same garment form — replicable across workshops, across regions, and across centuries.

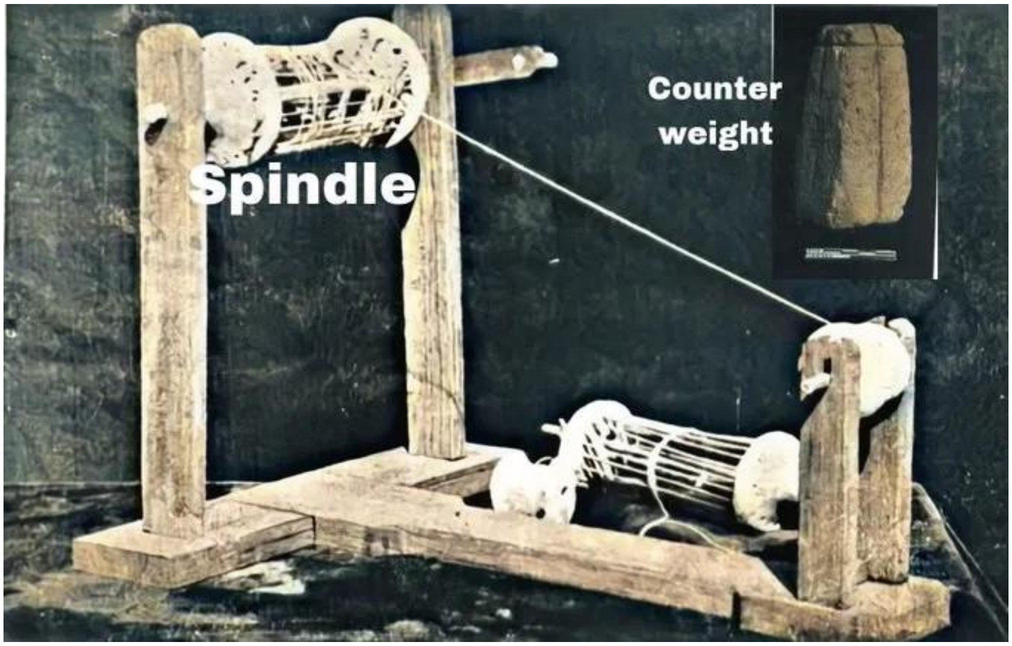
The causal chain runs directly from the counterweight on the Lothal spinning wheel to the 3,200-year morphological stability of the Harappan-derived garment form documented in Section 5. This is not an inferential stretch. It is a functional necessity: the garment continuity we observe in the figurine record is only possible if the textile production system that feeds it maintains consistent material parameters. The Lothal चरखा is the upstream device that enforces those parameters.

Multiple counterweights of different masses found across Harappan sites are not random debris. They are a calibration set. Different fibre types — cotton, wool, mixed — require different tension settings to produce equivalent thread characteristics. Maintaining a range of counterweights is the same epistemological act as maintaining the Harappan standardised weight system: measurement as a governance tool, applied here to thread production rather than trade.

The colonial attribution of the चरखा as a medieval technology democratised by Gandhi requires revision. Gandhi claimed recovery, not invention. The Lothal evidence establishes that what he was recovering had its roots at 2500 BCE. The spinning wheel is a Harappan technology that colonialism interrupted.

3. The Weaving System: Administrative Marking and the Loom Weight Corpus

Loom weights from Harappan contexts dating to approximately 2000 BCE carry inscribed signs from the Indus script system. This single fact carries disproportionate evidential weight for the argument of this paper.



Loom weights are production infrastructure, not personal objects. Their function is to maintain warp tension during weaving — mechanically analogous to the spinning counterweight, operating at the weaving stage. A loom weight that carries an administrative mark is a loom weight that has been brought within a system of recordkeeping, attribution, or quality specification. The specific meaning of the inscribed signs remains undeciphered. But their presence is unambiguous: textile production in the Harappan civilisation was administered, not merely practiced.

Whatever the inscribed signs encode — workshop identification, fibre specification, weight class, trader mark — they connect the weaving infrastructure directly to the Indus script system. The script appears on seals used in long-distance trade, on standardised weights, and now on loom weights. Its distribution tracks the infrastructure of the managed Harappan economy. Textile production is within that economy, not peripheral to it.

This is the administrative layer of the textile system. The same layer that Kauṭilya's Arthaśāstra documents for water governance — knowledge systematised and administered through state apparatus — is present in the textile domain two millennia earlier, documented materially rather than textually.

Table 1: Documented Components of the Harappan Textile Production System

Component	Evidence	Date (BCE)	Site(s)	Analytical Significance
Spinning apparatus	Lothal चरखा with counterweight tension mechanism	c. 2500	Lothal	Mechanised spinning; calibr tension control; thread diam standardisation
Spinning calibration	Multiple counterweights of varying mass	2600–2000	Pan-Harappan	Calibration set for different fi types; measurement as governance
Weaving infrastructure	Loom weights — plain and inscribed	c. 2000	Multiple sites	Production infrastructure wit administrative/script system
Fastening technology	Button corpus: circular, square, geometric, scalloped	2600–2000	Mehrgarh, Nausharo, Rakhigarhi, Karanpura	Standardised fastening geometry; quality-control rejection documented
Textile interface	Fabric impression on Ns-44A button face	2600–2000	Nausharo	Direct physical evidence of button-textile contact; weave structure preserved
Garment morphology	Figurine dress record	2500 BCE–700 CE	Pan-South Asian	3,200-year morphological continuity of garment form
Thread-grip engineering	Square button with diagonal crosshatch face	2600–2000	Multiple sites	Surface texture prevents loo slippage; mechanical proble solved by design

Component	Evidence	Date (BCE)	Site(s)	Analytical Significance
Quality control	Karanpura 11-division button — inner geometry off	~2500	Karanpura, Rajasthan	Rejected specimen implies production standard and acceptance criteria

4. The Button Corpus: Standardisation, Design Variation, and Quality Control

The Harappan button corpus is a manufacturing archive. We do not treat it as decorative. We read it as an engineer would read a parts catalogue: standardised function, documented variants, material specifications, and — critically — evidence of quality control.

4.1 Typological Range and Functional Standardisation

The corpus spans multiple sites and multiple centuries: Mehrgarh (Mr- prefix specimens), Nausharo (Ns- prefix specimens), Rakhigarhi, and Karanpura. Across this geographic and temporal range, the fastening geometry is constant: two perforations, placed centrally, sized for thread passage. The form varies — circular, square, star-edged, scalloped, rectangular — but the functional core does not.

Typological variety within a standardised functional specification is the signature of a mature product category. It indicates that the fastening solution is settled — the two-hole geometry is not under investigation, it is established — while aesthetic variation serves social and regional differentiation functions. This is the same pattern seen in contemporary button production: the two-hole geometry is standard; the surface treatment is variable.

4.2 Surface Engineering: The Thread-Grip Problem

Nausharo specimen Ns-44A shows a diagonal crosshatch texture on the button face. This texture is not decorative. A button in service is under shear stress at the thread loop: the loop tends to migrate toward the perforation holes, and the garment fabric tends to pull the button toward the edge of the buttonhole. Surface texture on the face of the button — particularly diagonal crosshatch, which is non-directional and provides grip in all orientations — resists loop migration and fabric pull.

This is an engineering solution to a mechanical problem. Someone observed loop migration and applied a surface treatment to resist it. That observation and response is exactly the kind of applied functional knowledge that the colonial interpretive tradition classifies as craft intuition rather than engineering decision. We classify it as engineering.

4.3 The Textile Interface: Ns-44A Fabric Impression

The surface of Ns-44A preserves a fabric impression — the weave structure of the textile this button was in contact with. This is direct physical evidence of the button-textile interface. If the impression is analysable — thread count, weave type, fibre diameter — it constitutes a direct sample of the textile this button fastened. The button becomes a transfer medium for textile data. This specimen deserves dedicated materials analysis.

4.4 The Karanpura Button and the Quality Control Problem

The Karanpura button from Rajasthan, dated to approximately 4,500 years ago, carries eleven outer concentric-circle units arranged radially around a central boss, with six concentric circles within the inner ring. The outer units cannot be placed with perfect geometric equality by compass-and-straightedge: 360° is not divisible by 11. The actual spacing requires either iterative physical approximation from a master template or a pre-calculated angular increment of 32.7° per division.

The inner geometry on this specimen does not close correctly. This is not a failure of the craftsman. It is evidence of a production standard. This button was made against a norm — and did not meet it. The existence of a rejected specimen is proof that acceptance criteria existed. Rejects are only possible in a system that has defined what correct looks like. That definition is the quality control system.

The first image in our corpus shows another high-geometry button from Nausharo: seven radial divisions, each with four concentric circles, accurate to 1% across identical units, with inter-centre distances accurate to 5%. The note accompanying this specimen records that such accuracy is only achievable if all units were made from the same mould. Mould-based standardisation at sub-millimetre scale across a 3-centimetre object is not craft. It is precision manufacturing.

5. The Garment Record: 3,200 Years of Morphological Continuity

Harappan figurines from approximately 2500 BCE depict women wearing a waist-to-hip wrapped garment with a defined upper edge, worn low on the hips, with the midriff exposed. Sculptural representations from 700 CE show the identical garment: same cut, same wearing convention, same silhouette. The span is 3,200 years.

Morphological stability of this duration is not cultural conservatism. It is technical evidence. A garment form is stable only when the material system that produces it is stable: fibre type, spinning parameters, weave structure, fabric weight, drape characteristics, and cutting geometry must all be reproduced consistently to produce a garment that looks and moves identically across workshops and centuries. The continuity we observe in the figurine record is the downstream signature of an upstream production system that held its parameters across 3,200 years.

The Lothal spinning wheel and its counterweight system are the devices that enforce those parameters at the thread-production stage. The loom weight corpus is the infrastructure that enforces them at the weaving stage. The garment continuity in the figurine record is the output that both of those systems produce.

The colonial and post-colonial interpretive tradition reads the figurine garment as cultural practice — dress as social behaviour. We do not dispute that dimension. But social behaviour is downstream of material possibility. You cannot wear a garment that cannot be made. The 3,200-year continuity of the Harappan garment form is simultaneously a social fact and a manufacturing fact. The manufacturing fact is the one that has been suppressed.

6. Silk at Chanudaro: Independent Sericulture and the Limits of the Diffusionist Model

The standard history of silk assigns its invention exclusively to China. This is not a neutral observation — it is a founding premise of a diffusionist model in which sericulture knowledge moves outward from a single Chinese origin, reaching other regions as transmission, import, or imitation. The Harappan evidence demolishes it.

SEM (scanning electron microscopy) analysis of fibres recovered from Harappan bronze artefacts at Chanudaro — conducted by Thapar et al. (2008) — identified two distinct silk thread forms, neither of which is *Bombyx mori*, the domesticated silkmoth of Chinese sericulture. The first matches *Antheraea* sp., a wild silkmoth genus indigenous to South Asia. The second remains unidentified to species but is consistent with *Philosamia* spp. (Eri silk), also a South Asian wild species. The Chanudaro fibres are dated to the mid-third millennium BCE — contemporaneous with the earliest Chinese silk evidence.

This is not Chinese silk found at a Harappan site. This is silk produced from South Asian wild silkmoth species, processed and incorporated into artefacts at an Indus urban centre, at the same moment that Chinese sericulture was developing from a different moth, on a different ecological and technological trajectory. Two independent traditions. One designation — 'China invented silk' — covers only one of them.

The Species Evidence and What It Forecloses

The diagnostic force of the Thapar et al. finding lies in the species identification. *Bombyx mori* is the product of millennia of Chinese domestication; it cannot be transferred without the sericulture system that produced it. Wild *Antheraea* species — *Antheraea mylitta* (tasar silk) and related taxa — are ecologically native to the Indian subcontinent. Their presence in Harappan fibre assemblages does not represent imported Chinese silk arriving at the Indus. It represents local knowledge of local moths, local fibre-processing, and local integration of silk into the Harappan material system.

The SEM morphological analysis that supports this identification is not inferential. The cross-section geometry, surface features, and thread-form characteristics of the Chanudaro fibres are diagnostically distinct from *Bombyx mori*. The identification rests on comparison with known reference specimens of both *Antheraea* sp. and *Philosamia* spp. The two thread forms at Chanudaro suggest not a single silk-processing event but a practice with sufficient variety to draw on at least two species — consistent with a tradition of wild silk use rather than a single instance of contact with an external source.

The Thapar et al. study was published as a Nature Precedings preprint (2008). It has not been superseded or contradicted. The evidentiary basis — SEM fibre analysis with species-level morphological comparison — is methodologically sound. It is cited here on that basis, with the publication status noted.

System Logic: Silk Within the Integrated Harappan Textile Framework

The Chanudaro evidence does not stand alone. It extends the argument of this paper. We have shown that Harappan textile production was an integrated system: spindle whorl standardisation at production scale, loom weight arrays implying organised weaving infrastructure, dye infrastructure capable of producing the chemical complexity that later Indian textile traditions exported intact to Egypt and Mesopotamia (GemsOfINDOLOGY 2026, Paper 6). Wild silk fibre processing fits this system without requiring special explanation.

Wild silk — tasar, Eri — is not chemically simple fibre. *Antheraea* silk is sericin-heavy, requires degumming, and produces a coarser, more textured thread than *Bombyx mori*. Processing it for incorporation into artefacts — as the Chanudaro bronze evidence shows — implies knowledge of fibre preparation beyond simple reeling: degumming technique, thread processing, integration into a finished object. This is not incidental fibre use. It is organised material knowledge applied to a non-trivial fibre type.

The bronze artefact context is analytically significant. Silk does not survive in most South Asian archaeological deposits; the recovery of silk fibres from a bronze surface is a preservation accident, not a representative sample. The bronze acted as a chemical preservative, protecting organic material that would otherwise have decayed. What the Chanudaro fibres show us is a glimpse of a practice whose full extent the archaeological record cannot recover. The absence of silk in other Harappan contexts is a taphonomic condition, not a historical one.

This is the same archaeology-of-absence argument we made for cotton textiles in Paper 6. Organic materials decay. The record that survives is not the record that existed. The Chanudaro silk fibres are preserved by metal contact — a contingent survival. The argument from absence — 'Harappan silk production is unattested therefore it did not exist as a systematic practice' — collapses the moment the preservation bias is named.

The Diffusionist Model and Its Epistemological Function

The claim that China invented silk is not merely a historical claim — it is a structuring assumption of a diffusionist model that systematically positions South Asia as a receiver of knowledge rather than a generator of it. Müller's framework for interpreting the Vedic corpus as deriving its sophistication from outside the subcontinent reproduces this logic in a philological register. The textile evidence is its material register.

What the Chanudaro evidence forces is the recognition that the Indus valley was not downstream of Chinese sericulture. It was operating its own tradition, from its own ecological resources, at the same historical moment. The diffusionist model cannot accommodate this without fundamental revision — which is why it has not accommodated it. The Thapar et al. finding has been available since 2008. It has not been integrated into standard accounts of silk history. The question is not why the evidence is unclear. The evidence is clear. The question is why the framework resists it.

The Griffith-Müller-Witzel tradition's interpretive reflex — assign knowledge generation to external origins, assign South Asian practice to transmission or imitation — is not a failure of data access. It is a structural feature of the framework. The Chanudaro silk is one more instance where the framework fails the evidence.

Primary Source

Thapar, B.K., et al. (2008). *New Evidence for the Use of Silk in the Indus Valley Civilization*. Nature Precedings. https://doi.org/10.1038/npre.2008.1900.1. [Preprint; SEM fibre analysis of Chanudaro bronze artefacts; species identification: *Antheraea* sp. and *Philosamia* spp.; dated mid-third millennium BCE.]

GemsOfINDOLOGY. (2026). From Seeds to Systems: Ecological, Technological, and Archaeological Constraints on Cotton Textile Adoption in Egypt, Mesopotamia, and the Indus Valley (2600 BCE–1300 CE). Zenodo. https://doi.org/10.5281/zenodo.19648141

7. The Epistemological Problem: Why the System Was Not Recognised

The Griffith-Müller-Witzel tradition of Indological scholarship imposed a ritual and symbolic interpretive lens onto texts that are better understood as governance, functional regulation, and applied knowledge. We have documented this problem across multiple papers in this series. The present paper adds a material dimension to the same critique.

The archaeological tradition that catalogued Harappan buttons as ornaments or fasteners, spindle whorls as beads, and loom weights as clay objects was not incompetent. It was operating within an interpretive framework that could not recognise functional knowledge as knowledge when it appeared in South Asian material form. The framework reserves the category of invention for the documented moment of European origination. Everything prior is precursor. Everything from South Asia is craft.

The Jeffrey patent comparison makes this visible. Two objects, functionally identical, separated by 3,880 years, receive categorically different epistemological treatment: one is data, one is invention. The asymmetry is not about the objects. It is about the framework that receives them.

The consequences are not merely historiographical. The colonial administration that dismissed South Asian technical knowledge as primitive craft used that dismissal to justify replacing indigenous production systems with imported ones. The destruction of the Indian textile industry under British trade policy in the 18th and 19th centuries was enabled by the prior epistemological move that classified that industry as artisanal rather than industrial. You cannot destroy an industry you have classified as craft, because craft is not an industry — it is a cultural practice. Colonial epistemology performed the classification before colonial economic policy performed the destruction.

We name this explicitly. The button is not a small object. It is evidence of a system. The failure to read it as such was not accidental.

8. The Complete Production Chain: From Fibre to Fastening

We can now assemble the complete documented chain:

Stage	Technology	Evidence	Date (BCE)	Key Feature
1. Cultivation	Cotton cultivation, Gossypium arboreum	Archaeobotanical — Mehrgarh, Harappa	c. 5000–2600	Indigenous domestication; earliest cultivated cotton
2. Spinning	Frame चरखा with counterweight	Lothal Vol. II, pp. 553	c. 2500	Mechanised; tension-calibrated; thread diameter control
3. Weaving	Frame loom with weighted warp	Inscribed loom weights; fabric impressions	c. 2000	Administrative marking; system-level regulation
4. Dyeing	Indigo — resist and mordant methods	Fustat assemblage; dye residue analysis	c. 2600–2000	Documented in GemsOfINDOLOGY 2026 (Paper 6)
5. Cutting / finishing	Edge reinforcement at fastening points	Inferred from button mechanics	c. 2600–2000	Buttonhole requires reinforced aperture
6. Fastening	Two-hole button corpus	Mehrgarh, Nausharo, Rakhigarhi, Karanpura	c. 2600–2000	Standardised geometry; quality control; 3,880-year prior art over Jeffrey patent
7. Garment system	Stable dress morphology	Figurine record 2500 BCE–700 CE	2500 BCE–700 CE	3,200-year morphological continuity

Every node in this chain is archaeologically attested. No node requires inference from absence. The chain is documented.

9. Conclusion

The Harappan civilisation operated an integrated textile technology system. The evidence for this system is distributed across multiple site reports, multiple artefact categories, and multiple millennia — which is precisely why it has not been assembled into a coherent argument before now. Each component was classified in its own narrow category: buttons in the ornament catalogue, spindle whorls in the domestic implement catalogue, loom weights in the clay object catalogue, garment depictions in the art history catalogue. No single catalogue could see the system.

We see it because we read the artefacts as engineers rather than antiquarians. A counterweight is a tension-control device. A button with crosshatch is a thread-grip solution. A rejected button is a quality-control document. An inscribed loom weight is an administrative record. A 3,200-year stable garment form is a manufacturing specification.

The Geoffrey patent comparison is not a rhetorical flourish. It is the argument in miniature: the same object, in two different epistemological frameworks, receives two different ontological statuses. In one framework it is data. In the other it is invention. The framework that assigned data status to the Harappan button was colonial. We are correcting it.

This paper is part of the GemsOfINDOLOGY decolonisation series. Its argument complements the cotton textile system paper (GemsOfINDOLOGY 2026, Paper 6, DOI: https://doi.org/10.5281/zenodo.19648141), which establishes the Indus zone as a system-level textile knowledge exporter, not a peripheral supplier. Together, the two papers establish: the Harappan civilisation had a complete, administered, calibrated textile production system; that system had a continental export reach; and the failure to recognise either of these facts is an epistemological problem that colonial scholarship created and post-colonial scholarship has yet to fully correct.

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