Faculty of Design

2023

Choice Conditions and Behavioural Leverage Points in Complex and Adaptive Systems

Schmidt, Ruth

Choice Conditions and Behavioural Leverage Points in Complex and Adaptive Systems

Ruth Schmidt

Applied behavioural design solutions and behavioural public policy interventions often start with the presumption that the environments into which they will be placed are stable, yet many behavioural policies and interventions occur within complex system contexts that are likely to change over time. As a result, while creating targeted, evidence-based solutions to address discrete behaviours in users' immediate environments—often referred to as improved 'choice architecture'—can help achieve directed behavioural change, behavioural design practitioners are also likely to benefit from new strategies that can help them see how larger system forces will impact (or be impacted by) new solutions. This suggests that designing for behaviour within complex systems may benefit from ways to understand how system and institutional 'plumbing'—the underlying choice conditions, or 'choice infrastructure'— enables and shapes behaviours, as well as how design efforts must recognise where behaviours, judgement, and decision-making are constrained by broader cultural or institutional ideologies that contribute to underlying paradigms, norms, and belief systems.

This paper proposes a model that practitioners can use to systematically capture various system forces that may impact human and system behaviour, as well as how these tensions might influence each other or support emergent behaviours and system conditions over time. The model takes the form of a matrix created by two complementary dimensions: first, the progressive scale of micro, meso, and macro system levels, and second, the increasingly embedded nature of system activity and mechanisms that build from targeted instances and interventions to underlying infrastructures that indirectly support behaviours, to

ideological influences on behaviour in the form of mental models or belief systems that bound and shape behaviour within systems. After describing the rationale and conceptual model for this view, the paper uses the example of responsible research assessment (RRA) reform as an illustrative case. It concludes by suggesting how further interrogating the matrix content can provide new opportunities for behavioural systems design, helping practitioners explore the notion of system stability in complex system contexts, determining where potential areas of leverage may exist in the form of emergent activity or 'hotspots', and preventing against the potential of unintended consequences or inaction.

Introduction

Behavioural science has traditionally excelled at encouraging targeted behavioural change through relatively low-cost, low-disruption interventions within well-defined, stable environments (Hallsworth & Kirkman, 2020). These solutions tend to employ findings from empirical research to help individuals achieve goals such as establishing healthier habits or becoming better savers; they have also been used globally at societal levels to promote better hygiene, reduce gender-based violence, and increase childhood vaccinations (OECD, 2017). Once placed into larger system contexts, however, these behavioural solutions may find themselves at the mercy of exogenous forces and infrastructural constraints that render interventions *brittle*, preventing them from working as effectively or as initially planned and increasing the risk that what works in one context may not work elsewhere or in the future (Schmidt & Stenger, 2021a; Ewart & Loer, 2020). Recent recognition that heterogeneity is a feature, not a bug, of behavioural solutions (Soman & Hossain, 2020; Bryan et al., 2021) further indicates the need to develop new ways to design for behaviour within systems that work across varied environments and audiences and create choice conditions for emergence, rather than with a mindset of correction.

The ability to effectively design for behaviour within complex systems is perhaps particularly necessary if behavioural design is to scale in application (Ewart et al., 2020; Howlett, 2019). This suggests that behavioural design will benefit from frameworks or strategies that allow practitioners to better understand how behaviours are entangled within present-tense system conditions and how those system conditions may change in the face of interventions designed to elicit specific forms of behavioural change. This paper first reinforces the need to work at micro, meso, and macro levels in order to understand behaviour at different system scales, and then suggests the value of augmenting behavioural design's traditional focus on immediate environments and *choice architecture* with more distributed *choice infrastructure*—the plumbing that indirectly scaffolds behaviours within systems—as well as insight into pervasive institutional ideologies that shape individuals' predispositions and postures toward choice. It then explores this model concretely through the case of responsible research assessment (RRA) reform to indicate its practical use, speculating on how it can help design practitioners diagnose behavioural entanglements within systems and expose where hotpots or emergent activity can provide insight into where to focus behavioural design efforts. It concludes by reflecting on several aspects of solving for behaviours within systems raised by this approach that demands further exploration, including recognising how ideologies and structures can reinforce unhealthy stability within systems, strategies for identifying opportunistic areas of potential disruption or emergence, and risks of potential unintended consequences inherent in system design.

From interventions for behavioural change to behaviour within systems

Despite a long history of diagnosing and designing conditions within a targeted, well-defined environment to achieve behavioural change in the form of improved choice architecture (The Behavioural Insights Team, 2014; OECD, 2019; Michie et al., 2011; Thaler & Sunstein, 2008), the evidence-based practice of applying insights from behavioural science to achieve targeted behavioural change has only more recently considered how system contexts and adaptation impact interventions (Schmidt & Stenger, 2021b). Yet many behavioural interventions are situated in conditions that are fluid or actively in flux, characterised by self-organising agents with emergent properties

and feedback loops that result in responsive, non-linear dynamics: in other words, within complex and adaptive systems (Kurtz & Snowden, 2003; Carmichael & Hadžikadić, 2019; Rutter et al., 2017). Failing to consider this complexity risks reducing the robustness of behavioural interventions, resulting in solutions that may become brittle due to variances in applied contexts, the impact of broader system dynamics on behavioural interventions, and the evolution of external conditions or end recipients of solutions (Schmidt & Stenger, 2021a).

In addition, behavioural design's tendency to situate preferred choices in self-interest as a key tenet of decision-making—often characterised as making people "better off, as judged by themselves" (Thaler & Sunstein, 2008)—is problematic in a systems context. Beneficial system outcomes may conflict with personal or self-interested ones, and the linear, aggregated accumulation of individual wins is often non-congruent with system success (van der Bijl-Brouwer & Malcolm, 2020). Further still, socio-technical systems (STS) theory and approaches that are conceptually and methodologically aligned with STS, such as Actor Network Theory (ANT), recognise that positioning humans as a centre of gravity in problem-solving overlooks the critical and complementary role of non-human agents in shaping choice conditions (Abbas & Michael, 2022). This suggests that approaches that recentre behaviour related to relationships, interactions, and dynamics between agents and entities—rather than focusing on individual humans or behaviours—may be beneficial when exploring, analysing, and designing conditions to support behaviour within complex systems (Sangiorgi, 2010; Schmidt & Stenger, 2021a).

As such, borrowing from systems design methodologies and insights promises to help behavioural design identify how current conditions inform and constrain behaviours within complex systems and create redesigned behaviourally informed solutions and conditions in the interest of generating beneficial, strategic system outcomes (van der Biji-Brouwer 2019). More broadly, doing so promises to expand the scope of behavioural design applications from discrete interventions optimised for human behavioural change to the broader remit of employing behavioural science to support a wider set of net-positive system activities that encourage more resilient, sustainable, and healthier systems.

Doing this systematically requires expanding on how behavioural practitioners see the interrelationships between systems activities and redefining the boundaries and territory of the system being explored. One way to achieve this consists of plotting two complementary axes: the first axis represented by micro, meso, and macro system scales, which indicate (respectively) individual components, institutional-level operations, and societal- and cultural-scale forces; and the second as the escalating nature of influences and mechanisms that shape behaviour: from individual instances or interventions (targeted/direct effects) to infrastructures (distributed/indirect effects), to ideologies (diffuse/implicit effects).

Levels within complex systems: Micro, meso, and macro scales

The designer Eliel Saarinen is famous for his reminder to design for multiple scales within a system and to "always design a thing by considering it in its next larger context—a chair in a room, a room in a house, a house in an environment, an environment in a city plan" (Hill, 2012). While each system level is itself a locus of invention, defined by its problem frames and potential solutions, system designers recognise that they are also irrevocably interconnected (Buchanan, 1992). As such, designing choice conditions for policy within systems requires attention to relationships between system components and agentic activity at micro, meso, and macro scales as much as on individual components themselves (Jilke et al., 2019; Maier & Cash, 2022).

In this case, the smallest unit level of individual offerings, agents, and outcomes operates within specific contexts at the *micro* level in the form of concrete actions and interactions between individual agents or artefacts. At the *meso* level are platforms, processes, and structures that facilitate the use and exchange of micro-level instances, which form the basis for relationships that support and connect components of the micro and macro levels. Finally, the *macro* level is represented by wider system-level dynamics and structures that perpetuate the informal norms and formal laws of social, ecological and/or technical systems and govern extra-institutional exchange systems and policies that maintain systemic stability and interoperability (Johnson, 2012).

Mechanisms for shaping behaviour: Interventions, infrastructure, and ideology

A second axis can be defined by the degree of explicitness by which system contexts and mechanisms shape behaviour, starting with *individual interventions or instances* of system activity that directly target behavioural change, to *infrastructures* that more indirectly inform behaviour through underlying 'plumbing,' to tacit *ideological belief systems* and mental models that implicitly shape the conceptual foundation of individuals and systems that dictates what behaviours may even seem possible.

The most explicit influences and mechanisms on system function work directly on individual agents, entities, or policies. These can manifest organically, due to the environment within which they operate, or as deliberate interventions designed with the intent of achieving specific, well-defined results, such as 'nudges' or regulatory policies or constraints (Thaler & Sunstein, 2008). Broader system choice conditions may occur at the level of environmental contexts and structures within ecosystems—the 'choice infrastructure' (Schmidt, 2022)—that influence a wider array of system components and impact their behaviours more indirectly, implicitly, or at greater scale (Sangiorgi, 2010). This kind of system 'plumbing' can be tangible (e.g., technological or physical structures) and intangible (e.g., information channels, standards, and social hierarchies) and may operate simultaneously as a substrate to increase the effectiveness of targeted behavioural interventions while also creating conditions that indirectly shape behaviour (Darton & Horne, 2013; Kania et al, 2018)—such as in open plan office environments that foster certain behaviours and interactions, yet are not traditional behavioural interventions (Lindberg et al., 2016).

Finally, ideology—the embedded belief systems and mental models that shape individual, institutional, and societal postures toward choice—is perhaps the least direct, but most potent, mechanism for shaping behaviour. These conceptual frames are frequently hidden in plain sight, appearing invisible, natural, and even inevitable to participants (Schön & Rein, 1994). Changing these mental models, therefore, requires revising not just system rules but the conceptual schemas that define underlying system goals and implicitly shape how we behave. This makes disrupting mental models and

conceptual paradigms that underlay system goals and mindsets extremely difficult but a very powerful form of system change (Senge, 1990).

Mapping the territory of system behaviour

Assembling these axes, with the X-axis representing increasing levels of system scale and the Y-axis corresponding to the mutability of mechanisms that shape behaviour, yields a landscape of system forces on behaviour. Populating this territory with representative illustrations of system forces and mechanics helps us see how diverse system choice conditions influence behaviours at individual, collective, and institutional levels (Figure 1).

Analysing this landscape from a behavioural design standpoint provides several higher-level insights. First, interventions, infrastructure, and ideologies, while distinct, are frequently intertwined, as when infrastructure provides a fertile context for targeted interventions or when cultural ideology permeates institutions and impacts individual behaviours or rewards certain populations with the benefits of infrastructural investment while leaving others out. Conversely, infrastructural changes that result from policy—such as the adoption of seatbelts in cars—can overcome ideological resistance and the human tendency to cling to unpopular policies when they become normalised through familiarity (Pacheco, 2013; Gourville, 2005; Surowiecki, 2009). This highlights that creating change within systems may be a matter of balancing high-leverage opportunities for scale (which are more likely to be at the level of infrastructure and ideology) with the cost and investment required for effective implementation (Senge, 1990), but also that identifying the best starting place or constellation of efforts may require looking for opportunistic conditions that increase the likelihood of getting an initial foothold.

Figure 1. Mapping system conditions for behavioural change by scale and mechanism explicitness/embeddedness.

Whereas the model above shows a generic territory for exploring system mechanisms' effects on behaviour, employing it in the interest of a concrete behavioural systems issue can provide more insight into more practical use. Below, the issue of responsible research assessment (RRA) reform provides a contemporary challenge with which to explore how behaviours are shaped by system conditions that provoke intervention-, infrastructure-, and ideological-level change.

An illustrative case: Reforming academic assessment and 'impact'

While academia shares many issues related to hiring, promoting, and retaining talent with other industries and disciplines, research and researcher assessment also face unique conditions with significant implications on the career arcs of academic talent (Curry et al., 2020; Schmidt et al., 2021). Progressing through career paths requires the pursuit and accumulation of status indicators, typically in the form of citations, to

demonstrate 'impact'; this binds institutional and researcher interests tightly to those of academic publishers and grant-making bodies and often results in pitting researchers' self-interests at against system fitness and sustainability. As such, academic research assessment exemplifies a system whose relative stability belies unhealthy dynamics, suggesting that taking a systems lens toward entity, ecosystem, and paradigmatic behaviours may help identify the dynamics that make this system resistant to change and how inserting new interventions, infrastructures, and ideologies might help.

Interventions: Identifying opportunities for targeted behavioural change

Academics tend to be solo operators, with career progression often defined by competition for scarce resources or opportunities that result in a heavy emphasis on individual accomplishments. It is also beset by the same biases in hiring and promotion as many other industries. To overcome this, academia has long employed micro-level behavioural interventions such as blinded resumes or auditions to reduce hiring bias (Goldin & Rouse, 2000; Bohnet, 2016), which more recently have been augmented by new RRA-informed approaches such as the use of narrative CVs that promote holistic descriptions of research impact over quantitative metrics and the use of frameworks like CRediT to represent a more nuanced view on scholarly contributions (Lacchia, 2021; Holcombe, 2019).

Meso-level institutional interventions to complement these approaches escalate design for behaviour to an institutional level, as exemplified by studies indicating that automatically putting both men and women up for competitive promotions can reduce gender inequities in career progression (He et al., 2021). Finally, examples of forcing change at the macro-level of systems can be seen in policies to increase uptake of open data protocols and make funded research publicly available in the US, parallel to Europe's COAlition S embraced by funding agencies (Nelson, 2022; cOAlition S, 2021). In each case, these interventions start with a distinct behavioural goal—encouraging more diverse hires or promotions or open access data sharing, respectively—that informs intervention design.

Infrastructure: Modifying scaffolds that support ecosystem behaviours

Many ecosystem-level behaviours in academia are supported and constrained by system infrastructures in the form of institutional processes and structures that shape decisions and actions without driving specific behaviour change or pursuing a singular, preferred outcome. In the case of RRA, the benefits of establishing new infrastructural conditions for micro-level behaviours can be seen in examples such as allowing career researchers to participate in review committees and exposing them to processes that would otherwise remain opaque (Rutgers University, 2022). At the meso-level of institutions, tools such as SPACE (Schmidt, 2022) and INORMS Research Evaluation Group's SCOPE frameworks (Himanen & Gadd, 2019) enable organisations to build research reform capacity through guidelines that are more directional than prescriptive and designed to cultivate institutions' abilities to flexibly foster contextually appropriate strategies that align with their organisational values.

While intra-institutional infrastructure typically operates under a coherent, centralised set of rules, the wider macro-level research assessment reform ecosystem is comprised of a global assortment of academic institutions, scholars, governing bodies, publishers, and grantmaking entities, all of which have independent infrastructures, goals, and measures of success while also remaining reliant on others' behaviours to maintain system stability. The pursuit of citations, for example, forces researchers into playing a game whose rules are set by journals and held in place by journal infrastructures; the perceived lack of alternative mechanisms to generate scholarly currency and prestige required for researcher advancement (e.g., citations, the ability to network), hold this stable, yet undeniably inequitable, system in place (Rouhi et al., 2022). Indeed, because infrastructure often acts as a conduit for information and access, identifying where existing structures benefit some populations and penalise others is often an important first step in creating greater system equity.

Ideologies: Recognizing the power of paradigms as a medium for behaviour

The ideological underpinnings of research assessment run deep, inculcated by notions of academia as a calling, disciplinary traditions that keep fields siloed, and the infamous mantra of publish-or-perish. Academia's narrowly defined sense of impact as citations or publications in high journal impact factor (JIF) journals is also a manifestation of ideology, which results in perverse incentives that influence the judgment, decision-making, and behaviour of researchers, grant-making entities, and publishers alike.

Internalised belief systems about attaining academic success subsequently feed micro-level researcher behaviour; for example, perceptions that novel or interdisciplinary work will take longer to get cited or fail to find a home at a highly ranked journal can actively dissuade researchers who rely on publications and citations for advancement from pursuing certain research agendas in favour of less risky paths to promotion (Stephan et al., 2017). At a meso-level, institutional pressures to pursue funds and prestige often result in rewarding researchers with grant track records over those with less obviously lucrative qualities or focusing on metrics that drive rankings and ratings over more qualitative goals for diversity, equity, and inclusion (DEI), which are often espoused as core values but are harder to quantify (Schmidt et al., 2021).

Finally, the macro-level effects of larger-scale societal norms on academic system ideologies often manifest as beliefs about the value of scholarly achievement and even the very purpose of education. This has been unusually fraught in the recent US context, reflected in efforts to emphasise ideologies of 'useful' disciplines vs. 'optional' ones that value critical thinking, including sociology, anthropology, or gender and ethnic studies. Ideologies external to academia also play a context-setting role; societal paradigms about caretaking responsibilities disproportionately impact women's abilities to make professional gains, especially in the wake of the Covid-19 pandemic (Clay, 2022) that exacerbated drains on women's productivity in authorship, research capacity, attaining funding, and networking (Alon et al., 2020; Shockley et al., 2021; Pinho-Gomes et al., 2020). Coupled with increasing conservative ideological pushback to DEI programs, this threatens to further paralyse an unhealthy system by diluting whose perspectives are heard and perpetuated.

Populating these issues and approaches into the matrix format presents a more holistic view of choice conditions present in RRA systems (Figure 2), allowing us to see areas of activity, gaps, and potential relationships between individual forces that can inform potential opportunities to intervene.

Seen in the context of RRA, the matrix reveals a few interesting things. While the number of items populating any one cell or row is not necessarily an indication of its importance, the preponderance of items related to ideology reveals clues to the entrenched nature of academic behaviours. The lack of activity in certain areas of the terrain is also enlightening; for example, the heavy representation in interventions compared with infrastructural solutions suggests that more might be explored at the level of institutional structures and processes. Finally, seeing where various activities reinforce one another can provide a starting point for identifying where redundancy might feed system resilience and, conversely, where breaking one link in the chain or cultivating newly emergent activity into a critical mass might cascade into other areas or provide an opening for new ways of operating.

Implications for systemic behavioural design

In addition to providing insight into where an accumulation of system forces might amplify existing tendencies or where tensions indicate areas are potentially ripe for disruption, using the matrix to reflect upon the landscape of system conditions and behavioural activities can help practitioners recognise how centres of gravity may be holding current systems in place, as well as where emergence, outliers, and hotspots might demonstrate potential for change.

Centres of gravity and system stability

Systems—even unhealthy ones or those in flux—are often ideologically structured to resist change. Recognising where system structures and dynamics force behaviours to revert to the norm can supply insight into what holds these systems in place: What system conditions seem to impose a kind of gravitational pull? Which conditions may not show up frequently, but which display a kind of institutional 'charisma' or outsize influence when present?

Medium or mechanism of change	Micro	Meso	Macro
Ideology Predispositions that conceptually frame how choice is perceived	Internalized 'publish or perish' pressure Academia seen as a 'calling' JIF and citations = research quality	Prioritizing rankings and rating to demonstrate prestige	Narrow notions of academic 'impact' Purpose of education Heteronormative notions of caregiving
Infrastructure Underlying contextual plumbing that informs functionality/access	Early career researcher (ECR) participation on review panels to learn the ropes	SPACE and SCOPE frameworks	System of peer review System of journal impact factor (JIF) and citations as academic currency
Instances & Interventions Targeted situations or strategies designed to elicit behavioral change	Narrative CVs CRediT framework Blinded auditions or resumes	Barriers to DEI in the form of historical approaches to hiring Auto-nominations for promotions to increase gender parity	Open data requirements and COAlition S
	Micro Situated offerings and settings	**Meso** Organizational or community structures	**Macro** Sociotechnical systems/policy

System level

Figure 2. Behavioural barriers and mechanisms for change in the context of responsible research assessment (RRA) reform

Stable systems are often built upon positive feedback loops, macro-level rules, and power dynamics that appear normal due to their pervasiveness. However, they are infused with ideologies that fundamentally limit the ability to conceive new solutions (Peters, 2020; Colfer & Baldwin, 2016). Recognising where ideologies hold behaviour captive can provide clues to the paradigms that hold systems in place; this is especially important given that attempting to introduce new ideological change at any level is often constrained by the fact that a system's capacity to change is limited by the opportunities that are conceptually available to its participants (Wiener, 1985).

In addition to limiting conceptions of what is possible, systems' tendencies to revert to norms dictated by their underlying ideologies suggest that significant system impact may be less likely to emerge from those already in power than outsiders who would benefit from disruption. Indeed, a notable recent RRA innovation—eLife's 2022 decision to forego traditional peer review and promote review transparency—arose from an 'outsider' publication that perhaps had less to lose from disrupting the status quo (Else,

2022; Saenen et al., 2021). This illustrates how even seemingly minor bottom-up agitation can supply a spark and potential starting point for meaningful change by making alternatives visible and, therefore, increasingly perceived as possible on a wider scale.

Opportunism, outliers, and emergent self-organising

Donella Meadows' list of leverage points of increasingly potent strategies for systemic behavioural change designates the "power to add, change, evolve, or self-organize system structures" as the fourth most powerful of the set (Meadows, 1999). This suggests several related questions in the context of behavioural design within systems: Where are early signals of emergent new practices or conditions in flux? Where might instances of unusual activity or positive deviance supply insight into how exceptions might take hold against the usual norms?

Behavioural interventions tend to emphasise explicit behavioural change, which can accidentally overlook how behaviours emerge organically from choice conditions or as secondary effects, as well as how these emergent functions may themselves become significant system forces (Boulton et al., 2015; Schmidt & Stenger, 2021b). Yet there is increasing evidence that complex systems deliberately designed to foster self-organisation, learning, and creativity can lead to emergent behaviours and relationships that increase overall system benefits and resilience (Birney, 2014; Stacey, 2006; Wheatley, 2006; Hasan, 2014). Seeking opportunities to support emergence also reinforces findings that employing generalised principles can yield more effective, creative, and humane outcomes than forcing participants to adhere to strict rules or external processes (van der Bijl-Brouwer & Malcolm, 2020; Jones, 2014). This reinforces Elinor Ostrom's work that suggests cultivating processes within self-organising communities can increase the community's ability to effectively institute adaptation relative to their particular goals (Ostrom, 1990).

It also suggests the value of developing a deeper understanding of how conditions within complex system settings can opportunistically spur emergent behaviours in unplanned, even unexpected, ways. This aligns with recent behavioural arguments that recognise the value of agency in behavioural interventions (Reijula & Hertwig, 2022; Banerjee & John, 2021) and indicates that well-designed choice infrastructure has the

potential to raise the bar for solutions while also providing room for emergent and personalised solutions (Schmidt, 2022). When principles are used generatively—as in those used in 'universal design' (Connell et al., 1997)—they can serve as platforms for invention and increase solution extensibility by providing criteria that enable many possible good solutions for diverse audiences without defining a single perfect instance, while simultaneously avoiding tendencies to meet just-good-enough minimum standards (Serlin, 2012).

Unintended consequences

The use of evidence-based approaches to policy and systems design boosts confidence in the potential to deliver successful outcomes, yet even thoughtfully designed solutions can become brittle under complex system conditions, resulting in unintended consequences or changing the system into which they are placed (Schmidt & Stenger, 2021a). For example, interventions designed to increase the diversity of applicants or new hires may be successful but also create new system tensions when the minoritised individuals disproportionately inherit mentorship responsibilities or when insufficient institutional support undermines retention. Proactively probing for unexpected outcomes through dark logic methods or leading metrics to complement lagging ones can help identify these tensions in advance and enrich designers' abilities to design solutions accordingly (Bonell et al., 2014; Schmidt & Stenger, 2021b; Emery et al., 2021).

Regardless, any fear of introducing unintended consequences must also be tempered with the reality that inaction itself carries risks. Where evidence-based practice excels at indicating likely positive benefits of implementing an intervention, persuasively calculating the financial and opportunistic risk of not intervening is a more difficult challenge that is only amplified when designing within complex systems. Developing methods to simulate and prototype the implications of implementing behavioural solutions in conditions of complexity—as well as the implications of failing to do so—is deserving of further exploration and attention.

Conclusion

Many significant challenges occur within systems contexts characterised by complexity and adaptation, requiring designers to intervene in systems that are designed to be resistant to change and navigate the reality that progress is not a straight line nor always design-led. Overcoming this requires practices and methods that leverage behavioural insights and approaches but also expand beyond them to support system structures that are likely to change over various contexts and time. Augmenting traditional behavioural interventions with greater insight into choice infrastructure and ideological foundations for choice builds on behavioural science's proven ability to deliver targeted behavioural change while also recognising where conditions that impact behaviour are multi-faceted and interwoven.

It is also worth noting that conceptualising and implementing systems-level behavioural interventions represents a significant methodological shift for behavioural design. Analytic approaches well-suited to more discrete behavioural challenges may be ill-equipped to navigate the complex, entangled, and emergent nature of systems; where traditional analytical policy-making processes may continue to work for complicated scenarios, they are not a satisfactory substitute in complex challenges that resist breaking problems down into constituent parts and aggregating resulting solutions (van Wijk et al., 2029; Snowden & Boone, 2007). As such, behavioural design practice will benefit from systems methods that solve for connections, interactions, and dynamics (Van der Bijl-Brouwer & Malcolm, 2020) and a more relational and infrastructural approach to designing for judgment, decision-making, and behaviour that builds on—while not replacing—behavioural design's evidence-based approach by incorporating abductive problem-solving approaches from design research and strategy (Schmidt, 2020).

References

1. Abbas, R. & Michael, K. (2022). '*Socio-Technical Theory: A review*' in S. Papagiannidis (ed.), *TheoryHub Book*. http://open.ncl.ac.uk
2. Alon, T., Doepke, M., Olmstead-Rumsey, J., & Tertilt, M. (2020). *The impact of COVID-19 on gender equality* (No. w26947). National Bureau of Economic Research.

3. Banerjee, S., & John, P. (2021). Nudge plus: Incorporating reflection into behavioral public policy. *Behavioural Public Policy,* pp. 1–16. doi:10.1017/bpp.2021.6

4. Bertrand, M., Mullainathan, S., & Shafir, E. (2006). Behavioral economics and marketing in aid of decision making among the poor, *Journal of Public Policy & Marketing*, 25(1), 8–23.

5. Birney, A. (2014). *Cultivating System Change: A Practitioner's Companion*, Dō Sustainability, Oxford

6. Bonell, C., Jamal, F., Melendez-Torres, G.J., & Cummins, S. (2015). 'Dark logic': theorising the harmful consequences of public health interventions. *Journal of Epidemiology and Community Health,* 69:95–98. doi:10.1136/jech-2014-204671

7. Bohnet, I. (2016). *What works*. Cambridge: Harvard University Press.

8. Boulton, J. G., Allen, P. M., & Bowman, C. (2015). *Embracing complexity: Strategic perspectives for an age of turbulence*. Oxford: Oxford University Press.

9. Bryan, C.J., Tipton, E. & Yeager, D.S. (2021). Behavioural science is unlikely to change the world without a heterogeneity revolution. *Nature Human Behavior* 5, 980–989. doi:10.1038/s41562-021-01143-3

10. Buchanan, R. (1992). Wicked Problems in Design Thinking. *Design Issues* 8(2), 5–21. doi:10.2307/1511637

11. Carmichael, T. & Hadžikadić, M. (2019). The Fundamentals of Complex Adaptive Systems. In *Complex Adaptive Systems. Understanding Complex Systems*. Springer, Cham.

12. Clay, R.A., ((2022) 2022). Trends Report. *American Psychological Association* 53(1), 66.

13. cOAlition S. (2021). Plan S: Principles & Implementation. https://www.coalition-s.org/addendum-to-the-coalition-s-guidance-on-the-implementation-of-plan-s/principles-and-implementation/

14. Colfer, L. & Baldwin, C. Y. (2016). The Mirroring Hypothesis: Theory, Evidence and Exceptions. *Harvard Business School Finance* (Working Paper 16-124), doi:10.2139/ssrn.2770675

15. Connell, B.R., Jones, M., Mace, R., Mueller, J., Mullick, A., Ostroff, E., Sanford, J., Steinfeld, E., Story, M., & Vanderheiden, G. (1997). The Principles of Universal Design. *NC State University, The Center for Universal Design.* https://design.ncsu.edu/research/center-for-universal-design/

16. Curry, S., de Rijcke, S., Hatch, A., Pillay, D., van der Weijden, I., & Wilsdon, J. (2020). The changing role of funders in responsible research assessment: progress, obstacles and the way ahead (RoRI Working Paper No.3). *Research on Research Institute*. doi:10.6084/m9.figshare.13227914.v2

17. Darnton, A. & Horne (2013). ISM Model, Scottish Government

18. Else, H. (2022). *eLife* won't reject papers once they are under review — what researchers think. *Nature*. https://www.nature.com/articles/d41586-022-03534-6

19. Emery, A., de Molière, L. Lang, P., Nicolson, M., & Prince, E. (2021). IN CASE: A behavioural approach to anticipating unintended consequences. *Government Communication Service*.

20. Ewert, B., & Loer, K. (2020). Advancing behavioural public policies: In pursuit of a more comprehensive concept. *Policy & Politics*. doi:10.1332/030557320X15907721287475

21. Ewert, B., Loer, K., & Thomann, E. (2020). Beyond nudge: Advancing the state-of-the-art of behavioural public policy and administration. *Policy & Politics*. doi:10.1332/030557320X15987279194319

22. Goldin, C., & Rouse, C. (2000). Orchestrating impartiality: The impact of "blind" auditions on female musicians. *American economic review*, 90(4), 715–741.

23. Gourville, J. T. (2005). The curse of innovation: A theory of why innovative new products fail in the marketplace. *HBS Marketing Research Paper* 05-06.

24. Hallsworth, M., & Kirkman, E. (2020). *Behavioral Insights*. MIT Press

25. Hasan, H. (2014). Complexity theory. In H. Hasan (Eds.), *Being Practical with Theory: A Window into Business Research*, pp. 49–54. Wollongong, Australia: THEORI.

26. He, J. C., Kang, S. K., & Lacetera, N. (2021). Opt-out choice framing attenuates gender differences in the decision to compete in the laboratory and in the field. *PNAS,* 118 (42), e2108337118. doi:10.1073/pnas.2108337118

27. Hill, D. (2012). Dark Matter and Trojan Horses: A Strategic Design Vocabulary. Russia: Strelka Press.

28. Himanen, L. & Gadd, E. (2019). Introducing SCOPE – a process for evaluating responsibly. https://thebibliomagician.wordpress.com/2019/12/11/introducing-scope-aprocess-for-evaluating-responsibly/

29. Holcombe, A. O. (2019). Contributorship, Not Authorship: Use CRediT to Indicate Who Did What. *Publications*, 7(3), 48. MDPI AG. doi:10.3390/publications7030048

30. Howlett, M. (2019). *Designing Public Policies: Principles and Instruments*. Routledge.

31. Jilke, S., Olsen, A. L., Resh, W., & Siddiki, S. (2019). Microbrook, mesobrook, macrobrook. *Perspectives on Public Management and Governance*, 2(4), 245–253.

32. Johnson, J. (2012). Cities: systems of systems of systems. In Portugali, Juval; Meyer, Han; Stolk, Egbert and Tan, Ekim (Eds.) *Complexity Theories of Cities Have Come of Age.* Springer Complexity. Berlin: Springer-Verlag: 153-172. doi:10.1007/978-3-642-24544-2_9

33. Jones, P. H. (2014). "Systemic Design Principles for Complex Social Systems," in *Social Systems and Design*, Gary S. Metcalf (ed.). Tokyo: Springer.

34. Kania, J., Kramer, M., & Senge, P. (2018). Water of systems change, Retrieved from http://efc.issuelab.org/resources/30855/30855.pdf

35. Kurtz, C. & Snowden, D. (2003). The new dynamics of strategy: Sense-making in a complex and complicated world. *IBM Systems Journal,* 42(3), 462-483.

36. Lacchia A. (2021). A new form of CV for researchers. *Nature Index*. Retrieved 20 Jan 2023 from https://www.natureindex.com/news-blog/new-form-of-cv-resume-for-researchers-scientists

37. Lindberg, C. M., Tran, D. T., & Banasiak, M. A. (2016). Individual Differences in the Office: Personality Factors and Work-Space Enclosure. *Journal of Architectural and Planning Research*, 33(2), 105–120.

38. Maier, A., & Cash, P. (2022). Designing for human behaviour in a systemic world. In A. Maier, J. Oehmen, & P. Vermaas (Eds.), *Handbook of Engineering Systems Design* (1 ed., 1-34). Springer. doi:10.1007/978-3-030-46054-9_16-1

39. Meadows, D. (1999). *Leverage Points: Places to intervene in a system*. Hartland: The Sustainability Institute

40. Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, 6(1), 42. doi:10.1186/1748-5908-6-42

41. Nelson, A. (2022). Memorandum for the heads of executive departments and agencies. *US Office of Science and Technology Policy*.

https://www.whitehouse.gov/wp-content/uploads/2022/08/08-2022-OSTP-Public-Access-Memo.pdf

42. OECD. (2017). *Behavioural Insights and Public Policy: Lessons from Around the World*. Paris: OECD Publishing. doi:10.1787/9789264270480-en.

43. OECD. (2019). *The BASIC Toolkit*. Paris. OECD.

    https://www.oecd.org/gov/regulatory-policy/tools-and-ethics-for-applied-behavioural-insights-the-basic-toolkit-9ea76a8f-en.htm

44. Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge: Cambridge University Press.

45. Pacheco, J. (2013). Attitudinal Policy Feedback and Public Opinion: The Impact of Smoking Bans on Attitudes towards Smokers, Secondhand Smoke, and Antismoking Policies, *Public Opinion Quarterly,* 77(3), 714–734, doi:10.1093/poq/nft027

46. Peters, B. Guy (2020). Designing institutions for designing policy, *Policy & Politics, 48* (1), 131–147. doi:10.1332/030557319X15579230420090

47. Pinho-Gomes, A. C., Peters, S., Thompson, K., Hockham, C., Ripullone, K., Woodward, M., & Carcel, C. (2020). Where are the women? Gender inequalities in COVID-19 research authorship. *BMJ global health,* 5(7), e002922. doi:10.1136/bmjgh-2020-002922

48. Reijula, S., & Hertwig, R. (2022). Self-nudging and the citizen choice architect. *Behavioural Public Policy,* 6(1), 119–149. doi:10.1017/bpp.2020.5

49. Rouhi S., Beard R., & Brundy C. (2022). Left in the cold: the failure of APC waiver programs to provide author equity. *Science Editor,* 45(1), 5–13. doi:10.36591/SE-D-4501-5

50. Rutgers University (2022). Sociology Graduate Handbook, *Rutgers University*.

    https://sociology.rutgers.edu/images/academics/graduate/Graduate_Student_Handbook_4.21.22.pdf

51. Rutter, H, Savona, N., Glonti, K., Bibby, J., Cummins, S., Finegood, D.T., Greaves, F., Harper, L., Hawe, P., Moore, L., Petticrew, M., Rehfuess, E., Shiell, A., Thomas, J., & White, M. (2017). The need for a complex systems model of evidence for public health. *The Lancet,* 390(10112).

52. Saenen B., Hatch A., Curry S., Proudman V., & Lakoduck A. (2021). Reimagining academic career assessment: Stories of innovation and change. *European University Association.*

https://eua.eu/resources/publications/952:reimagining-academic-career-assessment-stories-of-innovation-and-change.html

53. Sangiorgi, D. (2010). Transformative Services and Transformation Design, *International Journal of Design 5*(1), 29–40. http://ijdesign.org/index.php/IJDesign/article/view/940.

54. Schmidt, R. (2022). A model for choice infrastructure: Looking beyond choice architecture in Behavioral Public Policy. *Behavioural Public Policy,* pp. 1–26. doi:10.1017/bpp.2021.44

55. Schmidt, R., & Stenger, K. (2021a). Behavioral brittleness: The case for strategic behavioral public policy. *Behavioural Public Policy,* 1-26. doi:10.1017/bpp.2021.16

56. Schmidt, R. & Stenger, K. (2021b). Roughly right: A model for behavioral planning. *Strategic Design Research Journal,* 14(1):138-148. doi:10.4013/sdrj.2021.141.12

57. Schmidt, R., Curry, S., & Hatch, A. (2021). Creating SPACE to evolve academic assessment. *eLife.* doi:10.7554/eLife.70929

58. Schmidt, R. (2020). Strange bedfellows: Design research and behavioral design, in Boess, S., Cheung, M. and Cain, R. (eds.), *Synergy–DRS International Conference 2020*, 1443–1457. doi:10.21606/drs.2020.252.

59. Senge, P.M. (1990). *The Fifth Discipline: The Art and Practice of the Learning Organization*. New York: Doubleday.

60. Schön, D., & Rein, M. (1994). *Frame reflection: Toward the resolution of intractable policy controversies*. Basic Book.

61. Serlin, D. (2012). Architecture and Social Justice: Independent Living on Campus. *Boom: A Journal of California*, 2(1), 3–54. doi:10.1525/boom.2012.2.1.53.

62. Shockley, K. M., Clark, M. A., Dodd, H., & King, E. B. (2021). Work-family strategies during COVID-19: Examining gender dynamics among dual-earner couples with young children. *Journal of Applied Psychology, 106*(1), 15–28. doi:10.1037/apl0000857

63. Snowden, D. J. & Boone, M.E. (2007). A Leader's Framework for Decision Making. *Harvard Business Review* 85(11): 59–70. https://hbr.org/2007/11/a-leaders-framework-for-decision-making

64. Soman, D., & Hossain, T. (2020). Successfully scaled solutions need not be homogenous. Behavioural Public Policy, 1–10. doi:10.1017/bpp.2020.24

65. Stacey, R. (2006). Ways of Thinking About Public Sector Governance in *Complexity and the Experience of Managing in Public Sector Organizations*, ed. Ralph Stacey and Douglas Griffin (London: Routledge)

66. Stephan, P., Veugelers, R. & Wang, J. (2017). Reviewers are blinkered by bibliometrics. *Nature,* 544, 411–412. doi:10.1038/544411a

67. Surowiecki, J. (2009) Status Quo Anxiety. *The New Yorker.* https://www.newyorker.com/magazine/2009/08/31/status-quo-anxiety

68. Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. New Haven: Yale University Press.

69. The Behavioural Insights Team. (2014). *EAST: Four simple ways to apply behavioural insights*. London. BIT. https://www.behaviouralinsights.co.uk/wp-content/uploads/2015/07/BIT-Publication-EAST_FA_WEB.pdf

70. van der Bijl-Brouwer, M. and Malcolm, B. (2020). Systemic Design Principles in Social Innovation: A Study of Expert Practices and Design Rationales. *She Ji: The Journal of Design, Economics, and Innovation,* 6(3), 386–407. doi:10.1016/j.sheji.2020.06.001

71. van der Bijl-Brouwer, M. (2019) Problem Framing Expertise in Public and Social Innovation. *She Ji: The Journal of Design, Economics, and Innovation,* 5(1), 29–43. doi:10.1016/j.sheji.2019.01.003.

72. van Wijk, J., Zietsma, C., Dorado, S., de Bakker, F. G. A., & Martí, I. (2019). Social Innovation: Integrating Micro, Meso, and Macro Level Insights. *Institutional Theory. Business & Society,* 58(5), 887–918. doi:10.1177/0007650318789104

73. Wheatley, M. J. (2006). *Leadership and the New Science: Discovering Order in a Chaotic World.* Oakland: Berrett-Koehler Publishers, Inc.

74. Wiener, J. (1985) Women's history on trial. *The Nation*, 241, 7 Sept. 1985, 161. link.gale.com/apps/doc/A3928021/AONE?u=anon~eeb4a7b7&sid=googleScholar&xid=615bff1

Author

Ruth Schmidt, Associate Professor, Institute of Design at Illinois Tech, https://ruthkschmidt.com, schmidt@id.iit.edu