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ORIGINAL ARTICLE

Hybrid Human-AI Co-Creation in Design

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ABSTRACT

Human-AI co-creation is often inferred whenever artificial intelligence participates in creative work. Yet computational participation alone does not establish co-creation: agency, authorship, initiative and responsibility remain negotiated throughout the design process. The study examines such negotiation through a focused model-building synthesis of thirteen publications and a structured online questionnaire completed by sixteen design professionals. Retrospective cross-source analysis identified recurring patterns of computational participation and consolidated five situated AI roles, Synthesizer, Expander, Reframer, Evaluator and Co-Performer, alongside four boundary conditions: instrumental, overlapping, contested and unclassified participation. Empirical patterns located AI-supported activity primarily in research, ideation and development, while perceived control remained predominantly human-led. These findings informed the Integrated Hybrid Co-Creation Framework (IHCF), which connects design stage, enacted role, initiative distribution, recursive interaction and governance within a single process-oriented structure. Rather than treating AI roles as fixed system properties, the IHCF conceptualises co-creation as a relational configuration that emerges through situated interaction. The resulting distinction between co-creative participation and bounded computational support provides a clearer basis for analysing agency, authorship and responsibility in hybrid design practice.

Keywords: Co-creation; human-AI collaboration; distributed agency; negotiated authorship; participatory design; AI governance; design methods.

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INTRODUCTION

Co-creation has become an important mode of innovation for addressing problems that require distributed expertise, interpretation and decision-making. However, participation alone does not constitute co-creation. Its analytical significance depends on how agency, labour, authorship, value and decision authority are distributed and negotiated (Drain and Sanders, 2019; Teli et al., 2020; von Busch and Palmås, 2023; Gemser et al., 2025). Artificial intelligence intensifies this problem. Generative and analytical systems can organise information, produce alternatives, reframe possibilities and influence evaluation, yet responsibility remains socially, legally and institutionally human. The central question therefore shifts from whether AI participates in design to how computational participation becomes co-creative and under which conditions such participation remains bounded assistance. Human-AI scholarship provides important foundations for addressing this distinction. Research has examined autonomy, authenticity, authorship, communication, feedback and different levels of creative collaboration (McCormack et al., 2019; Rezwana and Maher, 2022; Haase and Pokutta, 2024; Breckner et al., 2025), while hybrid intelligence emphasises complementary human and computational capacities rather than automation alone (Dellermann et al., 2019). Design-specific studies further locate AI within professional processes. Computational support varies across the Double Diamond (Lee et al., 2025, Quiñones-Gómez et al., 2024), assumes different collaborative modes and interaction forms (Fang et al., 2025, Quiñones-Gómez et al., 2025), requires active arbitration of computational propositions (Yu, 2025) and changes as creative tasks evolve (Zhou et al., 2026, Quiñones-Gómez, 2026). Collectively, such studies clarify where AI enters design and how interaction unfolds, but design stage, enacted role, initiative distribution, recursive interaction and governance remain analytically fragmented. Consequently, the conditions separating co-creative participation from instrumental computational support remain insufficiently integrated. The study addresses this gap through a focused model-building synthesis of thirteen design publications combined with a structured online questionnaire completed by sixteen design professionals. Four existing frameworks supplied complementary conceptual resources: the Co-Creative Design Framework (CCDF) contributed agency, interaction dynamics, communication and reciprocal modification (Davis et al., 2025); the Human-AI Collaboration framework (HAIC) contributed cognitive participation, division of labour and shifting initiative (Song et al., 2024); the AI-Augmented Double Diamond supplied temporal organisation across design stages (Bouschery et al., 2023); and the AI Collaboration in Engineering Design framework (AICED) contributed transparency, traceability and design-stage governance (Obieke et al., 2025). The IHCF extends beyond aggregation of these frameworks by connecting temporal organisation, initiative, situated computational participation, recursive interaction and governance within a single process-oriented structure. Cross-source analysis further consolidated five situated AI roles, Synthesizer, Expander, Reframer, Evaluator and Co-Performer and four boundary conditions, instrumental, overlapping, contested and unclassified participation. Such categories provide an analytical distinction between computational presence and co-creative participation while preserving ambiguity where collaborative status cannot be assigned unequivocally. The investigation addresses three questions:

RQ1: How is initiative perceived and negotiated in AI-supported design and how are such configurations situated across different stages of the design process? **RQ2:** How are interaction practices described in relation to authorship, collaborative status and perceived creative value in human-AI design workflows? **RQ3:** Which task, phase and infrastructural conditions shape epistemic contribution, interpretability, attribution and accountability in human-AI co-creation?

THEORETICAL BACKGROUND

Co-creation scholarship increasingly understands collaboration as a reorganisation of problem framing, authority, legitimacy and attribution rather than as the simple aggregation of individual contributions (Trischler et al., 2019; Drain and Sanders, 2019). Improvisation, experimentation and reciprocal sense-making further position co-creation as an emergent process in which outcomes cannot readily be attributed to a single actor (Henricks, 2015). Human-AI design extends this relational logic to computational participation. Open-ended design activity creates conditions for iteration, alternative framing and reciprocal adaptation (Vaccaro et al., 2024), supporting an account of hybrid co-creation as distributed epistemic agency across human judgement, computational propositions, design materials and interpretive infrastructures (Giaccardi and Redström, 2020).

Within such configurations, agency remains relational and temporally variable rather than fixed by technological capability. Initiative can shift across ideation, interpretation, selection and implementation, while authorship emerges through prompting, rejection, modification and contextualisation (McGuire et al., 2024; Wan et al., 2024). Reciprocal adaptation further distinguishes co-creation from unilateral automation: computational propositions can redirect design activity, while human intervention can alter subsequent generation (Zagalsky et al., 2021; Breckner et al., 2025). Interaction continuity, feedback, pacing and turn-taking consequently become part of how creative agency is negotiated (De Jaegher and Di Paolo, 2007; Rezwana and Maher, 2022). Hybrid co-creation also depends on infrastructural conditions extending beyond immediate interaction. Transparency, provenance, data stewardship, attribution, contestability and documented decision-making shape whether computational participation remains interpretable, attributable and accountable (Gerdes, 2022; Noriega et al., 2021). Such conditions connect creative participation with questions of responsibility and governance, particularly where computational contributions influence problem framing, evaluation or decision-making.

These relational, temporal and infrastructural concerns are distributed across four complementary frameworks. The AI-Augmented Double Diamond structures progression across divergent and convergent design activity; HAIC addresses cognitive participation, division of labour and shifting initiative; CCDF characterises agency, interaction dynamics and reciprocal modification; and AICED foregrounds transparency, traceability and design-stage documentation. Rather than constituting a predetermined model, these frameworks supplied sensitising concepts for examining design stage, computational function, initiative, reciprocal interaction, authorship and governance. The subsequent analysis considered how such dimensions converged, diverged or required extension when compared with the empirical accounts of design professionals.

METHOD AND DATA

The study followed an exploratory mixed-methods design structured around three sequential components: a focused model-building framework synthesis, a structured questionnaire completed by design professionals, and retrospective cross-source integration. The literature component followed the iterative model-development logic of Oates et al. (2012) and was conceived as a focused framework synthesis rather than an exhaustive systematic review. A structured literature-mapping dataset supplied the sampling frame, with criterion-based selection restricted to publications classified within the Design domain as Human-AI Co-Creation or Human-AI Collaboration. The literature mapping covered publications available up to mid-2026, including the Human–AI Collaboration framework (HAIC) (Song et al., 2024), the AI-Augmented Double Diamond (Bouschery et al., 2023), the Co-Creative Design Framework (CCDF) (Davis et al., 2025) and the AI Collaboration in Engineering Design framework (AICED) (Obieke et al., 2025). Following duplicate consolidation, the final analytical corpus comprised thirteen publications represented through 36 activity-level records. Multiple records were retained when a publication described distinct design stages, activities, or relational configurations. Additional recent publications informed contextual positioning but did not alter the analytical corpus or retrospective role coding. Literature records were examined for computational function, human intervention, initiative distribution, reciprocal interaction, contextual judgement, authorship, contestability, provenance and accountability. Initial coding retained source terminology, while subsequent comparison organised recurrent patterns into a provisional conceptual structure. The four source frameworks operated as sensitising resources rather than predetermined coding categories, allowing wider literature records to contribute additional patterns concerning computational participation, human intervention, authorship and governance. The empirical component comprised a structured online questionnaire containing 32 closed and open-ended items, completed by sixteen design professionals recruited through purposive professional and academic networks. Participants represented industrial design, UX/UI, service design, engineering design, design strategy and related multidisciplinary fields, with professional experience ranging from fewer than five to more than twenty years and differing levels of familiarity with AI-supported practice. Questionnaire items addressed professional background, AI use, design-stage integration, perceived control, collaborative status, workflow implications, originality, authorship, bias, ethical concerns, personalisation and post-deployment activity. Literature records and questionnaire responses were analysed separately before integration. Closed responses were summarised through counts and percentages, while open-ended responses underwent two retrospective coding cycles. The first retained participant terminology to identify computational functions, design phases, control configurations, interaction patterns, authorship concerns, ethical tensions and governance issues. The second compared these patterns with the literature synthesis and sensitising frameworks. A structured codebook linked reported activity, design phase, computational function, human intervention, initiative configuration, role classification and boundary status. Five situated roles were consolidated through this comparison. Synthesizer referred to organisation, analysis, or connection of existing information; Expander to generation of alternatives and possibilities; Reframer to changes in problem interpretation or formulation; Evaluator to comparison, prediction, testing, or assessment against criteria; and Co-Performer to iterative production or refinement through repeated human-AI exchange. Four boundary conditions retained cases that resisted exclusive role assignment: instrumental participation indicated bounded computational support; overlapping participation indicated multiple situated roles; contested participation captured disputed independence, authorship, control, or collaborative status; and unclassified participation retained insufficient, contradictory, or missing evidence.

Cross-source integration examined convergence, extension and contradiction. Recurrent patterns supported consolidation of the five roles, participant accounts refined situated meanings and divergent cases informed the four boundary conditions. The resulting categories therefore emerged from comparison between literature records and questionnaire accounts rather than direct adoption from any source framework. Reported frequencies, quotations and boundary cases provide empirical grounding for framework construction rather than an independent test of a pre-existing IHCF. The unit of analysis was the participant-phase-role instance. Multiple roles could be assigned within a phase when supported by distinct activities, although each participant was counted no more than once per role within that phase. Missing responses were excluded from relevant descriptive calculations without imputation, while vague or inconsistent accounts were retained as contested or unclassified cases. Perceived control was retrospectively recoded as a three-point ordinal index: 1 represented fully human-controlled bounded assistance, 2 mostly human-controlled activity with some automated decisions and 3 partially controlled activity involving AI-generated and AI-filtered options. The index served descriptive analysis only and was not administered as a pre-existing scale; control was not measured separately across design phases. All literature selection, questionnaire construction, recruitment, data preparation, coding, framework synthesis, descriptive analysis and interpretation were conducted by the sole author. No second coder participated and no inter-coder comparison was conducted. Analytical consistency was supported through explicit coding criteria, repeated coding cycles, analytic memos, documented classification decisions and retention of divergent cases. Coding records documented participant code, response excerpt, activity, phase, computational function, role, boundary status, rationale and associated memo.

Before questionnaire access, an information page described the research purpose, institutional affiliation, study topics, estimated completion time, voluntary participation, withdrawal before submission, academic use, publication of aggregated findings, confidentiality and contact details. An optional contact field meant that data collection was confidential rather than fully anonymous at source. Contact information was removed before analysis, participant codes P01-P16 were assigned and selected quotations were reviewed to minimise re-identification risk. Consent was indicated through voluntary continuation and submission. The complete questionnaire, participant information materials, response formats and coding documentation are available from the corresponding author upon reasonable request. Participant-level responses are not publicly available because consent covered confidential academic analysis and publication of aggregated findings rather than unrestricted release.

RESULTS

AI-supported activity was concentrated in ideation and conceptualisation (n = 11, 68.8%), research and data analysis (n = 10, 62.5%), and prototyping and development (n = 6, 37.5%). Despite substantial computational participation across such activities, perceived control remained predominantly human-led. Ten participants reported fully human-controlled assistance, four mostly human-controlled activity with some automated decisions, and two partially controlled generation and filtering. The resulting three-point index produced a mean of 1.50 (SD = 0.73), a median of 1, and an interquartile range of 1-2. Nine participants characterised AI primarily as a tool, six as a collaborator, and one provided no response. Phase-specific initiative scores were not collected.

The sixteen participants represented eight countries: Spain (n = 6), Italy (n = 4), and Brazil, France, Germany, India, the Netherlands, and Thailand (n = 1 each). Professional experience ranged from 0-5 years (n = 1) to more than twenty years (n = 3), with five participants reporting 6-10 years and seven reporting 11-20 years. Regular AI use was reported by six participants, occasional use by nine, and no prior use by one. Industrial design and UX/UI were each selected by seven participants, service design by six, and design strategy by five; multiple disciplinary selections were permitted.

Retrospective coding revealed a marked concentration of situated roles across design stages. Synthesizer appeared eight times in Discover and nowhere else; Expander appeared thirteen times in Develop and nowhere else; Reframer appeared once in Define and once in Develop; Evaluator appeared seven times in Deliver and nowhere else; and Co-Performer appeared six times in Develop and nowhere else. No role terminology appeared in the questionnaire. Synthesizer activity centred on information organisation and pattern identification, Expander on alternative generation and rapid variation, Reframer on changes in problem interpretation, Evaluator on prediction, comparison, testing, and assessment, and Co-Performer on iterative idea or artefact refinement.

Cross-source integration of the empirical patterns with the four sensitising frameworks resulted in the Integrated Hybrid Co-Creation Framework (IHCF), presented in Figure 1. The resulting architecture connects design stage, situated role, initiative distribution, recursive interaction, and governance within a single analytical sequence. Role placement across stages represents conceptual possibilities rather than observed prevalence; the empirical role-phase distribution reported above therefore remains distinct from the conceptual associations represented in the framework.

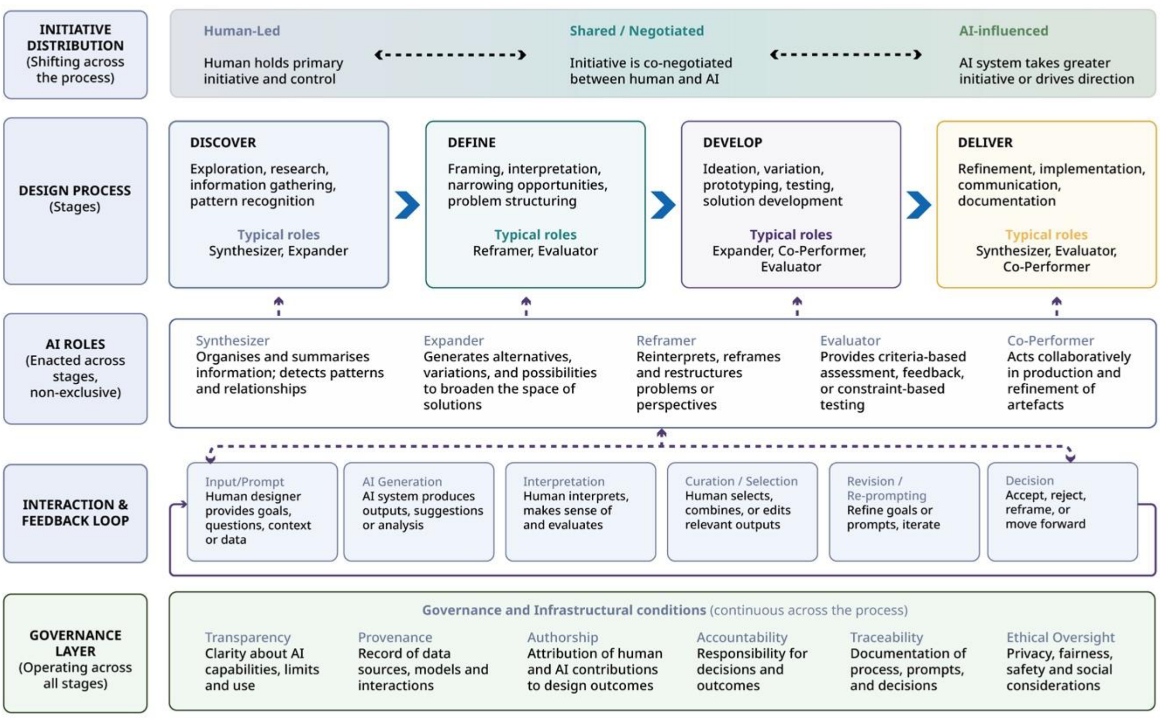

Fig. 1. Integrated Hybrid Co-Creation Framework (IHCF).

Figure 1 organises the IHCF through interconnected analytical layers. A design episode is first situated according to initiative configuration and process stage, followed by identification of one or more enacted computational roles. The recursive interaction layer traces generation, interpretation, curation, revision, and decision across successive exchanges. Governance extends across the entire sequence through transparency, provenance, authorship, accountability, traceability, and ethical oversight. Greater computational initiative does not transfer responsibility, which remains human and institutional across hybrid design activity. Participant P10 illustrates application of the role and phase dimensions. The statement “gathering and organising information and data in research” was identified as information structuring, assigned to Discover, and coded as Synthesizer. A later reference to “hypothesis definition … and scenarios prototyping” was identified as alternative problem construction, assigned to Define, and coded as Reframer. The case captures non-exclusive role enactment across design stages rather than a stable computational identity. No phase-specific control score, interaction record, provenance record, or governance documentation was available for the case; initiative, recursive interaction, and governance consequently remained unclassified rather than retrospectively inferred. Further quotations illustrate the remaining situated roles. P14 characterised Expander activity as “Faster ideation & exploration”. P03 referred to “Improving prediction accuracy” in Evaluator activity and described AI as a “Reliable Co-Creator” in Co-Performer activity. Not all accounts, however, fitted a clear collaborative configuration. P01 described visualisation and communication without direct contribution to the design process, indicating instrumental participation. P03 enacted several roles across different activities and remained overlapping at participant level. P13 presented inconsistent adoption evidence, while P15 combined instrumental use with concern regarding excessive computational independence. Retention of such boundary cases preserved the distinction between computational presence and co-creative participation rather than forcing all AI-supported activity into the five situated roles.

Open-ended accounts further associated iterative prompting, contextual awareness, critical oversight, and human refinement with closer alignment between generated material and design intent. Contrasting accounts referred to superficial outputs, limited contextual understanding, fragmented continuity, and substantial correction requirements. Interaction fluency was therefore treated as an interpretive analytical dimension rather than as a directly administered or scored instrument, and no statistical relationship among interaction fluency, trust, and creative confidence was examined.

Open-ended responses also raised concerns regarding authorship, ownership, privacy, transparency, accountability and continued human oversight. Governance-related concerns provided an additional empirical dimension. Eight participants reported direct experience of biased outputs, while four additional participants expressed concern without direct observation. Prompt histories, decision logs, metadata access, and formal governance records were not measured systematically. Accordingly, governance within the IHCF represents an analytically derived cross-stage condition informed by literature synthesis and participant concerns rather than an empirically observed organisational procedure.

DISCUSSION AND CONCLUSION

The findings position hybrid co-creation as a negotiated configuration rather than an automatic consequence of AI use. Computational participation alone remains insufficient to establish co-creative status, which depends on enacted role, initiative, contextual interpretation, recursive revision, contestability and responsibility within a situated design episode. Recursive interaction therefore extends beyond repeated prompting: earlier human and computational contributions must be capable of redirecting subsequent action through cycles of generation, interpretation, selection and revision (Davis et al., 2025). This interpretation extends existing accounts that locate AI across design stages (Lee et al., 2025; Fang et al., 2025), emphasise designer arbitration of computational propositions (Yu, 2025; Zhao et al., 2026), or trace changing interaction patterns across creative tasks (Zhou et al., 2026). The IHCF connects these dimensions within a single process-oriented architecture. Synthesizer, Expander, Reframer, Evaluator and Co-Performer describe situated configurations of computational participation rather than fixed system identities, while instrumental, overlapping, contested and unclassified conditions retain cases that resist straightforward collaborative classification. The distinction prevents computational presence from being treated automatically as co-creation. Governance provides a further condition of this relational account. Transparency, provenance, authorship, accountability, traceability and ethical oversight shape whether computational contributions remain interpretable, attributable, contestable and open to revision across Discover, Define, Develop and Deliver. Participant concerns regarding ownership, bias, privacy, interpretability and human oversight support inclusion of this layer, although formal governance procedures were not directly observed. Governance consequently operates throughout hybrid design activity rather than as a final constraint applied after computational participation has occurred. Interpretation remains bounded by the small purposive sample, self-reported data, heterogeneous AI experience, absence of direct observation, general rather than phase-specific initiative measurement, single-investigator coding and absence of formative assessment of IHCF interpretation or application. Role frequencies derive from retrospective classification and the focused literature synthesis served a model-building purpose rather than an exhaustive review of human-AI design research. Explicit coding criteria, repeated coding cycles, analytic memos and retention of divergent cases supported analytical consistency, although no independent coding comparison was conducted. Subsequent research could operationalise the IHCF through a Hybrid Co-Creation Toolkit addressing initiative distribution, role enactment, recursive interaction, transparency and governance. Initial studies should examine consistent practitioner interpretation of the five roles and four boundary conditions before developing items, scoring procedures, worked applications and openly licensed templates. Project-based studies could then incorporate direct observation, phase-specific initiative measures, multiple coders, longitudinal interaction records and governance documentation. No formative assessment, psychometric examination, or toolkit testing formed part of the present study. The central contribution therefore lies in reframing human-AI co-creation as a process of negotiated participation rather than a property of AI systems. The IHCF provides an analytical vocabulary for distinguishing co-creative participation from bounded computational support and for examining how agency, authorship, responsibility, interaction and governance change across design activity.

CONFLICT OF INTEREST

None to declare.

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