

Toward Innocence: Choreographing Computation in the Shadow of Spectacle

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#computational design

#synergies

#DIKW ladder

#design innocence

#design 3.0

Currently, the role of design and its significance is being drowned in gimmicks, as digital technologies now play a significant role in shaping the behaviours, performances and standards of societies, communities, organizations and individuals (Denning & Tedre, 2019). That stark observation, opening the call for *Cubic Journal* Issue #8, frames the dilemma of twenty-first-century computation. Digital technologies have woven themselves so completely into contemporary practice that it is now possible, and alarmingly common, for the craft of design to be mistaken for a talent show of software tricks (Caetano & Leitão, 2020). Parametric engines pump out ever-thicker lattices, immersive headsets allow us to rehearse projects before they exist, and generative models pour shapely novelties onto our screens faster than we can develop opinions about them (López-López et al., 2023; Oxman, 2017). Yet the brighter the spectacle, the more easily it obscures the purpose that once animated design: the careful alignment of material possibility, cultural meaning and lived need. Complexity produced first and explained later is the new cliché (Frické, 2009). A script churns overnight, a form appears at dawn, and the day is then spent inventing a story to justify what the algorithm decided while no one was looking. In that moment authorship blurs: is the designed entity the geometry, the code that birthed it, or the opaque commercial platform that still owns the underlying parameters? When the engine is sealed, we are left admiring not insight but vendor capacity. This editorial argues for a reframing of computational design—not as a pursuit of spectacle or optimization, but as a relational, ethical, and materially grounded practice. We call this shift Design 3.0 (Figure 1).

This editorial unfolds in three acts (fig. 1): first, a critique of spectacle and a call to recover ethical authorship; second, ten case studies of computational design in practice that ascend the DIKW ladder—from data, through information and knowledge, to wisdom (Ackoff, 1989); and third, a proposal for Design 3.0—an open, reflexive, reciprocal paradigm for the future.

Philosophical Grounding – Beyond Digital Gimmickry

To move out of the above cul-de-sac, the present issue of *Cubic Journal* proposes that we “search for innocence” inside the very computational milieu that so often corrodes it. Innocence here is not a nostalgic return to drafting tables; rather, it is the discipline of approaching each digital operation as provisional. Every line of code must remain open to revision, every data set negotiable, every interface a two-way conversation instead of a one-way funnel. The ambition is straightforward: let the machine’s plasticity remain a servant to human sense-making rather than an autonomous generator of spectacle.

Lucien Kroll understood the danger long before today’s neural networks. In *The Architecture of Complexity*, he warned that computer-aided design could lapse into what he called “self-contained, closed and repetitive” cycles (Kroll, 1987). His corrective was a slight change of acronym with vast ramifications: abandon CAD as the paradigm and adopt CUD—computer use *in* design. What matters is the preposition; the computer should be situated inside a broader ecological choreography, not perched above it dispensing final answers. Kroll’s advice has aged well. Where early CAD threatened to standardise ornamental detail, contemporary generative models attempt to standardise attention itself, feeding us torrents of auto-completed images that look distinct yet feel eerily interchangeable. We have inherited his problem at planetary scale, and we need a comparably simple compass: begin each project by asking for whom the algorithm will work, with whom it will collaborate and toward what end.

Abstraction, however, is never enough; we need a practical yardstick for deciding when a computational workflow genuinely serves design and when it merely dazzles. John Wood’s hierarchy of synergy—data, information, knowledge and wisdom—offers that measure. At the base of the ladder lies data: raw facts captured in open form

so that anyone can inspect, correct or extend them. When those facts are patterned into relations that suggest action, they become information. Let those patterns seep into material practice—code meeting grain, yarn or breath—and knowledge appears. Only when knowledge bends toward ethically attuned judgement, responsive not only to clients but also to ecosystems and future strangers, do we arrive at wisdom. John Wood’s hierarchy of synergy—data, information, knowledge and wisdom—offers that measure (Ackoff, 1989; Wood, 2017). At the base of the ladder lies data: raw facts captured in open form so that anyone can inspect, correct or extend them. When those facts are patterned into relations that suggest action, they become information. Let those patterns seep into material practice—code meeting grain, yarn or breath—and knowledge appears. Only when knowledge bends toward ethically attuned judgement, responsive not only to clients but also to ecosystems and future strangers, do we arrive at wisdom (Ackoff, 1989; Frické, 2009; Rowley, 2007; Zins, 2007). In this model innocence is no naïve blank slate; it is an insistence on climbing continually, refusing to mistake elaborate output at the lower rungs for conclusive achievement. Each of the ten contributions that follow occupies a rung on

this ladder and, more importantly, demonstrates an awareness that no rung is secure unless it remains connected to the one above and the one below.

Progress up the ladder depends on what might be called *breakability*. A breakable tool reveals its workings, welcomes tinkering and can survive a fork in its own code base. Unbreakable engines—closed, commercial, inscrutable—may run swiftly but resist collective learning. Breakability flourishes only inside something larger: a digital commons (Becker et al., 2015; Friedman & Hendry, 2019). Point clouds of a market street, EEG logs from an empathy experiment, sonic spectrograms of fish-farm drones—if such data are openly licensed, they become the seedbed for collaborative interpretation. A photogrammetric model of a mosque falling into disrepair can be annotated by historians, augmented by schoolchildren and contested by community elders, turning the very act of scanning into long-term stewardship. Innocence in this sense is communal; it de-centres the heroic auteur in favour of distributed caretaking.

To keep the commons alive we must choreograph three verbs—*scripting*, *sensing* and *interacting*—in

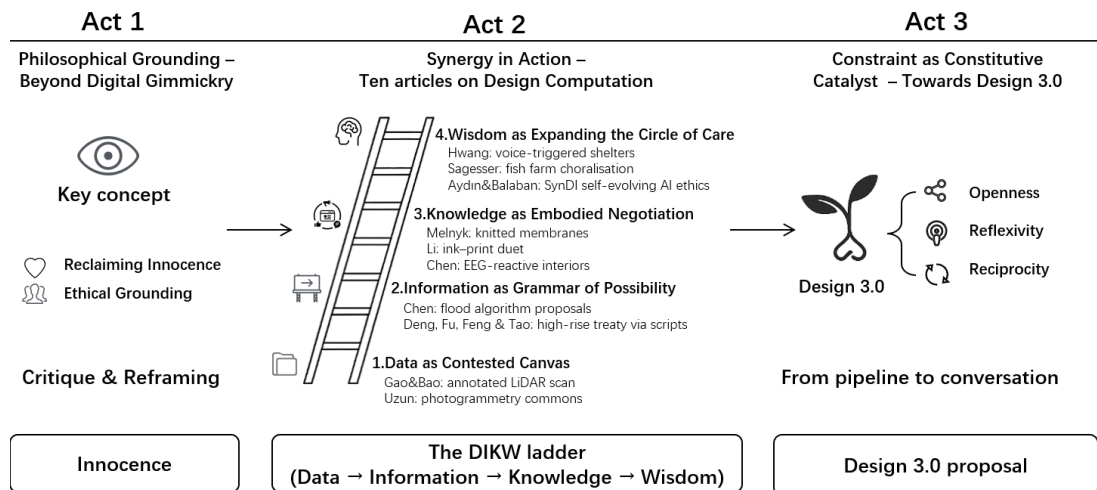


Figure 1. Toward Design 3.0: A Three-Act Journey Through Computation. Source: authors

reciprocal rhythm. Scripting encodes hypotheses; a modifiable script keeps hypotheses contestable. Sensing translates flux—light, carbon, stress, affect—into machine legibility; when sensors are transparent they invite criticism and recalibration rather than smuggling bias under the guise of objectivity. Interacting completes the feedback loop: people confront the computational representation, and the representation, in turn, shifts. Remove interaction and scripting lapses into solipsism; remove scripting and interaction slumps into gimmick. The most compelling projects in this volume recognise the choreography: mixed-reality alley surveys where locals overwrite the architect's scan; EEG-adjusted interiors where lighting engineers learn from the occupant's nervous system; AI chorales that force commuters to listen to the mechanical lungs of fish ponds at the edge of the city.

Yet universal access to code does not by itself guarantee equitable authorship. The mantra that “anyone can type `Hello World`” recalls Joseph Beuys's “everyone is an artist,” but the slogan conceals new gate-keeping (Beuys, 2007). Prompt-driven image generators privilege those fluent in prompt rhetoric; platform dashboards intimidate users unfamiliar with slider logic; jargon of machine-learning pipelines can freeze conversation before it starts. If innocence is to survive, design education must treat debugging as civic literacy, version control as common historiography and parametric adjustment as dialogue rather than a pass-fail exam in software bravado.

Another obstacle masquerades as progress: the cult of performance metrics. Joules saved, minutes shaved, kilograms of carbon offset—these are indispensable, yet they can flatten design into an engineering spreadsheet (Douglas et al., 2021; Floridi et al., 2021). Human-centred outcomes prove emergent and often wilfully deviate from projected benchmarks. Instead of worshipping optimisation, we might valorise *potential*: the capacity of a system to host futures not yet known. Potential only becomes

visible when many actors—designers, users, bystanders, other species—stress-test the system, question its sensors and renegotiate its interface. Innocence, re-cast, means extending hospitality to difference and unpredictability without losing coherence.

Design, then, resembles ecology more than assembly line. A façade algorithm that moderates daylight will alter indoor temperature; that temperature shift will modify occupant behaviour; occupant behaviour will feed back into the building-control sensor network, altering the sunrise data that tomorrow's algorithm will parse. Linear pipelines—capture, model, fabricate—become loops of mutual adjustment. The designer's task is to choreograph these loops so that every participant can understand and, when necessary, intervene before a feedback spiral calcifies into unintended harm (Simon, 1988).

That choreographic responsibility suggests five working principles that hover, implicitly, behind every page that follows. First, keep scripts exposed so hidden assumptions stay contestable. Second, treat data—whether meshes, bio-signals or drone-song—as civic infrastructure rather than proprietary commodity (Becker et al, 2015; Friedman & Hendry, 2019). Third, keep the body in the loop: allow craft, proprioception and affect to reshape code at every iteration. Fourth, engineer algorithms that can interrogate their own premises and welcome external audit. Fifth, judge success not by closure but by a system's capacity to absorb revision.

All these threads converge on a single ambition: to restore humane purpose to digital ingenuity without trimming that ingenuity's exploratory wings. The paragraphs above have named the traps—gimmick, spectacle, metric fetish—and provided the scaffolding—synergy, commons, breakability—needed to avoid them. What remains is to test those ideas against real practice. The ten articles that fill the remainder of this issue do precisely that. Some work close to the ground, in alleyways that become

communal canvases for LiDAR; others occupy speculative skylines, where parametric timber towers listen to wind-tunnel data as carefully as to literary allusion. Still others listen to heartbeats, stitch yarn into algorithms, or translate agricultural machinery into choral lament. Each, in its own idiom, asks whether innocence can survive the rigors of contemporary complexity. The answer will depend on whether the tools remain breakable, the data shared, the body present and the ethical loop kept vividly, sometimes painfully, alive. We invite the reader to climb the ladder with us and judge.

Synergy in Action – Ten articles on Design Computation

The theoretical scaffolding of design computation's philosophical grounding remains inert unless subjected to the friction of real-world application, contradiction, and critical evaluation. The ten research projects presented here are not merely case studies categorized by discipline; they constitute a continuous, critical journey through ten windows. Each window reveals how a specific investigation navigates the DIKW ladder (Data-Information-Knowledge-Wisdom), and crucially, how this navigation actively reconfigures the ladder's very structure. We traverse projects where data becomes a contested communal canvas, information is transmuted into contingent agency, knowledge manifests as embodied craft wrestling with digital abstraction, and wisdom demands the painful expansion of ethical care beyond immediate human concerns. The DIKW stages are not overt signposts within the prose but implicit compass points, their true significance emerging from the critical connective tissue woven between the projects.

Data as Contested Canvas: Ownership and the Politics of Representation

We begin grounded in the dense, self-organized chaos of Baishizhou, Shenzhen. Xinrui Gao and

Hanzhe Bao's work transcends the typical use of Mixed Reality (MR) and LiDAR as mere data capture tools. Their HoloLens deployment is not about creating a pristine, authoritative digital twin. Instead, the real-time point cloud becomes a *provocative, scribble-ready surface*. When residents see their alleyways rendered as shimmering digital dust and are handed the tools to annotate shadows, demand micro-courtyards, or veto sightlines, data ceases to be a passive asset. It becomes a catalyst for collective negotiation and spatial reimagining. The critical insight here is profound: data gains life and meaning only when it becomes malleable and accessible to the community it represents. The "synergy" is not just technological integration; it's a socio-technical intervention challenging top-down planning paradigms. However, critical questions arise: Who defines the parameters of annotation? How are conflicting resident inputs resolved? Does this digital participation mask underlying power imbalances in the physical redevelopment process? The project powerfully demonstrates first-order synergy but also exposes the inherent political tensions in democratizing spatial data.

Thousands of kilometres away, **Fatih Uzun and team** engage in a different form of data democratization through photogrammetry. Harvesting tourist snapshots of Ottoman doorways to stitch into 3D meshes released under open licenses transforms historical fragments into a shared digital commons. This act challenges traditional gatekeeping in heritage conservation. Historians tracing lost inscriptions and schoolchildren colorizing missing tiles exemplify data becoming a platform for diverse forms of engagement and knowledge reconstruction. The critical link between Baishizhou's alley scan and the photogrammetry commons is not precision, but *radical ownership and accessibility* (Becker et al., 2015; Friedman & Hendry, 2019). Both projects assert that data's value lies not in its fidelity alone, but in its capacity to be touched, altered, and reinterpreted by the many, thereby transform-

ing "facts" into socially negotiated constructs. Yet, it also highlights a critical limitation: the digital archive's dependence on existing photographic records inherently privileges certain viewpoints and overlooks undocumented elements, raising questions about the completeness and bias inherent in crowd-sourced datafication.

Information as Grammar of Possibility: From Signal to Invitation to Act

Possessing data is inert; its transformation into actionable information requires asking "So what?". **Xi Chen** poses this question urgently to Hong Kong's flood-prone To Kwa Wan. Feeding complex datasets (rainfall, tides, population density, building age) into a Physarum-inspired growth algorithm (Nakagaki et al., 2000) does not yield a singular, optimized solution. Instead, it generates a *branching family of possibilities* – levees conceived in bamboo and mycelium, each representing a distinct negotiation between ecological function, community needs, and spatial constraints. This information isn't presented as an oracle's decree but as a *grammar of possibilities*. The algorithm's output serves as provocative sketches, tangible starting points for neighbourhood workshops to accept, reject, or hybridize. Information here is reframed from static answer to dynamic *invitation for situated action and co-design*. The critical strength lies in its rejection of computational determinism. However, the challenge remains: How effectively can complex algorithmic outputs be translated for meaningful community engagement? Does the "slime mold logic" remain an opaque black box to residents, potentially undermining true co-creation?

Similarly, **Xi Deng, Runxin Fu, Shiyao Feng, and Biaoqing Tao** navigate the complex interplay of forces in high-rise design. They juggle multiple generative scripts – daylight simulation, wind flow analysis, structural optimization – not to find a single "perfect" form, but to orchestrate a "negoti-

ated treaty" between micro-climate, material properties (like Tao's sustainable wood modules), and cultural resonance (Feng's translation of Shanshui painting principles). (Koyama, 2017; Oxman, 2017) The computational tools here manage complexity, balancing competing objectives to generate viable options. The machines do not "know" the answer; they know how to efficiently explore the solution space and keep the complex conversation between human designers, environmental constraints, and cultural imperatives moving forward without premature collapse. Second-order synergy, therefore, is revealed as the critical craft of transforming raw data streams and complex simulations into *poised, comprehensible invitations for human judgment and intervention*. The critique surfaces in the potential gap between algorithmic exploration and the architect's intuitive synthesis: Does the emphasis on parametric balancing risk diluting bold, culturally resonant gestures that might not score optimally on all simulated metrics?

Knowledge as Embodied Negotiation: The Tacit Dialogue of Craft and Code

When computational invitations meet material reality and human skill, information thickens into embodied knowledge. **Virginia Melnyk** exemplifies this through the intricate dance of knitting. Nylon and elastic yarns are knitted into specific ribbed membrane patterns, physically stretched over transforming scissor-grid frames, and observed as the textile "remembers" and responds to torque. A wall panel folding to a quarter size and popping back wrinkle-free is not just efficient; its *material knowledge encoded through yarn tension, structure, and elasticity*. This physical behaviour then feeds back into the digital design process, teaching the algorithm about real-world material resilience and the limits of purely geometric simulation. Knowledge emerges from the iterative, tactile dialogue between the digital pattern, the physical properties of the yarn, and the forces exerted by the mechan-

ical structure. Code is inscribed in material behaviour, and material behaviour, in turn, rewrites the code's assumptions (Oxman 2017). The critical edge lies in its rejection of digital abstraction divorced from physical consequence. Yet, the challenge is scalability: Can the deep material knowledge gained through small-scale prototyping be reliably translated to larger architectural applications without unforeseen complications?

Li Xiaoqiao pursues a parallel negotiation in digital printmaking. The "digital print matrix" is not a final, pristine digital file commanding perfect robotic reproduction. Laser-sintered grooves interact unpredictably with ink viscosity and paper fibers, introducing "blemishes" – deviations that are not errors but integral to the final aesthetic, echoing the unpredictability of traditional engraving. The final artwork becomes an artifact of negotiation between algorithmic precision (the digital matrix), machine execution (the laser), and the tacit knowledge of material behaviour (ink bleed, paper absorption). Neither the programmer nor the machine alone possesses the final "knowledge"; it co-emerges through their interaction with the physical world. This challenges the notion of digital perfection and elevates the role of material contingency. Critically, it asks: Can this embrace of the "glitch" or material agency be systematized without becoming merely another controlled aesthetic? Does it risk romanticizing unpredictability? (Boden, 2004).

Xinyi Chen pushes embodied knowledge further, integrating physiological data streams (EEG, eye-tracking, galvanic skin response) directly into environmental systems. As occupants' states shift (alert to calm), lighting dims or intensifies, acoustic properties adapt, scent diffusers activate. The critical shift here is profound: The room ceases to be a passive container and becomes an active, somatic collaborator. The "interface" dissolves; knowledge of human state is embedded in the environment's real-time response. The "synergy" is the seamless, almost unconscious, feedback loop between body, sensor,

and environment. However, this raises significant critical concerns: the pervasive monitoring inherent in such systems (Floridi et al., 2021), the potential for subtle behavioural manipulation (Leslie, 2023), and the risk of reducing complex human emotional states to quantifiable bio-signals. The knowledge is embodied but also potentially invasive.

Wisdom as Expanding the Circle of Care: Ethics Beyond the Human

Climbing the final rung demands expanding the ethical horizon beyond immediate human utility. Chuteng Hwang's intelligent shelter system for rural women at risk in Mongolia integrates speech-emotion recognition (SER). A detected tremor in a voice during a routine call, shared *with consent*, triggers a social-services dashboard. Here, the algorithm aspires not to surveillance but to *advocacy*. Wisdom means leveraging technological acuity (SER's pattern recognition) explicitly in service of vulnerable lives, holding the technology accountable to urgent human need. The critical tension is palpable: balancing proactive support with privacy, ensuring algorithmic detection of distress is accurate and culturally sensitive to avoid false alarms or misuse, and embedding genuine consent mechanisms within potentially coercive contexts (Mökander, 2021) The wisdom lies in the system's intention – care for the marginalized – but its realization hinges on meticulous ethical safeguards against technological overreach.

Marcel Zaes Sagesser re-tunes the pervasive drone of Guangzhou's fish-farm aerators into a complex choral lament. Field recordings are computationally analysed (clustered using IRCAM tools), transcoded into musical notation, and re-voiced by human opera singers, played through low-hanging horn speakers in a gallery. This computational transcoding makes audible the hydro-acoustic metabolism linking carp, the low-tech aerator technology, the river ecosystem, and the sprawling urban conurbation. Commuters pausing, phones raised,

become momentarily aware of this interconnected "techno-sonic space." Wisdom here involves using computation not to simplify or dominate nature's soundscape, but to *reveal hidden connections and foster ecological awareness through aesthetic transformation* (Floridi et al., 2021). The critique focuses on the act of translation itself: Does the artistic mediation through opera singers and gallery context romanticize or distort the original soundscape's meaning and its impact on local residents? Is it an act of care for the ecosystem or an aesthetic appropriation?

Serdar Aydın and Beryar Balaban's conceptual Synergistic Design Intelligence (SynDI – implied in the prompt) pushes the circle outward most radically. Voxel assemblies evolve through AI fitness tests *combined* with ongoing human critique. Crucially, the system evolves not just its geometry but its *own rule-set*, explicitly questioning its values: "Can delight outweigh carbon?" "Who is entitled to judge delight?" Wisdom, in this vision, resides in creating computationally augmented systems capable of *ongoing ethical self-questioning* and negotiation, explicitly considering non-human stakeholders (embodied in metrics like carbon) and challenging the very criteria of success (Friedman & Hendry, 2019; Leslie, 2023). This represents the most ambitious synergy: integrating technical optimization, human values, environmental impact, and meta-ethical reflection into a dynamic, never-closed loop. The critical challenge is immense: avoiding infinite regress in value-setting, preventing the AI from developing opaque or undesirable ethical heuristics, and ensuring meaningful human oversight remains possible in complex, self-modifying systems. It risks becoming either unworkably abstract or ethically unsettling.

Synthesis: Five Critical Propositions for Contested Terrain

Collectively, these ten investigations, critically examined, crystallize five fundamental proposi-

tions for design computation operating in ethically and materially complex terrain:

Open the Script (and Interrogate Its Biases): Executables (LiDAR workflows, Physarum algorithms, SER models, knitting patterns) must expose parameters and lineage for scrutiny, adaptation, and forking. This is not just technical transparency but an ethical imperative to challenge embedded assumptions and power structures within the code itself (e.g., Who defines "distress" in SER? What spatial priorities are baked into the Physarum rules?) (Ackoff, 1989; Frické, 2009; Mökander, 2021; Rowley, 2007; Zins, 2007).

Treat Data as Civic Infrastructure (with Access and Responsibility): Point clouds, environmental sensor data, heritage scans, physiological traces, or aerator dronesong should be governed as shared resources, not proprietary assets. This demands robust frameworks for ethical access, privacy protection, and ongoing maintenance, acknowledging that data always carries the biases of its collection context (e.g., tourist photos for heritage) (Becker et al., 2015; Friedman & Hendry, 2019).

Embed the Body and Materiality (Resist Disembodied Abstraction): Computational processes must be continually modulated and informed by tacit craft knowledge, proprioceptive feedback, material behaviour, and somatic experience. Optimization detached from physical consequence and human sensation is ethically and functionally hollow (Melnik's knits, Xiaoqiao's ink bleed, Chen's responsive rooms) (Oxman, 2017).

Loop the Ethics Explicitly (Design for Audit and Evolution): Ethical considerations cannot be a one-time checkbox. Algorithms and systems must be architected to surface their premises, solicit critique, and facilitate audit *throughout* their lifecycle. Value trade-offs (e.g., delight vs. carbon in SynDI) must be made transparent and revisable (Hwang's consent mechanisms, SynDI's rule-set evolution) (Floridi et al., 2021; Leslie, 2023).

Design for Negotiation, Not Closure (Embrace Contingency): The ultimate success of computationally augmented design lies not in achieving a perfect, final form, but in creating resilient systems – social, spatial, material – that can host ongoing revision, adaptation, and negotiation in response to changing contexts, values, and unforeseen consequence (Chen’s levees as conversation starters, Sagesser’s transcoding revealing connections, the open-ended ethical loop of SynDI) (Simon, 1988).

The ten windows described above do not merely illustrate these propositions; they are the propositions enacted, tested, and often found straining under real-world pressures. Their value lies precisely in their incompleteness and their struggles. Where a project successfully keeps the DIKW ladder open and contested like Baishizhou’s scribble-ready scans or To Kwa Wan’s generative levees, we see synergy fostering agency (Floridi et al., 2021, Leslie, 2023, Mökander, 2021.) Where projects risk stalling at technological spectacle or overlooking critical ethical tensions (e.g., pervasive biodata monitoring, the opacity of complex algorithms, the potential bias in SER), we diagnose the points of friction demanding greater critical vigilance. Where projects strive to climb towards wisdom – advocating for the vulnerable (Hwang), sonically reconnecting urban dwellers to ecological metabolism (Sagesser), or attempting computationally-mediated ethical reflection (Friedman & Hendry, 2019)– we note the demanding social, technical, and ethical habits required: radical openness, deep material engagement, explicit value negotiation, and a commitment to care beyond the immediate.

Design computation, as revealed through these ten critical windows, is not a neutral pipeline delivering efficiency (Lawson, 2006). It is a field of contested gestures, constantly negotiating between the abstract potential of the digital and the messy, ethical, embodied reality of the world. By staging these gestures – from the collaborative annotation of an alleyway scan to the operatic lament of a fish farm drone – we glimpse how critical awareness

and ethical responsibility can, and must, survive the seductive rigors of computational power. The enduring challenge, and the true synergy, lies in keeping the tools breakable, the data shared and scrutinized, the body and its materials present and respected, and the ethical loop vividly, sometimes painfully, alive and central to the process.

Constraint as Constitutive Catalyst – Towards Design 3.0

The seductive myth that unfettered computational power equates to boundless creative freedom lies in ruins, decisively dismantled by the ten projects curated within this issue. Instead, a far more potent and philosophically rich narrative emerges: constraint – whether material, social, temporal, or ethical – is not the antithesis of innovation but its very crucible. It acts not as a cage limiting possibilities, but as a catalyst demanding specificity, forcing negotiation, and generating unforeseen forms of intelligence and wisdom. The ascent through the DIKW hierarchy (Data → Information → Knowledge → Wisdom), long presented as a smooth, linear progression, is revealed here as a path marked by friction, iterative negotiation, and situated recalibration. Wisdom, crucially, is not the pristine absence of error achieved through computational omnipotence, but the hard-won *integration* of constraint into purposeful, pluralistic, and ethically resonant outcomes. This reframing necessitates a fundamental shift in computational design practice, moving beyond instrumental efficiency towards a deeply reflexive and dialogical paradigm – a shift we tentatively term Design 3.0.

The projects presented offer compelling evidence for constraint’s constitutive power. Melnyk’s knitted membranes stand as a testament to material intelligence. They do not spring from abstract, idealized digital forms but emerge dialectically from the physical memory of yarn – its tensile strength, elasticity, and inherent tendency to rebound. The design process *demand*s an embodied understand-

ing; stretch and recoil must be *felt* and negotiated with, not merely simulated in a frictionless virtual environment. This material constraint forces a dialogue between the digital model and the physical reality, resulting in structures imbued with a unique, responsive materiality that pure computation could not conceive. Similarly, Xi Chen's flood-responsive shelters find their *raison d'être* within the chaotic unpredictability of monsoon seasons. Here, environmental volatility is not an obstacle to be eliminated through predictive control, but the primary engine driving responsive form. The constraint of unpredictability becomes the catalyst for adaptive intelligence, leading to architectures that co-evolve with their volatile context rather than imposing a static, potentially brittle order upon it.

Chuteng Hwang's voice-sensitive shelters illuminate the critical role of socio-cultural constraint. This project powerfully demonstrates that Artificial Intelligence, for all its analytical prowess, only becomes genuinely *humane* when rigorously filtered through layers of cultural sensitivity and contextual understanding. Without this essential filtering – this imposition of ethical and social constraint – raw data processing risks degenerating into surveillance, however well-intentioned. The constraint of cultural context transforms AI from a potentially extractive, universalizing force into a situated, responsive partner. These projects collectively underscore a profound truth: constraint is not merely a boundary condition to be satisfied but the very source of the problem's definition and the subsequent richness of the solution. Wisdom emerges *through* the struggle with limitation, not by its eradication.

Yet, the same constraints that offer generative potential also surface profound cautions, demanding critical vigilance. Xinyi Chen's emotion-aware interiors, while promising empathic environments, simultaneously risk a dangerous reductionism. The complex, multifaceted emotional states of human occupants could be flattened into a mere "flicker of biometrics." This raises critical philosophical and

ethical questions: Who defines the parameters of "emotional stability"? Whose norms are embedded in the algorithms interpreting physiological signals? The constraint of measuring emotion through biometrics, if not critically interrogated, risks creating environments that enforce a narrow, potentially oppressive, definition of acceptable affective states rather than responding to genuine human complexity.

Similarly, SynDI's recursive AI loop exemplifies the risk of ethical closure inherent in self-optimizing systems. The danger lies in ethical feedback becoming purely self-referential, a closed loop where the system optimizes only according to its initial, potentially flawed or incomplete, value parameters. The constraint of the initial rule set, if not designed for radical openness, can lead optimization down a path of collapsing value systems, reinforcing biases and excluding alternative perspectives. These risks do not constitute an argument against innovation or the use of constraint; rather, they argue powerfully for a *deepened commitment to reciprocity*. Computational design must transcend mere adaptation; it must cultivate systems that remain fundamentally *open, contested, and responsive* to the values, needs, and critiques of those who inhabit and are impacted by them. This reciprocity is the ethical counterweight to constraint's generative power.

This necessary openness finds its most promising expression in platforms that reconceptualize data not as an inert resource to be mined and processed, but as a vibrant, conversational medium. As evidenced by the author's work on ModRule and echoed in this issue's projects (Lo et al., 2015), purely performative participation within digital design pipelines leads to stagnation. True co-creation requires platforms that treat constraints – budget limitations, regulatory frameworks, community preferences – not as inconvenient barriers to circumvent, but as *invitations to negotiate* meaningfully. ModRule demonstrated success by embedding constraints as core elements of the design dialogue, not external obstacles.

Projects that gamify feedback, visualize co-impact, and make the revision process transparent and legible actively create spaces where users transition from passive consumers to empowered co-designers (Sanders & Strappers, 2008). This principle manifests across scales within this issue: Gao and Bao's LiDAR point cloud becomes a shared canvas, literally "scribed upon" in the alleyway, inviting local knowledge to annotate and refine digital representations. Uzun's photogrammetry mesh is actively "annotated in classrooms," transforming students from observers into active contributors shaping their own learning environment's digital twin. SynDI's most radical aspect might be its persistent questioning, forcing the designer to repeatedly interrogate *why* they value what they value – transforming internal design logic into an explicit, contestable dialogue. This is not mere feedback; it is the embodiment of design-as-dialogue (Bjögvinsson et al., 2012).

This shift necessitates moving decisively beyond the dominant "pipeline" model of computational design (*Capture* → *Model* → *Simulate* → *Optimize* → *Output*). This linear, transactional approach is insufficient for the complexities of socially embedded, ethically aware design. We require a reflexive framework centred on the concept of the ongoing conversation. Within this framework, the three verbs anchoring this issue – Scripting, Sensing, Interacting – undergo a significant reconfiguration:

Scripting transcends merely writing code; it becomes the act of *scripting expectations*, frameworks for engagement, and the very rules of the conversational space. It encodes not just instructions, but invitations and boundaries for participation (Coyne, 1995).

Sensing moves beyond passive data extraction; it becomes an active process of *constructing significance*. It involves selecting what to sense, interpreting data through situated understanding, and recognizing that data is never raw but always already framed by the sensors and their context (Suchman, 1987).

Interaction evolves from simple interface adjustment into the complex act of *value negotiation*. It is the dynamic process where differing perspectives, needs, and interpretations meet, clash, and ideally, find synthesis within the designed system or artifact (Winograd & Flores, 1986).

What crystallizes from these observations is the outline of a new paradigm: Design 3.0. If Design 1.0 was characterized by artisanal, handcrafted creation rooted in individual skill and tacit knowledge, and Design 2.0 by the rise of algorithmic power, automation, and optimization-driven processes (often prioritizing efficiency over deeper values), then Design 3.0 must be computationally fluent yet philosophically anchored. It requires a dual literacy: mastery of digital tools coupled with deep critical reflection on their purpose, impact, and embedded values (Denning & Tedre 2019). This paradigm actively embraces three core, interdependent principles:

Openness (The Invitational Imperative): This extends beyond open-source code to encompass open libraries, open data standards, and open platforms explicitly designed for forking, adaptation, and recombination (e.g., Creative Commons-licensed photogrammetry models enabling community remixing). Openness here is not just technical accessibility but a commitment to epistemological plurality, allowing diverse interpretations and uses to flourish. It actively resists technological enclosure and proprietary silos.

Reflexivity (The Self-Interrogative Imperative): Design 3.0 systems must possess mechanisms to question their own assumptions, values, and biases. This is not optional introspection but a core functional requirement. It involves building feedback loops that expose the normative foundations of algorithms (e.g., SynDI's recursive rule evolution forcing value articulation), auditing for unintended consequences, and designing for adaptability in the face of critique. Reflexivity acknowledges the inherent situatedness and partiality of all knowl-

edge, including computational knowledge (Beck et al., 1994).

Reciprocity (The Co-Adaptive Imperative): This principle demands technologies that evolve with users, fostering a bidirectional flow of agency. It rejects the designer/user dichotomy, instead promoting co-adaptation where both the system and its inhabitants shape each other (e.g., EEG-controlled environments where the user's cognitive state actively modulates the space, creating a continuous feedback loop). Reciprocity recognizes that meaningful interaction generates mutual transformation (Bannon & Ehn, 2012).

Design 3.0 implies a profound rethinking of computational authorship. It moves away from the romantic notion of the sole genius creator (Design 1.0) or the purely algorithmic generator (Design 2.0) towards recognizing shared intentionality. Authorship becomes distributed across humans (designers, users, communities), machines (algorithms, AIs with varying levels of agency), and contexts (material constraints, cultural norms, environmental conditions), echoing what Latour (2005) described as the entanglement of heterogeneous actors in networked assemblages. The design outcome is the emergent property of this complex, dynamic network of intentionalities interacting within a constrained field.

However, articulating this ambitious vision surfaces significant, unresolved challenges that computational design must urgently confront:

Scalability vs. Integrity. The Dialogical Dilemma: Can the intensely situated, dialogical processes exemplified by SynDI – processes that thrive on nuanced negotiation and reflexive depth – successfully scale to the level of city planning or global platforms without collapsing under administrative weight or drowning in unmanageable noise? As Ostrom (1990) has shown in her work on governing the commons, scale introduces

dilemmas of coordination and enforcement that are absent in small communities. Can a city-scale digital forum maintain the same degree of reflexive integrity, meaningful participation, and capacity for value negotiation found in a small co-housing project? The risk is profound: scaling dialogue without careful design for deliberation and synthesis can lead to superficial participation, algorithmic curation of voices (introducing new biases), or sheer bureaucratic paralysis. Design 3.0 must innovate mechanisms for *representative depth* and *structured deliberation* at scale, avoiding both the tyranny of the loudest voice and the sterility of averaged consensus. Can we design systems that aggregate local dialogues into higher-order wisdom without losing their situated authenticity?

Governance. Stewarding the Digital Commons: As design becomes increasingly co-produced through shared data streams, 3D scans, and evolving procedural models, the question of governance becomes paramount. Who stewards the resulting digital commons? Who has the authority, and by what legitimate process, to moderate edits to a collaboratively built LiDAR-based urban plan? As tools like photogrammetry and procedural modelling become ubiquitous, existing intellectual property regimes and planning regulations are woefully inadequate. This problem mirrors debates in open-source software communities, where governance models range from benevolent dictatorships to distributed councils (De Laat, 2007). Commons-based design demands not only open platforms but robust, transparent, and equitable new forms of custodianship and peer governance.

Equity. The Perils of Affective Inference: Projects engaging with affective computing – interpreting voice tremors, facial micro-expressions, galvanic skin response, or EEG patterns – carry an immense burden of ethical scrutiny. Emotional inference is fundamentally not neutral. As Crawford and Calo (2016) argued, predictive systems tend to reproduce social bias under the guise of neutrality. Algorithms

trained on datasets skewed by cultural, racial, gender, or socioeconomic biases will inevitably reproduce and amplify those biases, leading to false positives (misinterpreting states), false negatives (failing to recognize valid expressions), and systemic exclusion or misrepresentation. Without constant critical interrogation and inclusive co-design processes that question the underlying assumptions of affective models, the promise of empathy risks devolving into a subtle form of technosolutionist tyranny.

The path of Design 3.0 is not towards the elimination of constraint in pursuit of computational utopia, but towards its conscious, critical, and creative embrace. Constraint is revealed as the constitutive ground upon which meaningful design emerges. Material limits demand ingenuity and foster material dialogue. Social and ethical constraints demand reflexivity, reciprocity, and the hard work of pluralistic negotiation (Manzini, 2015). The friction inherent in navigating these constraints is not noise to be eliminated, but the essential signal guiding the ascent from data towards genuine wisdom – wisdom understood as situated, responsible, and co-created understanding.

The transition from pipeline to conversation, from optimization to dialogue, from isolated authorship to shared intentionality, represents a profound philosophical and practical shift. It demands fluency not only in the languages of computation but also in the languages of ethics, social theory, and critical philosophy (Latour, 2012). The unfinished agendas of scalability, governance, and equity are not mere technical hurdles; they are the defining ethical and political challenges of this new era. Addressing them requires moving beyond technocratic fixes towards fostering genuine design cultures of openness, reflexivity, and reciprocity (Escobar, 2018). Only then can computational design fulfil its potential not as a tool of control or efficiency alone, but as a catalyst for fostering more humane, just, and wisdom-infused ways of being in the world. The constraint is the catalyst; the conversation is

the method; the goal is a more deeply intelligent and equitable co-habitation. To break the algorithmic spell, we must script with care, sense with accountability, and interact with intention. Design 3.0 begins not in code, but in co-authorship.

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Bio

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