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Rethinking Culture as Infrastructure:

A Boundary Object for Diversity in HCI

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Insights

- Culture can act as a boundary object connecting diverse HCI perspectives without reducing differences to national stereotypes.
- The cultural infrastructure framework links heuristics, situated meaning, and power across three levels of analysis.
- Cultural assumptions become infrastructure when embedded in interfaces, datasets, workflows, institutions, and forms of authority.

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From the mid-1990s to the early 2000s, culture occupied a visible place in HCI. Researchers examined cross-cultural interaction, localization, international usability, and national cultural models. This work challenged the assumption that users, interfaces, and interaction principles were culturally neutral.

Over time, culture lost some of its intellectual appeal, becoming associated with national categories, checklists, and simplified accounts of difference. In their weakest form, cultural models converted probabilities into portraits of people: *Indian users are collectivist; Western users prefer individual control.* Recurring patterns can inform design, but a first approximation was too often mistaken for a full explanation.

Meanwhile, HCI developed more politically precise vocabularies. Feminist HCI foregrounded pluralism, embodiment, participation, and positionality [1]; postcolonial computing examined empire, development, and unequal epistemic authority [2]. Decolonial, more-than-human, data justice, and planetary approaches further expanded accounts of diversity, knowledge, power, and interdependence.

This necessary shift produced a paradox: Culture became less visible as an organizing concept just as cultural questions became pervasive. Whose knowledge counts? Which values enter systems? How do classifications reproduce inequality? Which forms of

life and intelligence does design recognize? The cultural question fragmented into specialized conversations that do not always travel easily among researchers, designers, engineers, policymakers, and communities.

CULTURE AS A BOUNDARY OBJECT

Culture remains one of the simplest concepts through which HCI can communicate the non-neutrality of technology. It can refer to shared practices, identities, histories, institutions, values, languages, or ways of knowing. This flexibility is often treated as conceptual weakness. It can also be an advantage.

Susan Leigh Star and James R. Griesemer [3] described boundary objects as sufficiently adaptable to different viewpoints while retaining enough common identity to support coordination. Culture can perform this role in HCI. A software engineer, ethnographer, community organizer, and policymaker may not define culture identically, but the concept can open a shared conversation about assumptions, difference, meaning, and power.

Culture should not replace feminist, postcolonial, decolonial, more-than-human, or planetary HCI. It can provide a boundary object through which their insights encounter one another and become communicable to wider audiences. To do this without returning to national stereotypes, however, culture must be approached through progressively deeper levels of analysis.

THE CULTURAL INFRASTRUCTURE FRAMEWORK

Culture has been approached in HCI through traditions often kept apart. Level 1 is broadly positivist or postpositivist: Culture is operationalized as patterned difference supporting probabilistic design hypotheses. Level 2 is interpretivist and constructionist: Culture is situated meaning negotiated through practice. Level 3 draws on critical theory: Patterns and meanings are examined as historically constituted through power. Each therefore makes culture a different object of knowledge and offers only partial visibility.

The discussion above exposes a gap: HCI lacks a simple way to connect these orientations without collapsing their differences or letting one stand for culture as a whole. In response, I propose the cultural infrastructure framework. My contribution is to integrate these traditions as connected levels of analysis. Figure 1 moves from visible interfaces, behaviors, and heuristics, through situated meanings and practices, to less visible relations of power, knowledge, and legitimacy. It traces how assumptions travel across levels and become embedded in artifacts, classifications, workflows, and institutions. I use cultural infrastructure to name the relations, alignments, tensions, and contradictions connecting them.

Level 1 treats culture as design heuristics. Comparative or psychometric evidence may suggest likely patterns in communication, deference to authority, uncertainty avoidance, individual or collective decision-making, and interface preferences. Such knowledge can guide initial hypotheses about how to recruit participants, organize evaluation, present information, or structure interaction. It offers breadth and practical orientation: What is likely to work here?

The limitation is myopia. A claim such as "This is a collectivist community" cannot explain why people act collectively in some situations and competitively in others. Level 1 findings must remain provisional. They are prompts for inquiry, not conclusions about individuals.

Level 2 treats culture as sense-making. It asks what technologies mean within situated practices, identities, relationships, and histories. It examines how people interpret, appropriate, resist, and work around systems, and how technologies reshape valued knowledge and social roles. This level asks: What does this technology change, and why does that matter here?

Level 3 treats culture as power, knowledge, and legitimacy. Its epistemological affinity is with critical theory. It examines how ideologies, institutions, professional discourses, semiotic systems, and political-economic arrangements shape what counts as true, normal, desirable, or technologically possible. Power here includes formal control, but also the capacity to stabilize categories, representations, narratives, and technological frames. This level asks: Who defines the problem? Which meanings and knowledge acquire authority? Whose interests become embedded, and who can contest them?

Infrastructure is relational rather than a list of things. Language, interfaces, datasets, buildings, people, standards, and institutions become infrastructural through the durable arrangements connecting them. These arrangements enable particular forms of action, coordination, and legitimacy while constraining others. Such conditions are often taken for granted until breakdown or conflict makes them visible [4].

LLMS AS CULTURAL INFRASTRUCTURE

Large language models make cultural infrastructure especially visible. An LLM is not neutral before meeting diverse users. Culture enters through those who fund and build it, the texts that become its training data, and those who label and moderate outputs. It is also shaped by privileged languages and norms and by different means of interaction, such as chat, voice, copilots, or agents. These choices are not merely technical [5]. At level 1, interfaces shape turn-taking, tone, and trust. At level 2, people position the model as a tool, collaborator, expert, or authority. At level 3, companies and institutions shape which knowledge and values gain legitimacy, whose labor remains invisible, and who controls the infrastructure. LLMs do not merely contain cultural bias; they reorganize knowledge, authority, and interaction.

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SEEING THE THREE LEVELS IN ALIBAUG

I encountered these tensions while evaluating the mKRISHI Fisheries app in Alibaug in India. The app combined

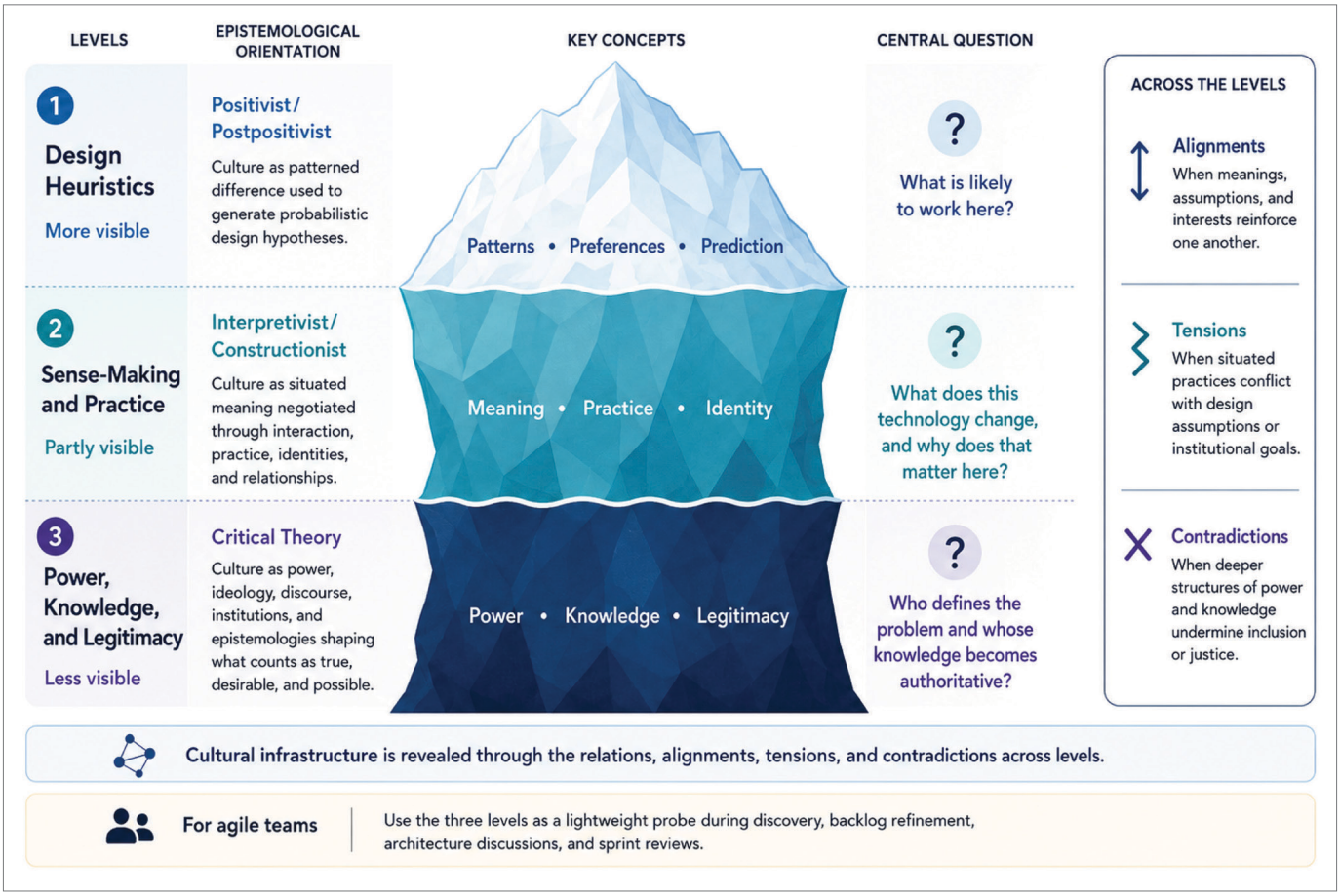


Figure 1. The cultural infrastructure framework: Three progressively deeper levels of cultural analysis in HCI. Cultural infrastructure is revealed through alignments, tensions, and contradictions across levels.

satellite data and local catch records to indicate likely fish locations and provided weather forecasts intended to improve safety and reduce wasted diesel [6].

At level 1, cultural knowledge informed interface and process. The project used visual displays for varied literacy, while engagement was organized collectively through fishing societies and familiar meeting spaces, including a church. Collectivism and uncertainty avoidance offered heuristics: Fishers might defer to authority, prefer group engagement, or value forecasts that reduce uncertainty. These ideas could shape interface choices, training, and evaluation, but could not explain the whole setting.

At level 2, the app altered the meaning and value of knowledge. Knowing where fish might be found had been experiential, competitive, and sometimes passed between generations. By making algorithmic predictions broadly available, the app redistributed expertise and identity. It created tensions between inherited knowledge and scientific prediction, cooperation and competition, and small-scale and industrial fishing. A usable interface could therefore be meaningful in one sense while disruptive in another.

At level 3, the application became a site where competing cultures of knowledge and legitimacy defined sustainable fishing. Fisheries scientists privileged predictive modeling and ecological measurement; Tata Consultancy Services framed technological and social innovation; fishing societies managed the consequences of redistributing information among actors with unequal resources. The conflict concerned which representations of fish, knowledge, progress, and sustainability acquired authority.

The application can therefore be *dissected* across the three levels. Its cultural infrastructure was not located solely in the screen, the fishers, the algorithm, or the institutions. It lay in the evolving relationships among them. The most revealing problems were cross-level contradictions: A feature could succeed at level 1, unsettle identities and knowledge at level 2, and generate conflicts over knowledge, legitimacy, and control at level 3—all at the same time.

A THREE-LAYER CULTURAL PROBE FOR AGILE DESIGN

Working teams rarely have months for ethnography. Cultural infrastructure thinking should therefore enter decisions that already exist in agile development rather than become a separate, heavyweight phase.

A lightweight three-layer cultural probe can be used during discovery, backlog refinement, architecture discussions, and sprint reviews. For each significant feature or system decision, the team asks the following:

Level 1: Heuristics. Which behavioral or cultural patterns are we assuming? What evidence supports them? Which interface, workflow, or engagement decision follows?

Level 2: Sense-making. Which practices, identities, relationships, or forms of knowledge might this decision preserve or disrupt? What kind of adaptations or work-arounds might emerge?

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Level 3: Power, knowledge, and legitimacy. Who defined the problem, categories, and measures of success? Which meanings, ideologies, and forms of knowledge become authoritative? Who controls the system, who benefits, who bears risk, and who can challenge its decisions?

The output should not be another checklist. Teams record four linked items: the assumption, the evidence, the design consequence, and the trigger for revisiting the decision. A persona assumption might change recruitment; a finding about shared-device use might change authentication; a conflict over what counts as valid knowledge might change data fields, governance, or escalation procedures.

The probe also asks one integrative question: Where are the levels aligned, and where do they contradict one another? This turns cultural reflection into traceable design work without pretending that a brief exercise replaces situated research.

GUARDRAILS AGAINST CULTURAL REDUCTIONISM

The framework requires explicit guardrails. Level 1 describes probabilities, not destinies. Nationality is never a complete proxy for culture. Every heuristic should be tested against level 2 practices and level 3 relations of power, knowledge, and legitimacy. Designers, companies, scientific disciplines, and standards are culturally situated too; culture is not something only "users" possess.

Most importantly, localization is not cultural infrastructure. If culture appears in a specification only as language, currency, country, or demographic profile, it remains external context. Culture becomes infrastructural when assumptions about people, knowledge, authority, value, and desirable futures are materialized in interfaces, classifications, datasets, workflows, and institutions.

WHAT THIS OFFERS HCI

Rethinking culture as infrastructure does not revive the checklists of the 1990s. It recovers culture as a boundary object while giving it greater analytical depth. The three levels integrate predictive reach, situated meaning, and critical reflexivity. The framework makes visible how a technically successful system can simultaneously generate tensions in meaning, knowledge, legitimacy, and control.

Culture is not a fourth specialist discourse competing with feminist, postcolonial, decolonial, more-than-human, or planetary HCI. It is a connective metaconcept through which their concerns can be translated across audiences and related to concrete design decisions.

The challenge is not simply to ask whether technology fits a culture. It is to trace how cultural assumptions become infrastructure and what worlds they make possible.

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