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A Tale of Two Conceptual Tools: Analysing Leverage Point Tools in Relation to a Water Utility's Circular Economy Transition

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'Design for Transitions' (DfT) is a nascent and rapidly expanding field that intersects with systems and transitions theories and practices in order to address the "wicked systems" intrinsic to the 'polycrisis'. We align with DfT and 'systemic design' calls to further integrate and deepen related approaches at the nexus of multiple disciplines. More specifically, we aim here to integrate and deepen: firstly, conceptualizations of 'leverage points' that overlap/cross-cut DfT and systemic design, and; secondly, the implications of such conceptualizations in relation to practice (e.g. a retrospective case of a regional Australian water utility's circular economy transition). Taking as one starting point Meadows's 'leverage points' framework, core to several design and systems approaches, we position another approach and model from Zivkovic. Through three analysis processes, we compare the conceptual tools then apply each to analyse the case. Our analysis reveals how each tool surfaces different system and intervention logics, and opportunities for enhancing a systems design approach with respect to the transition in focus. On the basis of our analysis, we discuss some benefits and limits of the two tools, which can contribute to theoretically and practically deepening DfT and systemic design. We highlight the possibility for future work in integrating the two tools together, potentially enabling a multi-dimensional understanding of system components, behaviours, underlying logics, relational fabrics within and outside of the system, and enhanced capacity for change.

KEYWORDS: systemic design, design for transitions, theory-practice relations, leverage points

RSD TOPIC(S): Cases & Practice, Mapping & Modelling, Sociotechnical Systems

Introduction

"Design for sustainability transitions" (DfST), "design for transitions" (DfT) (Gaziulusoy & Öztekin 2019) (Boehnert 2019) (Boehnert et al 2018) (Wallace 2019), and "transition design" (TD) (Irwin 2015) (Irwin, Tonkinwise & Kossoff 2015) have emerged as a "fifth order design" field (Mortati 2022) in response to the increasing complexity of multi-system, multi-phase, and multi-level (Geels 2005) sustainability and socio-technical "transitions". More recently, and particularly relevant for us here, are intersections and overlaps emerging between DfT and "systemic design" including attempts by Van Selm and Mulder (2019), Kjøde (2022), Culén (2023), Hummels et al (2024), etc., to integrate respective frameworks. It is at this nexus and contemporary cusp of such systems and transitions theories and practices (and relevant to the "multi-scalar transformation" theme of this conference), that we zoom into two conceptual tools that provide a set of heuristics for working with complex, adaptive systems. Our aim here is to reflect on their benefits and limitations in a DfT case, to contribute to evolving a theory of leverage specific to DfT.

In terms of our own DfT work, we broadly echo Van Selm & Mulder's (2019) call to further integrate and deepen approaches in the field given the explosion in popularity of the term 'transition' in and beyond design. Kjøde (2022: 3) notes that little research exists into how designerly contributions are being applied to sustainability transitions in the context of current professional design practice. Furthermore, Van Selm and Mulder's (2019: 331) survey found only "a very limited of number of case studies," hence their proposal "that in order to further develop the academic field of transition design, scholars should focus on analysing and evaluating those cases. Development of the academic field might also increase the value of non-academic projects, as it allows to move from random experimentation and trial-error process, towards a structured process and best practices." While their literature review found only one case that met

the TD criteria and process thereby testing the TD model (e.g. Irwin 2019), we're aware of more DfT cases (including those cited in Alina Miller & Baumber 2024). We concur, nonetheless, with their conclusion (referencing Ceschin & Gaziulusoy 2016: 141) that TD/DfT remains "too big picture" and that there's a need for research linking "theoretical insights and practical tools."

Leverage points for transitions – two conceptual tools

In the overlap between DfT and systemic design, there is a shared concern for the interventions required to catalyse systemic shifts or, in the words of this conference theme, the emergent and distributed "impacts" within "multi-scalar transformation." DfT core theories include those from "transitions management" (TM), in which interventions can be understood in terms of phases of breaking down and re-building (Loorbach 2014, Hebinch et al 2022) and in terms of multiple levels. In relation to these framings, and despite occasional references to systems and leverage points, there is scant DfT work that explicitly and systematically queries where to intervene, what are types or points of intervention, and the effectiveness of these. This is further echoed in a call from Murphy (2022) to evolve leverage theory through research into dimensions of leverage (including incorporating other features of "physics" of systemic change), methodologies for leverage, strategies with leverage, and execution on leverage.

In terms of 'leverage points', there is some relevant prior DfT work: Meadows's (1999) framework is utilized in Richardson et al (2005, see also Irwin et al 2020)'s consultancy for the UK Design Council in illustrating how sustainable product design can exert wide ranging influence, and Gaziulusoy (et al 2021) used "deep leverage points" via Meadows to identify potentials for post-pandemic DfST transitions. Our work here builds on such precedents and aims to take leverage point theory a step further.

Reminding us that Meadows considered her framework as "a work in progress" (1997: 3), Murphy (2022) points out several approaches parallel to and/or building upon Meadows, including those from Kania et al (2018), Birney (2021), and Abson et al (2017) (among others) that have incorporated action and design-oriented approaches. These adaptations build on the gap between Meadows's framework and more prescriptive and actionable approaches, noted by Murphy (2022). He argued that this gap is perhaps rather the domain of "leadership scholars". Further critique from Chan et al (2020: 706)

highlights Meadows's framework being unsuitable for cases of adaptive management, "where decisions are not simple products of rules nor of feedback loops". Additionally, Chan et al (2020: 706) highlight the incongruencies of the framework in working with social systems where individuals and groups have competing and evolving purposes.

This situates our turn here to Zivkovic's (2015) 'nine leverage/focus areas for enabling systemic innovation/change' based on a complex systems leadership approach (explored further on page 7). Zivkovic's model provides an alternative conceptualisation of leverage points and thus is complementary in deepening understanding 'leverage points' for DfT (via our two selected tools - Meadows and Zivkovic).

In terms of the gap between theory and practice, we see such 'conceptual tools' as useful devices that, on one hand, index relevant theories and, on the other, provide heuristics relevant to practice. More specifically, Zivkovic considers her nine leverage/focus areas to be a 'model' or a 'complexity based diagnostic tool for tackling wicked problems'. On the other hand, Meadows's outline of 12 leverage points is considered a framework due to its broad application. With these framings in mind, we compare the two tools but also use them to turn to a practical case and unpack how elements of both these tools map to our unit of analysis – a water utility's Circular Economy Roadmap. Our mapping exercise and analysis reveals gaps and opportunities in terms of enhancing the roadmaps 'transition-ness'.

The circular economy roadmap being analysed was produced by a multi-disciplinary strategic design consultancy (in which the lead author was a part of) for a state-owned regional Australian water utility from July 2022 and May 2023. While the project resulting in the roadmap did not employ an explicit DfT or systems methodology, the project team ingrained a systems orientation within the methodology and problem-framing. The roadmap and case are further extrapolated on page 9.

What might be considered to constitute a 'transition', much less a 'transition case' can vary considerably. In terms of scale, cases in TM tend to be long-term and large-scale (f.ex. spanning decades at the scale of a nation-state), though DfT cases tend to be shorter and smaller including transition within an economic sector or even within an organization (e.g. Wallace et al 2024). In terms of the nature of transition, there is also debate over whether DfT is reformist versus revolutionary, and cases span this

spectrum. It's also important to note here critique of the 'circular economy model,' as a 'transition' ambition, with calls to further integrate the material and socio-political dimensions of change (Melles & Wölfel 2023). In terms of 'transition' here, we understand our case (the CE roadmap) as organization-level socio-technical change, in which this and other regional projects and initiatives are part of longer-larger sustainability transitions.

Our method and units of analysis

In our study here we have sought to understand the systemic and adaptive nature of the CE roadmap in order to generate reflections on 'transitions' and 'leverage points', through investing three units of analysis: the two tools ("*Meadows's framework"* and "*Zivkovic's model"*) (see Table 1), and the unit of analysis ("*the CE roadmap*" or "*the CE roadmap initiatives" or "the initiatives"*) (see Figure 1).

We conducted three processes of analyses. Firstly ('analysis 1'), using a visual mapping technique (in the software Miro), we compared the tools in terms of similarities and differences regarding understandings of "systems" and "leverage points/levers." Secondly ('analysis 2'), and more in-depth, we interpreted the enumerated leverage points in Meadows's framework as a set of analytic categories or codes, which we then applied to analyse the CE roadmap. Data (comprising lists of activities, artifacts and other elements) from the roadmap actions were recorded, coded and clustered in spreadsheets. Thirdly (in-depth 'analysis 3'), we mirrored the procedure of the second but with Zivkovic's model. The second and third analyses enabled the lead author to better understand the systemic nature of the roadmap actions, to unpack the conceptual tools in more depth, and to surface some potentials in the case from both a 'systems' and 'transition' perspective (e.g. implications for future research, see Discussion section).

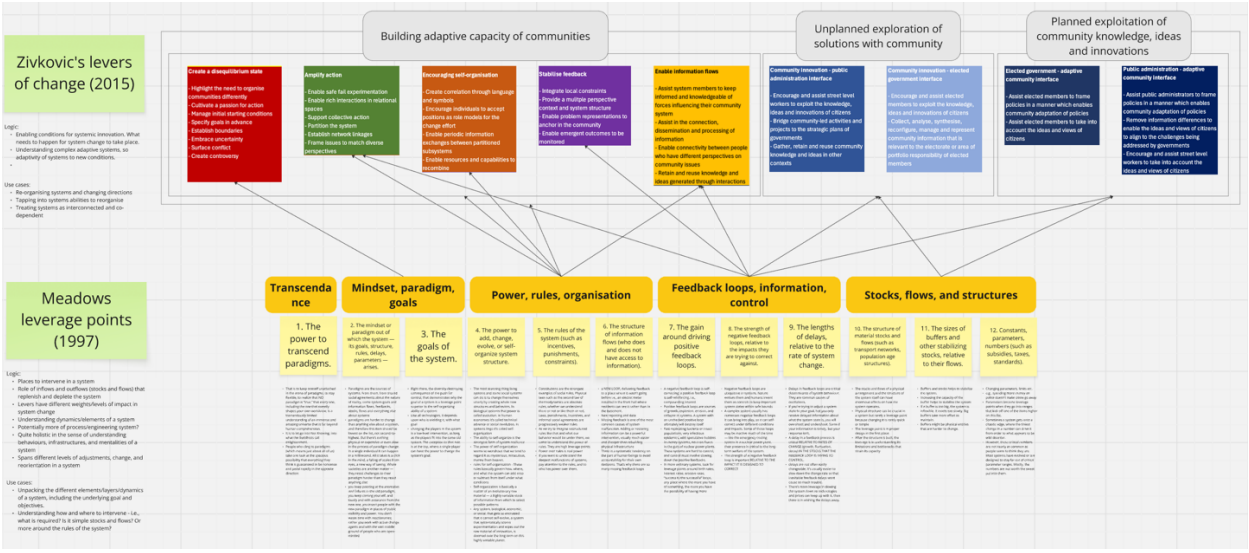

Figure 1. Example of mapping exercise showing 'analysis 1' (observations regarding similarities and differences are not visible). Source: Author.

Through these analytic processes, the lead author detailed several observations, which results in a series of findings about the conceptual tools in relation to one another and, more specifically, about what each tool revealed about the CE roadmap.

Situating the conceptual tools: Meadows's leverage points and Zivkovic's leverage/focus areas

"Leverage points," Meadows (1999: 1) famously explains "are places within a complex system…where a small shift in one thing can produce big changes in everything." An American environmental scientist and activist, Meadows was a pioneer in 1980-90s systems 'dynamics' and engineering. She didn't coin the term 'leverage points,' but her concise and compelling set of points, at the time developed to articulate flaws in the World Trade Organization and other trade deals (Meadows 2008), was immediately then and is still widely popular today (and thus requires less introduction). Sometimes critiqued for its technical language and engineering specificity, her framework (sometimes known as "Meadows's 12" or "M12") (see Table 1, column 1) has been adapted and restructured in various ways for different disciplines and application domains (as highlighted earlier in the paper).

On the other hand, Zivkovic's complexity-based model is informed by complexity science and works closely with the "collective impact approach" (see Kania & Kramer

2011) and theories of complex systems leadership (Zivkovic 2020) (f.ex. Hazy et al 2007). Zivkovic has applied her theories to practice, focusing on community capacity-building, community-government interfaces, and leadership through systemic innovation labs that catalyse "solution ecosystems" (Zivkovic 2018a, 2018b, 2023) (Eggers and Muoio 2015), where it is acknowledged that there is no one approach to systemic change. In solution ecosystems, coherent action addresses "interdependent causal factors" by taking a "buckshot approach," that is often described as a kind of "systems acupuncture" (Zivkovic 2023: 4).

Zivkovic's model has been cultivated for and within her professional development programme (see Zivkovic 2020). This model has been further developed as a diagnostic tool for monitoring and reporting on the actions in a solution ecosystem (which we have used as a software application in other projects). The model works closely with complex systems leadership theories, where emergence is led by cultivating conditions that foster innovation and self-organisation and by nurturing shifts from one attractor to another. We here summarize her model, along with Meadows's 12 leverage points, in the table below.

	Meadows's (1999) Leverage points: Place to intervene in a system	**Zivkovic's (2015) leverage/focus areas for tackling wicked problems**
Description	Twelve "**leverage points**" (revised from the previous list of nine published in 1997). Her numbering reflects an ordering of leverage points from the easiest to action but least effective to the hardest to action but most effective (1999:3).	Zivkovic outlines a "**complexity-accepting model**" that treats communities as complex adaptive systems, and addresses the reluctance of governments to treat communities as such. She describes her model as including "**nine leverage/focus areas**", with each leverage/focus area including several 'initiatives' (or indicators) that enable systemic innovation and change to occur

		(shown in brackets against each focus area below).
Knowledge fields	Systems science, globalisation	Systemic social innovation, social entrepreneurship, systemic design, complexity science, complex systems leadership
Leverage points	12. Constants, parameters, numbers (such as subsidies, taxes, standards) 11. The sizes of buffers and other stabilizing stocks, relative to their flows. 10. The structure of material stocks and flows (such as transport networks, population age structures) 9. The lengths of delays, relative to the rate of system change 8. The strength of negative feedback loops, relative to the impacts they are trying to correct against 7. The gain around driving positive feedback loops 6. The structure of information flows (who does and does not have access to what kinds of information)	The following five focus areas centre on "**building the adaptive capacity of communities** to enable the emergence of new ways of working that have improved system functioning and performance" (2015:4): • Create a disequilibrium state (8) • Amplify action (6) • Encouraging self-organisation (4) • Stabilise feedback (4) • Enable information flows (4) The following four focus areas "concentrate on **assisting government systems to balance the unplanned exploration of solutions with communities and the planned exploitation of the knowledge, ideas and innovation** that emerge from community-led activities" (2015: 4):

	5. The rules of the system (such as incentives, punishments, constraints) 4. The power to add, change, evolve, or self-organize system structure 3. The goals of the system 2. The mindset or paradigm out of which the system—its goals, structure, rules, delays, parameters—arises 1. The power to transcend paradigms	• Public administration-adaptive community interface (3) • Elected government-adaptive community interface (2) • Adaptive community-public administration interface (2) • Adaptive community-elected government interface (3)

Table 1. Overview of Meadows's framework and Zivkovic's model for "leverage points".

Now, below, we move to a practical case to further examine how the tools are related/differentiated and how, when applied for analytic purposes to the case, reveal different aspects of intervention and leverage points.

Situating our case: A regional Australian water utility's circular economy transition

Our case was part of a broader political agenda to drive action on carbon emissions reduction and enhance climate resilience measures across Victorian Water Corporations through integrating circular economy (CE) principles into their operations. The 'circular economy' has emerged as a potential solution to make better use of resources while generating economic gains and alleviating pressure on the environment (Velenturf & Purnell 2021), and has been widely adopted and driven by practitioners, across various sectors. Subsequent water-specific adaptations from the International Water Association (2016) and World Group (Delgado et al 2021) have translated CE objectives and actions for a water management context. Since 2020, the Environment,

Land, Water and Planning division of State Government have released policy, funding, regulations, and coordination measures (among other mechanisms) to embed circular economy into waste management practices across Victoria. Specific actions and resources have been aimed at water corporations, including the roll-out of the Circular Economy (Waste Reduction and Recycling) Act 2021, the formation of a water sector CE working group, and the release of government seed-funding for water sector CE projects.

Wannon Water are a regional water utility in southwest Victoria who supply water and sewerage services to residential, commercial, industrial and rural customers. In 2022 they were granted Government funding to design a 'CE roadmap' and subsequently employed the services of a Melbourne-based strategic design agency to undertake a "place-based, systemic approach" to articulating a pathway for transitioning to a circular economy (Wannon Water 2023). The project also integrated perspectives and activities from waste and resource recovery specialists to drive understanding on material flows and opportunities for recovery. The project delivered a "CE roadmap" (Figure 1) to guide action in embedding circularity within the organisations operations and kick-starting a broader regional industry transition.

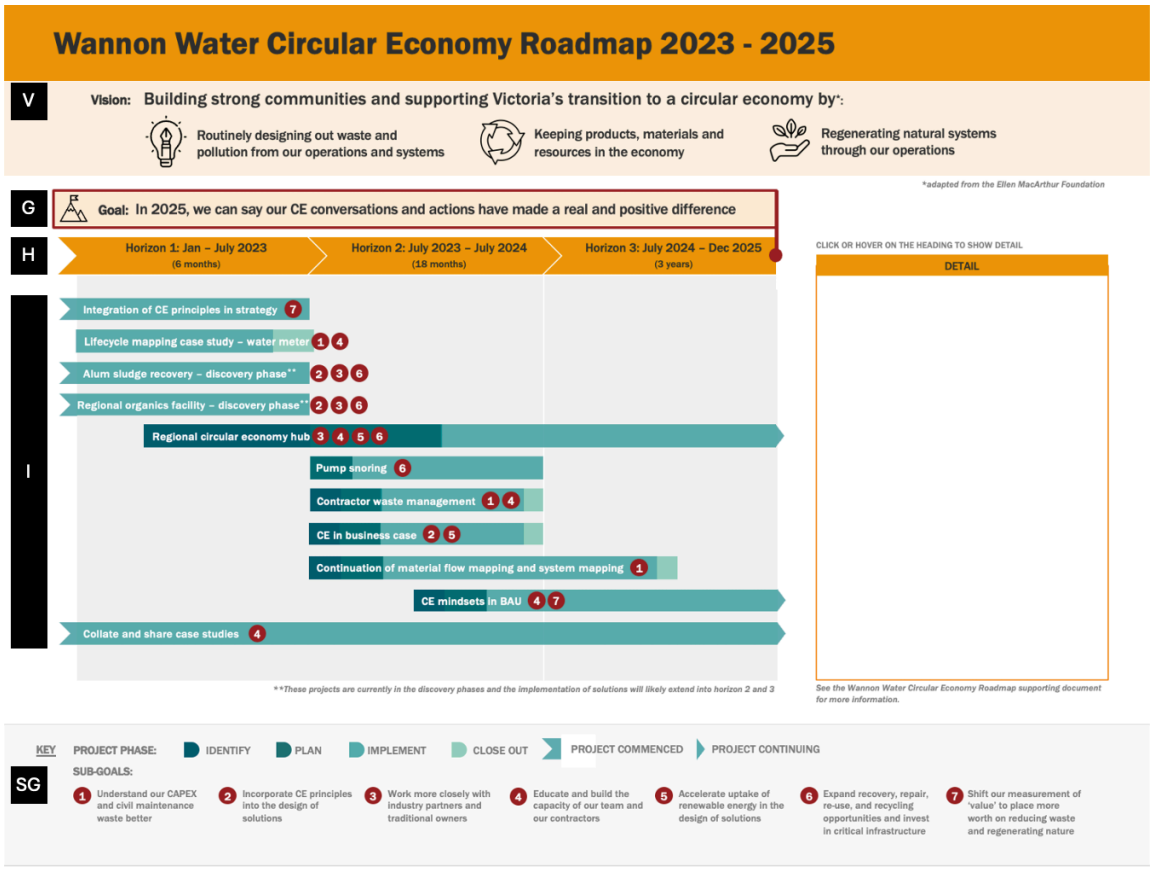

Figure 2. The "CE Roadmap" (Wannon Water 2023). Key elements (black boxes in the image) include: The vision (V), the goal (G) for the end of the three-year period, the three horizons (H) for organising the packages of work and implementation of actions, the 11 initiatives (I, in turquoise) mapped across the horizons and broken into four "project phases" aligned with the organisations internal project management approach, and seven sub-goals (SG) that might be considered the 'focus areas' or 'leverage points' for change. Source: Wannon Water website.

Our analysis is bound by the following elements:

- The 'CE roadmap' – this outlines a programme of internal (and some external) activities to be delivered by the regional water utility between 2023-2025. The roadmap was crafted through a strategic design process with internal employees and regional stakeholders and is further detailed in the 'Wannon Water Circular Economy Roadmap report' (which is out of scope for analysis but informs our reading of the roadmap).
- The CE roadmap initiatives – these include seven broad sub-goals and 11 specific initiatives, which each initiative mapping to one or more sub-goals. The sub-goals are informed by exploratory research and a material flow analysis and highlight

the key ‘leverage points’ for enhancing circularity across the system. The initiatives, while more specific, are also treated as ‘leverage points’ in our analysis given their role of designed interventions, and their close integration with the sub-goals. The initiatives were developed by employees at the organisation in response to the research findings. The initiatives and sub-goals were iterated in relation to findings from research, prioritisation activities, and testing with employees.

- While not directly in scope in terms of our analysis, it is worth recognising the CE roadmap as being an outcome of a broader project, which began in July 2022 and concluded in March 2023. In undertaking the project, the utility assembled a mixture of technical, design, strategic and internal organisational experts, including a strategic design consultancy, resource recovery engineers, and members of the utility’s own strategic services team. The project also included delivery of a sector-wide toolkit for creating a CE roadmap (the elements and effects of which are beyond the scope of our analysis here).

Our analysis reported here of the CE roadmap was performed retrospectively, using publicly available documentation on the Wannon Water website (Wannon Water 2023) as well as the lead authors recalled experience within the CE roadmap project. Permission to use the CE roadmap project for purposes of this analysis has been sought and given by the utility.

This analysis is largely conducted by the lead author who led the development of the CE roadmap in her capacity as a strategic designer (e.g. an “insider” to the work) and who has since left her consultancy position to enrol in doctoral research studies (supervised by and collaborating with the co-authors). We acknowledge that this “insider” status presents both challenges in overcoming biases in analysis, as well as insight into the affordances and complexities that shape the roadmap. The ‘live’ nature of the roadmap should also be acknowledged, with the water utility continuing to evolve and iterate their circularity and broader sustainable development pathways.

Findings from our multiple analyses

Our three processes of analysis result in several findings, firstly in terms of relations/differentiation between the conceptual tools and, secondly, in terms of each

of the tools as applied to analyse the case. The findings are introduced below with the most interesting findings pulled out and extrapolated further.

Findings from analysis 1 (comparison of conceptual tools)

Mapping and analysis of the framework and model revealed several similarities and differences (see table 2 below). The primary difference being Meadows's structural and mechanistic approach to understanding a system typology, in comparison to Zivkovic's focus on enhancing the relational structure or fabric of complex adaptive systems. Another notable difference includes a divergence between the tools in how 'leverage points' are conceptualised with Zivkovic (2015: 1) describing them as "addressing systemic blocking areas [to adaptivity] and enabling systemic innovation", while Meadows (1999) describes them as "places to intervene" where a small shift can have a big impact on a systems behaviour. This reflects Meadows hierarchical ordering of leverage points in terms of the depth and weight of leverage points, meaning that deeper leverage points will be more transformative yet harder to manoeuvre.

In addition to these differences, the tools introduce some different concepts. Zivkovic includes the concept of 'interfaces' between community and government including characteristics of those interfaces for enabling the systems to adapt and respond in relation to one another. She also highlights the role of 'conflict' and 'disequilibrium' in building adaptivity. On the other hand, Meadows includes the concept of 'transcendence' as the deepest leverage point, noting the ability to go beyond the current system paradigm.

While the framework and model differ on several fronts (including their purpose), they both treat systems as complex, adaptive, and interconnected, and recognise the potential for change through strategic intervention. Additionally, they deal with similar themes such as emergence, adaptivity, leadership, and leverage in varying and complementary ways (unpacked in the table below). In terms of the specified 'leverage points', they similarly highlight system organisation, feedback, information flows, and system goals as places to intervene in catalysing change, indicating a shared understanding of complex system dynamics.

	Meadows's framework (1999)	**Zivkovic's model (2015)**
Purpose and type of system in focus	Conceptualises and structures **'places' to intervene** in **complex socio-technical systems.** Highlights a dynamic structure, components, and dynamics contained within a singular system.	Focuses on **developing the adaptive capacity** of communities (framed as complex adaptive systems), as well the **interfaces** with government systems, and increasing adaptivity and responsiveness at these interfaces.
Underlying logic	Meadows draws from **complexity theory** and **systems theory**, noting that a holistic understanding of how complex systems behave, structure, and organise is crucial for understanding where to intervene.	Draws from **complex adaptive systems theory** and **complex systems leadership theories** in focusing on the capacity of networks to organise, learn, interact and adapt as a determinant in solving complex problems.
Leverage point terminology and characteristics	Defines leverage points as places within a complex system where a small shift can have a significant impact on a systems behaviours. She also describes them as "points of power", "interventions", and as being counterintuitive or not immediately obvious. She also frames her leverage	Uses "leverage areas" and "focus areas" interchangeably. Positions the leverage/focus areas as areas that "address systemic blocking factors and enable systemic innovation and change to occur in communities" (2015: 1). Additionally, she introduces 'characteristics' of these initiatives that will "support the desired

	points primarily as an outsider 'looking-in' on a complex system.	enabling condition at each of the focus areas" (2015: 2).
Relationship between leverage points	Outlines a **hierarchy** of shallow and deep system components/ leverage points, indicating the varying 'weights' of different components in creating change. She notes that those components at the greatest depths (i.e., the mindset or paradigm or power to transcend) are the hardest to change.	Acknowledges three adjoined/interacting 'entities' or 'systems' – community, public administration, and elected government - and draws attention to a series of **interdependent** levers for building adaptive capacity within community and at the interfaces for elected government and public administration to respond.
Adaptivity	Meadows doesn't explicitly deal with adaptivity, but her leverage point theory recognises how systems evolve and respond to interventions. Additionally, she builds in the idea of transcendence as the deepest leverage point which might be considered adjacent and related to the concept of adaptivity.	The model is centered on increasing the adaptivity of community as well as the responsiveness of community-government systems. The model proposes leverage/focus areas that enhance the relational and structural fabric of complex adaptive systems.
Multi-systems and interfaces	Meadows's work does not explicitly mention how leverage points interact in and between multi-systems,	Zivkovic uses the term 'interfaces' to describe overlaps and relations between complex systems. She frames two

	or at cross-boundary interfaces. However, her framework recognises the interconnectedness of systems, and that leverage points can ripple through related systems.	interfaces between communities and government – the 'administrative-adaptive interface' and the 'innovation-to-organisation interface'.
Leadership	Meadows does not explicitly mention the role of leadership in her framework. Rather she advocates for leading and making decisions based on a holistic understanding of systems and finding the leverage points across the system to catalyse significant and lasting change. She emphasizes that effective change requires understanding how complex systems work and where to apply leverage to shift conditions.	Four complex systems leadership theories inform the model's five focus areas for building adaptive capacity of communities. These theories consider leadership not to be held in a particular person or role but to be a process embedded in all the interactions amongst agents in a system. The focus is on providing a coordinated network within which stakeholders can learn, interact, and adapt to maximise their effectiveness in solving complex problems.

Table 2. Similarities and differences between Meadows's framework and Zivkovic's model for working with leverage points.

Findings from analysis 2 (Meadows's framework in relation to the "CE roadmap initiatives")

Overall, there was consistency between the "CE roadmap initiatives" and Meadows's framework, as many of the initiatives are targeted at adjusting different dynamics of the socio-technical system arrangement, including the underlying system goals and values.

Key findings include: (1) the framework enabled roadmap initiatives to be analysed in terms of 'weight' and 'force' of leverage; (2) in some cases, roadmap initiatives are attached to more than one leverage point highlighting how initiatives were multi-faceted and integrated across multi-layers of a system; (3) the framework helped to frame and bound the organisational system, but made fewer affordances for overlaps with other systems the organisation is embedded and/or in relation with (4) and the mapping exposed a gap in initiatives focused on feedback loops as well as measurement and evaluation of change. A selection of these findings is extrapolated below.

Expanding on finding 1, Meadows's framework enabled the initiatives to be explored in relation to the 'weight', 'force', and 'depth' of their leverage in sparking system change. For example, initiatives at the higher end of Meadows's hierarchy (e.g., 1-3) included "integrating CE principles into strategy" and "shifting measurement of 'value' to place more worth on reducing waste and regenerating nature". These are likely to have 'deeper' leverage and be more transformative in shifting the system yet are more difficult to implement and the impact difficult to measure (Fisher and Riechers 2019). Acknowledging these varying difficulties of implementation or 'depths of leverage' presents an opportunity for enhancing the 'leverage strategy', such as the order in which initiatives are undertaken, drawing connections between how the initiatives relate to or influence each other, and outlining different approaches to implementation based on how deep the leverage point is in the system structure.

Initiatives at the lower end of Meadows's hierarchy (e.g., 10 -12) included 'alum sludge recovery – discovery phase' and 'regional organics facility – discovery phase'. These infrastructure and technology-centred initiatives have lower leverage in overall system change (according to Meadows) but they have the quickest, most tangible and measurable impact in terms of addressing key wastes and are potentially critical solutions for enabling circular flows. This reveals a potential tension with Meadows's framework, noting the transformative potential of what might be considered 'shallower leverage points', particularly ones that intersect with other systems. Working with a hierarchical idea of leverage exposes a split between initiatives aimed at deep value-system work, and the technology and material-centred initiatives – both with enabling and transformative capacities in their own rights. Related to this is finding 2 which notes

that initiatives were evidently entangled across Meadows's hierarchy with initiatives positioned at the lower end having connections to leverage points at the upper end, and vice versa. This raises questions about the sequence in which leverage points are actioned, and the dynamics between leverage points in balancing, reinforcing, and counteracting one another in a broader transition pathway.

Findings from analysis 3 (Zivkovic's model in relation to the "CE roadmap initiatives")

Overall, Zivkovic's model helps to analyse the roadmap initiatives in terms of developing the relational network and fabric for advancing the change work. It also drew attention to the interfaces between the utility and government/administrative bodies in influencing the organisations circularity work. It should be noted that for the purposes of this analysis, the term "communities" in Zivkovic's model was interpreted as the water utility's internal community and in some instances its wider industry network.

Key findings include: (1) the "roadmap initiatives" mapped to the community adaptive capacity focus areas, indicating a potential capacity inherent in the initiatives to build a relational network of circular economy activity and implement principles more broadly across the organisation; (2) there was a gap in the initiatives regarding the 'stabilising feedback' leverage point as well as in terms of addressing some of the specific characteristics outlined against Zivkovic's focus areas (3) there was a gap in the initiatives in terms of how the water utility might address or work with interfacing systems such as government/administrative bodies in advancing their circular economy transition.

Finding 1 highlights the alignment between the initiatives and Zivkovic's focus areas. Examples within the focus area *'create a disequilibrium state'* include roadmap initiatives such as 'integration of CE principles into organisational strategy' and 'incorporating CE principles into the organisational business case to create and frame solutions'. These initiatives can be viewed as 'managing initial starting conditions', 'specifying goals' and 'establishing boundaries' for circular economy work across the organisation. Similarly, under the focus area *amplifying action*, there are several initiatives that align such as 'undertaking research into a regional organics facility' and implementing 'pump snoring'. These initiatives were brought into the 'CE roadmap' as established projects that could

be amplified within a larger narrative of 'CE transition', thus connecting them into the scaffolding of circular economy work.

Finding 3 notes that the initiatives didn't map to the four focus areas centred on the interface conditions and relations between the complex system and government bureaucracy. This discrepancy brings attention to the relationship between bound systems (such as that of the water utility) and influencing/governing systems outside the bound systems 'realm of control'. This framing that Zivkovic offers encourages a 'shift in viewpoints' from the organisation to the interfaces with structures and governing bodies that influence 'change conditions'. The shift in viewpoints to the relations between the water utility and its regulatory environment (and other systems its embedded and in relation with), potentially encourages a broader framing around how the organisation acts and adapts its pathway in relation to its stakeholders.

Discussion and conclusion

Our analysis compared two leverage point conceptual tools in relation to a DfT case - a roadmap aimed at scaffolding an organisation-level socio-technical change, as part of a longer-larger 'circular economy transition' being driven by the State Government. This exercise revealed several insights that could be relevant to practitioners working with organisation-level, socio-technical transitions as well as theoretical development for DfT, including:

- Meadows's and Zivkovic's framework/model are useful analytical tools for working with leverage points (and systems more broadly) and can be beneficial if applied separately or in combination. Meadows's framework provides a typology of system elements/dynamics and provides a hierarchy of leverage, while Zivkovic's model lays out leverage/focus areas for building the adaptive capacity of complex systems to innovate and change. As outlined in the analysis above, the tools revealed different aspects about the roadmap, with Meadows's highlighting the depth and weight of leverage points in a system, while Zivkovic illuminates adaptive capacity and relational networks within systems, as well as multi-system interfaces. In combination, they may be able to achieve a multi-dimensional understanding of complex system components, behaviours and relational structures. For practitioners, the tools can provide a framing of the

dynamics to be addressed in orchestrating complex socio-technical change processes, as well as reveal knowledge gaps about systems (and structure investigations), and guide leverage point strategy.

- In line with complex adaptive system theories, and transition design frameworks (Irwin 2015), leverage point identification and strategy must be place-based, situated and respondent to the capability of the current system, as well as attuned to broader transition dynamics. Our case was reflective of this, in presenting a portfolio of initiatives that were specific to "windows of opportunity" within the organisation and sought to strike a balance between small, incremental changes, exploratory technical projects, and more long-term values-based interventions. Furthermore, the interventions were linked to multiple leverage points across the conceptual tools, highlighting an integrated approach to systemic leverage. While the change strategy presented diverse initiatives that worked across multiple 'depths' of leverage, the interdependency between the initiatives and their role in initiating a broader movement around 'transition' was less clear. Practitioners therefore might consider how leverage point strategy attends to the 'red thread' between interventions – how they work together or potentially against each other in driving change - and turn to aspects of Zivkovic's work to inform how learning, leadership, and adaptivity are integrated into intervention portfolios.
- Zivkovic's attention to 'interfaces' between complex adaptive systems and governance structures, introduces concepts around multi-system relations, power dynamics in change processes, and creating 'change conditions' at system boundaries. This revealed gaps in the roadmap around the enabling conditions for the 'boundary initiatives' (i.e., those that were considered more 'regional projects' led by the organisation, such as the regional CE hub) as well as the broader strategy. Therefore, practitioners using leverage point strategy might better consider the action and conditions required at multi-system and governance interfaces, including conditions for collaboration, power dynamics between systems, and the capacity of systems to convene, negotiate and adapt. Furthermore, practitioners might consider what catalytic interventions sit at the 'relational interfaces' between systems, and the distributed impact of these

interventions across multi-systems in sparking change. These 'relational interfaces', entangled in multi-system structures, might be considered sites for pluriversal encounters (de la Cadena and Escobar 2023) where deep relational work between systems takes place to negotiate transition paradigms.

- Leadership in leverage point strategy could be further analysed in terms of theories of power and complex adaptive leadership, before being used to delineate different strategies to identifying leverage points. Our conceptual tools dealt with two different theories of leadership in change processes and thus reflected different approaches to propelling change. Zivkovic's approach recognised and reflected the leadership embedded within agents in a system and incorporated a focus on the conditions for embedded leadership to be realised (i.e., enhancing spaces for interaction, evolving processes of decision-making etc.). Meadows's approach, on the other hand, was more aligned to informing structural decision-makers. Our case reflected elements of both approaches as it built in exploratory initiatives for system learning, as well as interventions that targeted structural decision-making mechanisms such as integrating CE into the organisational strategy. Practitioners might consider how their leverage point practice assumes a position on leadership and subsequently accounts for the system's capacity to implement and action leverage points. Furthermore, we advocate for further integration of leadership theories, DfT, and leverage points to enable a more concrete understanding of leverage point strategy in relation to leadership approaches.

Concluding words

The fifth-order design realm presents new challenges in articulating leverage points for multi-level, multi-system, and multi-phase transitions, particularly regarding how leverage points are conceptualised, how they're identified (and by whom), how they're enacted, and how they're evaluated or measured to inform ongoing transition processes. Through a comparison of Meadows's framework and Zivkovic's model, and application to a design for transitions case, we've presented a series of insights for practitioners that may help to perceive some benefits and limits of the conceptual tools in facilitating a deeper understanding of system structures, interfaces, and adaptivity.

Our analysis could be further deepened through integrating other (and more recent) leverage point frameworks, as well as gathering more data from our DfT case to evaluate the effectiveness of the CE roadmap initiatives. We could also monitor the roadmap beyond the project and the water utility (e.g. within the larger and longer sectoral and bioregional context) as well as also study the co-evolution of interventions targeting particular leverage points (e.g. in what specific and manifold ways could "a small shift in one thing produce big changes in everything"). As per our above cautionary notes (regarding what can be considered a 'transition' case and our critical understanding of CE), more expansive case/practice research would help us to more carefully position this (and other) cases in the debate over 'transition' versus 'transformation' research and, even, in relation to what Meadows calls system "transcendence."

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