

Situating the (Un)Common Landscapes of Shared Futures: Developing Speculation as a Co-Design Framework of Cognitive Apprenticeship to Empower Diverse Stakeholders and Contest Bias

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Abstract

This article discusses the development of a framework within five primary cases that explore collaborations with local municipalities, corporations, organizations, various stakeholders, and educational institutions. It reviews the progression of speculation, from a pragmatic response to immediate educational demands modeling critical and experimental approaches from professional practice, toward an approach to cognitive apprenticeship (CA) (Collins et al., 1987), foregrounding digital and material discourse as a post-disciplinary externalization of cognition within situated practice (Brown et al., 1989). Speculation is developed as an operative tool or a structured operation within the design process, linking critical research components to material realities and potential futures. This approach reflects a decentralization or distribution of developmental influence and responsibility from a relatively isolated or compartmentalized linear system with strong biases toward internal, centralized knowledge to a network directly engaged with research perspectives, sociotechnical systems, situated knowledges, and practices in everyday life. Through CA techniques, including distributed scaffolding (Puntambekar, 1997), and activity sequencing (Tharp, 1993; Dennen, 2000), an iterative approach to ethnomethodological variation influenced foundational metacognitive development exemplified by higher-level progression of learning trajectories in the case studies, both inside and outside of ‘the school,’ addressing broad variation in participant competencies and substantial participant groups (up to 460). We argue that at the core of this utility is the flexibility to embrace complexity and address ongoing change while still situating foundational themes and competencies (including critical approaches to knowledge sources, participatory processes, and projected futures) as necessary components in a logical, ethical, understandable, and exploratory framework.

Keywords: speculation, speculative design, design education, cognitive apprenticeship, situated practice, co-design, social semiotics, sociotechnical systems, metacognitive abstraction, visual research, futuring

1. Introduction

The practice of everyday life uses and builds on the structures and systems of meaning that are central aspects of understanding ‘design’ in professional disciplines. Writing this paper on a laptop, simple clothing choices as social performance, and interacting with material objects and landscapes all involve the use, replication, and semiotic instantiation that is networked in countless disciplines, tools, developments, hierarchies, and their implications. Design from this inclusive vantage point empowers diverse individuals while it situates human culture as shared intertextuality. The approach discussed in this text takes advantage of the widespread use and

availability of design infrastructures and artifacts. It positions the design process as a theoretical framework for development and evaluation while providing a structure for research methods, perspectives, critical thinking, and validity.

Speculation is developed as an operational framework connecting material realities to processes of futuring. Building on cognitive apprenticeship (CA) techniques (Collins et al., 1987), including distributed scaffolding (Puntambekar, 1997), and activity sequencing (Tharp, 1993; Dennen, 2000), the pedagogy enables the integration of (and variation among) themes, practices, ideas, etc., within situated practice (Brown et al., 1989). The framework situates diverse human and non-human knowledges as necessary for understanding semiotic landscapes in the interconnected contemporary world, which we argue is increasingly essential as a critical antidote to bias, marginalization, and exclusion in the development of shared futures.

1.1 Scope and Format

In the following section, *2. Pedagogical Contexts of Case Studies*, we outline the pedagogical details of each case study. The third section, *3. Developing Speculation as a Pedagogical Framework*, reviews the main pedagogical perspectives, terms, and conceptual objects, discussing how they are defined and initially operationalized within the case studies. First, *3.1 Defining and operationalizing speculation in situated practice*, reviews how speculation was operationalized, followed by *3.2*, an overview of the development of cognitive apprenticeship within design education, which later influences aspects central to use outside of 'the school.' In *3.3*, we discuss how digital and material discourse was foregrounded as a post-disciplinary externalization of cognition. In *4. Speculation as a framework connecting realities to futures through discourse*, we discuss primary aspects of the framework, including how ideas of co-design and decentralization influence how the main knowledge areas are engaged in the pedagogy. The conclusion briefly reviews how the conceptual model of speculation links to sociotechnical systems, artifacts, and practices in everyday life. Through CA techniques and an iterative approach to ethnomethodological development, foundational metacognitive knowledge influenced higher-level progression, as exemplified in the learning trajectories of cases 3 and 4, as well as workshop data outside of institutional education (cases 2 and 5).

The discussion is organized to reflect the development of the conceptual framework, starting from a practical correction of curricula to a systematic approach to learning strategies. We introduce key conceptual, theoretical, and methodological aspects in successively complex, abstract, or metacognitive stages, often tied to preceding knowledge. In each step, a series of skills, practices, and perspectives represent a broader scale of abstraction. From the perspective of CA, each series of cognitive knowledge developments introduces metacognitive layers of higher-level understanding.

As a pedagogical format, it documents relevant social factors, concepts, methods, and approaches in the conceptual grounding and source material from cases. We use examples from the case studies not as illustrations but as visual, digital, and material data that exemplify the central tenet of cognitive apprenticeship (CA) to 'make cognitive and metacognitive processes more visible' (Collins et al., 1987). Through case data, we explore how speculation was developed toward a pedagogical framework and refined for use in critical processes of future thinking outside of 'the school'. We argue that this represents a co-design framework that decentralizes authority and responsibility in the design process, promotes inclusion, and contests bias.

2. Pedagogical Contexts of Case Studies

The first case study (1) includes two representative instances (1.a, 1.b) of a pedagogical trajectory developed iteratively over four years during institutional change, where foundational challenges were identified and influenced the introduction and development of approaches to speculation and cognitive apprenticeship. The cases had similar tutor teams (5), participants (14, 18), teaching conditions (16 weeks), and settings within a transdisciplinary department at Design Academy Eindhoven (DAE). Case 1.a partnered with the Municipality of Eindhoven and 1.b with a global technology corporation, ASML.

The second case (2) consists of 17 workshops (2018-2023) that began after the initial case study (1.a) and were used as an opportunity to experiment with and refine approaches to speculation and futuring processes in conjunction with the institutional contextualized cases in 1, 3, and 4. Thirteen (13) workshops were conducted in a single session lasting 1.5-3 hours, one (1) session lasting 4 hours, while the remaining three (3) workshops were conducted over two sessions of 2.5 hours. The workshop participants represent diverse social roles, competencies, and professional objectives. They included governmental and institutional executives, policy officers and advisors, professional designers and artists, supervisory boards, researchers, operational and program managers, innovation brokers, curriculum developers and consultants, students, tutors, and a few workshops (3) were open to supporting staff as well. The variation among participants was essential for exploring and refining ideas of abstraction, which are central to the development of speculation in this discussion.

The third (3) and fourth (4) case studies build upon the first study (1) and are in the context of design education at the Willem de Kooning Academy (WdKA) in Rotterdam. The third case study (3) encompasses three successive iterations (3.a, 3.b, 3.c) of a two-week course for all first-year students ('Practice 1', P1) and partnered with the Municipality of Rotterdam. Each iteration involved multiple tutor teams (6, 6, 7) facilitating three consecutive two-week courses, incorporating close to or above 450 participants in all three instances (460, 443, 437). The fourth case study (4) consists of three successive iterations (4.a, 4.b, 4.c) of a 16-week course for third-year students ('Practice 3', P3), incorporating roughly 135 students divided over three sections in each iteration. Case 4.b partnered with the Municipality of Rotterdam, and 4.c partnered with ACCEZ, an organization representing Dutch greenhouse horticulture stakeholders.

The final case (5) is a workshop (2.5 hours) with 48 municipal managers of Rotterdam and a 30-minute follow-up interview with 3 managers. This exploration builds on approaches from the institutional cases (1, 3, 4) and the series of workshops (2) by exploring how approaches can be refined for different contexts, participants, and objectives.

Table 1. Case Study List

Case No.	Date	Title	Primary Institution	Partners	Partner participants	Meetings/Duration	Participants Class Size	Group Size	Tutors	Research tutor to student ratio	Profile/competencies		
1	2017 / 20	DAE											
1 a	2017	Alternate Societies: An Exploration of Data Ideas in Possible Futures	DAE	Municipality of Eindhoven	4	m2-4	2-6hr/wk for 14 wks	14	14	1-2	5	1:14 - 1:3	HBO year 2-3, single transdisciplinary dept.
1 b	2020	ASML Business as Unusual. Engineering Design for a (Post) Pandemic Reality	DAE	ASML	2	m2-4	2-6hr/wk for 14 wks	18	18	1-2	5	1:18 - 1:6	HBO year 2-3, single transdisciplinary dept.
2	2018-23	Speculation Workshops	Multiple	Multiple		17, 13x 1.4-3hr session, 1x 4hr session, 3x 1.5-3hr double session.	5-25	5-25	5-25	1	1:5 - 1:25	various	
3	2020 / 21 / 22	WdKA P1											
3 a	2-3/2020	Gen Z / Rotterdam Futures	WdKA	Municipality of Rotterdam	46	P1	4-12 hr/wk for 2 wks x 3 repetitions, 6 sections	460	23-32	3-6	18	1:32-1:16, 1:5:32	HBO year 1, 16 majors
3 b	2-3/2021	Rotterdam 2050	WdKA	Municipality of Rotterdam	23	P1	4-12 hr/wk for 2 wks x 3 repetitions, 6 sections	443	15-25	3-6	18	1:25 - 1:8	HBO year 1, 16 majors
3 c	2-3/2022	Speculative Futures / Pasts of Rotterdam	WdKA	Municipality of Rotterdam	N/A	P1	4-12 hr/wk for 2 wks x 3 repetitions, 7 sections	437	15-25	3-6	18	1:25 - 1:8	HBO year 1, 16 majors
4	2020 / 22	WdKA P3											
4 a	9-12/2020	Visual, Digital, and Material Ideologies	WdKA	Municipality of Rotterdam	3	P3	8-16hr/wk for 14 wks	55	55	1-6	1	1:55	HBO year 3, 16 majors
4 b	9-12/2021	Water Everywhere. Post-pandemic futures for a world of water	WdKA	Municipality of Rotterdam	3	P3	8-16hr/wk for 14 wks	135/45	15-48	1-2 / 3-6	9/3/1	1:48	HBO year 3, 16 majors
4 c	9-12/2022	Retrospectives from the Future. The changing roles of Dutch greenhouse	WdKA	ACCEZ, Municipality of Rotterdam	5	P3	8-16hr/wk for 14 wks	135/45	12- 49	3-6	18/5/1	1:49 - 1:10, 1:49	HBO year 3, 16 majors
5	2022	BRIM, Rotterdam 2047	WdKA+	Municipality of Rotterdam	48/all	2.5 hr	48	48	5-8	5	1:48 - 1:10	Municipal managers	

3. Developing Speculation as a Pedagogical Framework

The introduction of new pedagogical approaches is often a reliable source of opposition, if not confusion. Staging experimentation within 'live' educational contexts introduces obvious risks, especially in collaborative projects with local municipal governments or multinational corporate tech leaders, and were increased due to long durations (up to four months), varied tutor or student configurations, and large numbers of participants (from 50 to over 450). This was, and remains, an obvious concern for researchers, policymakers, administrators, partners, tutors, and students involved in the changes. Therefore, it is important for validation, understanding, and operational trust, to qualify and situate the assumptions, conceptual approaches, and expectations of methodologies that informed the decisions.

3.1 Defining and Operationalizing Speculation in Situated Practice

In this exploration, speculation was initially incorporated as a conceptual bridge to challenge the fixed outcomes of disciplinary silos. The pedagogical approach builds on the foundational perspective of Cognitive Apprenticeship (CA), contextualizing the development of new knowledge through practices of materialization and visualization as a means to make internalized cognitive and metacognitive processes more visible and available for reflection and development (Collins et al., 1991). Speculation is developed as a generalist, structural approach that requires detailed specification, incorporating flexibility with contextualized focus as an exemplification of situated practice (Brown et al., 1989).

Following case 1.a, for the remaining trajectory of case study 1, speculation was developed as a primary cognitive and metacognitive model. It was not explicitly foregrounded but positioned as an implicit privilege, opportunity, and responsibility of the expert, researcher, and maker. Throughout this progression, it became increasingly important that as a flexible approach to practice, it required responsibilities (e.g., scientifically valid methodology, ethics) as a condition of the development potential it offered. The series of workshops in case 2 explored and refined approaches throughout the overall trajectory. In cases 3 and 4, the progression exemplified by case 1 was refined to foster foundational metacognitive knowledge at an earlier stage for highly varied and more numerous participants as a co-design framework that addresses bias.

Design practices, materialization, mediation, and most human actions are speculations. Humans project, extrapolate, connect, assume, and speculate quite frequently. Expectations and estimations about future moments are built on information based on our experiences of today and yesterday. Walking on a sidewalk is an expectation of stable concrete, lack of atmospheric disruption, and social adherence to traffic laws. In

professional design practices, specializations such as material studies and digital interaction or interface development exemplify how testing and prototyping reach into the near future to explore impending possibilities. Longer-term and larger-scale scientific megaprojects also employ speculation to a remarkable degree: Developing a new substrate and fastening system for bolts used in 60 years for a yet-to-be-designed space station (NASA), a 26.7 km wide circular track to explore the interactions of ‘objects’ that comprise all life but are never seen with the naked eye (CERN), or in the context of ‘nuclear semiotics and Geiger counter cats’ (Thibault, 2022). The production of ‘history’ is even a field for nuanced employment of speculation (Bolin, 2009). All speculate within different timeframes and veracities of probability, but none are known facts.

3.1.1 Distinguishing Speculation in Situated Practice from Speculative Design Practices

The pedagogical developments reviewed in this discussion frame speculation as a generalized operation of materiality through time. This approach is refined as a conceptual model connecting realities to futures through discourse, exploring patterns or biases in the relationship between humans, sociotechnical systems, and temporal linearity. The conceptual model is not restricted to a type of output, tied to a specific strand of social advocacy, or based on a fixed opposition to existing structures (e.g., economic, governmental, environmental). Therefore, while we do align with many of the critical and exploratory perspectives in primary texts (Auger, 2013; Dunne & Raby, 2014; Johannessen et al., 2019; Mitrović, 2015; Tharp & Tharp, 2015), there are distinct differences central to the pedagogy discussed.

We actively resist the stark distinctions between traditional design, and speculative and critical design (SCD) as mutually exclusive, polar opposites (Auger, 2013; Dunne & Raby, 2014; Johannessen et al., 2019; Mitrović, 2015). While such aspects may be the focus of specific explorations, the primary intention is to develop research and development approaches as skills that support design processes, regardless of outcome or intention, instead of a predetermined perspective that dictates the overall practice. In this pedagogy, speculation is as much about the future of the participant or professional discourse as it is about human culture and themes at large.

From this perspective, it is unfeasible to talk about the future as a whole or from a general perspective. We can only understand possible futures through specifics. Thus, the study is not interested in developing a subjective conceptual reflection on life and then designing a communicational vehicle for it. It focuses on identifying phenomena, themes, or practices and developing ways to become more intimate and connected with humans in the context, using discourse as a tool for exploring and making sense of the world as it exists.

Discourse in this discussion begins with the understanding that meaning is connected to a network of semiotic resources that structure human practices. Discourse is a central characteristic of human culture but has no value or tangible data to refer to without specification. It is only useful if we can shine a spotlight on it and begin to explore contextual specificity. ‘Discourse must not be referred to the distant presence of the origin, but treated as and when it occurs (Foucault, 1972:25)’. Artifacts *do* have politics (Winner, 1980), that can be situated, interrogated, and understood. One significant distinction between other primates and humans is our ability and necessity to structure life through sociotechnical ‘artifacts’ and processes (Latour, 1992, 1994, 1996). In the case studies, discourse is the appearance of fresh produce in local supermarkets, the practice of exposing a body part as social currency, biases of subjective reporting of live news events, marginalization or exclusion in everyday digital infrastructures, or identifying future stakeholders of non-gendered processes.

Instead of leading toward a conceptual abstraction, we begin with the understanding of a complex network of semiotic resources and refine the focus to specific discursive practices, artifacts, and infrastructures. This development incorporates anthropological and sociological methods and perspectives, including ethnography, digital, visual, and material culture and ideology, social semiotics, semiotic landscapes, and sociotechnical systems. Discourse is the default. We proceed from discourse in the abstract to more and more focused sites. In contrast to limiting discourse to the object of output as an applied communicational objective (Tharp & Tharp, 2015), this framework explores and operates through the actual manifestation of discourse in the real world. The case studies represent a transition from explorations focused on discourse as the object of output to practices exploring discourse as the subject, as the data. It focuses on practices that work through discourse instead of toward discourse.

In this way, we move beyond normative uses of speculation in design education that situate the designer in a privileged position of expertise to explore futures (Dunne & Raby, 2014). The practices developed in this framework are not tied to envisioning specific futures or futures at all. The series of workshops (Case 2) largely focuses on externalizing cognitive processes in modeling how speculation influences future thinking, implications of stakeholders, and those not yet accounted for or marginalized, etc. This is to produce new understandings regarding processes of conceptualizing, evaluating, and developing futures, but rarely are literal futures or prospective visualizations an output. Cases 3 and 4 transcend open-ended ideas of design fiction (Sterling, 2005, 2009) as the studies are tethered to specific historical, sociotechnical, and ethnographic data. The practices operate much more closely to rigorous empirical extrapolations than interpretive artistic expressions.

Early explorations between educational institutions and external partners influenced this assessment. The framework represents a critical tool developed to address results that were subjective and ambiguous, if not vague, contradictory, or simply confused. This characteristic would arise again toward the end of case 1 and influenced the initial motivation to systematize approaches that later focused on developing fundamental metacognitive knowledge.

3.2 Cognitive Apprenticeship and Design Education

Cognitive Apprenticeship (CA) was initially developed in the context of ‘teaching the craft of reading, writing and mathematics’ and extends learning models from traditional apprenticeship (Collins et al., 1987) as a means to make internalized cognitive and metacognitive processes more visible, or available for reflection and development (Collins et al., 1991). It consists of four dimensions: (1) knowledge types (subject or domain-specific, heuristics, controls, learning strategies), (2) specific methods of teaching and learning (modeling, coaching, scaffolding, articulation, and exploration), (3) how the activities are sequenced (macro to micro, increasing complexity and diversity in practice), and (4) the social context (situated learning, communities of practice, intrinsic motivation, cooperation) (Collins et al., 1987, 1991).

CA is uniquely appropriate for developing approaches in the case studies. In the later sections, we discuss how cases 1, 3, and 4 utilize participants’ expertise in visualization and materialization to develop cognitive and metacognitive skills, and how cases 2 and 5 draw on shared competencies used to make sense of everyday semiotic landscapes (primarily objects and spaces). Both approaches reflect the central focus of CA, to make cognitive processes more visible and accessible for development. Perhaps the most obvious connection to CA, and the initial exploration site, is the relationship between design education and traditional apprenticeship.

The pedagogical context of design education in cases 1, 3, and 4 is a trajectory from a craft-based apprenticeship model that somewhat tacitly employs aspects of CA. In practice and education, the design process is a conceptual model that structures development as a logical relationship of phases and practices, incorporating aspects of sequencing and scaffolding. Iterative processes, prototyping, materialization, replicating a ‘brief’ and the practice of group critique mirror CA aspects of modeling, coaching, scaffolding, articulation, exploration, situated practice, and communities of practice. We acknowledge and exploit the presence of apprenticeship pedagogical models in design education to introduce an array of specialized knowledge with a central objective of facilitating new metacognitive knowledge.

3.2.1 Design Process

As a transition from apprenticeship models, the initial incorporation of new skills and perspectives were those connected directly with practice. This allowed a familiar and structured approach to incorporating new knowledge, unlike a theoretical or research-focused course that is separate from practice. The design process was utilized as a foundation for development and analysis that offers temporal and thematic entry points for new knowledge. In the case studies, the design process is a series of steps or phases that categorize and compartmentalize activities and perspectives as a linear framework for development. It consists of four steps or phases: (1) research and orientation, (2) conceptual development, (3) design development, and (4) implementation. While the development phases can vary and are not strictly linear in practice (Bierut, 2006), they offer a level of abstraction that generalizes design processes or creative production. In the case studies, this abstraction allowed an inclusive and intertextual approach that was functional across disciplines and ultimately outside of ‘the school.’

3.2.2 Incorporating Approaches from Professional Practice in Pedagogy

Case 1.a was the initial prototype and proof of concept for the other cases. It was the first time that the various perspectives and skills were drawn together into a comprehensive post-disciplinary pedagogical structure, specifically one that could meet or exceed the expectations of existing departmental trajectories. It exemplifies how critical yet exploratory models from practice are incorporated within standardized institutional pedagogy through situated practice and other CA techniques. Specifically, for example, the practice of situating discourse in everyday realities through visualization and materialization as a means to critically explore possible futures. This was the focus of a series of workshops developed by the authors (as professionals employing critical and experimental practice) as early as 2005¹ (Jagodzinski, 2010).

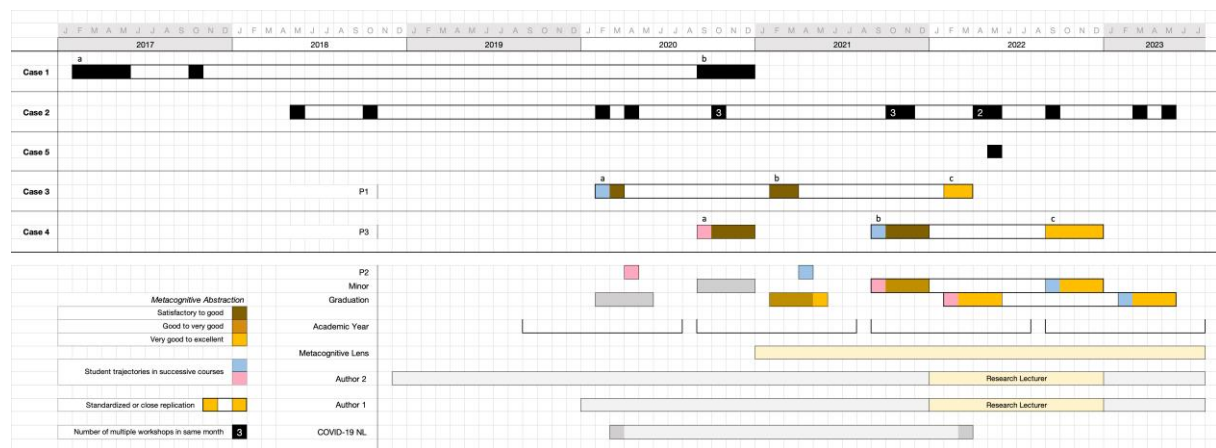
The subsequent cases represent moments when the authors were in positions to integrate more extensive progression based on this model. In the timeframe of case 1, the second author was the department head, the first author was a core lecturer; and they worked together to develop the curricula. In cases 3 and 4, the second author was a manager consultant in curriculum development from the administration level (e.g., developing the conceptual model of the metacognitive lenses), while both authors held positions of research lecturer. The first

¹ Broadcasting Tongues, 2005, Moscow, RU, Prague, CZ, Katowice, PL.

author developed the pedagogical models, frameworks, content, sequencing, and course structure that transitioned to a metacognitive lens perspective from the ground up. During and after the case studies, the authors functioned as advisors to terminal graduation project development and evaluation in both institutions.

Building perspective from every level was significant as it facilitated tracking educational trajectories through actual student data. Additionally, digital forms and notebooks were used for distributed scaffolding and sequencing of activities that produced data on engagement rates and knowledge development. This aspect was in use before COVID restrictions to a limited degree, but the necessity of remote education provided the urgent need and subsequent opportunity to utilize digital tools to facilitate CA techniques in the pedagogical implementation¹. Table 2 is a timeline of the case studies with expanded data for cases 3 and 4, including indications of metacognitive abstraction in educational trajectories, as represented by student data.

Table 2. Timeline of Case Studies with Case 3 and 4 Pedagogical Trajectories



3.2.3 Metacognitive Abstraction as a Development Factor

In cases 1, 3, and 4, the development of foundational metacognitive abstraction is understood as a significant factor, broadening the perspectives, abilities, and engagement of participant practices or student potential when present. Case 1.a represents a time (2017) when curriculum changes were realized throughout the entire 4-year trajectory. Practically this means that every student in the case was building on at least 3 prior classes that introduced knowledge utilized in the study. At this time, the foundational curricula were able to develop cognitive and metacognitive knowledge that could be abstracted in practice as an indication of its reception. Specifically, this included a series of pedagogical explorations that introduced aspects of anthropological methodology, material culture, visual ideology, and social semiotics (among others) as a research, editorial, and open design exploration into visual and material ideologies, cultural translation, and abstraction². It also builds on previous explorations in 2014³ and 2015⁴ that connected to the outside world as an initial means to broaden landscapes of potential regarding design value, process, experimentation, and output and contest normative 'job demands.'

3.2.4 CA Activities, ZPDs, & Design Process Comparative Timeline

Reflecting on the design process and CA approaches in the case data exemplifies how metacognitive knowledge may be developed at early stages. Table 3 depicts the pedagogical timeline of CA activities in case 3.c. It represents a more realistic reflection of how non-linearity is observed in actual practice. In contrast to strict linear phases, the design process stages largely overlap, reflecting an approach that integrates multiple skills and perspectives through cycles of activities. The development phases increase with complexity yet are more open to

¹ Governmental mandates for remote education are indicated in the *Timeline of Case Studies*, Table 2.

² Colloquially referred to as 'the Subculture Project' by students and other tutors. Between 2004 and 2019, over 110 research publications and even more trajectories were produced. The project was explored at Parsons, The New School, NY, USA & DAE, NL. It built on the early exploration, 'Broadcasting Tongues', and influenced approaches in cases 3 and 4, as well as the trajectory of education in the latter years at WdKA that built on 3 and 4.

³ Man Made Gods, 2014, Natlab, Eindhoven, Eye Museum, Amsterdam, NL.

⁴ Some Things You Can't Download, 2014-2015, Lantern Vensteren, NL.

expansion. This departs from traditional apprenticeship ‘job demands’, enabling a focus on aspects of the process instead of a fixed-end output.

The progression represents a transition from linear models of traditional apprenticeship that relied on a low student-to-tutor ratio and individualized customization of development components or processes to a framework approach that (1) incorporates situated practice and flexible ‘zones of proximal development’ (ZPD) (Vygotsky, 1987) for participants (and tutors) with varied competencies, objectives, and roles (from executives, policymakers, and board members to managers, tutors, students, and secretaries), (2) engages a greater number of participants (460) and potential tutors by incorporating distributed scaffolding (Puntambekar, 1997) to sequence activities, (Tharp, 1993; Dennen, 2000) that (3) model new approaches, and implicitly develops specific metacognitive perspectives. (This is in contrast to each different tutor team determining the context and specification of knowledge relative to their single discipline, genre, or niche market.) The individual variation and motivation facilitated by situated practice also allows the pedagogical structure to address a repetition of ZPD expansion and contraction more comprehensively and in greater depth as is exemplified in Table 3.

Table 3. CA Activities, ZPDs, & Design Process Timeline

Case Study 3.c, Speculative Futures / Pasts of Rotterdam, Framework timeline																								
Week 1										Week 2														
Day 1					Day 2					Day 3					Day 4					Day 5				
CONTENT																								
Domain knowledge																								
Heuristic strategies																								
Control strategies																								
Learning strategies																								
METHOD																								
Modeling																								
Coaching																								
Scaffolding																								
Articulation																								
Exploration																								
SEQUENCING																								
Global before local																								
Increasing complexity																								
Increasing diversity																								
SOCIOLOGY																								
Situated learning																								
Community of practice																								
Intrinsic motivation																								
Cooperation																								
ZPD challenges																								
Phase 1: Research & Orientation																								
Phase 2: Conceptual Development																								
Phase 3: Design Development																								
Phase 4: Implementation																								

The first study (1) initially foregrounds digital and material discourse in the context of design education as a means to explore new perspectives, practices, technologies, emerging markets, etc., — many in daily use — that were outside of the traditional professional or departmental canon of focus or output. Professional practice reflected emerging social and technological changes more rapidly than inside the educational institution, and this gap of knowledge was clear and ever-present to the mentor team comprised of professionals. It was, first and foremost, a sign that the students were being underserved, a challenge we attributed, in large part, to the restrictions of disciplinary silos, traditional design roles, client relationships, and normative outputs. As the cases would show, this knowledge gap was a missing critical foundation of specialized skills, approaches, and cognitive tools for engaging with the outside world and developing a broader perspective.

The cases are contextualized within an institution that paid specific attention to high-quality craft-based material production and finishing in design. This presented a unique opportunity, as all the students possessed at least a foundational level of knowledge into materialization across a few disciplines and often a trajectory of expertise in one or more specializations. The consistent level of design expertise, beyond the literal practices of production, represented a conceptual model and practical understanding of materials, processes, conventions, and potential contexts of human use. Foregrounding discourse in this context builds on the foundational knowledge, connecting value in visual, digital, or material manifestation, first to the larger network of infrastructures and practices of digital and material discourse, then to the production of meaning in everyday life.

3.3.1 Discourse and Realities

Case 1.a introduced a contextual restriction limited to everyday life, required a research trajectory that produced or collected data to situate the theme or phenomenon, and that aspects of this research be explicit in the output. It focused on externalizing cognitive approaches or assumptions to data from research as discursive objects and, in doing so, challenged trade-based ‘job demands’ regarding expectations of normative practice, output, function, and client or partner relationship. This is to say that value in design development was less deterministic in terms of expectations tied to disciplines or practices and instead allowed the development of a relationship or network between the participant, material realities, and material discourse.

In Figure 1 (left), municipal data, observational research, and a series of interviews produced knowledge regarding the approval or disapproval of individual data collection in urban spaces. The functional prototype suggests restricting formerly hidden cameras, microphones, sensors, etc., to designated urban interfaces for utilization, awareness, collaboration, and contestation of data privacy. It explores the containment of interaction, playfulness, curiosity, and fear regarding data privacy within material structures.

On the right, the students, as participant observers, identified the contemporary performative practice of exposing one’s body or private details as a form of currency on social media. By extending existing social practices and digital infrastructures into the near future or an alternative present, the video explores mediation and remote connection across public and private everyday contexts, practices of consumption, commodification, and social monetary systems. In a way, this foreshadowed the rise of platforms such as Discord and Onlyfans.

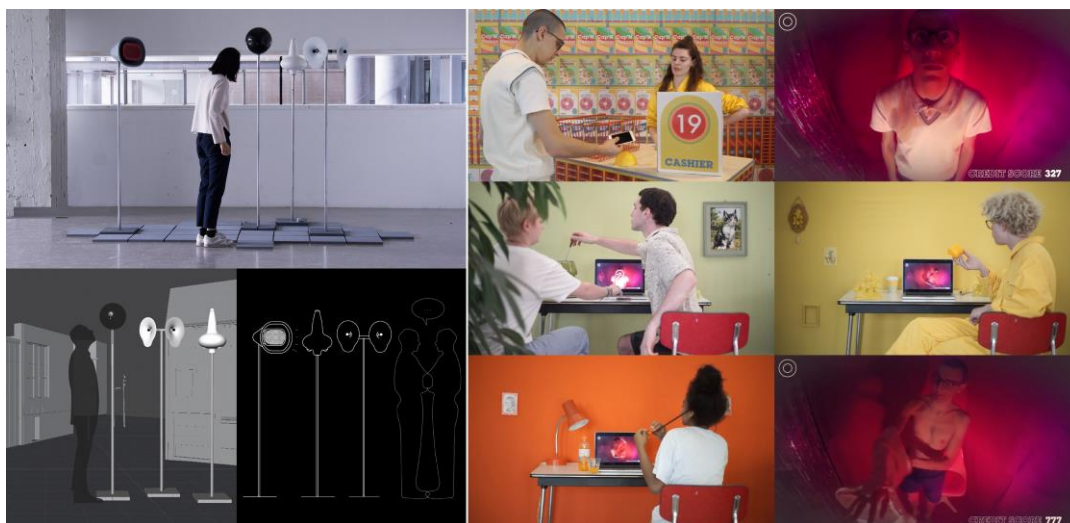


Figure 1. Explorations from Case 1.a, **Alternate Societies: An Exploration of Data Ideals in Possible Futures**, a collaboration with the Municipality of Eindhoven (2017), left: **Smart Senses**, by Jade Chan in collaboration with Antonio Davanzo & Iosif Abaab, right: **Welcome Mr. Mayfield**, by Ellen Pearson & Job Claasen

The case frames material discourse (value) as relative to material realities (context). It introduces a conceptual model that describes ‘local’ design practices within a logical framework that connects their development and semiotic potential to the production of meaning in everyday life. In other words, foregrounding discourse as interconnected (at a global scale) yet enacted locally introduces a logical structure that connects value (discourse) to context (realities). This perspective reflects a conceptual model aligned with social semiotics.

3.3.2 Social Semiotics, Semiotic Landscapes, and Sociotechnical Systems

Social semiotics challenges de-contextualized meaning systems and emphasizes the production of meaning within social practices (Eco, 1976; Lemke, 1995). In the context of specific places and communities, ‘semiotic landscapes’ position the interaction between ‘ways of seeing’ (Berger, 1972) and semiotic resources ‘as a historically, culturally, and geographically situated social practice through which discourses, communities, and identities are mediated and reproduced’ (Jaworski & Thurlow, 2010). Ecosocial semiotic networks, or sociotechnical systems, focus on material processes and semiotic systems as a complex network of interrelated cultural practices that produce variation in identity, community, and ideology (Lemke, 1995).

The understanding that meaning is contingent on social context, practices, and places aligns with the connection between discourse and realities. Emerging social practices, digital infrastructures, and popular culture introduce new discursive structures that challenge canonical semiotic meaning (Kress, 2010:142). This takes one metacognitive step outward, where design ideas, objects, processes, and systems are understood as shared semiotic resources interwoven into everyday life and in constant flux. The student participants represent early experts in design knowledge, and working from this vantage point can offer approaches to explore our interconnected contemporary lives.

3.3.3 Semiotic Formations

Ecosocial semiotic theory validates an approach that begins with a localized practice or artifact as representative of socially meaningful patterns. Semiotic formations are an ‘intermediate level of conceptual analysis’ between system-level characteristics and local social practices (Lemke, 1995). They ‘formulate the scale from microsocial to macrosocial in terms of actions (social practices) and patterns of relations of actions (cultural formations) and not in terms of entities and aggregations of entities (individuals, corporate groups, societies)’ (p. 86). From this perspective, the semiotic landscapes that comprise and structure our everyday life are entry points to observe and analyze how biases in the larger system scale influence characteristics of human difference and distinction. Focusing on local practices from the network level aligns with the participants’ expertise in design infrastructures, production processes, social histories, etc. This aspect is exemplified in cases 2 and 5 by focusing on shared competencies of everyday landscapes (e.g., chairs, coffee machines, or garbage cans).

3.3.4 Visual, Material, and Digital Ideologies

This attention to different scales is present when the focus is narrowed to specific artifacts and identities, reflected by the interrelated concepts of cultural biographies and social histories of objects (Appadurai, 1986: 34; Kopytoff, 1986) that represent ‘two kinds of temporality, two forms of class identity, and two levels of social scale.’ This connects to Lemke’s concepts of cultural formations and social practices. To address this in the context of design and digital infrastructures or sociotechnical systems, we build on Spitzmüller’s idea of ‘graphic ideologies’ as ‘any sets of beliefs about graphic communication means articulated by users as a rationalization or justification of perceived orders and communicative use of graphic elements’ (p. 257).

Understanding how humans utilize semiotic resources as identity practices is especially relevant in the contemporary world, where social identities can be momentary, highly stratified, contextually relative, open to change, and reuse, yet are tied to variations or biases of material and digital infrastructures (Appadurai, 1990; Castells, 2005), and emergent forms of social and digital practice (Pink & Hjorth, 2012:147). This fact is rather obvious for a fashion designer exploring how identity is entangled with class distinction, community affiliation, production processes, or supply chains. However, it is just as beneficial for an interior architect, transformation designer, or interaction developer, and as the cases show, it is equally useful for municipal managers, policy advisors, and supervisory boards.

In the workshops (case 2), participants overwhelmingly opted for generalized, non-personal, low-risk input that requires minimal effort (at least in appearance). This is understandable and expected, given the social context. The general, shared objects (e.g., a table, clock, chair, or notebook) are useful because of the common understanding. Due to their ubiquity, they embody substantial and consistent ideological significance. Tables, clocks, and chairs are such reliable features in the everyday landscapes of human life that they often recede into the periphery. However, it’s jarring when the supporting structures defy our normative expectations. Variations and differences in everyday material interfaces tap into shared competencies and, in the workshops, are a foundation for critical reflection on shared future thinking, planning, and potential value.

While digital infrastructure is often out of our immediate observation, its influence penetrates all facets of life,

especially visual and material ideology. For example, our close relationship to material culture, industrial production, and expectations of material constraints are challenged by the explorations in Figure 2. The woven textile on the left mimics the properties of LCD screens with thread and layered weaving processes, and the two chairs on the right use the characteristics, operations, and expectations of materiality we associate with digital infrastructures, yet IRL. Both explorations began as relevant and focused conceptual inquiries into the relationship between human culture and digital infrastructures supported by data from everyday social practices and semiotic landscapes. Through iterative studies and prototyping, each developed a complex production technique to materialize the digital entanglement.



Figure 2. *Digital Ideologies in the Material World*, left: *Technomimicry*, woven textile, Lianne Polinder, 2014, center/right: *Return to Default*, Collection of chairs (two of three depicted) Janne Schimmel & Moreno Schweikle, 2018.

3.3.5 Uncommon Landscapes and Shared Unknowns

Extending the ideas of social semiotics into explorations or representations of digital infrastructures can often lead to unrecognizable terrain. The uncommon landscapes in digital spaces mirror the shared unknowns central to speculation and critical future thinking. Recognizable indications of human social structures or practices are limited, and the conditions or influences producing this digital materiality are unfamiliar. At first glance, the strangeness offends our shared competency of split-second clarity, which we rely on to make sense of everyday landscapes. It seems like junk data or a computational error. The links to ideology and identity are obscured by the coarseness of machine abstraction.

However, this unfamiliarity is significant because it represents disjunctures in semiotic systems. On the left of Figure 3 is a screenshot from a virtual class in Mozilla hubs that was repeated in cases 1, 3, and 4. It seems counterintuitive, but using this digital context, specifically, because it is disconnected from material expectations, was a highly useful practice of shared unfamiliarity or a collective disassociation from social hierarchy. We liken the practice to a Zen tea ceremony, where all must shed external identities and tools of advantage, entering by crawling through a small door, 'nijiriguchi,' as a sign of shared humility (Handa, 2013). In this digital environment, the unfamiliarity and lack of control are experiences shared by all.

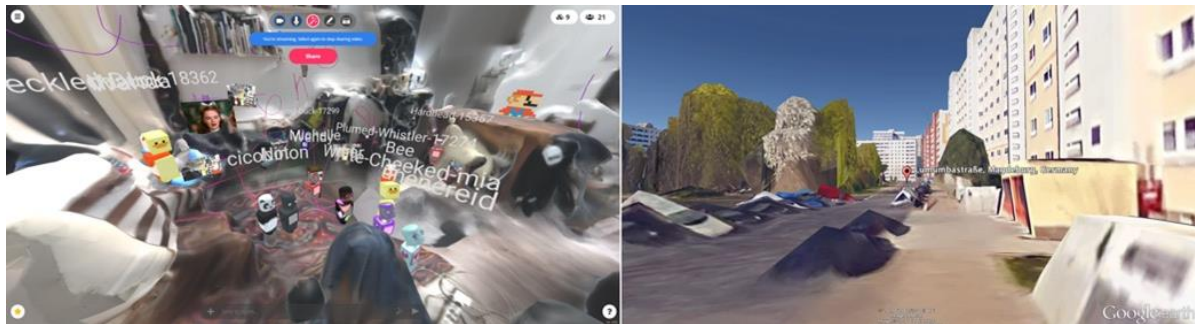


Figure 3. *Uncommon semiotic landscapes*, left: *Remote class in Mischa's living room*, Virtual class in Mozilla hubs, repeated in cases 1, 3, and 4, from 2019-2022, facilitated by Mischa Guvorich. (This image is from a class on the first day of COVID-19 lockdown in the Netherlands, March 2020.) right: *Lumumba x50*, A video still from a speculative ethnography of digital landscapes using Google Street View to materialize differences and disjunctures in digital infrastructures, by first author (2016).

The exercise was a way to develop a familiarity with uncommon spaces. Instead of a mandatory task of frustration, interacting with digital material landscapes was framed as an exploration of new worlds, akin to how an anthropologist may traverse an uncommon landscape and observe or participate. Prototypes presented in this context often produced more beneficial conceptual reflection, as opposed to a physical class, around a table and using a laptop. The physical performances of social identity, especially institutional architecture, furniture, and media infrastructure, all represent material counter-narratives. In contrast, the digital space forces all participants into the unknown, and personal and material biases are lessened in this void.

3.3.6 Data & Digital Subjectivities

The prevalence of digital infrastructure within numerous everyday contexts provides a unique opportunity to exploit existing 'mundane' processes, technologies, or information sources. When consulting a map on a mobile device, the processes that filter and display meaningful locative data are usually not a direct concern of the user. Viewing and uploading images to social networks are complex negotiations of data transfer, organization, analysis, distribution, and visualization, yet seem easy. The techniques and algorithms used to produce the abstract visualization of city streets on Google Street View are not often in users' minds as they traverse the virtual terrain. Figure 3, right, explores speculative ethnography using Google Street View to materialize differences and disjunctures in digital infrastructures (2016). The unfamiliarity and immateriality of digital infrastructures are often disregarded, yet from the perspectives of design, technology, mediated social practices, etc., the disjunctures are representative of underlying biases.

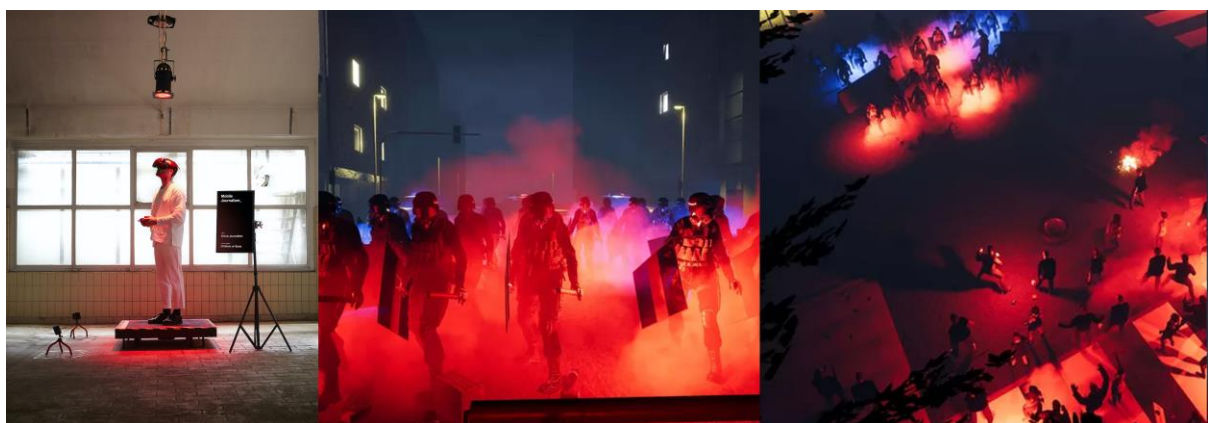


Figure 4. *Mobile Journalism*, Jim Brady, 2018

The ability to translate and re-contextualize aspects of material landscapes and first-hand experiences through intermediation processes has led to new ways in which the world is represented and seen (Uricchio 2011). Using shared tools and techniques (from stock photos to VR worlds), it is possible to contest material structures, reuse, misuse, remix, or otherwise engage with processes of resemiosis to imagine new values and social realities. Figure 4 depicts an exploration into bias and information manipulation of news coverage, focused on the context

of urban protests. The VR installation forces visitors to question the validity of their opinions as the immersive experience embodies conflicting subjectivities. Using a real-time gaming engine, it incorporates user tracking, a vibration pad, and live content integration to simulate a shared experience from different perspectives of social roles. Embodying the individual narrative of a police officer, journalist, or protester, the exploration exploits digital infrastructures to immerse the user in a nuanced experience of subjective data.

The preceding examples explore how sociotechnical systems, human culture, and digital, visual, and material ideology are not only entangled but exhibit disjunctures and biases as central characteristics (Bijker, et al., 2012; Suchman, 1992). The case studies also incorporated and developed perspectives to de-center or question human relationships to technological systems and non-human 'objects' through approaches to situating knowledges (Haraway, 1998) as conceptual approaches to developing critical methods, along with data-driven studies that engage with object-oriented ontologies (OOO), speculative realism (Harman 2002, 2012, 2016), alien phenomenology (Bogost, 2012), and even at times reflecting on what it's like to be a bat (Nagel, 1974). Modeling experimental approaches with emerging technologies from professional practice allowed more varied and critically focused possibilities for producing data. Figure 5 depicts professional practices modeled through on-site interaction and prototyping development in the space between institutional learning and real-life experiences. Figure 6 is a master's thesis advised by the second author at the University of Delft that develops a critical analysis of smart technologies in urban landscapes from the perspective of feral pigeons.

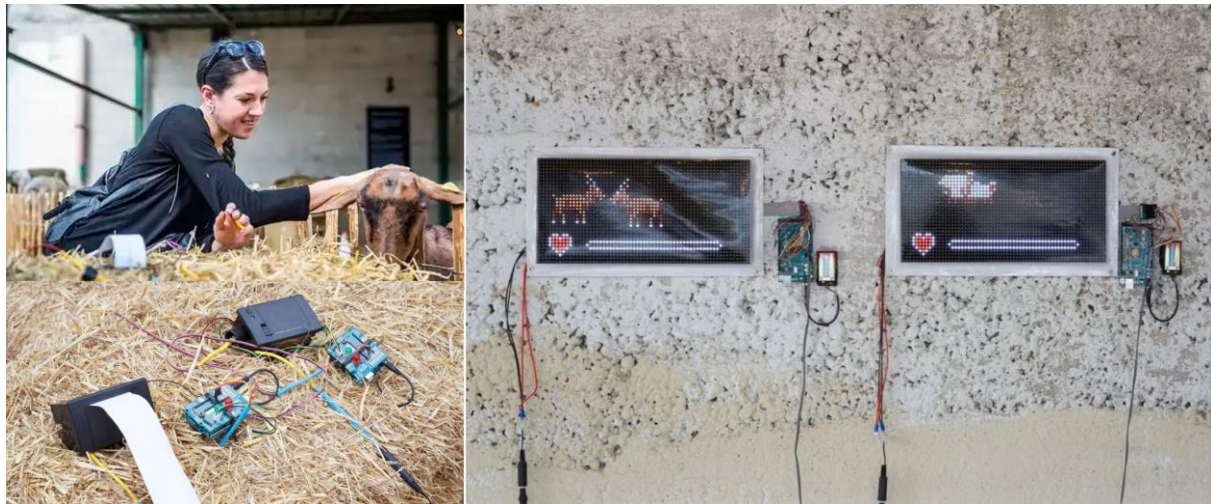


Figure 5. **Petting Zoo 2.0**, Milan, Salon de Mobile (2016), Two prototypes exploring the interaction of digital infrastructures, humans and animals. Left: a prototype developed by the first author used simple electronics as a biofeedback loop, continuously displaying the participant's heart while they interact with animals, as a material receipt of the interaction. Right: students Vito Boeckx, Luca Claessens, Yi-Ting Lee, Carl Rethmann, Joep Truijen, and Armands Vecvanags with assistance from tutor Sjef Fransen prototyped a realtime, digital mediation of animal activity as a parallel to direct human experience. Supervision by second author.



Figure 6. **Experiencing the City: Towards a more pigeon inclusive Smart City**, Peter Kalkman, 2018. 'This graduation thesis critically reflects on the Smart City. It critiques certain values embedded in the technology used to source and analyze data, and manage the city, when it comes to the world of human experience. The theoretical critique is eventually expressed in a critical design. Applying the values of the Smart City to the feral pigeon.'

The trajectory of case 1 exemplifies a transition and the development of approaches used in the other cases. It marks a shift from discourse as the object of output to discourse as the subject of inquiry. While the transition was not fully realized until cases 3.c and 4.c, the developmental changes as a metacognitive perspective, in distinct contrast to existing traditional departmental silos, were overwhelmingly evident in the explorations. The trajectory of one particular student, Simon Dogger, encapsulates, in the manner of a lightning bolt, why and how the post-disciplinary approach to externalizing cognitive processes, the development of speculation as a framework, and the resulting metacognitive knowledge represent substantive life tools for embracing knowns and unknowns in shared futures.

As a third-year design student, Simon contracted meningitis. He endured a lengthy existential battle and recovery, certainly, in part, due to the persistence we would later observe; however, it deprived him of a central faculty: his sight. Returning from a tumultuous three-year hiatus, Simon attempted to complete his final year and a half of design education. His former department of enrollment and others rejected the request to enroll. To the enormous credit of the second author and a shared faith in the flexibility and efficacy of the pedagogy under development, Simon was enrolled in the department.

A collective of alumni from the department, each having already developed cognitive and metacognitive knowledge within the same pedagogical approach, functioned as an extension of CA techniques, as cognitive apprenticeship naturally occurs within communities of practice (CoP) (Dennen & Burner, 2007). Immersed in the unknown, Simon redeveloped his design expertise within a broader metacognitive perspective to explore the immateriality of digital infrastructures, the subjectivity of data, everyday biases and exclusion, and subsequently, the development of tools to influence his and others lives. TikTik is an app that translates spatial characteristics to haptic feedback using existing wireless digital infrastructure (GPS, Wi-Fi, Bluetooth) as an assistive way-finding tool. The Emotion Whisperer (Figure 7) uses sensor-equipped eyeglasses and a smartphone app to identify a conversation partner's or multiple partners' facial expressions. The haptic interface relays nuances of interpersonal communication that were previously unseen but now may be felt. The case represents the potential of post-disciplinary cognition made accessible and, in this instance, literally tangible.



Figure 7. *The Emotion Whisperer*, Simon Dogger, 2017

3.3.7 Ownership, Sourcing, and Transparency

Toward the end of the first case trajectory (Case 1.b, 2020), the development of foundational metacognitive abstraction subsided. The institution had formally transitioned from departments, which were replaced by topical courses renewed every semester that focused on simulating the practice of individual tutors, as an irony-inducing regression into a buffet of traditional apprenticeship. The post-disciplinary foregrounding of discourse that was developed across successive years within the 'department' was reduced to a single course in one semester. Without an institutional framework for knowledge development, benchmarks, or sequencing, the shared expectations of cognitive and, especially, metacognitive knowledge development among courses or within successive years were unaligned, if not entirely missing.

Disappointingly, this was exemplified with increasing frequency by student projects — even professional work produced years later — that merely replicated the exact technique modeled by tutors in foundational exercises as a rote application disconnected from context or content relationships. Not only does this reflect a low level of reception, but it also produced tension regarding ownership or the commodification of knowledge and practices modeled in CA, which was a significant factor with students, tutors, administration, and external partners. The second author, who developed and managed the case partnerships (as 'department head' and 'studio course leader'), explains as a matter-of-fact: *'The more successful the process is, the more everyone wants to own it.'*

The final study in the first case (1.b) was a culminating test of the approach, yet with additional variables. The

condensed approach incorporated primary aspects and activities in one semester to develop the needed foundational knowledge in parallel with higher-level abstraction and expertise. One significant advantage was an ideal teaching team comprised of functioning professionals who were also part-time teachers and had experience working together or in connection through successive courses or activities over a number of years. As an example of the second author's confidence in the framework, the tutor team, and what also may appear strikingly similar to a high-stakes, all-in approach to testing efficacy, the case partnered with ASML, one of the largest suppliers in the semiconductor industry and the most highly valued European technology company, as of December 2023 (O'Grady & Kenyon, 2023; Tarasov, 2022).

With this partnership, the case study was tested at the top level of corporate contextual value. It was a proof of concept that partners in the 'outside world', especially innovation leaders, could facilitate, and profit from, the space to resist fixed outcomes and re-evaluate value as an ongoing process. It also exemplified how a traditional project brief and contractual client relationship could support flexibility and open-ended output, initially through framing but ultimately by leveraging the value and potential present in ongoing developments produced through the framework.¹

Advanced technology corporations must actively develop their future. This was reflected in the case partnership by awareness and reception to alternate perspectives and critical approaches to futuring. A significant aspect of innovation development is the ability to perceive an entire landscape of possibility and still push past known boundaries. This flexibility was critical in the condensed approach of developing foundational knowledge, which enabled exploration through discourse, exploiting design and material infrastructures to produce data.

While technology rapidly moves into new material realms, its infrastructures and implications are often out of view, hard to make sense of, or altogether immaterial. ASML is a corporation with highly protected intellectual property, and therefore it was even more beneficial for aspects of data production to be extended through design, production, and mediation infrastructures and networks. Incorporating observational, human, and non-human research perspectives and critical approaches to interrogate design infrastructures, sociotechnical systems, and semiotic networks was necessary to account for an initial lack of material data (which the partner addressed thereafter). This was exemplified by an exploration focusing on data from grey market objects of industrial refuse originating from ASML, which were available for resell on eBay. As specialists interrogating material artifacts, production infrastructures, use lifecycles, and potential social meaning, the case overwhelmingly proved the efficacy of the approach. This was evident in the progression of student knowledge, from the perspective of internal evaluation, and within partner reviews.

The broad potential and specific challenges identified by this case trajectory would strongly influence the motivation to systematize the knowledge that was often modeled directly by the authors or co-tutors toward a more generalized framework that connected directly to source ideas, themes, perspectives, and methods. This produces more flexibility and potential for new outcomes. It also requires more effort, criticality, and individual input from participants, shifting responsibility and development influence toward their interaction and attention to framework details. In the final cases, this approach is refined as a co-design framework that decentralizes authority and responsibility in the design process, essentially linking responsibility and ethics to external knowledge or data that the participant must represent empirically instead of interpreting subjectively.

4. Speculation as a Framework Connecting Realities to Futures Through Discourse

The framework is a means to add rigor and criticality to practices of research, questioning their role and validity. Practices referred to as 'desk research' by students and tutors were often a misunderstanding or misrepresentation of how foundational facts differ from cycles of research as a logical progression from initial assumptions, conceptual grounding, and operationalization toward appropriate methodologies for data production, analysis, and reflection. Fortunately, the initial case studies had proven that the development of foundational metacognitive abstraction was possible by foregrounding discourse, incorporating CA perspectives within design education (situated practice, distributed scaffolding), and embracing variation in use and ethnomethodological development, directly and indirectly. The pedagogical structure forces participants, in cases 1, 3, and 4, to develop their own research studies, design developments, and in doing so, incorporate new skills to develop a greater metacognitive perspective (which, in turn, increases the potential value and flexibility of the process and output).

¹ Just as the initial introduction of approaches modeled experimental and critical professional practices, the use of traditional client and brief structures to afford development space and potential is a craft central to the professional practices of the authors and frequent co-tutors. In fact, as a testament to CA communities of practice and metacognitive embodiment, the cases benefited from former students, now professionals, who were instrumental in facilitating higher-level progression. Case 1 included one, cases 3 and 4 included two, and case 5 included three.

This highlights a primary challenge for the depth and variation of research in the context of an increasingly transdisciplinary design education that is entangled with emerging technologies, practices, and identities; How to connect design students to ideas and practices of research in ways that produce first-hand experience and insight, not overly deterministic, yet still linked to an individual trajectory of development and innovation. An alternative corrective route is to develop a strict definition, range of applications, or typology of frameworks. The disadvantages of rote application are exemplified in early cases by deficits or disconnections within contextual specificity, methodological appropriateness, and related data production, operationalization of assumptions, conceptual inconsistencies or contradictions, and general nuance for creativity in research practices. Such knowledge is not simple to facilitate, but it is certainly possible. The final cases reflect an approach that develops this complex array of knowledge with exponentially greater participant numbers and engages with a broader variation of competencies and perspectives. The studies refine a middle ground that introduces a series of cognitive exercises through visualization and materialization, developing knowledge and flexibility at successive stages instead of beginning with fixed design research typologies, or its opposition, an undefined validity.

4.1 Co-Design and Decentralization

We incorporate the idea of co-design ‘in a broader sense to refer to the creativity of designers and people not trained in design working together in the design development process’ (Sanders & Stappers, 2008). ‘The act of making here is not just a performative act of reproduction, but a creative act which involves construction and transformation of meaning, by any or all of the people just mentioned, and in all those activities’ (Sanders & Stappers, 2014). We build on these sentiments by interrogating, imploding, or challenging the ideas of who (or what, and when) the participants are and are not ‘in all those activities’ and even how ‘activities’ are distributed through a network of material, economic, social, cultural, and environmental implications. Working through discourse, we approach the future by reconnecting co-design participants, stakeholders, and their respective implications. This links to ideas of reassembly and semiotic resources coming into focus through use and materialization, akin to Latour’s black box (1994).

The framework partially replaces the guidelines and criticality of an individual mentor or team by decentralizing design responsibility and externalizing control structures. The participant-driven approach delegates aspects of responsibility and specific details of learning activities not only as a pedagogical requirement but also regarding normative methods to make sense of life. Developing learning strategies with varied participants and competencies embraces ideas of ethnomethodology (Garfinkel, 1967), which in this development is a critical awareness of how pragmatic activities ‘on the ground’ often differ from normative, formalized discourse. Specifically, this perspective was focused on supporting the development of practices that are individualized and empowering for participants while still representative of a broad landscape of variation at every step. Much of this was possible because foundational knowledge was developed at an early stage and consistently in this manner throughout the pedagogical trajectory.

4.2 Main Areas of Knowledge

The development consists of three interrelated areas of knowledge loosely corresponding to realities, discourse, and futures. They are not mutually exclusive. In the case studies, the different aspects are explored in tandem and mutually inform each other. This is largely framed by the ability to externalize research perspectives, beginning with logical and ethical relationships to empirical data and observational phenomena. Through implicit activities and explicit exercises, human and non-human knowledges are situated, or imploded (Dumit, 2014), critically exploring sociotechnical systems and social semiotic networks of meaning as made meaningful through specific practices, contexts, discourses, and semiotic formations. Engaging with processes of prototyping, materialization, and visualization, we are developing new tools, perspectives, and practices, prefiguring new worlds. This sounds overly fantastic, but at the scales and perspectives involved, it is accurate, and from the perspective of ecosocial semiotics, discourse theory, design anthropology, co-design, and research through design, this is not merely an environmental characteristic but a fundamental operation of everyday life — the materialization of discourse through time is how we understand human culture.

The main course structure is a repetition of the knowledge areas that increase with complexity, and the multi-year pedagogical trajectory mirrors this approach at a different scale. This repeated development of familiarity and control facilitates a relationship between the participants and knowledge areas, as opposed to a theoretical overview followed by the expectation of value through replication. Since the knowledge areas are engaged repeatedly with increasing complexity, it allows for a range of productive outputs or results for each activity.

For example, in cases 3 and 4 (and in the broader learning trajectory), exercises that explore the development of an initial (visual) research study are engaged repeatedly within each course. The results in many of the cycles or iterations are not necessarily research studies. This is an intentional space for ethnomethodological development that fosters individual and idiosyncratic approaches (as long as data is valid, ethical, and logical). What it offers

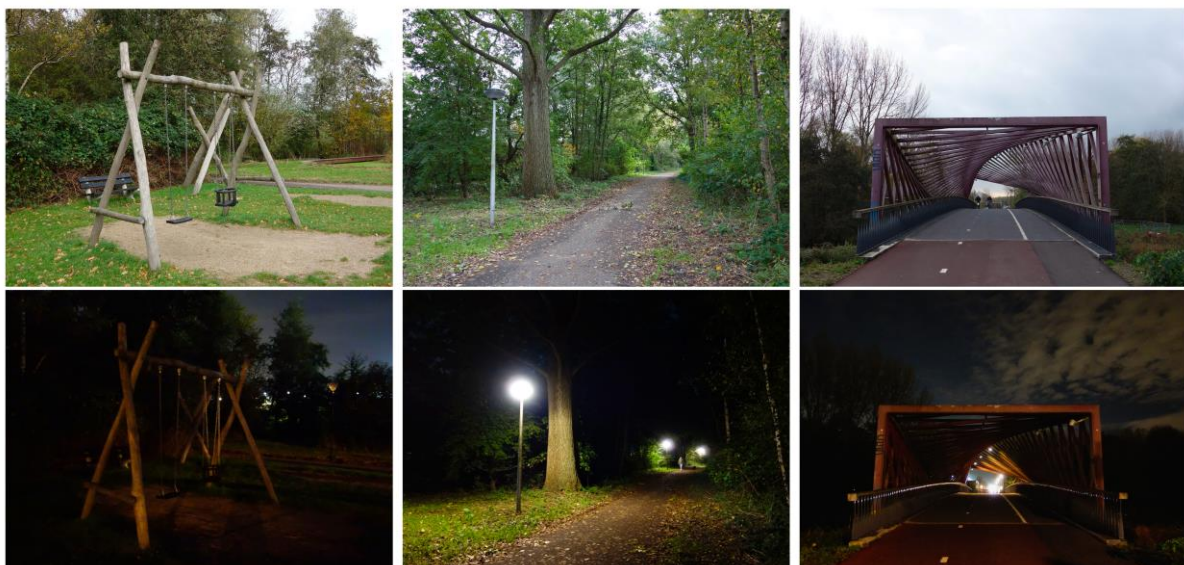
is an initial provocation, and the result is often a reflection of initial perceptions (familiarity, interest, opposition, confusion). We very intentionally create safe spaces to foster variation, including opposition or confusion, as this still engages with the subject area. In this way, the only unacceptable result is no result. If the realm of possible outcomes can embrace an exploration at the extreme perimeters, it will remain productive.¹

'A consequence of the specialization of technology production and its separation from locations of use, in sum, is that the development of useful systems must be a boundary-crossing activity, taking place through the deliberate creation of situations that allow for the meeting of different partial knowledges.'
(Suchman, 2002)

4.2.1 Interrogating the Everyday

This links to *realities* and focuses on producing, collecting, and analyzing empirical data, exploring visual, material, and digital culture on the ground in contexts of everyday life. It familiarizes participants with methods and perspectives to operationalize research assumptions and develop reliable data to produce knowledge. In the succession of courses, from the first year through graduation preparation, an influential early exercise was framed as, *Interrogating the Everyday*. Distributed scaffolding was facilitated by digital notebooks, online scheduling, individual process documents, shared worksheets, or a combination thereof. The curricula reviewed or comprehensively covered visual methods in social and cultural research from sociology (Pauwels, 2010; Pauwels & Mannay, 2020) and anthropology, including observation (Ciesielska et al, 2018), ethnography (Robben & Sluka, 2011; Fusch et al, 2017), interviewing, questionnaires, sampling basics, (Bernard, 2006), ways of understanding visual culture (Chalfen, 2011; Collier & Collier, 1986; Wagner, 2011a; Wagner, 2011b), ideas of material culture (Hebdidge, 1988; Appadurai, 1986; Kopytoff, 1986), specific methods relevant to data production, collection, and analysis in visual research: shooting scripts (Suchar, 1997), photographic surveys (Krase & Shortell, 2011), video diaries (Bates, 2013; Kenten, 2010), image coding and content analysis (Grady, 2007; Lutz & Collins, 1991), and iconographic tracking (Gries, 2015).

Research and data production (or collection) were framed as an exploration into social semiotic networks focused on a specific context, material process, social practice, or otherwise, a phenomenon able to be empirically observed (from the onset). In all successive courses, exploring methodologies to produce or collect data and developing approaches to engage with the outside world were continually developed as an exercise explored early in the course progression. During the foundational year (case 3), this was an overview of activities that implicitly developed approaches to researching everyday phenomena (Figure 8), in case 4, this was explicitly formalized as a sequence of activities within the initial four weeks, scaffolded through digital documents titled, 'Situating and Interrogating Cultural Phenomena through (Visual) Research Studies'. In the final learning trajectories (outside of the case studies), because cognitive knowledge and metacognitive perspectives had been developed, this often was more integrated within material production as a 'Rough Research Study Outline'.



¹ We are careful to draw strict ethical restrictions that exclude the motivated production of objectification, marginalization, exclusion, hate speech, etc. While such topics are very often central aspects contested in design research explorations, we have no space for the amplification or facilitation of such content.

Figure 8. **Day and Night Repeat Photography.** In the exploration above, the student operationalized a straightforward assumption regarding visibility and the perception of safety. Using repeat photography to compare day and night, the study exemplifies how the production of data through valid methodologies, the development of research design and reflexive analysis expand the cognitive and metacognitive knowledge of the participant. Depicting three comparisons from a series of twenty in a study by Sterre Baaima.

In Figure 8, an initial assumption regarding the perception of safety and differences in visibility between night and day was initially disregarded by the student as too obvious or simple. However, operationalizing basic assumptions regarding everyday life while engaging skills of their profession (photography, visual analysis, research design, etc.) builds on situated practice and was a primary influence for expanded learning trajectories.

Figure 9 are process documents from an introductory exercise for third-year students (case 4.c). Building foundational knowledge by externalizing cognitive processes allowed third-year students to embrace phenomena in the everyday with more variation, individual motivation, and subsequent value (both for the process, and as an abstraction of knowledge for the participants). In the development of a self-initiated visual research study, the students engage with the outside world by using diverse multiliteracies and hybrid visual data (New London Group, 1996; Collier & Rowsell, 2014).



Figure 9. **Interrogating the Everyday: Developing a Visual Research study.** An introductory exercise for third year students focused on interrogating the everyday, exploring visual and material culture, multiliteracies, and hybrid visual data. From left: photographic survey of fruits and vegetables in local supermarkets; a visual composition exploring the perception and growth patterns of vegetables; (top) a photographic survey tracking representations of fruits and vegetables in the participant's morning commute; (bottom) color swatches depicting the perception of ideal and non-ideal apples; a visual survey of greenwashing in local supermarkets.

4.2.2 Situated Knowledges, Abstraction, and Bias

As briefly discussed earlier, the penetration of digital infrastructures within everyday practices, their tendencies to standardize, implications of technological determinism, human-centric ecological impact, imperialist design processes, etc., all call for techniques that can situate known and unknown knowledges (Dumit, 2014; Haraway, 1998; Haraway, 2016; Suchman, 2011). "Discourses are not just 'words'; they are material-semiotic practices through which objects of attention and knowing subjects are both constituted" (Haraway, 1997, 218).

Case 4, and the two courses that follow in the pedagogical trajectory, formalize exercises that build on Haraway's 'implosion project' as a critical interrogation of knowledge dimensions and gaps (Dumit, 2014). 'Implosion Projects are attempts to teach and learn about the embeddedness of objects, facts, actions, and people in the world and the world in them. The emphasis is on details and nonobvious connections, as well as on the many dimensions with which we can analyze them: labor, professional, material, technological, political, economic, symbolic, textual, bodily, historical, educational' (p. 350). This approach begins with a specific artifact, idea, process, or practice and exhaustively maps connections, gaps, knowns, and unknowns, as well as control structures, networks of influence, bias, and power relationships.

In the earlier courses, critical perspectives of STS, social semiotics, situated knowledges, de-centering humans, analyzing potential stakeholders, and specific elements of the implosion project are explored implicitly within learning activities with increasing complexity in the trajectory. Embedding the skills, methods, or perspectives within pragmatic activities exposes, and most often is able to transfer, the underlying potential and utility value without first requiring conceptual retention. All aspects are introduced and reviewed initially, but by developing situated and embodied knowledge first, the potential for abstraction and variation in practices is elevated.

Abstraction is most influential as a central approach in institutional cases (3 & 4) and workshop cases (2 & 5). In the series of workshops (case 2), a recurring challenge that produced bias and exclusion in group dynamics stemmed from participants' attachment to real-life outcomes. As a secondary result, the confidence tied to real-life attachments often overwhelmed more tentative contributions from other participants, exemplifying a rather myopic future projection. The speculation timeline was moved beyond the lifetime attachments as a corrective measure. However, this challenge reappeared through attachments participants had relative to offspring. Finally, moving beyond the lifespan of any potential offspring proved adequate. Because we rely on relationships with societal structures in the present or past, the further we venture into the future, or the more fantastic and spectacularly super-powered a possible future becomes, the more disconnected and irrelevant the exploration. Most cases explore 25 or 50 years, and occasionally 100 years.



Figure 10. **BRIM**, (2022) Case 5: A workshop with 48 municipal managers utilized a familiar format of the social card game, *Cards Against Humanity*, as an entry point and format to explore critical future thinking. Through abstraction future scenarios were explored using object-oriented ontology, situating non-human

perspectives and exploring potential future stakeholders. Midjourney AI was used to generate intentionally ambiguous visual data to externalize cognitive processes and landscapes of possibility with enough specificity for direction, yet openness for redefinition. Participants first developed an individual contribution, then collaborated for a final exploration and knowledge development. © 2023 Authors & Midjourney AI

In addition to time as a subjective abstraction, we incorporate object-oriented ontology, alien phenomenology, and non-human perspectives to address bias. In case 2, a clock or table in a possible future limits personal attachments and is removed from the individual enough to create a safe level of abstraction yet retain enough connection to present-day practices and structure to be useful. This is similar to case 5, where the aspirations of garbage cans in a possible future 25 years from now also reflect how abstraction is a means to minimize bias yet still participate through a proxy (Figure 10). In cases 3 and 4, sequenced activities were scaffolded through digital forms and documents, developing abstraction from personal aspirations (Figure 11), and speculative ethnographic accounts of humans, other organisms, and non-living objects connected to a central theme (which was used in successive courses). We have found that this abstraction is a way to overcome some cognitive biases (even social anxiety or insecurity) in initial studies and data. This was abundantly clear when it equally supported understandably timid, shy, and uncertain first-year students and the confident, socially mingling municipal managers.

Exploring everyday hopes and individual aspirations as future visions

This workshop begins by exploring aspirations for tomorrow in the hopes of everyday practices. Just as individuals are diverse, aspirations are also highly varied, from the dream of a rare sneaker, delicious meal, or party, to ideas of future employment, housing, social equality, ecological awareness, world peace, etc. Reflecting on personal hopes and aspirations reveals how individual perspectives are grounded in shared experiences, structures, and norms.

1. Intro aspiration exercise and discussion

1.a. What are small-scale aspirations you hope for in the immediate future, such as tomorrow or next month? At first glance, these may seem somewhat arbitrary or self-indulgent. This is okay.

List up to 3

1) I want to buy furniture for my room;
2) Clean the terrace, get it ready for the garden;
3) Cook more.

1.b. What are larger-scale aspirations or future differences that interest you? Often these unfold over many years, decades, or millennia and impact more lives than just your own.

List up to 3

1) Fashion industry becoming more sustainable;
2) Religion not being a factor in politics;

1.c. Aspirations and hopes of any scale are not just abstract ideas, they are experienced in specific practices, times, and places. What are contexts, routines, activities, or practices where aspects of the above aspirations are present or experienced?

The small-scale aspirations (furniture, terrace) exist because I moved houses, cooking more is a daily aspiration that probably many others feel as well. The larger-scale ones are societal, a lot of people feel them, however it's not our man's job to make the change and that's why it's hard to make these aspirations come true.

Figure 11. *Introduction aspiration exercise, Case 3.c, P1: Day 1, in-class activity and discussion (2022)*

4.2.3 Prototyping and Prefiguration: New Tools, New Worlds

In case studies 1, 3, and 4, the processes of literal materialization and visualization are tools to facilitate cognitive development. This is mirrored in cases 2 and 5 through the description, imagination, and shared

reference of material objects or spaces, exemplifying how prototyping and materialization are used to connect with diverse competencies. Acknowledging ethnomethodological differences between design students and municipal executives, for instance, allows the processes of materialization to be embodied differently, yet toward the same end. Thus, the activities exploring future aspirations and ethnographies of humans and non-humans is an exercise of materialization, prototyping, and prefiguration. Prototyping, materialization, and visualization (even textually, through mental images and imaginations) are practices that develop new tools, and perspectives, prefiguring new worlds. ‘By engaging in physical activities and producing material products that have meaning for us, we make it possible for those meanings to mediate our future actions’. (Lemke, 2000).

Prototyping, making, and any act of materialization is a practice that relies on competencies which are core aspects of what it means to be human, have an identity, and community. We constantly ‘make sense’ of everyday life through a range of assumptions about the meaning of material objects, structures, and landscapes. ‘At any given time, the characteristic cultural patterns of action of a community must be enacted through material processes, by actual human organisms in interaction with each other and with other elements of the ecosystem. Each enactment of a ritual, each performance of a song, each making of a tool, each writing of a sonnet will be unique and different, but it will also re-enact criterial features common to a cultural formation (Lemke, 2000).’

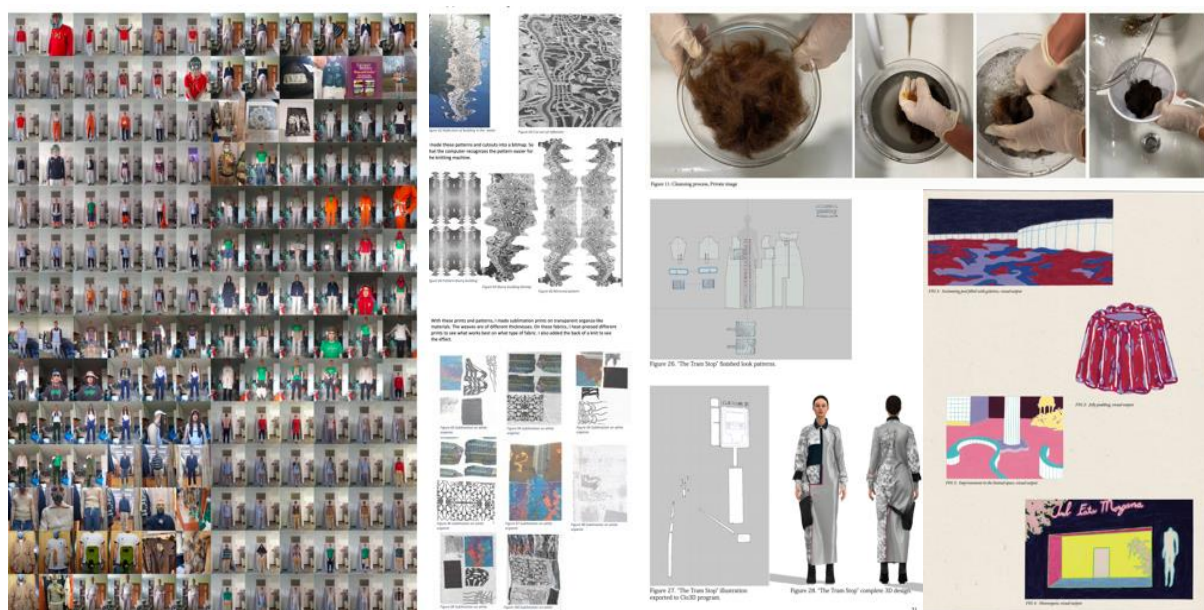


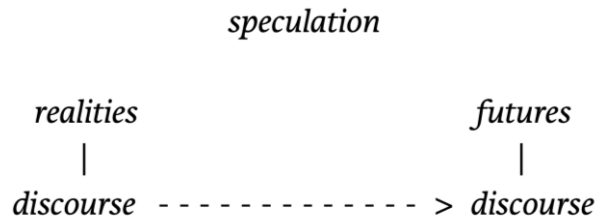
Figure 12. **Prototyping and prefiguration.** Iterative studies of materialization and visualization are repeatedly explored throughout the learning trajectories. This approach facilitates ethnomethodological variation in how knowledge areas are engaged and situated within practices. The development of hybrid methods, multiliteracies, and approaches to interrogating visual, material, and digital culture are representative of foundational metacognitive abstraction. As a point of evaluation, this foundational development was increasingly present in student trajectories of cases 3 and 4 as a result of curriculum changes (depicted in Table 1).

Proceeding to the final years of the learning trajectories, the attention to foundational metacognitive knowledge, and ongoing ethnomethodological development exemplifies the transition from discourse as output to discourse as subject, as data. This contrast is clear in the differences between the semi-structured and highly individuated approaches in case 1 and the refinement toward a systematic framework of speculation, as an operation that foregrounds discourse (value) and realities (context) in processes of materialization and visualization. Throughout the multiyear trajectory, students explore the contours, possibilities, and entry points of knowledge areas, developing intimacy and expertise. This is exemplified by student progression reflected in the development of hybrid methodologies and multiliteracies to engage emerging social practices and prefigure possible futures.

5. Conclusion

In this discussion, the process or operation of speculation is a logical relationship where everyday realities (today or yesterday) are symmetrical to possible futures, and both are joined by discourse. Speculation is not tied to a mode of practice or output. It is a conceptual model for how human culture and sociotechnical systems interact through time, using materiality as the context for development. This is the foundation of how speculation is

employed as an operative tool or a structured operation within the design process, linking critical research components to material realities and potential futures.



In many ways, this development is a reframing of the design process. It is a critical, value, and ethics-driven exploration that situates discourse within observable contexts to project, extrapolate, and speculate on future states. The foundation is an exploration of how meaning is produced, both by human action and as an ecosocial semiotic system of potential in everyday contexts. Everyone possesses at least foundational competencies regarding structures, objects, and practices of everyday life. Anyone who has worn clothing employs some level of knowledge regarding normative use and contextual appropriateness. In social life, we continuously rely on expectations of social behavior. We mostly walk on sidewalks and stop at crosswalks. We don formal attire for weddings and pajamas to bed. We trust banks in finished architecture more than out of the hatchback of a Honda Civic. We mostly don't manifest as angry mobs, as we also understand the moral and legal consequences.

Engaging experiences and ideas from everyday life (situated practice) with the rigor and critical awareness of scientific research was a key factor in producing foundational metacognitive knowledge at early stages. This development is reflected in cases 3 and 4, where the foundational knowledge was not present, fully formed, or connected at the onset of the studies (3.a and 4.a), yet through comprehensive curriculum changes throughout the foundational years, the results in 3.c and 4.c produced substantial development. It represents both the strictness of scientific methodology and the pragmatic ingenuity of human creativity, a middle ground largely facilitated by CA approaches, exemplifying the decentralization of development aspects toward a flexible yet scientifically grounded co-design framework.

The ability to foreground discourse is also an advantage of working with students with foundational knowledge regarding design objects and processes. The students will work within interior spaces, objects, design services, identities, fashion, film, media, illustration, animation, transformation, consulting, etc. There is already somewhat of an intrinsic motivation to develop a greater understanding of how the value of their creative manifestation is situated in everyday human life. While it may not be present initially, the experience and utilitarian knowledge of prototyping, critical, and speculative exploration are highly beneficial for visual, digital, and material creatives, producers, and researchers. Extending the scaffolding from classwork, documentation, digital forms, and notebooks to students' inquiries and explorations was a significant factor in the knowledge development in cases 3 and 4. In part, this assessment was exemplified by results produced with specific tutors. When the scaffolding was not followed, present, or extended, and modeling was missing in large part due to a lack of expertise or a disregard for shared teaching strategies, the students were not actively learning. Instead, the results revealed that they were merely employing current knowledge with a specific thematic twist of topical adherence.

The central aspect of shared connection through human practices, sociotechnical networks, and digital, visual, or material infrastructures is also why the approach extends outside of specific learning contexts, subjects, disciplines, professions, or trajectories. The familiarity and reliability of chairs, tables, and clocks reveal the complex competencies common to shared everyday practices. The cases have shown that tapping into the implicit expertise humans employ to make sense of everyday landscapes is a network of shared resources to explore future development.

"What emerges from these interdisciplinary approaches to technology and change is that culture and design are not separate analytical domains or extensions of each other. Rather they are deeply entangled, complex, and often messy formations and transformations of meanings, spaces, and interactions between people, objects, and histories. It appears now an accepted premise that culture is always already an ingrained and situated part of design practices, but the reverse is equally valid and relevant: by designing objects, technologies, and systems, we are in fact designing cultures of the future." (Gunn et al., 2013)

4.a. Reflection individual*Submit theory/process document**Briefly describe your role in the group*

I was responsible for half the script, co-directed the photo shoot and took part in it, did research, gathered footage.

Explain how the concept of speculation is present in your group outcome and why it was beneficial or not.

Doing this was very beneficial, as we ourselves (5 women) got together and created a great concept, so one could say that we were part of the speculation as well. The result in my opinion was a great representation of how the world could be different and inspired myself and I believe others to fight the inequality that still exists to this day unfortunately.

Figure 13. *Final reflection Case 3.c, P1 (2022)***Acknowledgements**

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