From Knowledge to Design: Materializing Social-Science Concepts into Virtual-Reality Scenarios through Designerly Descent Down the Ladder of Abstraction

Jeffrey C. F. Ho*
School of Design
The Hong Kong Polytechnic University
Hong Kong, Hong Kong
jeffrey.cf.ho@polyu.edu.hk

Zhengchun Jia
School of Design
The Hong Kong Polytechnic University
Hong Kong, Hong Kong
zhengchun.jia@connect.polyu.hk

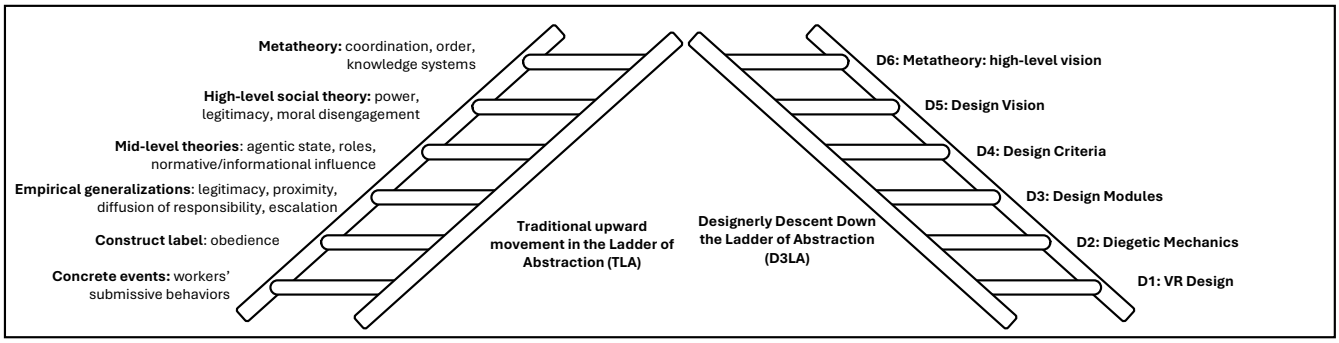


Figure 1: Traditional Ladder of Abstraction and Designerly Descent Down the Ladder of Abstraction

Abstract

Traditional academic disciplines often use the Ladder of Abstraction to move from observation to concepts and theory, treating downward movement primarily as the application of knowledge to explain phenomena. In design, however, moving downward is an act of making, where abstract knowledge is materially expressed through artefacts. This paper introduces Designerly Descent Down the Ladder of Abstraction (D3LA), a multi-rung model that articulates how theoretical commitments are systematically transformed into situated design decisions. Through a case of designing a virtual reality (VR) scenario, we show how a social science concept of indirect obedience descends from a metatheoretical vision to design modules, diegetic mechanics, and concrete VR design.

CCS Concepts

• **Human-centered computing → Interaction design theory, concepts and paradigms**.

Keywords

Ladder of abstraction, Virtual reality, Designerly way of using knowledge, Research through design

*Corresponding author.

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1 Introduction and Background

This work addresses the challenge of articulating how abstract concepts and theories participate in concrete acts of making. Traditional academic disciplines such as the social sciences commonly frame inquiry through a Ladder of Abstraction. Traditional upward movement in the Ladder of Abstraction (TLA) structures knowledge as a progression from concrete events to high-level theories. In this view, downward movement is predominantly explanatory rather than generative [8].

We offer a model we call the *Designerly Descent Down the Ladder of Abstraction* (D3LA) that articulates how theoretical knowledge are transformed into situated design artefacts. We accompany this model with one exemplar case that demonstrates how a social science concept is articulated in the design of a virtual reality (VR) scenario for construction safety training. We hope our work can serve as an invitation to the community to tackle the challenge of articulating the designerly way of using knowledge.

1.1 Beyond Technical Rationality

Schön's critique of technical rationality argues against viewing professional practice as the straightforward application of established knowledge, emphasizing that practitioners work under indeterminate and situated conditions that demand reflection-in-practice [11].

In such contexts, knowledge is generated and assessed primarily for its relevance to the work situations, rather than for its generality or formal validity. The traditional view of going down the ladder of abstraction shares the same limitation with the view of technical rationality.

For designers, downward movements on a ladder of abstraction are not primarily explanatory but generative: they involves intervening by translating concepts into artefacts, interactions, timings, and spatial arrangements. Using knowledge in design therefore entails situated judgment, interpretation, and material decision-making—activities that are not well captured by conventional notions of "applying" theory.

Redström's Making Design Theory similarly characterizes design knowledge as inherently situated and unstable, gaining meaning through engagement with specific artefacts and contexts rather than through abstract stability [10]. His notions of spectra, half-ready concepts, and provisional worldviews describe knowledge forms that remain actionable. Building on this lineage, D3LA extends this area of work by articulating the descent itself: it provides a procedural account of how theoretical orientations are progressively realized, transformed, and completed through design practice.

2 Method

This work adopts a retrospective, first-person Research through Design approach, treating the creation of the VR scenario as the primary site of inquiry. The analysis traces how theoretical commitments shaped design decisions as the artefact was developed. We report our positionality as design researchers working in construction safety contexts to situate the interpretations presented here. Our approach acknowledges that the articulation presented here is unavoidably subjective: it is authored from within the practice of design, where situated interpretation and judgment are constitutive of knowledge production rather than noise to be eliminated [1, 4].

3 Design Background and Outcome

Research on obedience and social influence shows that authority rarely operates through explicit commands alone. Instead, everyday organizational life is shaped by tone, framing, norm-setting, peer alignment, and subtle signals of approval or disapproval (e.g., [3, 12]). The construction safety literature recognizes VR as a medium for safety training, with focus on simulating physical hazards—falling objects, equipment operation, spatial conflicts, or hazardous pathways [2, 7].

Our work addresses this gap by treating VR not only as a medium for visualizing physical risk but as a medium for enacting social influence with the aim of arguing that social influences are latent hazards in labour-intensive industries. We needed to design scenarios that demonstrate how VR can materialize indirect obedience in an immersive experience.

3.1 VR Scenario Overview

The resulting VR artefact is a two-scene scenario. The player inhabits the first-person role of Jackie, a construction worker embedded within a small team. Two non-player characters (NPCs) structure the social dynamics: a Boss who sets expectations and frames the situation, and Allen, a co-worker who becomes the focal point of emerging pressure, and a small crew (with 12 NPCs as co-workers).



Figure 2: Screenshot of Scene 1 showing the Boss (with a white hard hat) and the crew.



Figure 3: Screenshot of Scene 2 showing the Boss witnessing the incident of a concrete hitting Allen.

Scene 1 (Figure 2) unfolds in a lunch-break area where the team is gathered. The Boss publicly frames delays as harmful to the interests of the company and co-workers. The Boss points out that Allen was being too slow yesterday. The crew nodded their heads. Allen apologizes and promises to work faster. The scene establishes a social climate in which speed appears morally preferable.

Scene 2 (Figure 3) moves to an active work zone, presenting a clean-up task that situates the player as a worker rather than a bystander. As the player completes the task, the Boss's attention shifts "up ahead" toward Allen. The Boss expresses approval for Allen's speed, implicitly endorsing him stepping beyond the barrier to save time, accompanied by a brief walk in that direction that naturally draws the player's gaze. Then, a falling concrete block strikes Allen and he collapses; the Boss reacts with surprise. The scene then fades to dark.

This overview provides the narrative and reference points needed for the subsequent section, which reconstructs how theoretical commitments were translated into specific design decisions that produced these scenes.

4 Designerly Descent Down the Ladder of Abstraction

This section presents, D3LA which describes a designerly descent, where each rung represents a materialization of theoretical commitments into visions, criteria, scenario structures, mechanics, and eventually situated artefacts. The descent that we presents begins at the top of the ladder of abstraction - metatheoretical ideas about social obedience were reframed as design commitments.

With D3LA, we articulate the generative descent designers perform with rungs on the ladder as the descenting steps:

- D6 - Metatheory: a high-level vision (e.g., seeing the gap and opportunity in improving construction safety from a social perspective).
- D5 - Design Vision: a design vision that sees design as a way to address the gap.
- D4 - Design Criteria: criteria specifying what the design should look like (e.g., "no explicit unsafe order"; praise amplifies pressure as social-related latent hazards).
- D3 - Design Modules: elements that constitute different VR social scenarios
- D2 - Diegetic Mechanics: guidelines describing how the scenario unfold, including in-world triggers, timings, and attention control.
- D1 - Design Outcome: VR scenarios with specific placements, pacing, and micro-decisions.

At each step of the downward movement, earlier-rung concepts are articulated within our own situated context as designers. This foregrounded, early interpretation contrasts with social-science conventions that seek to suppress or delay individual scholars' interpretation until late-stage theory-building at higher rungs [9].

4.1 D6 → D5: From Metatheory to Design Vision

The descent begins at D6, where the input consists of a high-level vision, namely seeing the gap and opportunities to improve construction safety from a social perspective. In the social sciences, such metatheories describe how power, hierarchy, legitimacy, and group norms organize collective action. At this rung, our interpretive move was to treat this metatheoretical input not as something to explain real-world cases, but as something to recast as a design agenda. Working within the context of construction safety—a domain characterized by being labour-intensive—we as the designers recognize the gap: safety training tends to foreground material hazards while leaving the social aspects of unsafe acts comparatively invisible. If obedience and influence are often subtle, then we can treat social relations themselves as latent hazards. This insight reframes the design task: safety is not only about equipment and procedures, but also about how workers navigate relational pressure.

The D5 design vision thus emerged, aiming to address the gap by making indirect obedience visible and actionable by staging, through VR, how subtle authority cues and peer alignment can perpetuate risky behaviors. Instead of directly telling participants that social pressure matters, the design seeks to build a world in which they can witness and feel how such dynamics unfold. This requires the scenario to preserve the indirectness of influence and show how relational cues can accumulate into a consequential action.

4.2 D5 → D4: From Design Vision to Design Criteria

The design vision established in rung D5 commits the project to making indirect obedience visible in a construction context. We as designers needed to specify what needed to exist in the VR scenario for the vision to be realized. This means assembling a collection of roles that are capable of staging subtle pressure; a minimal narrative structure that encodes escalation from social cues to unsafe behavior; and a proximal area in the virtual environment that resembles a construction site.

Therefore, the design vision is translated into criteria specifying (1) a multi-role social configuration (authority, pressured worker, peer crew, and player), (2) a two-scene escalation structure, (3) integrity constraints that avoid explicit unsafe orders while endorsing speed through praise, and (4) construction-legible boundary objects that make violations perceptually clear. These criteria specify the necessary conditions for staging indirect obedience as a latent hazard in VR.

4.3 D4 → D3: Design Criteria to Design Modules

We transformed the design criteria resulting at D4 into a set of reusable design modules that formalize the recurring elements needed to stage indirect obedience in VR. The modules express the designerly insights in a form that supports systematic scene building.

1. Role Archetypes
   - **Authority / Supervisor**: should lead the conversation, frame stakes, speak first, influence behavior without explicit orders.
   - **Pressure Target**: should appear in a weaker role, apologizes, promises increased speed.
   - **Peer Group / Crew**: should be positioned in a way that supports the supervisor, and amplifies norms through nodding.
   - **Player Role**: should appear as a peer.

2. Cue Types
   - **Authority cues**: opening lines that show authority and the framing of time pressure and collective burden.
   - **Group alignment cues**: nods, orientation, and attentive silence reinforcing expectations; cues should be shown after authority cues.
   - **Self-positioning cues**: apologies, admissions of slowness, promises to "move faster."
   - **Praise cues**: verbal recognition, reinforcement of speedy performance that implicitly condones unsafe shortcuts.

3. Spatial Templates
   - **Break-area social setting**: a social setting that is suitable for conversation (e.g., lunchbreak)
   - **Active work zone**: a space to show the consequences, with fenced boundaries, and overhead-risk areas

4. Temporal Devices
   - **Day-continuity marker**: transition from break to work to bind the narrative as a single shift.

- **Reference cues between scenes**: references back to earlier pressure ("look how fast Allen's working today").

4.4 D3 → D2: Design Modules to Diegetic Mechanics

The descent from D3 to D2 translates the design modules into diegetic mechanics, which are in-story actions that advance the scenario. They bind narrative progression and interactions into the VR experience. In this scenario, four mechanics materialize the modules as situated experiences.

Embodied Transition from Break to Work: At the end of Scene 1, the player must physically stand up to trigger the transition into work. The act of standing functions both as a scene trigger and as an embodied act of compliance.

Task-Based Labor Interaction: Scene 2 begins with the Boss assigning the player a routine clean-up task. This mechanic establishes the player as a legitimate worker embedded in the hierarchy. The task occupies the player's attention so that subsequent praise of Allen's speed emerges as part of the ordinary workflow.

Diegetic Attention Direction: After the task is completed, the Boss remarks that Allen is working quickly "up ahead" and physically walks toward him. This employs diegetic attention control: dialogue and character movement guide the player's gaze without UI overlays or camera manipulation.

Triggered Escalation into the Struck-by Event: The hazard event is then triggered. Only then does the falling object strike Allen. This sequencing maps the D3 escalation pattern directly onto D2 event logic, ensuring the incident is perceived as the consequence of accumulated relational cues rather than an arbitrary accident.

Through embodied transitions, design modules become in-story actions in VR, preparing the ground for D2 → D1 implementation.

4.5 D2 → D1: Diegetic Mechanics to VR Designs

This step involves many situated design decisions that cannot be exhaustively reported within the given space constraints. Instead, we focus on how diegetic mechanics defined at D2 are translated into concrete VR designs at D1. At D2, the scenario's embodied flow specifies what should happen and when, but not yet how these events are realized perceptually and spatially in VR. Realizing diegetic mechanics into VR designs requires extensive situated judgment, including character placement, animation tuning, occlusion management, voice pacing, trigger calibration, and performance considerations, while preserving the conceptual integrity established at earlier rungs. D1 is inherently dense and iterative: rather than cataloging every micro-decision, we illustrate how these decisions remain anchored to D2 and above.

Micro-spatial legibility and view-cone management: In Scene 1, the relative positions of the player, Allen, the Boss, and the crew are carefully arranged so that the player initially experiences peer relations alongside Allen, and only later—when the Boss and crew stand up—encounters the same authoritative and group pressure directed at Allen (Figure 4). In Scene 2, characters are positioned to keep authority cues visible, prevent occlusion during the praise moment, and ensure that boundary crossings and the overhead

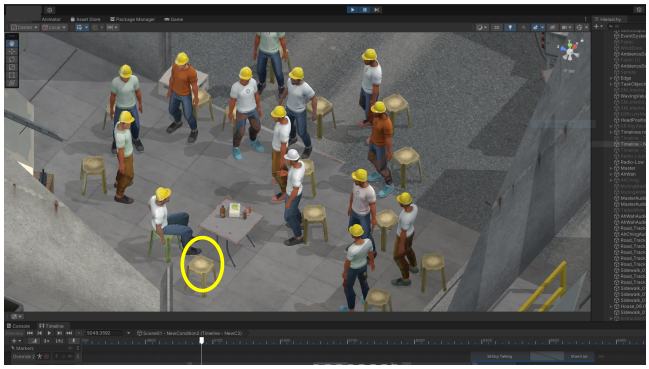


Figure 4: Relative positions of the player, Boss, and crew in Scene 1.

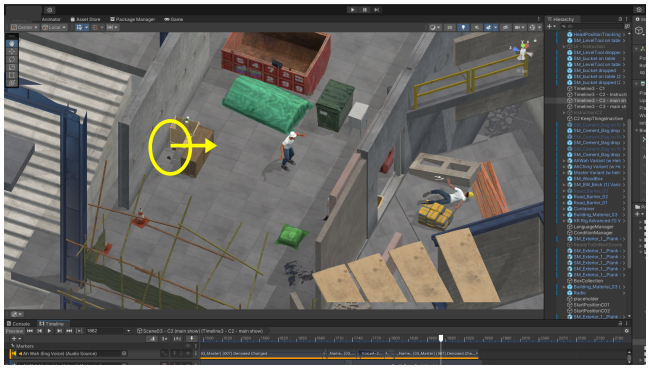


Figure 5: Relative positions of the player, Boss, and struck-by event in Scene 2.

hazard fall within the player's natural gaze following the attention-directing line (Figure 5). These adjustments materialize the social–physical causal chain by making relational cues perceptible at the right moment.

Behavioral texture through variation: To enact the D3 role of the crew as normative amplifiers, D1 introduces small but meaningful variations: heterogeneous workers and subtle differences in stance and attention (Figure 6). This prevents the group from appearing mechanically synchronized.

Timing and pacing: Dialogue tone, pacing, and emphasis are refined to maintain the distinction between framed expectation and explicit command. Voice lines are synchronized with gestures, gaze cues, and task completion so that praise, pressure, and escalation align with the social patterns defined at D3 and the mechanics specified at D2.

D2 → D1 summary: Through spatial tuning, behavioral variation, voice alignment, and trigger sequencing, abstract patterns of indirect obedience are instantiated as a coherent VR experience.

5 Discussion

This work contributes to design research by articulating how knowledge is *used* in design. While existing discourse has offered influential accounts of intermediate-level knowledge—such as strong

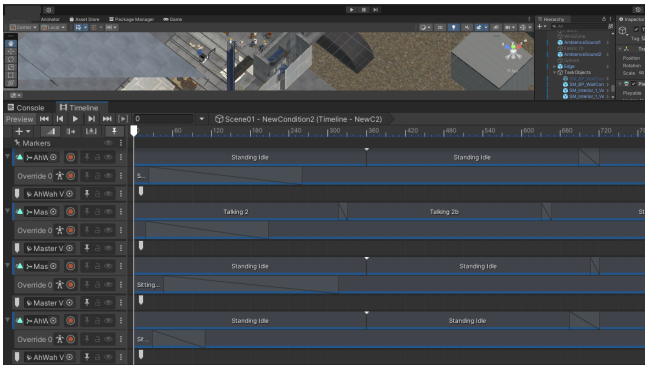


Figure 6: Animation timeline showing staggered peer behaviors.

concepts, annotated portfolios, and experiential qualities—in which design outcomes sit between the particular and the general [5, 6], these accounts say less about how designers operationalize abstract theory during the act of designing. D3LA addresses this gap by providing an articulated, procedural account of downward movement from theory to artefact.

5.1 Relation to Intermediate-Level Knowledge

D3LA does not primarily aim to propose a new intermediate-level knowledge form. Instead, it complements the types of intermediate-level knowledge by demonstrating one way in which abstract knowledge can be used in practice. By tracing how high-level vision (D6) descends through design vision, criteria, modules, mechanics, and design artefacts (D5–D1), D3LA makes visible how abstract commitments are progressively transformed into situated design decisions.

5.2 Positioning D3LA within Redström's Account of Unstable Knowledge

Our D3LA model is offered not as a fixed sequence of steps but as an incomplete and extensible knowledge structure. The version we present in this paper reflects the particular descent we undertook—one shaped by our design judgments, insights that emerged through making, and our interpretation of outcomes from the previous rung. However, each rung of the model is intentionally left open so that future designers or researchers can realize, extend, or reinterpret it through their own design practices. In this sense, D3LA behaves similarly to Redström's "half-ready concepts." What appears here is not a universal template, but rather a situated instantiation meant to support further variation. Whereas Redström foregrounds what kinds of knowledge remain productive in design because of their openness, D3LA focuses on how knowledge travels along the ladder of abstraction.

D3LA is not a prescriptive content hierarchy but a procedural account of descent that invites designerly completion at every level. Each rung functions as a space where designers can insert, transform, or challenge the knowledge that drives their practice. D3LA provides a structured descent that shows how knowledge becomes design artefacts. D3LA therefore fills a methodological gap by offering traceability across levels of abstraction. Designers may adopt D3LA in multiple ways—branching at intermediate rungs, substituting theories, or reinterpreting earlier commitments—without treating the framework as a prescriptive and rigid template.

5.3 Beyond "inspired by ..."

D3LA offers an articulated method for bringing concepts and theories from non-design disciplines into design practice, moving beyond the loose articulation that a work was "inspired by" prior concepts. It complements RtD contributions that formalize the design process (e.g., involved reframing) as knowledge production by showing one possible, procedural way to articulate how knowledge travels downward from abstract concepts into an artefact. We do not argue that D3LA is the only articulative pathway; we argue it is a workable, accountable pathway that makes the journey from theory to designs inspectable, supporting clearer discussion and critique of how theory participates in design work.

6 Conclusion

The core contribution of this paper lies in making visible the designerly transformation of theoretical constructs into material worlds. In our case, indirect obedience was not treated as an explanatory concept but as a design and framing resource that shaped spatial, narrative, and mechanical decisions in a VR scenario. D3LA offers a way to discuss the thickness of designerly reasoning and to bridge concepts from non-design disciplines with situated design practices.

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