

# WHAT IS SYSTEMS THINKING AND HOW DOES IT APPLY TO PREVENTION IN TAPPC?

A Discussion Paper prepared by the Systems Science and Implementation Capacity

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## Introduction

The Australian Prevention Partnership Centre (TAPPC) was set up to take a systems approach to preventing chronic disease. What does this mean? Can systems thinking improve the effectiveness and efficiency of our efforts to prevent chronic disease and promote health? How? What evidence is there that systems thinking will advance prevention? These questions are a focus of the research program in the Centre.

The purpose of this paper is two fold:

- 1) to develop some common language around the ways TAPPC investigators and collaborators engage with systems terminology and systems thinking in prevention. If we can know “where we are at” we will be better place to make advancements.
- 2) to identify examples of how the TAPPC work program takes a systems approach to prevention

## What is a System?

One of the most prominent scholars in the field of systems thinking is Donella Meadows. She defines a system as “a set of things—people, cells, molecules—interconnected in such a way that they produce their own pattern of behavior over time.”<sup>1</sup> A system is “a group of interacting, interrelated and interdependent components that form a complex and unified whole”.<sup>2</sup>

Key concepts are

- elements or components that make up the system parts
- relationships and interactions among each of the elements or components
- pattern of the system as a whole over time (called its dynamic behavior)

Systems-thinking has gained prominence in recent years in public health, as indicated by special issues in prominent public health journals: the *American Journal of Public Health*<sup>4</sup> the

*American Journal of Community Psychology and Health Education and Behaviour.*<sup>3-5</sup> This may be because solving problems in the familiar ways in public health has become too hit-and-miss: the problem of “weak prevention.”<sup>6</sup>

Systems tend to be nested within other systems: e.g., cells exist within tissues, tissues exist within organs, organs exist within people, who tend to be part of families, that are part of communities, located in countries and so on. This means that one person’s systems-view can be another person’s micro-component part of a bigger system. It all depends on the viewpoint being adopted and the scale of the analysis (that is where one places the bounds around the system of interest).

Boundary judgments define what is included and excluded, what is valued and what is ignored. One aspect of systems research is how a boundary judgment frames a problem and how this affects the success of different types of solutions.

As an example, many health problems have been reduced in the last 30 years as a result of medical interventions that treat people (the individual body as a system). But further gains in health may only be possible with approaches that widen the boundaries and consider ‘systems’ that extend beyond the human body. For example, people living in high-stress neighbourhoods, (social systems) where there is graffiti, rubbish, disorder, and high threat of crime, have higher rates of death than people who live in less stressful environments, even if they have jobs and a steady income, and a lifestyle conducive to health (i.e., they don’t smoke, do not abuse alcohol, have a good diet and exercise regularly) and they recover less well from routine medical procedures, such as heart surgery.<sup>7</sup> Similarly, researchers in adolescent health have suggested that interventions to improve housing would have a greater impact on future rates of sexually transmitted infections, alcohol use and depression than current preventive efforts. Even before sexual debut, issues like unstable housing and ongoing threat to personal safety, predict whether or not a teenager is likely to engage in sexually risky behavior.<sup>8</sup> This means that effective system interventions may be ones that change the boundaries within which an intervention operates.

### **What is Systems Thinking?**

First, it is **a perspective**, or a way of seeing things that “sharpens one’s awareness” of the whole, *and* the elements that make up the whole *and* the way the elements all inter-relate with each other to cause the system to behave in the way that it does. For this reason, systems-thinking is also occasionally described as ‘big picture’ thinking.<sup>9</sup>

Second, it refers to the use of particular **tools or methods** that help one describe, understand, or otherwise analyse a system.<sup>10</sup> Some of these tools act as mental short cuts to support the process of thinking about public health issues as problems with systems.<sup>11,12</sup> Others such as causal loop diagrams enable us to depict the elements in a system and the connections among them pictorially, which helps to highlight the complexity of some public health issues.<sup>13</sup> Yet others use mathematical equations to quantify the relationships among elements in the system, which allows one to simulate the impact of different interventions on the future behaviour of the system.<sup>14-15</sup>

Finally, systems-thinking refers to a specific **language or vocabulary** that is used to refer to characteristics of systems and their dynamic behavior over time. People talk of *reinforcing and balancing feedback loops* where changes in one part of the system have knock on effects that eventually amplify or dampen the initial change, or *non-linear effects* where

nothing seems to change despite huge effort until a tipping point is reached when a small push on one part of the system leads to a disproportionately large impact elsewhere.

Public health practitioners are often all too aware of the need to consider inter-relationships among causal factors and the complexities that this causes. In effect, they are already systems thinkers though they may not use the language or the terminology. So another of TAPPC's research activities will consider whether or not there is any advantage in understanding theories of systems change and using systems terminology to legitimize, strengthen, challenge and/or reconfigure current practice.

### **What is the Prevention System?**

Most people have a concept in mind when they hear the term "health system." We believe there is a prevention system as well, albeit right now, a partially hidden and incomplete one. Part of the role of TAPPC is to uncover the elements of the prevention system in Australia and help work out ways in which the different elements could be better connected to work together more effectively, efficiently and produce more equitable health outcomes.

The US Centres for Disease Control defines the public health system as "all public, private and voluntary entities that contribute to the delivery of essential public health services within a jurisdiction."<sup>16</sup> David Legge and colleagues coined a similar definition of the public health system in Australia: suggesting that it is made up by "those organisations, networks and groups whose work is in some degree organised explicitly around the project of public health."<sup>17</sup>

These definitions imply a tight boundary around the public health system. But is the public health system the same as the prevention system? Many people would say that they overlap but that they are different. Some of the elements of the prevention system were not designed explicitly to promote public health. For example, in Australia policies and programs that promote free access to education were designed for a different purpose (to promote education), but they are perhaps the biggest contributors to public health.

TAPPC will need to investigate such boundary issues in order to define the prevention system and attempt to resolve them. This will involve striking a balance between drawing a boundary wide enough to identify sufficient elements and organisational roles in the system to understand why health risks may be lower in some parts of the country than in others, and where and why prevention services and programs may be most effective; and narrow enough to make the task of understanding and acting within the prevention system 'doable'.

### **What Does it Mean to Take a Systems Approach to Prevention?**

There are a myriad of books, websites, software programs, modellers, journal articles and disciplines turning their attention to systems thinking right now. Colloquial use of the language, without recourse to definitions is also common.

What follows captures and names different ways in which practitioners and researchers appear to be using system concepts in relation to prevention at present. This is not a hierarchy.

**(1) *'Being systematic' about prevention***

Being systematic about prevention describes processes to transform sporadic or one off programs and partial investment in public health infrastructure into a regularised pattern of 'service' delivery. This may involve change to funding cycles, funding formulas, recruitment and placement of staff, reporting and accountability requirements, development of information and data for decision-making, and training in such fields as leadership and evaluation. The purpose is to increase reliability, efficiency, accountability and reach. A lot of the literature that supports this type of work overlaps with the fields of capacity building, scale up, institutionalisation and sustainability.<sup>18</sup>

**(2) *Working across 'different' systems to improve health***

The second approach recognizes that many of the determinants of health lie in systems outside of prevention: in the food system, the transport system, housing, and economic systems for example. Taking a systems approach involves working in and with these other systems. This could mean taking a 'health in all policies' approach,<sup>19</sup> or alternatively working to align objectives across sectors, giving favour to actions that promote health *and* improve outcomes in education, in transport, the economy and so on

**(3) *Recognising that the settings in which prevention action takes place (e.g., schools, worksites and communities) are ecological systems***

The third type of systems approach sees schools, worksites and communities as ecological systems in themselves, and that the effectiveness of health promotion and prevention practice can be improved with better understanding of the systemic characteristics of these settings (the interactions and dynamic complexity).<sup>20</sup> Ecological practice in health promotion often amounts to little more than acting on multiple levels.<sup>21</sup> It is more than this however. It involves understanding the natural dynamic in the system, how the levels interact with each other, and theorizing how an intervention will bring about systems-level change. So research in this area investigates how an intervention couples with the local system (e.g., how it embeds in local routines and talk),<sup>22</sup> how it changes roles and relationships, how it distributes resources and how it displaces (previous) activity. This is an advance on previous ways of working, which simply treated communities, schools and worksites as venues to access people, and deliver preventive interventions based on theorising individual change processes only. In other words, ecological systems thinking attempts to make full use of the power within the setting itself to create and reinforce change processes.<sup>23</sup>

**(4) *Explicit use of systems tools and systems theories to analyse and improve prevention practice***

This overlaps the category above and goes further to tap methods and ideas that have not yet been traditionally used in public health. Ecological systems thinking has a long history in the field of health promotion.<sup>24</sup> But only recently have prevention practitioners been accessing and using systems-methods first used in engineering,<sup>25,11</sup> management,<sup>26-28</sup> and mathematics and economics.<sup>29</sup>

Systems techniques have been used to:

- conceive how public health problems are generated and sustained, using modelling approaches that position the problem as an emergent outcome of the dynamic interactions among the parts of a larger complex system<sup>30</sup>
- enhance the effectiveness of a new or existing program by identifying forces in the system that may amplify or dampen likely effects<sup>15</sup>
- anticipate intended and unintended consequences in order to capture these in evaluation designs<sup>31</sup>
- describe the contexts into which programs and policies are placed in ways that capture how the dynamic of local context may work favourably or antithetically to the intervention<sup>31</sup>
- re-design system-level interventions, that is interventions for health improvement that move away from programs altogether and harness properties of systems. Examples include: interventions designed to change the mental models that practitioners have about a problem;<sup>32</sup> efforts to change the boundary within which a problem is being addressed to open up new opportunities to lever change;<sup>33</sup> attempts to better understand and tap into the processes of micro-adjustment made by “agents” (such as health care practitioners) in ways to bring about larger health improvement processes.<sup>29</sup>

Collectively, this effort represents a considerable departure from many aspects of traditional prevention or health promotion practice. Most program evaluation reports, for example, will describe the contexts within which, say, a new diabetes education program, or a sun smart policy is introduced. It is customary to describe contexts in terms of size, age and ethnic diversity of the population, rural/urban, types of government and non-government agencies involved, and possibly their size. But it is not customary to systematically report on how the new intervention aligns (or otherwise) with existing incentives, how cycles of review/ reflection/ evaluation may need to be rescheduled to be mutually supportive, whether existing information systems provide the right feedback and do so quickly enough to allow program implementation to be adjusted to changing circumstances, and readjusted if action does not seem to be effective.

Yet these are factors that are likely to be important not only for predicting success, they are vital to people who wish to replicate the success of the intervention in other jurisdictions. These are the dynamic system properties of the context.

### **How will system knowledge for prevention accumulate and grow?**

This is not yet a field where a systematic review on systems approaches to prevention will yield Level I evidence from randomised control trials on the value of systems thinking. The field is too new. Terms and language are used too variously. Besides, the terms and language of public health and disease prevention currently privilege more traditional ways of thinking about knowledge accumulation. So systems knowledge is not easy to identify.

But it would be a mistake to conclude that little knowledge has accumulated.

Public health researchers are publishing system-level interventions using keywords and terms in topic domains that describe population groups and risk factors. For example, one of the most successful system-level interventions in schools in Australia was the Gatehouse Project. It used a whole-school ethos changing, survey-feedback-action approach, achieving risk reductions in the order of 25-40% in smoking drinking and drug use.<sup>34-36</sup> While the authors wrote extensively about working at the system level in schools,<sup>37</sup> a researcher conducting a systematic review of systems approaches to prevention would likely not identify this project as a cluster randomised control trial that would be eligible for inclusion. So in the first instance, knowledge synthesis in systems approaches to prevention will need to use flexible methods to cast a wide net.

Also, because the field is relatively new, **knowledge synthesis** from case studies and quasi-experimental designs needs to be given early priority.

Further, because systems approaches privilege knowledge generation from practitioners,<sup>38</sup> TAPPC is devising ways to enable field-based insights on systems thinking to be gathered and shared in more prominent and deliberative ways. This is especially the case with complex adaptive systems where the lots of small local changes (adaptations) by the agents in the system (e.g., the clinician) add up to larger patterns overall, a concept known as emergence.<sup>39</sup>

For example, **Implementation Exchanges** are 2-3 hour meetings where practitioners and policy makers are invited to talk through the experience of scaling up a new program, implementing a new policy, adapting a program to a context or evaluating new initiative. We will use these opportunities to identify and discuss **new patterns** and **new ideas in systems practice** in prevention, and link practitioner experience back to theory and examples in the literature that may help boost, strengthen, legitimise and/or reshape field practice. The Knowledge Synthesis Capacity will also gather insights, wisdom and experience of systems knowledge in practice via **interviews** and **case studies**. Many practitioners and policy makers are systems-thinkers without using those terms or thinking of themselves as theorists. But they are. Resources within the Centre have been set aside for policymakers and practitioners to translate this knowledge into peer review publications. These interchanges are also expected to identify ideas for further research and testing.

See Table 1 for more examples of work across TAPPC and how it illustrates various ways of taking a systems approach.

**Table 1 Some examples of how TAPPC is taking a Systems Approach to Prevention**

1	Being systematic about prevention	<ul style="list-style-type: none"> <li>• Evaluation of the scale up of NSW Health’s Get Healthy at Work initiative within the Rapid Response Evaluation Capacity</li> <li>• Compiling the evidence on the cost effectiveness of prevention</li> <li>• Identifying the prevention workforce</li> </ul>
2	Working across different systems to improve health	<ul style="list-style-type: none"> <li>• Examining the food system in Australia to identify what is needed to create a healthy and equitable eating system</li> <li>• Developing and validating national liveability indicators associated with chronic disease risk factors and health outcomes</li> </ul>
3	Settings as ecological systems	<ul style="list-style-type: none"> <li>• ACT Health’s Whole of Government approach to healthy weights (e.g., the routines, practices and quirks of Education, Health and Community Services have to be understood together)</li> </ul>
4	Use of system tools to improve system practice	<ul style="list-style-type: none"> <li>• Modeling how/why patterns of alcohol consumption change over time and identifying points for intervention</li> <li>• Developing a picture of obesity causes and whether/how current approaches to prevention could be amplified and reinforced</li> </ul>

## REFERENCES

- 1 Meadows D. *Thinking in Systems – A Primer*. Vermont, Chelsea Green Publishing Company, 2009.
- 2 Waters Foundation. <http://watersfoundation.org/systems-thinking/definitions/> accessed on 14 July 2014.
- 3 McLeroy K. Thinking in systems. *American Journal of Public Health* 2006; 96: 403.
- 4 Foster-Fishman PG, Behrens TR. 2007. Systems change reborn: rethinking our theories, methods and efforts in human services reform and community based change. *American Journal of Community Psychology* 39:191-196.
- 5 Mabry PL, Milstein B, Abraido-Lanza AF, Livingood WC, Allegrante JP. Opening a window on systems science research in health promotion and public health. *Health Education and Behavior* 2013; 40: 5S.
- 6 Hawe P, Shiell A, Riley T. Theorising interventions as events in systems. *American Journal of Community Psychology* 2009; 43 (3-4): 267-276.
- 7 Pickett KE, Pearl M. Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. *Journal of Epidemiology and Community Health* 2001; 55 (2): 111-122.
- 8 Buffardi AL, Thomas KK, Holmes KK, Manhart LE. Moving upstream: eco-social and psychosocial correlates of sexually transmitted infections among young adults in the United States. *American Journal of Public Health* 2008; 98: 1128-1127.
- 9 Midgley G, Systemic intervention for public health. *American Journal of Public Health* 2006; 96 (3): 466–472
- 10 Williams B, Hummelbrunner R. *Systems Concepts in Action A Practitioners Toolkit*. Stanford CA, Stanford University Press, 2011.
- 11 Checkland P. Soft systems methodology: a 30-year retrospective. *Systems Research and Behavioral Science* 1999; 17: S11-S58.
- 12 Ulrich W, Reynolds M. Critical Systems Heuristics. In Reynolds M, Howell S. (eds) *Systems Approaches to Managing Change: A Practical Guide*. London: Open University Press, 2010.
- 13 Millen DR, Schriefer A, Lehder DZ, Dray SM. Mind maps and causal models: Using graphical representations of field research data. In CHI'97 Extended Abstracts on Human Factors in Computing Systems 1997: 265-266.
- 14 Hammond R, Complex systems modeling for obesity research. *Preventing Chronic Disease* 2009; 6 (3).



- 15 Homer. J., Milstein, B. Optimal decision making in a dynamic model of community health. Proceedings of the 37th Hawaii International Conference on Systems Science, 2004.
- 16 Centers for Disease Control. <http://www.cdc.gov/nphpsp/essentialservices.html>
- 17 Legge D, Rotem A, Waters J. System Wide Learning for Public Health. Report to the Commonwealth Department of Human Services and Health. Public Health Association, Canberra, 1995.
- 18 Milat AJ, King L, Bauman AE, Redman S. The concept of scalability: increasing the scale and potential adoption of health promotion interventions into policy and practice. *Health Promotion International* 2012, January 12, 1-14
- 19 Puska P, Ståhl T. Health in all policies-the Finnish initiative: background, principles, and current issues. *Annual Review of Public Health*, 2010; 31: 315-328.
- 20 Tseng V, Seidman E. A systems framework for understanding social settings. *American Journal of Community Psychology* 2007; 39 (3-4): 217-228.
- 21 LaMontagne A, Ostry A, Shaw A, Louie A, Keegal T, Yule J. Workplace Stress in Victoria: Developing a Systems Approach. Victorian Health Promotion Foundation, Victoria, Australia, 2006.
- 22 Hawe P, Riley T. Ecological theory in practice: illustrations from a community-based intervention to promote the health of recent mothers. *Prevention Science* 2005;6:227-236
- 23 Baron S, Beard S, Davis L, Delp L, Forst L, Kidd-Taylor A, Welch L. Promoting integrated approaches to reducing health inequities among low-income workers: Applying a social ecological framework. *American Journal of Industrial Medicine* 2014; 57 (5): 539-556.
- 24 McLeroy K, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs, *Health Education & Behavior* 1998; 15 (4): 351-377
- 25 Forrester J. *Industrial Dynamics*. Waltham, MA: Pegasus Communications, 1961.
- 26 Senge P. *The Fifth Discipline: The Art and Practice of the Learning Organisation*. Doubleday, New York, 1990.
- 27 Snowden D. Cynefin, A Sense of Time and Place: an Ecological Approach to Sense Making and Learning in Formal and Informal Communities. Conference proceedings of KMAC at the University of Aston, July 2000.
- 28 Van Beurden EK, Kia AM, Zask A, Dietrich U, Rose L. Making sense in a complex landscape: how the Cynefin Framework from Complex Adaptive Systems Theory can inform health promotion practice. *Health Promotion International* 2011;28:73-83

- 29 Auchincloss A, Roux A. A new tool for epidemiology: the usefulness of dynamic-agent models in understanding place effects on health. *American Journal of Epidemiology* 2008; 168 (1): 1-8.
- 30 Homer J, Hirsch, G. System dynamics modeling for public health: Background and opportunities. *American Journal of Public Health* 2006; 96 (3): 452-458
- 31 Hawe P, Shiell A, Riley T, Gold L. Methods for exploring implementation variation and local context within a cluster randomised community intervention trial. *Journal of Epidemiology and Community Health* 2004; 58 (9): 788-793.
- 32 Janzen R, Nelson G, Hausfather N, Ochocka J. Capturing system level activities and impacts of mental health consumer-run organizations. *American Journal of Community Psychology* 2007; 39 (3-4): 287-299.
- 33 Midgley G, Munlo I, Brown M. The theory and practice of boundary critique: Developing housing services for older people, *Journal of the Operational Research Society* 1998; 49: 467-478.
- 34 Bond L, Patton G, Glover S, Carlin JB, Butler H, Thomas L, Bowes G. The Gatehouse Project: can a multi-level school intervention affect emotional wellbeing and health risk behaviours? *Journal of Epidemiology and Community Health* 2004; 58: 997-1003.
- 35 Bond L, Thomas L, Coffey C, Glover S, Butler H, Carlin JB, Patton G. The long-term impact of the Gatehouse Project on the incidence of cannabis use in 16 year olds: a school-based cluster randomised trial. *Journal of School Health* 2004; 74: 23-29
- 36 Patton GC, Bond L, Carlin JB, Thomas L, Butler H, Glover S, Catalano R, Bowes G. Promoting social inclusion in schools: a group randomised trial of effects on student risk behaviours. *American Journal of Public Health* 2006; 96: 1582-1588.
- 37 Bond L, Glover S, Godfrey C, Butler H, Patton GC. Building capacity for system-level change in schools: lessons from the Gatehouse project. *Health Education and Behaviour* 2001; 28: 368-383.
- 38 Innes J, Booher D. Consensus building and complex adaptive systems: A framework for evaluating collaborative planning. *Journal of the American Planning Association* 1999; 65: 412-423.
- 39 Rickles D, Hawe P, Shiell A. A simple guide to chaos and complexity. *Journal of Epidemiology and Community Health* 2007;61(11):933-7