Using the multi-level perspective for problem articulation, leverage point identification, and systems storytelling in design

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Abstract: This research uses generative and reflective mapping processes in designerly explorations of the food system and the consumption and waste problem. Mapping was used to aid problem articulation and the identification of leverage points for design by using Geels' (2002) multi-level perspective (MLP) in conjunction with social practice theory (SPT) and design theory(DT). Blending these theories informed the use of canvases to map different aspects of the socio-technical system including the system's dynamics (MLP), people's everyday behaviours (SPT), and cultural aspects (DT). This resulted in modified canvases that can expand how the MLP is considered in design for transitions, an emergent area of design research and practice.

Keywords: MLP; multi-level perspective; design for transitions; problem articulation; mapping.

Biographical notes: Niki Wallace is an educator, researcher and practitioner whose research and work focuses on collaborative approaches to wicked problems. Their research explores experimental co-design methods and design's role in transitions to socially just and ecologically sustainable futures. Much of this work has played out through a living lab founded as a collective of designers, researchers, and activists who are co-creating carbon conscious futures through experimental and emergent design practices. Niki is the Course Leader of UAL's MA Global Collaborative Design Practice, founder of Net Zero Lab and a catalyst member of Climate Space.

Introduction

As designers contend with complex problems the risk of oversimplified design solutions reinforcing these problems increases, often resulting in unintended consequences. Engagement with 'wicked problems' increases this risk; their continually adaptive nature and obscured or paradoxical aspects make them difficult to define and seemingly impossible to solve (Rittel and Webber, 1973). This poses challenges for designers; particularly where power is lacking, or capacity is limited by constraints on time/ knowledge/know-how/funding. This paper explores the multi-level perspective (MLP) for use in design research/practice to expand designers' capacity for problem articulation, leverage-point identification and storytelling when engaging

with complex/wicked problems. Geels (2002) describes the MLP using three levels or 'structures', the landscape (slow moving, deep structures that impact upon other levels), the regime (stable centre of rules and norms) and the niche (fast-paced innovations). He presents the MLP as a heuristic that explores socio-technical transitions, where socio-technical systems (STSs) shift from one state to another.

Design for transitions is a growing area of interest for design research and practice; it requires larger time investments in problem articulation and the identification of suitable leverage points for design approaches. This research aims to contribute here by exploring canvases that use the MLP as a way of 'seeing' the interconnections across multiple levels of a problem space to inform holistic approaches. It is informed by an understanding of the MLP taken from Geels (2002, 2010, 2011, 2018) and Geels and Schot (2007, 2010) and has been complemented by its articulations in system innovations and transitions by Ceschin and Gaziulusoy (2016) and applications within Transition Design (Irwin, 2015, 2018; Irwin et al., 2015; Kossoff, 2011; Kossoff et al., 2015). In this paper, the MLP underpins the use of canvases that map problems using multiple theoretical lenses and plural perspectives to identify leverage points where designers can approach problems as part of a long-term problem commitment, what Willis (2015) calls 'life's work'. This approach is integral to the author's practice and draws on Escobar's (2018) Autonomous Design; a relational approach that reconfigures the client-designer relationship to one that approaches problems and co-creates for the pluriverse– 'a world where many worlds fit' (Escobar, 2018). Plurality is also outlined in complex adaptive systems (CAS) approaches which include multiple perspectives as part of systemic practices (Borkar et al., 2020; Zivkovic, 2015, 2018).

Engaging with plurality reveals how complex design approaches can use multiple leverage points that act like needles, performing a kind of 'systems acupuncture'—an oft- used metaphor in relation to systemic approaches (Ceschin and Gaziulusoy, 2016; Manzini and Rizzo, 2011). These interconnected approaches generate constellations of activity or 'solution ecosystems' (Eggers and Muoio, 2015) that span multiple levels in the system using strategic and tactical approaches. This idea of meeting complexity with complexity is integral to a CAS approach and draws on Ashby's (1961) law of requisite variety; a guiding principle in Cybernetics, the study of systems and communication within them. At the intersection of design and cybernetics, Glanville (2009) argues for the development of 'anti-cybernetics' where interest lies in the unmanageable. Both cybernetics and anti-cybernetics views appear relevant in approaches to complex/wicked problems.

Effective collaboration, sitting with unknowns, agility, flexibility, and a sensitivity to shifting contexts all are core aspects of a CAS approach, which is place-based, informed, adaptive, action-oriented and embraces complexity to navigate uncertainty (Zivkovic, 2018). Adaptive capacity is key here and highly collaborative teams are the CAS approach's real innovation (Borkar et al., 2020; Hassan, 2014; Zivkovic, 2018). This approach explores problems from multiple perspectives, co-creates with communities, and interfaces with local government; the latter is argued by Zivkovic (2013) as crucial for transitions. Collaborating with communities and government enables a plural view of complex/wicked problems and can reveal multiple action pathways with amplification/scaling potential. Recognising there is no 'one way' in the pluriverse, this research blends many ways of thinking and doing as part of a CAS approach within design for transitions. Reflection on the author's practice of this approach in a living lab observes how this work centres communities, builds adaptive capacity, and invites full participation through co-research and co-creation. This is complemented by interfacing with

government to gain support for initiatives and to influence policy and decision makers. The MLP is a useful heuristic in visualising this multi-level engagement however its limitations in design contexts prompted further reflection on its practical use.

This paper presents findings from explorations of the MLP through canvases used in design contexts, particularly in collaborative and participatory processes where problem articulation and approaches are co-created. It draws on the canvas used in the Transition Ojai workshop from Irwin and Kossoff (2017) and the modifications offer another use of the MLP within design that expand upon Irwin and Kossoff's canvas and its intended use. The canvases apply key concepts from CAS, MLP, social practice theory (SPT) and Design Theory (DT), utilise established theoretical knowledge in new ways, and expand how this knowledge is communicated and implemented in design for transitions.

Methodology and methods

This research is framed by critical pragmatism (Forester, 2013, 2017) which is participatory, political, deliberative and 'challenges us to listen critically to appreciate multiple forms of knowledge' (2013, p.19). This is guided by eco-philosophers, Plumwood (2002) and Macy (1991), design/cultural theorist, Fry (2009, 2011) and anthropologist, Escobar (2018), all of whom argue for relationality and responsibility as part of overcoming the hyper-separation between human and more-than-human worlds. It was conducted as Action Research (Swann, 2002) which provided a critical and reflective structure for expanding upon the author's mixed methods PhD research exploring 'what it takes' to transition a practice to approach complex/wicked problems. In the PhD, the MLP was used for articulating the problem of consumption and waste and identifying possible leverage points for the author to approach through design projects. One project, Rethink Rubbish, used the MLP to inform iterative co-creation with primary school students that aimed to mediate cultures of care and respect within a zero-waste transition. This paper expands upon this use of the MLP through seven new action cycles that have progressed the thinking and informed the modification of MLP canvases for use in mapping. Outputs from these cycles are presented in Figures 1–9.

Reflective practices

Critical reflective practices including Schön's (1983) reflective practice, deliberative practice, (Forester, 1999, 2013), embodied reflection (Escobar, 2018; Kinsella, 2007), and the author's reflective doodling method (2020b) have all played key roles in the reflection in this research. Deliberative practices that consider design's potential future impact informed the action taken; a process Forrester (2013) encourages in critical pragmatism. The author's lived experience also informed reflective processes; insights were gained through their design research, practice and teaching. Reflecting on the present in relation with past experiences is integral to embodied reflection, which Escobar (2018) describes as a dance between action and reflection. Articulating these processes can be challenging and a lack of clarity surrounding tacit knowledge is recognised by Schön (1983) as common for practitioners. Reflective doodling (Wallace, 2020b) was used to document thinking processes with the intent of supporting a clearer articulation of the otherwise tacit. As an active thinking-while-drawing process reflective doodling can also be described using cybernetics, as practitioner and page converse with one another. In this research reflective doodling was also used as a drawing-to-think process, where doodling is used to synthesise and construct ideas.

Visualising theories

Visualising complexity is challenging but helpful in articulating how different parts of complex/wicked problems interact, overlap, reinforce or resolve one another. Mapping problems in CASs is an iterative task, as systems (and problems) continually adapt to everchanging conditions, suggesting adaptive mapping techniques may be helpful. The MLP provides a way of articulating and visualising how complex/wicked problems emerge temporally – a key consideration in design contexts where deliberation on possible futures requires critical engagement with the historical emergence and current conditions of problems. Reflective doodling using digital MLP canvases for iterative/generative visualisations was used for problem articulation by increasing the visibility of a problem's interconnections and exploring it from multiple perspectives. Visualisation through mapping was a key method in this research.

Indigenous knowledges

The MLP is a helpful heuristic but without applicability, a heuristic remains trapped in theoretical contexts. There are lessons to be learned about the importance of contexts from Indigenous knowledges, which are 'associated with the long-term occupancy of a certain place' (Dei et al., 2000, p.6). In oral cultures such as Aboriginal culture, 'all thinking is dependent on the field or context [as compared to print-based cultures that] remain independent of the field or context, focusing on ideas and objects in isolation' (Yunkaporta, 2019, p.172). Listening and learning from Indigenous peoples expands the consideration of concepts that are context-dependent/trans-contextual. The author acknowledges their privilege in working with Indigenous knowledges as a Euro- Australian and aims to tread lightly and honour relationality when contextualising people and place in visualisations and in practice.

Background

Theories that examine systems, complexity, transitions, social practices, consumption and cultural mediation underpin this research and are applied in the context of design approaches to the consumption and waste problem. This problem spans resource extraction, design, manufacture, logistics, sale, use and disposal, all of which overlap in the STS. Cybernetics and CAS theory guide this attempt to consider multiple theories in relation to this wicked problem (Ashby, 1961; Dubberly and Pangaro, 2019; Froese, 2010; Glanville, 2009; Krippendorff, 2019; Macy, 1991; Wiener, 1948; Zivkovic, 2015).

The MLP informs the view of problems in STSs, building on the understanding of complexity in these systems (Geels, 2002, 2005, 2010, 2018; Geels and Schot, 2007, 2010; Schot and Geels, 2007). Social practice theory (SPT) reveals how people and their behaviours add to this complexity by intertwining behaviours with objects and their use/disposal (Hargreaves et al., 2012, 2013; Kossoff, 2011; Shove and Walker, 2010). Design theory (DT) explores how design – as a cultural mediator of artefacts and meanings – can impact STSs and how people behave within them (Bourdieu, 1984; Julier, 2008; Wallace, 2020a). The author's living lab provides the playground for this exploration.

Cybernetics and complex adaptive systems (CAS) theory

The adaptive nature of systems poses challenges in problem definition and strategy enactment. Informed design approaches rely on an understanding of STS's dynamic adaption to complex/wicked problems and attempts at their resolution. Cybernetics is highly relevant to

design for its study of communication within systems (Krippendorff, 2019) particularly causal relationships and feedback loops (Wiener, 1948). Feedback loops in a CAS can become intertwined, reinforcing feedback along the way and creating desirable/undesirable trajectories that result in lock-in effects known as path dependencies (Page, 2006). This is demonstrated in the fossil fuel sector, where investments in infrastructure have created a path dependency on fossil fuel energy. Dependencies can result from attachments to economic investment in the infrastructure, known as 'sunk costs' (Alcott, 2005; Jevons, 2007) however they are influenced by many factors. In Australia, fossil fuels are a stronger attractor than renewable energy due to the relationships between sunk costs, Australia's fiscal identity in coal, and its political ties to the fossil fuel industry (Crocker, 2013). Cybernetics helps us to understand these relationships, and Second Order Cybernetics recognises that as observers and participants in these systems we are also recursively trying to understand ourselves (Krippendorff, 2019). The overarching theory here is from complexity science, which is an area of study that combines systems science, complex systems theory, cybernetics, AI, and dynamical systems theory, (Castellani, 2018; Zimmerman et al., 1998). Complexity theory is applied in many different contexts including sciences, organizations, leadership, and here, in design.

Multi-Level perspective (MLP)

In design for transitions, understanding the dynamics of complex/wicked problems aids in problem articulation and informs the approach. The MLP is key here for its concern with how socio-technical transitions occur in systems spanning three levels: the niche (micro-level), the regime (meso-level) and the landscape (macro-level) (Geels, 2002, 2005, 2018). The MLP adopts a vertical, telescopic view of change (Hargreaves et al., 2012). It observes the temporal and systemic nature of societal change which is useful for designers' engagement with transitions as it provides insights into the emergence of complex/wicked problems. Geels presents case studies of historical transitions (2002) to demonstrate the multi-level nature of technological change, and a typology (2007) that explores variables in how these levels can influence one another. The MLP has attracted some critique (Genus and Coles, 2008; Smith et al., 2010) and Geels (2011) acknowledges the theorisation using historical case studies and particular (constructivist) lenses has added to contestation within its field. This research adapts the MLP through a number of canvases that were used in design for transitions projects.

Social practice theory (SPT)

Understanding the influence of everyday life is crucial for designers focussed on change. The way people behave in their everyday lives adds to the complexity in a system and SPT provides a view of change that is horizontal (Hargreaves et al., 2012) rather than the vertical perspective adopted in the MLP. SPT interrogates the way the things we do (such as brushing our teeth, shopping or relaxing) combine as practices enacted in our daily lives (Kossoff, 2011) and investigates how practices become bundled together and span multiple systems. The explorations of SPT in this research draw on Shove and Pantzar (2012) and Shove and Walker (2010) and are complemented by views from Hargreaves et al. (2012, 2013), Spaargaren (2011) and Kossoff (2011). Here, practices are understood as combining materials, skills and meaning (or a mental image), all of which combine recursively when enacting the practice. This can help designers contextualise the social change that design for transitions aims to achieve. The results from Kuijer's (2014) experiments using 'practice as a unit of design' demonstrate the way practices exist within webs of other practices and require 'a form of open design in which variety and change over time are facilitated' (Kuijer, 2014, p.97). Hargreaves et al. (2012, 2013) have explored the intersection of SPT and the MLP, as does transition design literature (Irwin et al., 2015; Kossoff, 2011; Kossoff et al., 2015) where it is understood that transitions combine change

in both systems and everyday life. This view of practices extends beyond individual performances without pushing to a systemic focus and SPT is used to explore how designers might leverage practices in design for transitions.

Design theory (DT)
Design theory (DT) often draws on multi-disciplinary theories, but as critical engagement and design discourse matures greater sense is being made of the role design plays in contemporary societies. Culture theory has a long history within design, initially as an aspect of design history that observed the cultural role played by objects (Fry, 1988). In contemporary views, culture theory is applied not just to objects but also to their encoding and decoding (Fry, 1988; Lees-Maffei, 2009). Explorations of cultural mediation typically draw from the work of Bourdieu (1984) to describe the meaning mediated through the cultural artefacts design produces. However, cultural mediation could also be connected to Vygotsky's (1997/1920) psychological view of communication theories. Despite Vygotsky's conceptualisation of culture as words/meanings rather than practices (Van der Veer, 1996) his theory holds value for designers who understand cultural mediation through its connection to semiotics in communication and design. Vygotsky describes how cultural mediation occurs as humans develop language and communication skills; that we learn to communicate within a cultural frame, and that language and culture are how we communicate ideas (Vygotsky, 1997/1920). Critical engagement with cultural considerations and the design industry reveals that design's dominant role (in the Global North) is to mediate consumer culture (Boehnert, 2018; Thorpe, 2012; Wallace, 2020a). Many authors recognise the cultural role of design, however critique of design's role in mediating (and accelerating) consumer culture is lacking in design discourse. Woodham's (1997) historical account of design's contribution to this problem is described by Buchanan as 'not only hostile but contemptuous of design practice' (Buchanan, 1998, p.261). However 'hostile' the critique may appear to design, social and environmental impacts are embedded within the mediation of consumption and design must take responsibility for its role in this. Culture theory and consumer theory (Baudrillard, 1998; Lancaster, 1966) help us to understand this role as 'dynamic, interactive, place-based and constantly engaged in exchange cycles, generating value and transmitting culture through a series of interconnected moments' (Wallace, 2020a, p.103). Whilst moments adopt numerous forms, they often overlap in the dominant social practices embedded within consumer culture. These theories help to explain the cultural role design plays, they also reveal potential ontological roles for design in the mediation of systemic change.

Findings
This research used the MLP for problem articulation and to identify leverage points for design approaches to the consumption and waste problem. Multiple canvases emerged from this process that also facilitated storytelling about the problem and the theories at play. In response to criticisms of the MLP's consideration of agency, Geels and Schot (2007) articulate the MLP as an 'overall 'global' framing for all transition pathways… and leave space for different 'local' subplots' (2007, p.415). This research explored consumption and waste as a 'sub-plot', where designers' agency was a key consideration. This draws on Giddens' (1984) structuration theory to describe designers as agents with design/mediation capabilities and their collective actions (recursively practicing design/mediating consumer culture) as contributing to a larger structure (the design industry/the consumption and waste problem). The 'bird's eye view' provided by the MLP offered useful perspectives of the structures and actors impacting stable social practices in consumption. What appeared to be lacking was an explicitness in recognising the ecological

impact of these practices and the cultural frames mediating them, which prompted critical reflection on how the MLP is used in design contexts. Canvases incorporating the MLP, SPT and DT were expanded to make the contexts explicit in explorations of the consumption and waste problem. These expanded canvases were also used to explore the food system. These findings present five kinds of MLP canvases that emerged during this research. The first adapts the MLP framework by adding two new levels in which problems can be explored visually, the second articulates leverage points for multi-level design approaches to a problem, the third compares two enactments of a practice, the fourth explores visual communications of the MLP as a holarchy, and the fifth is used for storytelling.

Expanding the transition design MLP canvas
In transition design the MLP is used to map the evolution of a problem to identify leverage points for design. Figure 1 presents an expanded structure for this canvas, using additional columns to communicate the evolution of a problem, its current conditions and a possible future, with additional levels for mapping the context and cultures of the STS. This canvas guided problem analysis and action pathways in multiple design projects by contextualising the problem within ecology, identifying aspects of thinking that could influence across levels, and by targeting practices and cultural frames as leverage points for design initiatives. Many may argue that paradigms and the environment are implicit in the MLP's landscape; the value brought by their extraction into new levels and the purpose this serves in design is outlined in the discussion. The added levels are tinted (for differentiation) and descriptions are provided for each level to increase the accessibility of the canvas for use in collaborative mapping exercises. Descriptions guide 'what goes where' on the canvas to address barriers to participation arising from knowledge-gaps in underpinning theories. It was noted (with workshop participants and students) that including simple descriptions increased the functionality and usability of the canvas, making it more accessible as a tool for non-experts.

Figure 1 Diagram showing the blank MLP canvas with the proposed expansion to include new levels and columns

	HISTORICAL EVOLUTION	CURRENT CONDITIONS	POSSIBLE FUTURE
ECOLOGY Ecological factors impacting on or impacted by activity across levels.			
LANDSCAPE Deeply structured by paradigm/politics/economics, very influential. It's usually slow moving but crises (eg war) can prompt rapid change.			
MENTALITÉ The ideologies and mindsets of people. What they believe, how they think and feel about things.			
REGIME The fabric of a society, its rules and norms and how these can influence the daily practices and behaviours of people within a system. This includes aspects of organisations and of people's everyday lives. The regime is a very stable part of the system.			
NICHE A more protected part of the system where experimental activity and innovations that challenge the norm are incubated. Change in the niche is fast-paced.			

Adding levels and restructuring the MLP model

Ecology

The MLP typically maps ecological events as part of the socio-technical landscape (Geels, 2002). While this is widely accepted, one of the challenges facing humanity stems from a disconnect from nature that can render ecological concerns invisible. This invisibility is often compounded by an 'anthropocentric rationalist' approach to raw material extraction and use, where the commons are treated as a resource to be exploited and sold (Plumwood, 2002). The inclusion of a level for ecology provides an overarching ecological context for the entire system which implements learnings from Indigenous knowledges about thinking in place-based contextualised ways (Dei et al., 2000; Yunkaporta, 2019). This modification to the way the canvas communicates the MLP serves multiple purposes: firstly, it explicitly positions the socio-technical levels (built system) within an ecological context (living system). Secondly, situating the MLP in an ecological context keeps ecological considerations front of mind during mapping. This is valuable in scenarios where economics overshadows other considerations and serves as a

reminder that ecological limits must be respected in transitions to different economic models (Raworth, 2017). Finally, it acts as a narrative device, revealing how activity from the other levels impacts ecology, or conversely, to show how an ecological event might impact other levels. This storytelling aspect can be useful during stakeholder engagement to illuminate ecological impacts of activity in STSs.

The explicit contextualisation of STSs within ecology maintains visibility of ecological concerns during analysis and fosters ecologically considerate mindsets during mapping. The intention here is to guide thinking during transition periods where new ecologically focussed mindsets are prone to relapse to old economically focussed mindsets, and the hyper-separation of built systems and living systems is yet to be overcome.

Mentalité

The mentalité observes different granular aspects of thinking that contribute to broader patterns of thought, paradigms. Paradigms are encapsulated in the landscape in Geels (2002) description of the MLP. This is not disputed here, however the impact of thinking can be overlooked when mapping/sensemaking using the MLP. As part of 'reflection on- action' (Schön, 1983), a pattern was recognised in the margin-notes of maps and canvases. Notes (made by the author and others) referenced modes of thinking and reminded participants of this often-invisible aspect of systems. Reflection led to deeper considerations of the role and influence of thinking in the MLP and where (if anywhere) it should be made explicit. The argument for this could be supported by Meadows' (1999) description of paradigms as one of the most influential leverage points within a system. Yet Meadows also describes the paradigm as one of the most challenging points to leverage (1999, p.17–19) as it is too entrenched and collectively held. If the paradigm is change-resistant, could we explore its contributing factors instead? Other aspects of thinking contribute to a paradigm but are held more individually and socially than structurally. During mapping, ideologies, mindsets, values, beliefs, attitudes and feelings were all identified as contributing to the mentalité in STSs. In their work exploring carbon lock-in effects, Seto et al. (2016) also discuss the influence that ideologies have over a problem (in their case, climate change) and describe the psychological barriers that ideologies, worldviews, cultural values and beliefs play in behaviours. This suggests that these softer more granular aspects of thinking (what Bateson (2017) calls 'warm data') hold relevance in the mediation of cultural change and could be a lever in approaching the broader pattern of thought – the paradigm.

The expanded canvas was used to map mentalité as a 'local' aspect in the sub-plot of consumption and waste, a modification that is particularly relevant for designers as cultural mediators and makers of meaning. As the intermediary between the production and consumption of goods, designers mediate both the act of consumption and the creation of waste. In the practices surrounding waste, meaning is made ideologically – initially through a disposable mindset that values convenience (Wallace, 2020a). A single-use plastic bottle is meaningful in its provision of hydration (enacted through the practice of drinking) and through its convenient delivery system/disposable packaging (encapsulated through the waste). If these aspects are obscured when mapping, designers' capacity to identify and leverage them is limited. By foregrounding mentalité through an additional level, cultural frames – in this example, disposability and convenience – can be made explicit. Making these cultural frames more targetable can inform approaches to cultural mediation outside of consumer culture. This was noted in two design projects and multiple mapping exercises.
Recognising how ideologies affect thinking during mapping and analysis can also aid in the

identification of possible ontological crossovers and permits a helpful alteration of the lenses used during analysis. Geels (2010) suggests that these ontological crossovers and adjacencies to social theories add to the perspectives gained from the MLP by extending the view of transitions across multiple ontologies. This indicates the mentalité's significant impact (for the observer and the observed) and could be identified as a 'locking mechanism' (Page, 2006; Seto et al., 2016) in both the landscape where it contributes to paradigms, and in the regime where it plays out through norms. This research argues that the mentalité's potential to 'lock down' activity in both levels warrants more explicit representation in MLP canvases to reflect this effect and more clearly communicate the cultural role played by people within systems.

Using the expanded MLP canvas for problem articulation and identifying leverage points
In CAS approaches it is understood that wicked problems can be too complex to be fully known/mapped and in this sense, all systems maps are flawed (or rather, works-in- progress). This approach calls for practitioners to articulate problems enough to find leverage points, often producing maps that are informed but incomplete. Actions are generally taken through safe-fail experiments which are 'good enough for now and safe enough to try' (Priest et al., 2021, p.34), providing small-scale ways forward that avoid catastrophic impact. Figure 2 presents a reflective doodle (sketched by the author) using the expanded MLP canvas to articulate the consumption and waste problem. It is presented here to demonstrate a designerly use of the canvas that though incomplete, is informed by research, generative discussions and mapping exercises in workshops from the Rethink Rubbish project.

During mapping, cultural frames emerged in the mentalité level alongside possible catalysts in the niche, both with potential for mediation through experiments influencing attitudes to waste. Though incomplete, the map articulated enough of the problem to inform safe-fail prototypes that aimed to cultivate the cultures of care and respect that are integral to healthy communities. Experiments in waste prevention and conscious consumption were co-created with children aged 5–12 with varying degrees of success. Each revealed the tension between the niche and regime norms which continually threatened initiatives, highlighting the importance of multi-level approaches in activating transitions.

Figure 2 A reflective doodle exploring the consumption and waste problem using the expanded MLP canvas with SPT and DT (originally presented in the author's PhD)
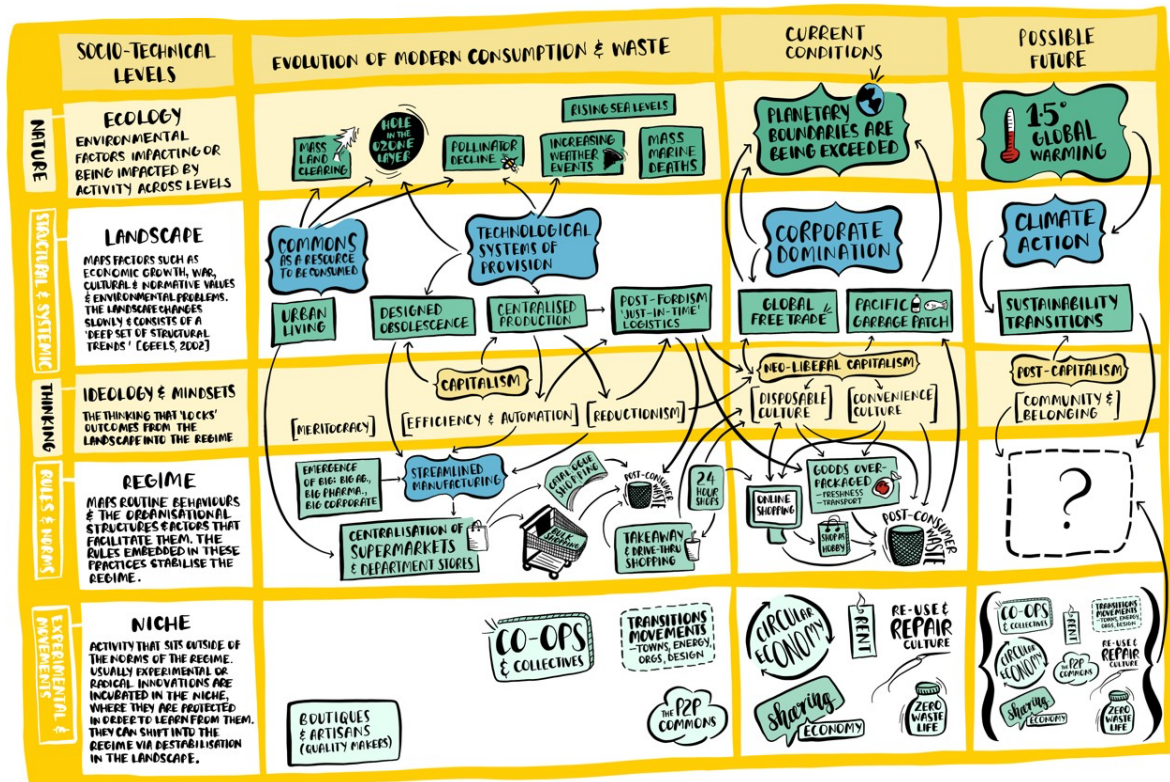
The author revisited this map (see Figure 3) to re-examine the problem and the potential for transitions pathways arising from destabilisation caused by the COVID-19 pandemic (details viewable in an interactive canvas at https://netzerolab.org/mlp). This map indicates the rise of waste in homes prompted by increased reliance on online shopping and a re-emergence of the 'citizen-consumer', called to duty to stimulate the economy. A care-culture was noted as possible – despite the rise in fascism – as was the potential for climate action in post-pandemic responses. The map explored new pathways for circular economies in the niche to penetrate the regime and informed the co-creation of multiple safe-fail experiments through the author's living lab. The experiments benefited from ontological considerations that co-create new (and multiple) ways of being in the world, mediated through land care, sustainable everyday practices, cultural shifts and policy support. The detail is not prescribed, but mapping helped locate where such a pathway might situate. This prompted multiple rounds of provocations presented as 'how might we' (HMW) questions that explore what might be possible at each entry point (see Figure 4).

These canvases used the MLP, SPT and DT to map problems and observe the relationships and impacts stemming from activity in the ecology, landscape, mentalité, regime and niche levels, highlighting the role mentalité plays. Outcomes are subject to influence across the MLP levels however it was noted that explicitly mapping ecology and mentalité increased the visibility of these aspects and aided analysis and identification of leverage points across the levels. By mapping the more granular aspects of mentalité, cultural mediation could also be explored as an entry point to inform approaches in design for transitions.

Figure 3 A reflective doodle exploring the impact of COVID-19 on the consumption and waste problem. Close-up detail: a web of shopping practices, their contribution to post-consumer waste and a possible leverage point for designers to contribute through implementations of circular economies as part of a COVID-19 response
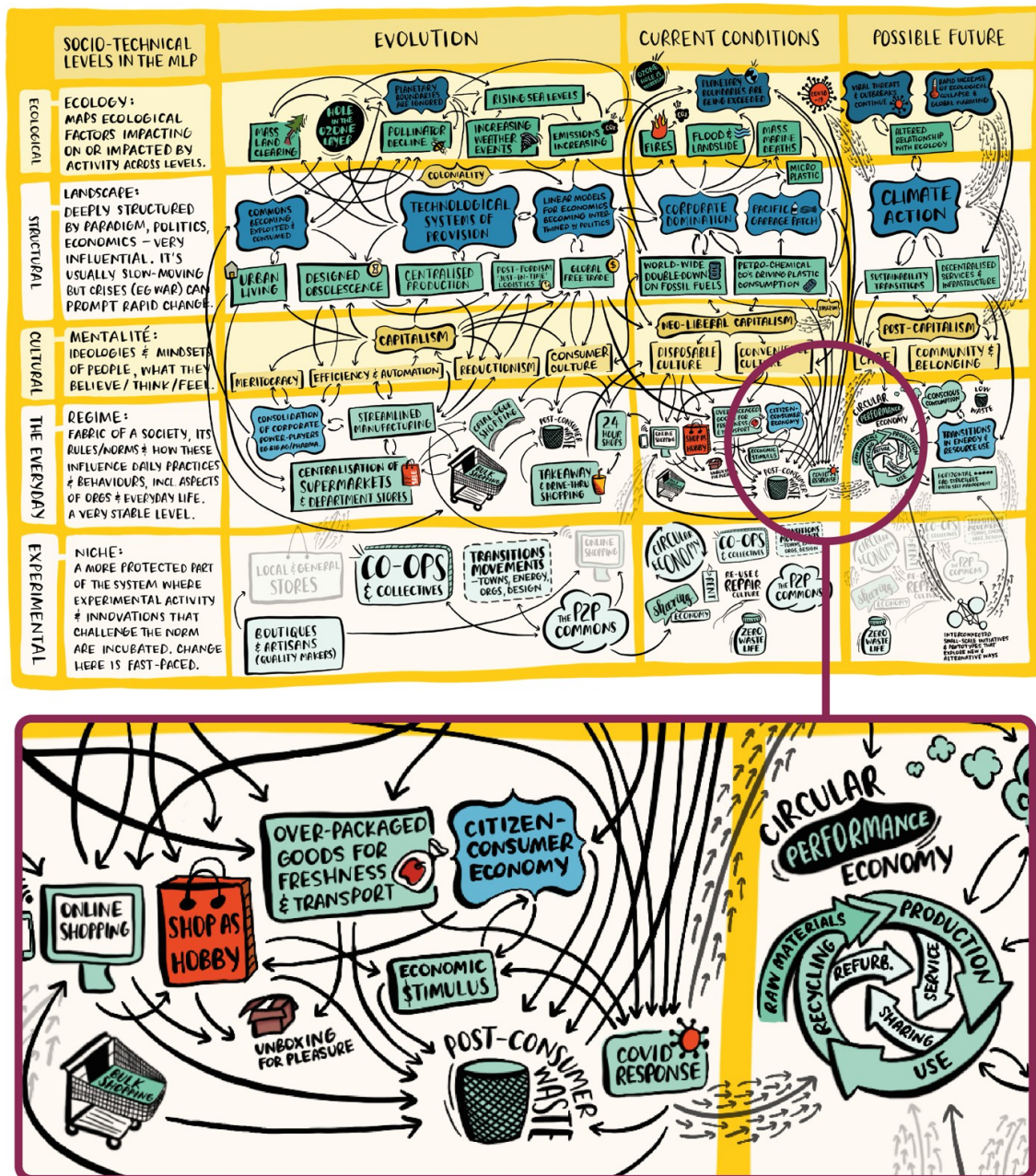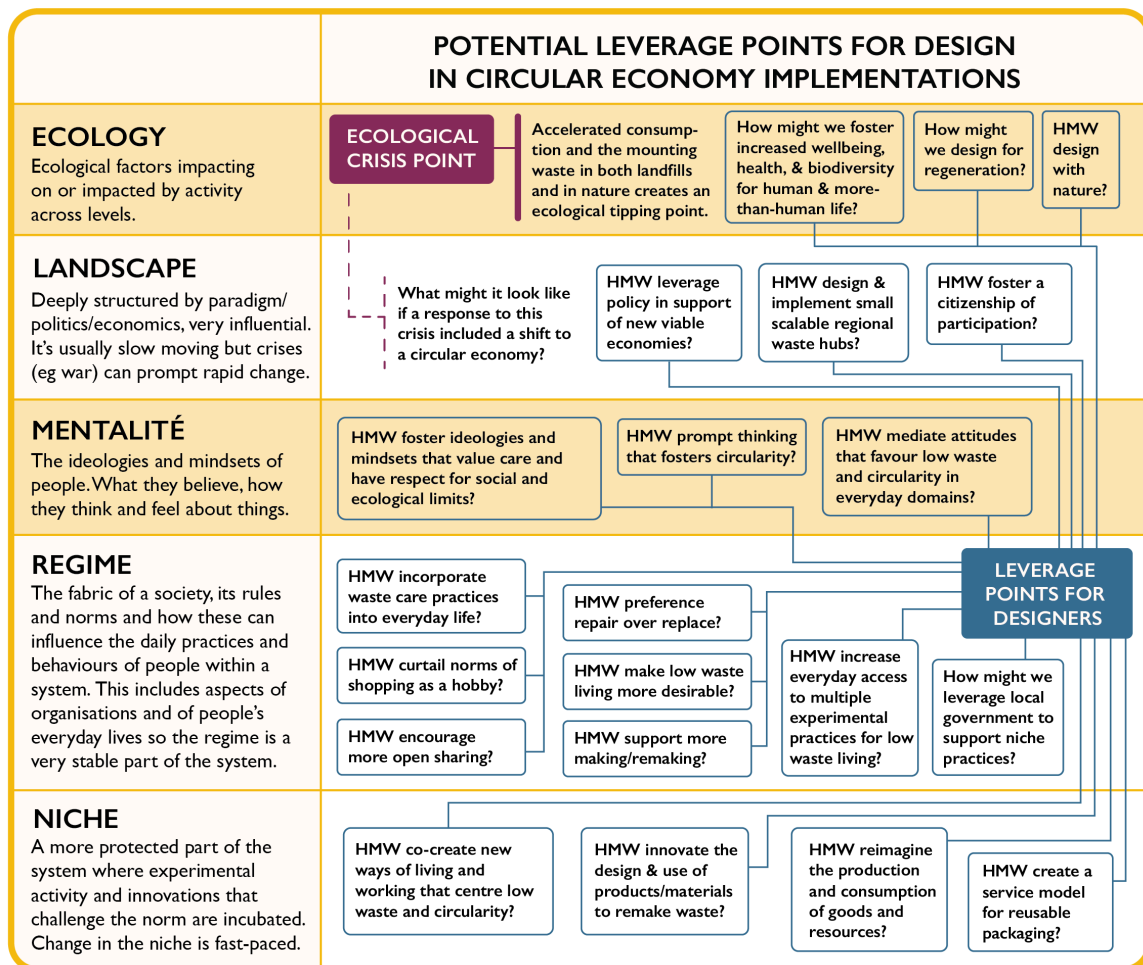
Figure 4 Using the MLP, SPT and DT to identify multi-level leverage points for designers in a circular economy implementation as part of an approach to the consumption and waste problem. This figure presents round one of a multi-round process. Additional rounds of HMW questions are posed for selected leverage points to explore the granular details of interventions, with each round using the MLP canvas to help visualise the multi-level, multi-stage nature of the approach

POTENTIAL LEVERAGE POINTS FOR DESIGN IN CIRCULAR ECONOMY IMPLEMENTATIONS

ECOLOGY
Ecological factors impacting on or impacted by activity across levels.

ECOLOGICAL CRISIS POINT

Accelerated consumption and the mounting waste in both landfills and in nature creates an ecological tipping point.

How might we foster increased wellbeing, health, & biodiversity for human & more-than-human life?

How might we design for regeneration?

HMW design with nature?

LANDSCAPE
Deeply structured by paradigm/politics/economics, very influential. It's usually slow moving but crises (eg war) can prompt rapid change.

What might it look like if a response to this crisis included a shift to a circular economy?

HMW leverage policy in support of new viable economies?

HMW design & implement small scalable regional waste hubs?

HMW foster a citizenship of participation?

MENTALITÉ
The ideologies and mindsets of people. What they believe, how they think and feel about things.

HMW foster ideologies and mindsets that value care and have respect for social and ecological limits?

HMW prompt thinking that fosters circularity?

HMW mediate attitudes that favour low waste and circularity in everyday domains?

REGIME
The fabric of a society, its rules and norms and how these can influence the daily practices and behaviours of people within a system. This includes aspects of organisations and of people's everyday lives so the regime is a very stable part of the system.

HMW incorporate waste care practices into everyday life?

HMW preference repair over replace?

HMW curtail norms of shopping as a hobby?

HMW make low waste living more desirable?

HMW encourage more open sharing?

HMW support more making/remaking?

HMW increase everyday access to multiple experimental practices for low waste living?

How might we leverage local government to support niche practices?

LEVERAGE POINTS FOR DESIGNERS

NICHE
A more protected part of the system where experimental activity and innovations that challenge the norm are incubated. Change in the niche is fast-paced.

HMW co-create new ways of living and working that centre low waste and circularity?

HMW innovate the design & use of products/materials to remake waste?

HMW reimagine the production and consumption of goods and resources?

HMW create a service model for reusable packaging?

Comparative mapping of social practices using the MLP canvas

Studying historical emergence within systems offers insights into how change might be activated in the future: as neither top-down nor bottom-up, but rather, a blend of both. Despite the knowledge that systems tend to change slowly, embedded in these systems is a plethora of practices that tend to be relatively stable but can change rapidly. Practices are recursive and mediated culturally, providing designers (as cultural mediators) with an immediate leverage point – particularly designers who are sensitive to the potential for ontological design approaches that are necessary in the enactment of change (Escobar, 2018; Fry, 2009, 2011, 2013, 2020; Willis, 2006). Using the MLP in conjunction with SPT allows additional insights into how practices can catalyse change in a multi-level, multi-stage approach.

SPT and Kossoff's (2011) Domains of the Everyday focus on aspects of daily life that are performed habitually and contribute to larger societal problems in regimes and landscapes. As the global population continues to grow, what seems like a 'little thing' (for example, individual use of single-use plastic) combines across the system to create something of significance (for example, microplastic pollution). This is visible in the waste problem, where the combination of

powerful players pushing plastics into everyday life and an 'I'm just one person' attitude towards single-use and disposable items has a cumulative impact. Shove and Walker (2010) argue that everyday practices are underrepresented in the MLP, which adopts a telescopic view, as opposed to SPT which is more microscopic in its approach. Geels (2010) has also acknowledged the benefit of considering the MLP in conjunction with social theories. Understanding how these theories relate before designing interventions aimed at changing behaviours is crucial, and the relational nature of social practices and the MLP will become more evident as this discussion continues.

Social practices mediate relations between images, skills and materials, and are performed in a repetitive fashion which leads to their stabilisation as social norms (Shove et al., 2005; Warde, 2005). For example, brushing our teeth involves an understanding or mental image of what it means to have clean teeth, combined with the skills to perform the act of brushing, and the materials or tools needed to brush. A change to any one of these aspects can create a ripple effect in the practice (Gram-Hanssen, 2011). For example, brushing with your non-dominant hand due to a broken arm might alter what is deemed acceptable or achievable as an image of clean teeth, as clumsy brushing skills might fail to brush as thoroughly. Frustration from this clumsiness might prompt a reconsideration of what constitutes a suitable material for brushing your teeth and could lead to the purchase and use of an electric toothbrush. Similarly, changing from a squeeze-tube of toothpaste to a charcoal-based tooth powder creates ripple effects as the skill of brushing your teeth must be altered in order to get tooth powder into your mouth without making a powdery-black mess. The likelihood of staining caused by charcoal can increase the need to clean-up a sink after brushing, which might lead to a location change for tooth brushing for example from the bathroom to the laundry, where mess might be less of a concern. Using tooth powder changes other skills and materials too – a scoop might be needed to get the powder from its package to your mouth and an extra cleaning cloth might be used to mop up any charcoal stains. Social norms of cleanliness have stabilised toothbrushing practice in the regime, however changes to the image, skills or materials of toothbrushing can alter the consumption patterns surrounding the practice, which impacts the surrounding systems of production and waste (see Figure 5). Though the simple act of toothbrushing feels personal, individual, and small, mapping it using the MLP canvas can track it horizontally using SPT and vertically using the MLP to reveal its scale and relationships across levels and systems.

Figure 5 merges the telescopic view of the MLP with the more granular view of SPT to show how an individual practice can span multiple levels and be connected across multiple systems/sub-systems. To communicate the impact of changes to a practice two ways of toothbrushing sit side-by-side to invite comparative analysis. Way one is the dominant 'normal' practice, using a disposable plastic toothbrush and tube of toothpaste. Way two uses a compostable bamboo toothbrush and tooth powder, thereby altering the image, skills and materials in the practice. Arrow-clusters indicate some niche aspects of the practice are shifting, evidenced by the shelf presence of these alternative materials in mainstream Australian supermarkets. Mapping practices in this way reveals the ripple effects created by behaviour change. The canvas can also facilitate ontological design processes by examining incremental changes in practices as part of transition pathways.

Figure 5 Using reflective doodling to map variations on the practice of toothbrushing (modified from original presentation in the author's PhD). Close-up detail: the regime/niche of 'way two', showing how changing the image, skills, materials in a toothbrushing practice has a ripple effect that straddles multiple levels
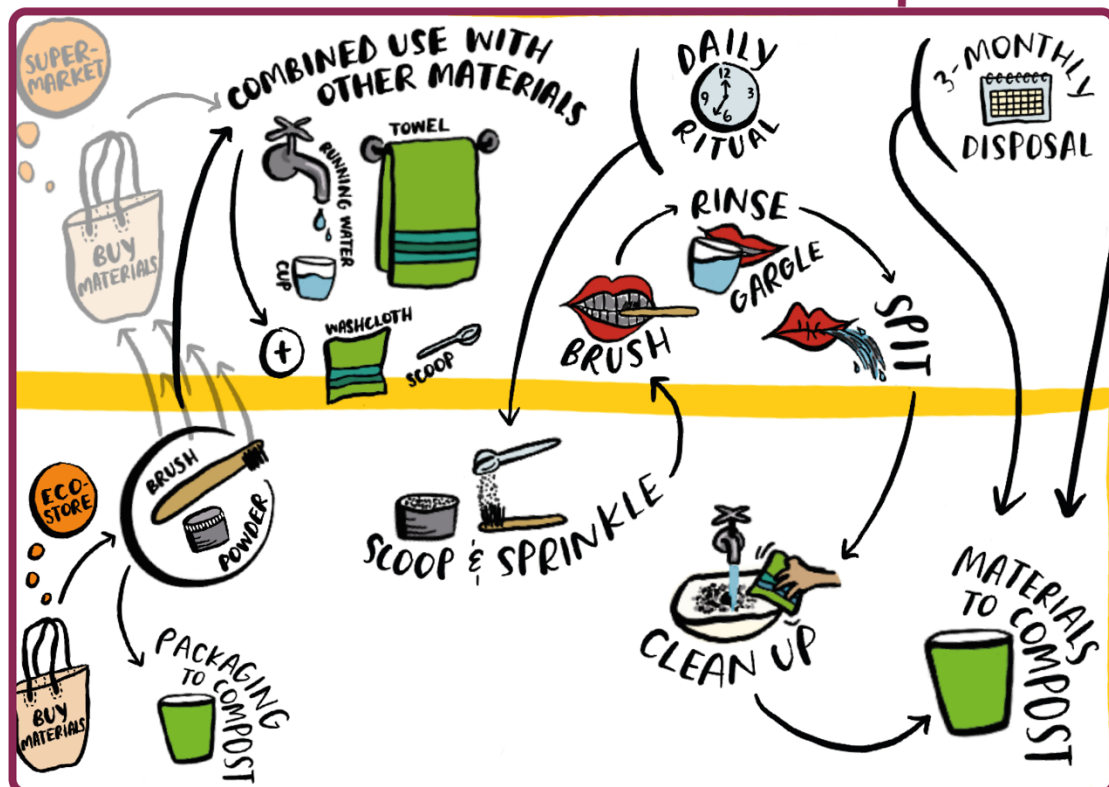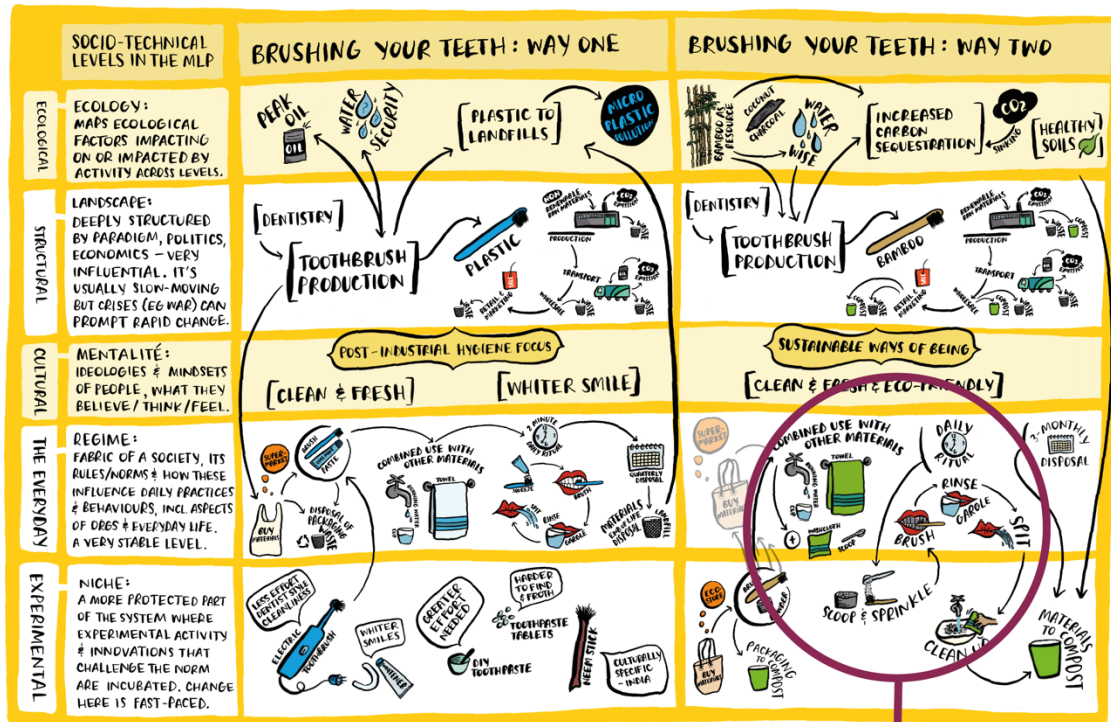
Representing the MLP as a holarchy

Geels describes how the 'nested character of [the MLP's] levels, means that regimes are embedded within landscapes and niches within regimes. Novelties emerge in niches in the context of existing regimes and landscapes with its specific problems, rules and capabilities' (2002, p.1261). In transition design literature (Kossoff et al., 2015) systems thinking complements this understanding (drawing particularly from Capra and Luisi, 2014; Koestler, 1975; Robertson, 2015; and Wilber, 2015) and offers the language of 'holons' (parts of) and 'holarchies' (wholes) to describe such nesting. This draws on living systems principles where hierarchical aspects are viewed as scales of systems rather than higher/lower levels of control, however Kossoff et al. recognise the incomparability of living systems and STSs in relation to socio-technical change. The compartmentalisation in the STS misaligns with the openness of human experiences in everyday life. Instead, they argue for the integration of Kossoff's (2011) framework for the Domains of the Everyday, which informs this research in its multi-level situation of everyday life. This adopts a 'whole system' approach to uses of the MLP, which is argued by Kossoff et al. as necessary for decompartmentalising STSs. Embracing this relationality also recognises the intersections of social practices across scales in systems. Kossoff et al. describe how home food preparation, a food market and agriculture represent different scales in the food system and how niche activity can nest in each of these scales. Conceptualising the MLP in this way accounts for the feeling of wholeness in each level, since holons are both parts of and wholes and can exist in different scales. Figure 6 visually represents holons of niche activity from the author's living lab that nest at different scales in the food system.

Figure 6 Using reflective doodling for storytelling about the MLPh, where niches are nested at different scales in the system
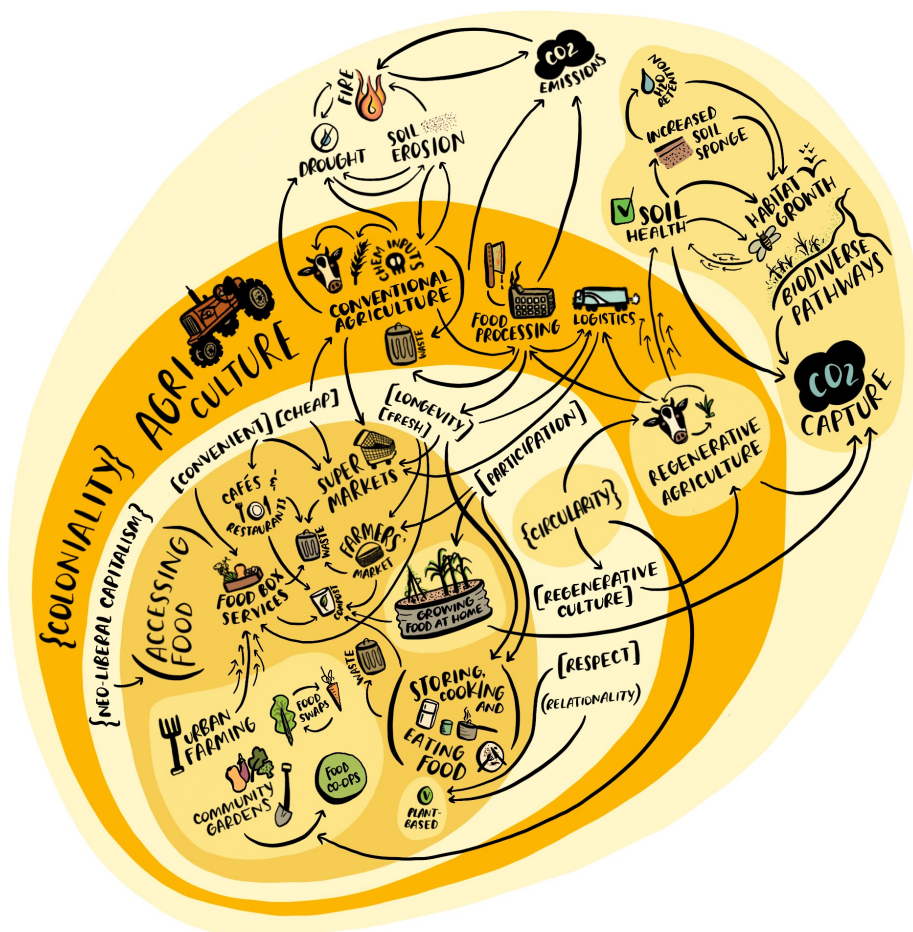
Viewing the MLP as a holarchy (MLPh) reflects the penetrability of each layer and their potential for influence upon one another. Tension between holons is expected as they interact across a system (holarchy). The niche remains protected but considering it in separation from its 'nest' denies the inherent relationality between the levels. Considering this using systems theory, where 'dynamic interaction [is] central in all fields of reality' (von Bertalanffy in Macy, 1991, p. 86) suggests visualising the MLP as a holarchy might better represent STS dynamics. Reflection on Geels' intent to represent a holarchy rather than an ordered system of levels of control (Geels and Schot, 2010), has prompted further consideration of how the canvas communicates. The structure provided by columns and rows is helpful during mapping but unintentionally communicates a hierarchy. It leads readers through a top-to-bottom, left-to-right (Western) reading process that suggests an order or power of one thing over another, however dynamic interactions between levels in the MLP occur in a number of ways. The levels are intended to suggest scale rather than order (Geels and Schot, 2010, p.19) but do not imply geographical scale. The niche can contain localised activity that is also a global phenomenon, for example, zero-waste lifestyles are practised in local/personal ways despite being part of global niche activity. The MLPh canvas aims to reduce the unintended hierarchy in the MLP canvas by using a non-linear structure and nested shapes.

Transitions rely on clear goals, collaboration, and niche activity that understands its context and the rising tensions from rules/norms that could impact its traction. In this sense, visually nesting the niche better represents the dynamic interplay between levels and views them as parts of and wholes. Figure 6 shows the way niche holons are nested at different scales throughout the system. This canvas from a food system project in the author's living lab shows how for example, the regenerative agriculture niche nests inside a landscape where the overarching paradigm, economy and culture of conventional agriculture impacts its uptake (see also Figure 8 which briefly outlines the initiatives in these niche holons).

An example of niche-nesting can also be seen in living labs, where innovation and experimental activity is typically protected by a lab's nesting within a regime institution, where experimentation is supported through funding/insurance/space. The visual nesting in Figures 6–8 is informed by articulations of nesting from Geels (2002) and Kossoff et al. (2015). The author also draws on their lived experience to communicate nesting as more reflective of how niches 'look and feel' in practice. These figures are informed by initiatives from within the author's living lab, some of which are outlined in Figure 8.

Storytelling
In an attempt to shift from mapping to storytelling, the MLPh canvas was also used to communicate a particular aspect of a problem. Figure 9 intends to build on Figure 3 by picking up one aspect of this map for systems storytelling: the triggering of changes to consumption practices and the subsequent impact on waste resulting from COVID-19. The background of Figure 9 displays complex detail with a reduced opacity allowing a simpler narrative to be foregrounded, revealing that 'citizen consumers' are shifting to online and bulk shopping practices and accumulating additional waste in their homes. The canvas shape invites a non-linear reading of this moment in time. It does not imply a timeline of events, but rather a cluster of activities occurring simultaneously in different parts of the system.

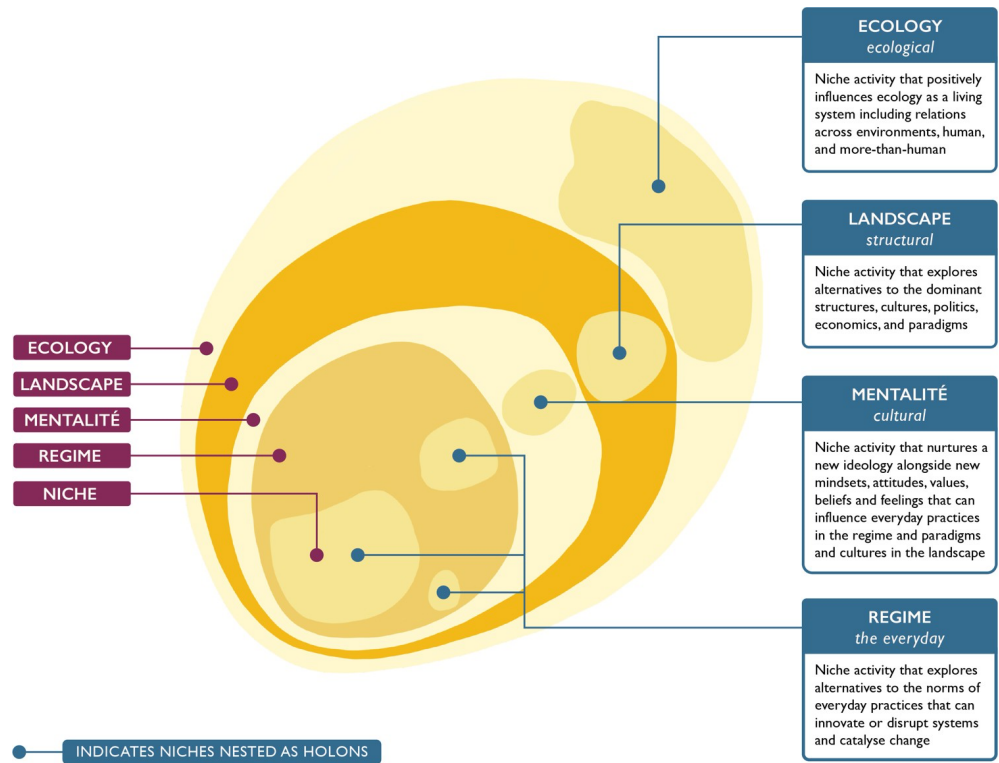*Figure 7 Communicating niche holons nested at different scales throughout the MLPh*

ECOLOGY
ecological

Niche activity that positively influences ecology as a living system including relations across environments, human, and more-than-human

LANDSCAPE
structural

Niche activity that explores alternatives to the dominant structures, cultures, politics, economics, and paradigms

MENTALITÉ
cultural

Niche activity that nurtures a new ideology alongside new mindsets, attitudes, values, beliefs and feelings that can influence everyday practices in the regime and paradigms and cultures in the landscape

REGIME
the everyday

Niche activity that explores alternatives to the norms of everyday practices that can innovate or disrupt systems and catalyse change

ECOLOGY
LANDSCAPE
MENTALITÉ
REGIME
NICHE

INDICATES NICHES NESTED AS HOLONS

Figure 8   Identifying leverage points for niche initiatives

ECOLOGY
ecological

Revegetation projects aiming to create biodiverse pathways throughout the region are catalysed on land donated by farmers in regen. transitions

LANDSCAPE
structural

Regenerative farming transitions are activated and documented to capture the farmer's story alongside key regenerative indicators

MENTALITÉ
cultural

Region-wide capacity building initiatives use a workshop-in-a-box that self-facilitates gamified processes of social learning that aim to foster circularity and systems seeing

REGIME
the everyday

Pop-up verge gardens for green waste capture, new community gardens and foragable pathways provide experimental ways to access plant-based food

ECOLOGY
LANDSCAPE
MENTALITÉ
REGIME
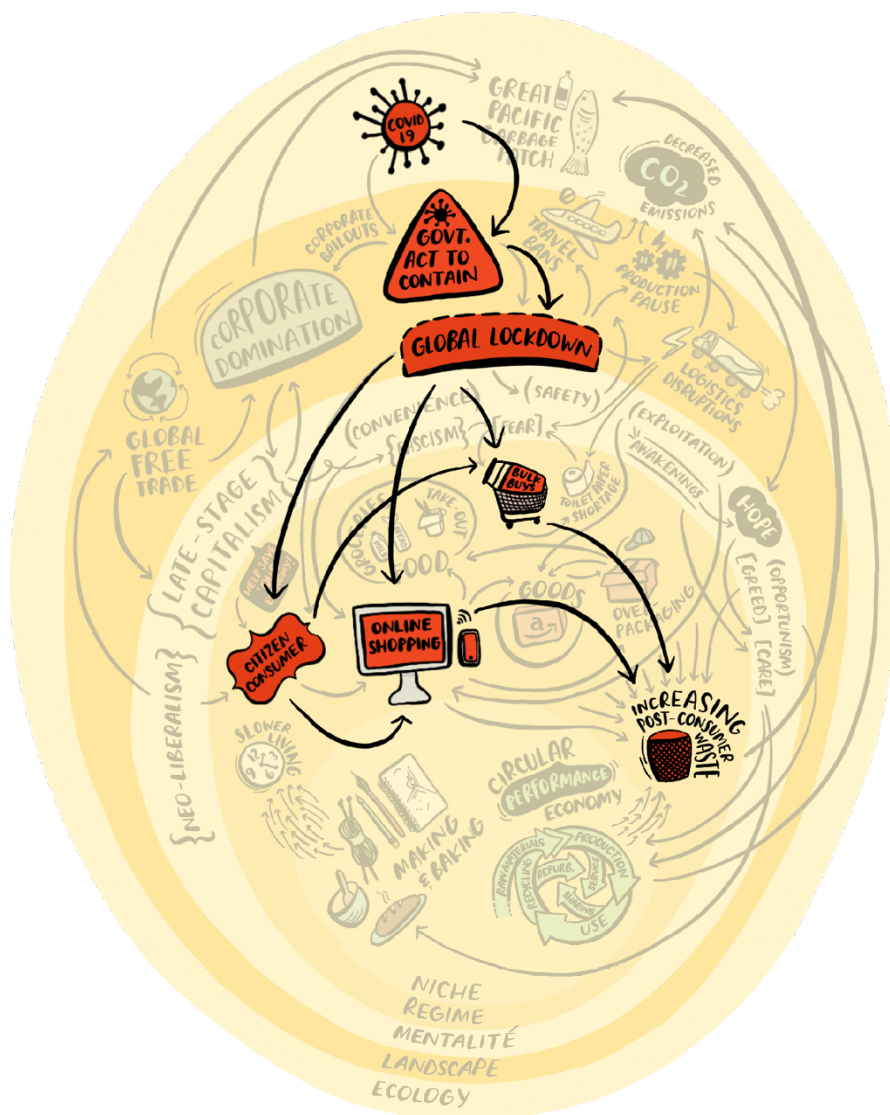NICHE

INDICATES NICHES NESTED AS HOLONS

Figure 9 A reflective doodle of the MLPh exploring changes to consumption and waste practices catalysed by COVID-19

Reflective doodling often results in simplified canvases created as rapid doodles during dialogue with other systems practitioners. Bateson's (2017) warm data techniques encourage observational dialogue and the MLPh has been useful in documenting discussions from which narratives emerge. This suggests the MLPh holds potential as a storytelling device for capturing where we are/where we could be and provides another approach for using for the MLP/MLPh for storytelling that will continue to be explored as this research continues.

Discussion

Explicit contexts

Relational perspectives are communal, place-based and contextual (Escobar, 2018) and recognise the interconnectedness of things (Dei et al., 2000; Yunkaporta, 2019). Learning from shared Indigenous knowledges, relational thinking was used to provide explicit context for people and place during mapping of systems and problems. Explicit interconnectedness and interdependencies are also key in living systems theory (Miller, 1965) and in the principles of autopoiesis (Varela et al., 1974) which observe the self- organising nature of living systems. Recognising ecology as the larger context for STSs clearly positions humanity and our built systems within a larger, finite, natural context. This place-based view increases the capacity to identify the STS's impact on nature and where nature impacts the STS, making natural systems more visible while actors consider the functions/failures of constructed systems. This is relevant when mapping with anyone unfamiliar with underpinning theories or with those who have a fragmented relationship with nature. An explicit ecological context could also build eco-literacy and add to social learning outcomes during co-mapping. Explicit acknowledgement of an ecology level provides a visible reminder that living systems are the context for STSs, and conscious consideration must be given to the natural world in mapping, problematisation and exploration of possible action. We (people) are also nature. To ignore the natural world is also to deny human-actors of our dual-roles in systems – as custodians in natural systems and as agents in constructed systems.

Thinking culturally

Designers' application of the MLP, SPT and DT benefits from making cultural frames identifiable to acknowledge how and where meaning is made. The inclusion of a mentalité level pays particular attention to the work of designers as cultural mediators. Discussions of thinking in the MLP often centre around paradigms (a pattern or model of thought) or worldviews (a philosophy of life or conception of the world) which Geels (2002) outlines as structural and held in the landscape, and Rosenbloom et al. (2016) describe as socially constructed by actors from the regime and niche. This research focused on whole system relations to consider the impact of thinking. Thinking is socially enacted through ideologies (systems of ideas and ideals), mindsets (attitudes held by people), values (principles that guide our actions and how we apply worth to things), beliefs (acceptance/denial of something's existence) and feelings (how we react/respond). All are key considerations that influence how the regime is analysed. This is about how people think and feel about something, and how these thoughts and feelings influence their construction of meaning. Nowotny's (2005) discussion of symbolic technologies reveals that 'culture, the sharing of meaning and the need to communicate… leads to an increase in complexity' (2005, p.18), which is demonstrated in the trans-contextual meanings surrounding waste. Meaning is constructed culturally as convenience, pollution, accessibility, affluence, poverty, livelihood, energy, movement and more, often in plural and paradoxical ways that result in increased complexity. There is a tension between the desire to reduce this complexity and the urge to address it (Nowotny, 2005). How we might feel about waste is also influenced by contexts including norms, aesthetics and perceived optics – all observable and described by Bateson (2017) as part of 'warm data'. Designers must acknowledge and vividly express the complex roles that people (as cultural thinkers and actors) play in systems to better

understand how messy these roles can be. This is more than social practices enacted recursively – many different thoughts and feelings are mixed up in this. A cultural view of the MLP and SPT acknowledges the value in warm data, accepts its messiness and attempts to make sense of it through iterative and adaptive approaches. Focusing on warm data and cultural enactments of mentalité might seem more useful in informing design approaches than discourse in the social sciences or transitions studies, however this also holds value for those outside of design.

Engagement with historical challenges

Attempts to engage with historical challenges in the MLP (Genus and Coles, 2008; Smith et al., 2010) also informed this research. Of note are challenges associated with the MLP's lack of focus on socio-cultural aspects and the lack of agreement on functional distinctions between levels as conceptual or empirical (Genus and Coles, 2008). In responses to issues of agency, Geels and Schot (2007) recognise the benefits of multi- paradigm approaches and describe how agency is conceptualised differently using different paradigms. They outline the MLP as a global model that is less attentive to the role of actors while acknowledging that this limits the MLP's ability to reflect 'different 'local' subplots' (2007 p.415). Research from Rosenbloom et al. (2016) pays attention to actors and their capacity to carry 'storylines' about innovations in energy technologies. They describe how actors use content and context to create narratives about incumbent technology selectively and discursively, and how competing framings of niche activity creates tensions between their perceived legitimacy/illegitimacy. Descriptions of storylines as 'repertories of language for meaning-making… and strategic tools' (2016, p.1278) connects to an often-lacking socio-cultural aspect of transitions, the influence of storytelling and meaning-making, which is highly relevant for designers. They conclude that 'the landscape may be largely socially constructed... interpreted and made meaningful through the actions of agents operating in the niche or regime seeking to advance their perceived interests' (2016, p.1286). This suggests an influential role is played by actors' mentalité in landscape construction, perceptions of niche innovation and the enactment of agency to support/stifle activity, thereby indicating a usefulness in making the mentalité more explicit and targetable. Though activity in the levels of ecology and mentalité was observable during mapping in this research, the observations were not part of an empirical study so the question of whether levels are conceptual or empirical remains. The canvases developed in this research attempted to engage with challenges in reflecting socio-cultural aspects of transitions by using additional levels to represent local aspects that focus 'on the micro ideas, decisions, actions or events of particular developmental episodes' (Poole and Van de Ven, 1989 p.643) and global aspects in ecology as the context for STSs. Making both more explicit appears to have benefits when using the MLP for problem articulation, identification of leverage points and storytelling.

Ontological considerations

Ontological considerations are 'concerned with the nature and agency of design' (Willis, 2006, p.70) and underpin aims to co-create new, pluriversal ways-of-being (Escobar, 2018). This approach also has alignments with Kuijer's (2014) use of practices as a unit of design. Geels (2010) describes ontological interconnections in the origins of the MLP, which drew on interpretivism/constructivism (actors engaged in continuous sensemaking) and evolution theory (heterogenous actors). Geels indicates benefits to considering power structures (2010, pp.504–505), I would argue their consideration is necessary as overlooking the role of power fails to engage with a system's true dynamics. A conflict ontology can be identified in the different

ideologies governing actors in the regime and niche, seen for example through niche social movements' struggle against dominant ideologies in the regime. This struggle is particularly relevant to ever-present issues of power relations and plastics, where vested interests in fossil fuels continue to inhibit implementations of circular economies despite a strong niche movement and clear pathways into the regime. Ignoring power relations limits actors' understanding and impacts their subsequent actions. Avelino's (2017) reframing of the MLP through a lens of power reveals the multiple dimensions of power and (dis)empowerment at play in systems. Viewing the MLP this way reveals how attempts at systemic change that fail to address dominant power structures also accept a future that includes the continued oppression of billions of people and animals, and a persistent extraction of natural resources and domination over ecology.

Applications in design
The presented canvases have been applied into real-world design for transition projects (in waste and food) that commenced in the author's PhD and continue through their living lab. Canvases have been used for independent and group mapping exercises to articulate wicked problems in the living lab and through the author's teaching. In each setting the canvases were flexible enough to map both the telescopic view from the MLP and the macroscopic views from SPT and have been used in conjunction with DT to apply each of these theories in ways that can inform design approaches. It was noted that the MLP's telescopic view made the systemic impact of concentrations of practices (norms) more visible, permitting deeper analysis and insights into the impact of a practice using SPT and DT. The columns provided a structure for investigating the temporality of problems and/or the impact of altering practices, creating multipurpose canvases for mapping and reflective doodling. The designerly 'code' embedded within sketching/drawing processes provides a means of communication for what might be difficult to otherwise verbalise (Cross, 2006). Explorations of the MLPh attempted to communicate the MLP in ways that are useful for those who are exploring transitions conceptually, focusing on problems more tactically and/or engaging in systems storytelling.

Conclusion
This research explored a use of the MLP combined with SPT and DT and presented canvases that aid in problem articulation and leverage points identification in design approaches. It has drawn on literature at a multi-disciplinary intersection to expand on the toolkits used in CAS approaches and by designers in design for transitions. Discussion of the canvases has demonstrated their usefulness in design research and practice, where their use has aided the understanding of problems and potential action pathways in complex engagements. The multiple (and staged) uses for each canvas can advance design thinking at various points of exploration and ideation and offer a new way to engage with the MLP for mapping, analysis and storytelling by making cultural and ecological aspects explicit. Using the same canvas to explore systems, problems, feedback loops, practices, and leverage points provides an underlying structure upon which multi-level patterns can emerge. The canvases act as thinking tools that can help inform the multi-level, multi-stage approaches that contribute to 'solution ecosystems'. They provide space for the complexity in problems to be visualised (both temporally and through their relationships) and for potential approaches to these problems to be explored with increasing granularity. The MLPh canvases also offer a conceptual reimaging of the visual 'form'

of the MLP as a holarchy, which complements the MLP's linear view by prompting non-linear thinking and inviting engagement with the 'all at once-ness' of complexity in systems/problems.

The canvases are presented here to catalyse further thinking about systems communication and the role designers might play in sustainability transitions, however the usefulness of these canvases extends beyond these projects and the field of design. Those engaging with sustainability transitions from other fields can also benefit from mapping activity across ecological and cultural levels to expand their sensitivity to the roles of people and place in transitions. While this research used the MLP to examine consumption, waste and food as part of the domains of everyday life (Kossoff, 2011) the MLP canvases could add value in other domains including work, education, health, and policy. The MLP and MLPh canvases provide a framework for examining the complex/wicked nature of many social and ecological injustices that are enacted across these domains. In fields such as community development and social services, social injustices could be made more visible and targetable by exploring their complex nature alongside the mindsets and beliefs that underpin them. And in other fields such as urban planning/built environments, health/medicine and farming/fishing/forestry a sensitivity to impacts on living systems and to the attitudes and values leading to inequities in access to affordable housing, green spaces, healthcare, food could be developed. Such a sensitivity could help locate leverage points where the relationships between healthy ecosystems and healthy humans can be strengthened and inequities can be addressed. Development of the visual communication of the MLP and MLPh continues alongside design experiments in the author's living lab and engagement with the framework and its practical application in projects continues. Documenting these applications through case studies is an area for future focus.

Acknowledgements

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