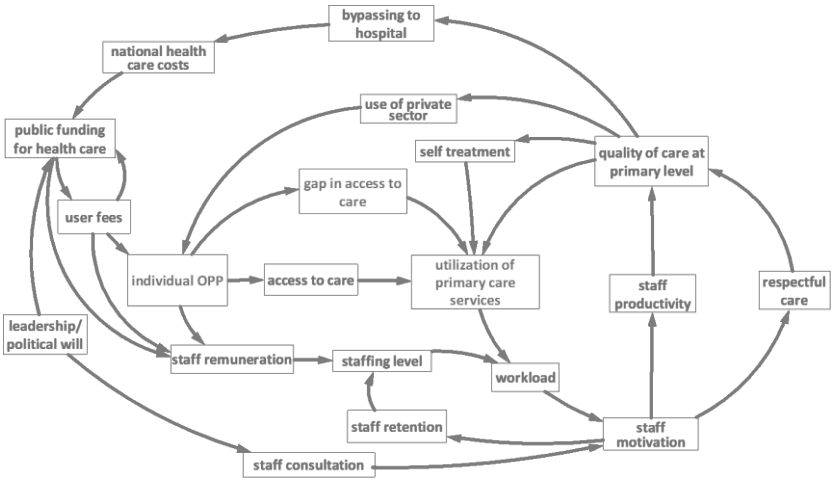

Participant Guidelines

Systems Tools for Complex Health Systems: A Guide to Creating Causal Loop Diagrams

COLUMBIA UNIVERSITY | MAILMAN SCHOOL of PUBLIC HEALTH

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Averting Maternal Death and Disability Program

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INTRODUCTION

For us to be effective systems thinkers it is important that we are able to reflect on the language and tools that we use to better understand the complexity inherent in health systems. If the language we use to describe health systems problems is linear and static we risk making the issues appear much simpler and so risk misrepresenting the very "reality" we are trying to understand or confront. Adopting such a reductionist approach might well result in the development of perfect solutions that address the wrong problem.

This guide was designed to help you through the steps of building a casual loop diagram.

You will want to have a piece of paper and coloured pens/pencils. You should have also already downloaded and become familiar with the VENSIM program, which you should open while reading this guideline.

Note: While VENSIM is extremely useful software for constructing causal loop diagrams, it is also possible to accomplish the same effect with PowerPoint, and with "old fashion" pencil and paper.

Good luck and enjoy.

STEP 1: DRAW A RICH PICTURE.

A rich picture is simply a drawing of the way you see a given situation at a particular moment in time. The quality of the art is not important. Instead what matters is that you represent all of the elements, relationships, emotions, and interactions relevant to the issue at hand. Try to use symbols and images instead of words, as this will facilitate your exploration of thoughts you haven't already articulated.

Rich pictures are often used in the synthesis phase as a mechanism to gather and capture information about complex situations as you begin trying to understand the complex issue. Rich pictures are ideally built through an iterative process of engagement and reflection with a group of key stakeholders. If you are working in a group, it can be helpful for each individual to draw her or his own rich picture and then have the group come together to discuss the different rich pictures. Sharing these with the group can help air individuals' differing perceptions and/or assumptions about the same issue. This in turn can pave the way for individuals to shed their mental models and work together to develop a more complex understanding of a situation.

Additional Information:

A really good resource if you want to explore more regarding systems thinking, complexity and rich pictures can be found through the Open University: Managing complexity: a systems approach – introduction. Look specifically at Section 7: Representing your experience of complexity.

It can be found at the following link:
http://openlearn.open.ac.uk/mod/oucontent/view.php?id=397869&section=7.1

Another link to an excellent online video tutorial that guides the creation of Rich Pictures from the Open University, United Kingdom. http://systems.open.ac.uk/materials/t552/

COMPLEXITY AND RICH PICTURES[1]

There are lots of ways of drawing a good rich picture and very few ways of drawing bad rich pictures. Below are a number of traps that you can fall into when creating your rich picture, and some checks you might use to ensure you have not fallen into the trap of the less-effective rich picture.

Although this discussion will focus on rich pictures, it is also talking about the complexity the rich picture represents. It is using the task of generating a useful rich picture to illustrate the process of experiencing and capturing complexity.

Trap 1: representing the problem and not the situation

This trap is one of the most fundamental mistakes you can make in systems thinking.

The point of a rich picture is to represent all you can about the situation. If you only focus on the 'problem' and include only the elements that seem problematic, you run the risk of removing the complexity of the situation. To only represent the problem elements means that you will limit what is included in the rich picture. Potentially you may limit possible solutions as you are only representing a single interpretation of a problem.

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1. This note is extracted from: The Open University. Managing complexity: a systems approach – introduction, accessed January 2011 http://openlearn.open.ac.uk/mod/oucontent/view.php?id=397869&section=1.7.2

In contrast, one of the reasons a situation seems to be complex is precisely the difficulty of identifying anything that could be described as the key issue. It seems to be a tangle of interrelated key issues.

So, the check for avoiding this trap is to ask:

- Does this rich picture represent the situation or is it just my interpretation of what the problem is? Does it include all the features noted as problematic?

Trap 2: the impoverished rich picture

A distinguishing feature of rich pictures that turns out to be important is that they are indeed "rich". Useful rich pictures are packed with information, interest and activity. Multiple stories are represented.

To achieve a "rich" rich picture you need to incorporate all that you know about the situation. Either put things into the picture as you re-read the description; or make lists of the stakeholders, the structures, processes, issues and concerns.

Indicate the connections and nature of these relationships. This can be done by using physical proximity within the picture, adding icons to present the nature of the relationship (heart, swords, and walls of silence). Think about the metaphors we use and represent these – feeling "swamped", drowning in work.

Use all the geographical locations, if this is relevant. Use all the processes. Include all the changes, and activities. Include perceptions as well as reported facts. Draw on published literature, interviews, reports, observations.

Some people use computer clip-art to draw rich pictures. It rarely works in my view. Some essential quality seems to be missing. Perhaps the act of sitting at a computer keeps the activity at a rational level – it does not allow for the impressions and half-formed awareness to express themselves through the act of making marks directly on to paper.

The check for avoiding the impoverishment trap is to ask:

- Have I included everything I know about the situation in my representation of it?

Trap 3: interpretation, structure, and analysis

If you deliberately impose your personal analysis on your picture, you preclude the possibility of seeing other, potentially more interesting, features later. Remember the rich picture is a representation of the complexity.

Beware of using existing organizational structures (for example staffing structures) that may take over and become the structure of the whole picture. It may be inevitable that interpretations suggest themselves as you draw. Stop yourself thinking "this is really about …" One way of stopping this is to jot the idea down somewhere – not on your picture – in the form of a question. Once you've written it down, the idea is much less likely to keep popping up as if it were trying to ensure you won't forget it.

So, the check for avoiding this trap is to ask:

- Is this rich picture telling just one story or is it rich enough to suggest lots of stories about what's going on?

Trap 4: words and wordiness

Lots of words tend to make the rich picture less rich. Part of the later use of a rich picture might include looking for patterns and using words may inhibit your ability to spot patterns.

The check for avoiding this trap is to ask:

- Do I have to do a lot of reading to see the relationships between elements in the picture?

Trap 5: the final version trap

Never assume your picture is finished. New realizations will crop up. Add these to your picture as you appreciate more and more of the complexity.

So, the check for avoiding this trap is to ask:

- Have I had any new insights about the complex situation since I last added something to this picture?

INCLUDING BEHAVIOUR OVER TIME GRAPHS (BOTG)[2]

One way to capture the dynamic changes over time in your rich picture is to include behaviour over time graphs. When thinking about the key elements in your rich picture, think about how these elements may have changed over time and include these in the picture. In the case study consider how some of the variables change for example quality of care, patient satisfaction, health worker motivation. In some documents you will see BOTGs referred to as Reference Modes.

The BOTG is a useful tool to capture patterns of change over time. It is a basic line graph showing the trend, or pattern of change, of a variable over time, .and when the pattern is not as expected, forces us to think about how and why these patterns occur.

The X axis is always labelled in units of time or can reflect change in time with defined beginning and ending points. Make sure that there is a clear logic to the time scale, why does it start and end where it does? Examination of when and where a particular pattern of behaviour starts, ends, or changes direction is also important.

The Y axis clearly identifies the variable being graphed and must be labelled with that variable's name. The variable can be "concrete" with easily measurable quantities, or "abstract" (e.g. stress, transparency), and should have a defined scale. Scales can be numeric (e.g., 2 to 1000 patients or "on a scale of 0 to100...") or descriptive (e.g., low vs. high)

STEP 2: IDENTIFY KEY VARIABLES.

Once you feel that your rich picture adequately represents the situation, identify the key elements/variables in your rich picture. Identify 10-12 variables to start, following these guidelines:[3]

a. Use nouns when choosing a variable name. For example, "user fees" is better than "paying user fees."
b. Variables should be measurable or observable, and should represent quantities that can change over time. Something like "state of mind" can't be measured, but "staff motivation" can and typically changes over time.

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2. Sources from Tips for Behavior-Over-Time Graphs (BOTGs)
http://www.watersfoundation.org/webed/mod3/downloads/Tips-BOTGS.pdf

3 Adapted from Pegasus Communications, "The Systems Thinker."
http://www.thesystemsthinker.com/tstgdlines2.html (note: this resource is no longer available at this site)

c. Variables should be neutral. “User fees” is better than “high user fees” or “increasing user fees.” “Quality of care” is preferable to “good care” or “bad care.”
d. When applicable, choose the positive sense of variable over the negative sense. “Staff motivation” is better than “Staff demotivation.”
e. When appropriate, distinguish between perceived and actual states. “Perceptions of quality of care” can differ from “actual quality of care.”

Be sure to include your outcome of interest in your list of variables.

Remember that your goal is not to identify every variable related to a given issue, but to capture the factors that, if changed, would have the biggest effects on your outcome of interest. Ideally you should not have more than 10 - 12 factors. You may be able to collapse some variables or eliminate those that do not have strong associations with any of the other variables.

When you name your variable be sure to be as explicit as possible, and define all of your variables to make sure that there is a common understanding of the construct that is captured by the variable. This is really important as it will assist you later when you develop your causal loop diagram.

STEP 3: CREATE AN INTER-RELATIONSHIP DIGRAPH (IRD).

Now that you identified the major variables from your Rich Picture, the next stage is to explore all possible relationships amongst the variables through the interrelationship digraph.

The IRD forces us to consider all possible interactions amongst the variables, challenges our mental models, identifies key outcomes and drivers in a complex system, and forms the basis from which we can identify feedback loops and begin to surface a causal loop diagram. We could easily jump directly into creating a causal loop diagram from the variables identified, but we would run the risk of simply recreating our own theory of how the system is functioning, without exploring all possible relationships through the IRD process.

The Interrelationship Digraph is a visual tool that:

- Builds on the rich picture
- Helps make use of team knowledge in the absence of hard data;
- Plots the complexity of causal relationships; and
- Builds team consensus on priorities.

What you end up with is:

- Drivers (the fundamental elements of a system that drive the other parts)
- Outcomes (the elements of the plan that can be used to measure success)
- Systems understanding of the causal relationships

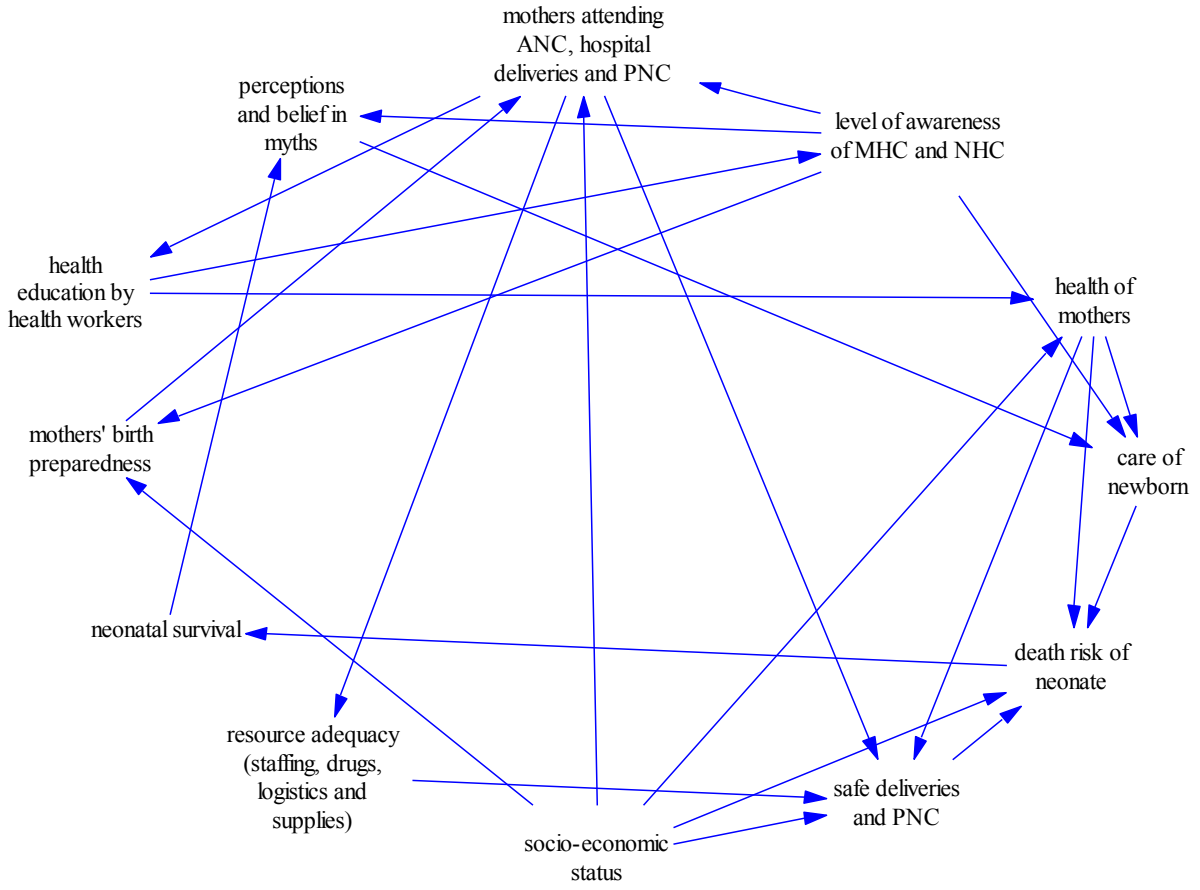
To construct the IRD:

Note: You can do this manually with pen and paper, but I strongly suggest using VENSIM – it makes it a whole lot easier to move variables around.

1. Agree on the issue or question – which informed your rich picture and variable selection.
2. Arrange the selected variables in a circle, place labels or “post-its” for every element involved in the issue.
3. Pick one of the variables to start with, and think about its relationship with each of the other variables in your circle. Consider the relationships in pairs. (you do not have to find a relationship between each pair)
4. Use an "influence" arrow to connect related elements.

5. The arrows should be drawn from the element that influences to the one influenced.
6. If two elements influence each other, the arrow should be drawn to reflect the stronger influence. Arrows can only be drawn IN ONE DIRECTION.
7. The relationship should be a direct relationship and not via another variable.
8. When you are thinking about how one variable relates to another, be sure to consider short term effects, long term effects, and unintended consequences. Try your best to abandon your mental model and think about associations you might not have initially identified. Where possible base your decision on existing evidence, or consensus amongst experts and be aware of your own assumptions.

Example—Developing the IRD for the "Dynamics of Neonatal Mortality in Uganda" case study

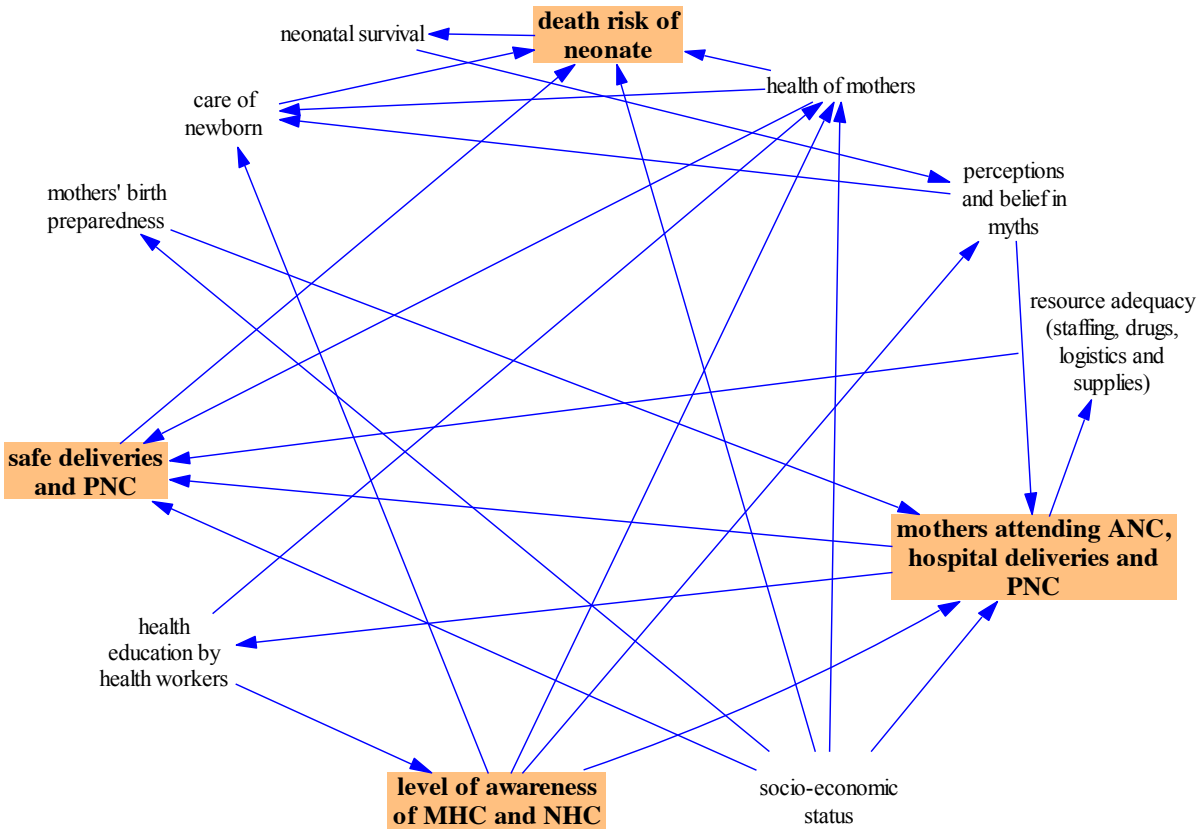


STEP 4: IDENTIFYING DRIVERS AND OUTCOMES.

Once you have examined all the possible relationships amongst the variables it is possible to identify the drivers and outcomes in the system.

- Count the arrows. Look at each variable and count how many arrows you have coming in to that variable and how many you have going out.
- If you are using VENSIM or PowerPoint you can rearrange your circle so that the drivers are towards the bottom and the outcomes towards the top.
- Variables with more arrows coming in than out are outcomes; those with more arrows going out are drivers.
- The elements with the most outgoing arrows will be "root causes" or "drivers."
- The ones with the most incoming arrows will be key outcomes or results.

Example—Identifying drivers and outcomes from "Dynamics of Neonatal Mortality in Uganda" case study



IRDs can be used independently of a step in the creation of a causal loop diagram. IRDs:

- Encourage team members to think in multiple directions rather than linearly
- Explore the cause and effect relationships among all the issues, including the most controversial
- Allow key issues to emerge naturally rather than to be forced by a dominant or powerful team member
- Systematically surface the basic assumptions and reasons for disagreements among team members
- Allow a team to identify root cause(s) even when credible data does not exist

STEP 5: CREATING A CAUSAL LOOP DIAGRAM.

Transforming an IRD into a causal loop diagram[4] (CLD) is an involved and iterative process. For you, the model developer, the objectives of this exercise are to use the IRD to surface the CLD, rather than rely on your own mental models of what you think is happening in a system, and then to explore the dynamic relationships in the system. Although there is no such thing as a "final" CLD, you want to strive for a CLD that can tell a clear story about a complex reality without being overly complex (and not too simple).

As you begin the process consider the following:[5]

1. What is the question or issue that is driving the creation of the CLD? The CLD is not an end in itself, it is developed to address an issue – whether this be through interventions, or identifying what new knowledge and research is required. Take a moment to think about the issue that triggered the rich picture and IRD. How has your thinking changed following that process? Try and articulate the issue in more specific terms and write this down. You will use this to develop the seed model upon which your CLD will be constructed (explained later).

2. What are the boundaries of your CLD model? What should be included in the CLD? You are not trying to draw the whole system, only those parts impacting on your issue. Be aware of whose voices are excluded and the implications of that decision.

3. Think about the level at which you want to intervene? Be aware of who "you are" in the process? Most commonly, the development of a CLD is informed through a collaborative process (even if one person ends up drawing it out in the end!). Be aware of who is in the room, and at what level of the system the group is situated and able to intervene. Are you at a national policy level, or district, facility, community? NGO or private versus public? This does not mean that you should not include variables that are above or below that level, but understanding your sphere of influence will help identify a starting point from which to build out the model.

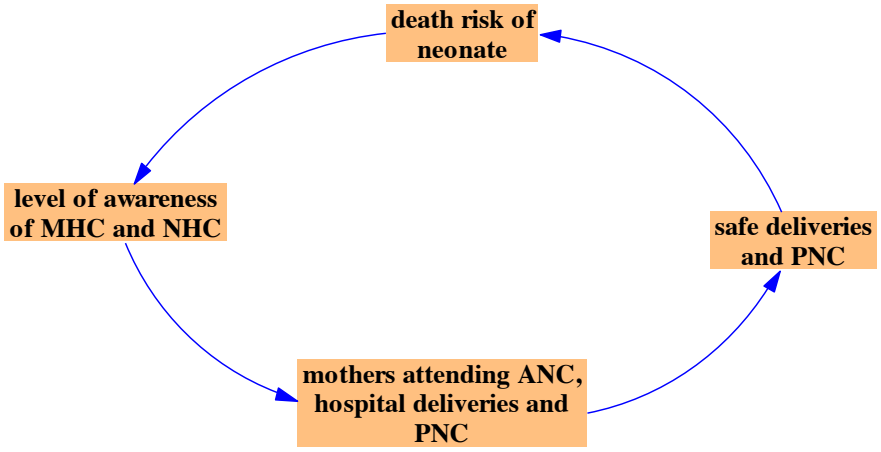
HOW TO BEGIN.

There are a couple of ways to approach this process. From experience one of the more useful ways is to surface a seed model using your IRD. Identify your outcome of interest and look at the drivers of that outcome, thinking about the level at which you are operating. Use this as the seed (you can have a couple of drivers but don't over complicate to begin). Now working between your IRD and your seed model, start adding in the variables that are linked to your outcome and driver(s).

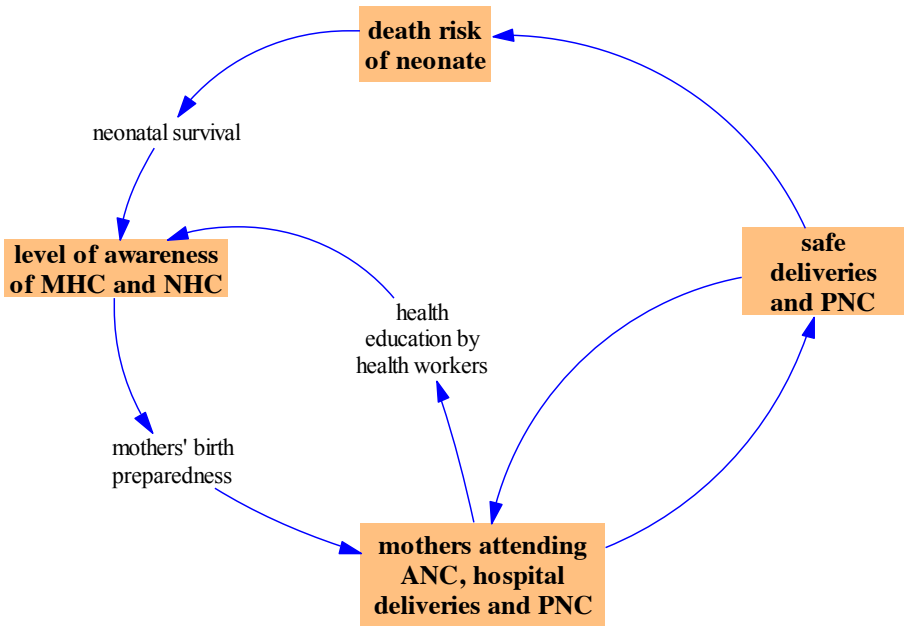
4 The terms systems map and causal loop diagram tend to be used interchangeably. I am moving towards calling them causal loop diagrams.

5 Based on Guidelines For Drawing Causal Loop Diagrams – The Systems Thinker V3N1 February 1992.

Example—Seed model for "Dynamics of Neonatal Mortality in Uganda" case study



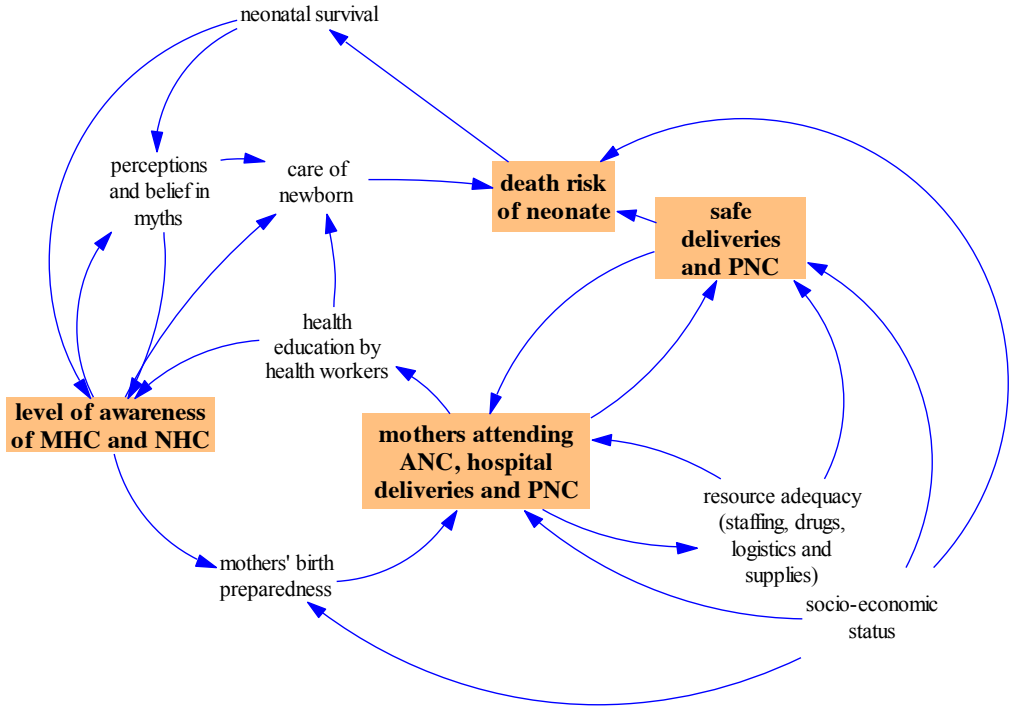
…and building onto the model by including more variables



At this phase it can be helpful to print a copy of your IRD (or work on two screens!)

Using a highlighter, trace the loops that are associated with the outcome. You may find that some of the smaller loops are redundant with respect to larger, more encompassing loops. If this is the case, you can delete arrows that indicate redundant loops. You may identify cases in which you can delete an arrow indicating a direct relationship where in fact an indirect relationship better illustrates the pathway of effect (For example: Your map shows that A→C, but also that A→B→C. If the latter relationship captures the mechanism of effect whereby A drives C, then you can delete the arrow directly connecting A and C).

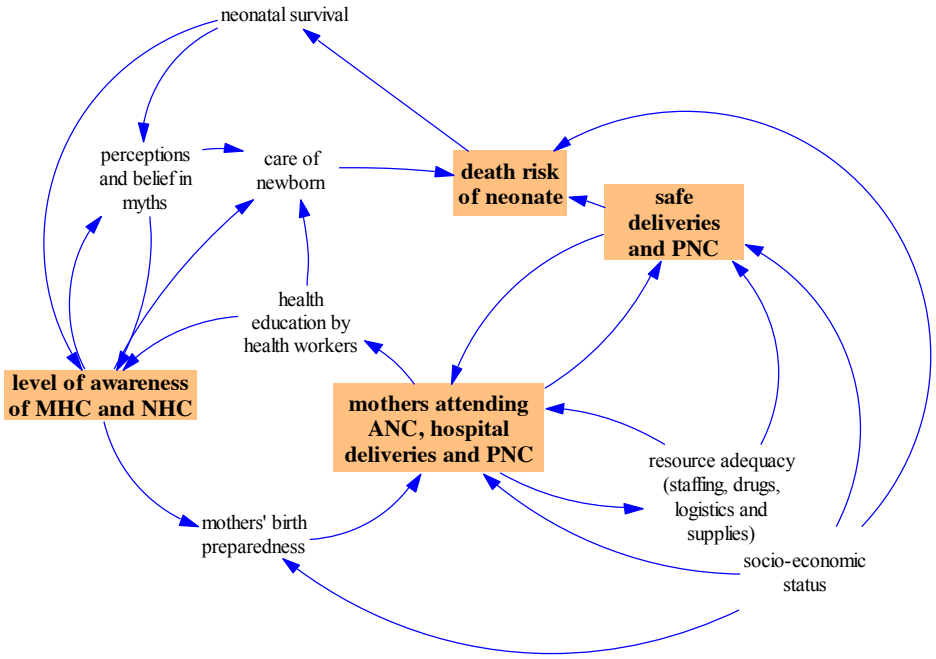
Example—Adding variables and arrows to the IRD for the "Dynamics of Neonatal Mortality in Uganda" case study



Note: If you have used VENSIM to create your IRD, you can also use the "Loops" tool to identify the feedback loops in your IRD.

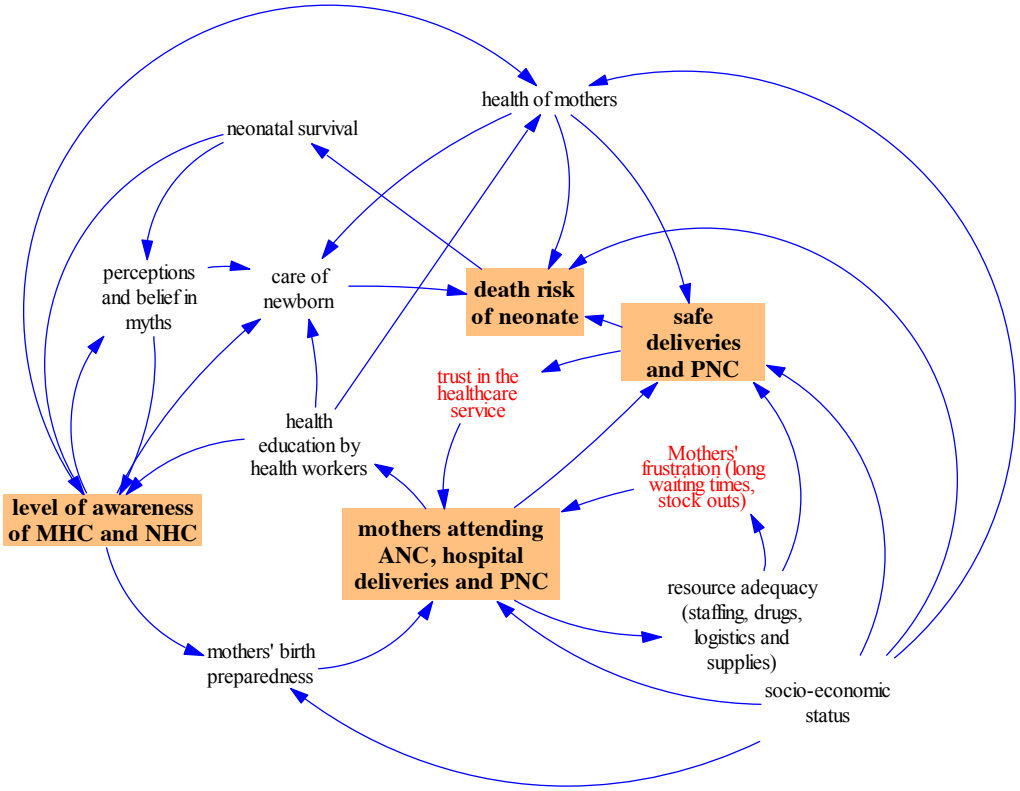
As you work through this process you may discover that instead of deleting you need to add arrows. During the IRD stage, for example, you may have had to draw a unidirectional arrow between two variables when in fact the variables are re-enforcing. At this stage you can add arrows to indicate that variables influence each other.

Example—Continuing to add variables and arrows to the CLD for the "Dynamics of Neonatal Mortality in Uganda" case study



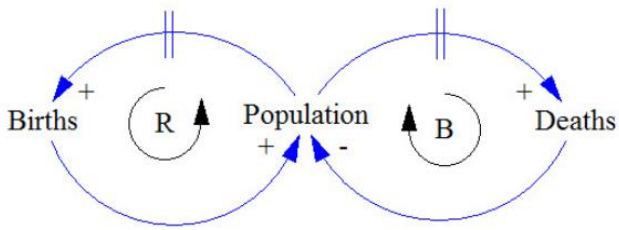
You may also find it necessary to add variables, particularly in places where you have omitted an intermediate variable that better explains the relationship between two other variables. But don't get carried away: "The purpose of the diagram is not to describe every detail of the…process, but to show those aspects of the feedback structure which lead to the observed pattern of behaviour."[6]

Example—Adding intermediate variables to the CLD for the "Dynamics of Neonatal Mortality in Uganda" case study



As you make these changes, the map may very well become a mess of crisscrossing lines. Do your best to move variables and arrows so that the variables that are associated with each other are close together and arrows do not intersect. Your goal is to produce a map that effectively represents relationships between key factors and their effect on your outcome of interest.

Significant delays. Identify which (if any) links have significant delays relative to the rest of the diagram. It is important to identify these delays as they are often the source of imbalances that accumulate in the system. You can depict a delay in the system by using to small parallel lines as follows:



[6] Kirkwood, Craig W., System Dynamics Methods: A Quick Introduction, 1998. <http://www.public.asu.edu/~kirkwood/sysdyn/SDIntro/ch-1.pdf>.

Causal Loop Diagrams.

First, remember that less is better. Start small and simple; add more elements to the story as necessary.

Show the story in parts. The number of elements in a loop should be determined by the needs of the story and of the people using the diagram. A simple description might be enough to stimulate dialogue and provide a new way to see a problem. In other situations, you may need more loops to clarify the causal relationships you are surfacing.

Also keep in mind that people often think that a diagram has to incorporate all possible variables from a story; this is not necessarily true. In some cases, there are external elements that don't change, change very slowly, or whose changes are irrelevant to the problem at hand. You can unnecessarily complicate things by including such details, especially those over which you have little or no control. Some of the most effective loops reveal connections or relationships between parts of the organization or system that the group may not have noticed before.

And last, don't worry about whether a loop is "right"; instead, ask yourself whether the loop accurately reflects the story your group is trying to depict. Loops are shorthand descriptions of what we perceive as current reality; if they reflect that perspective, they are "right" enough.

Extracted from

Goodman, M. Systems thinking: what, why, when, where, and how? The Systems Thinker 8(2) 1997

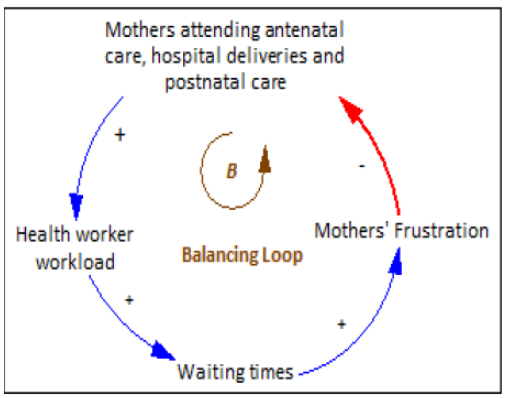
STEP 6: IDENTIFYING THE TYPES OF FEEDBACK LOOPS IN YOUR CLD.

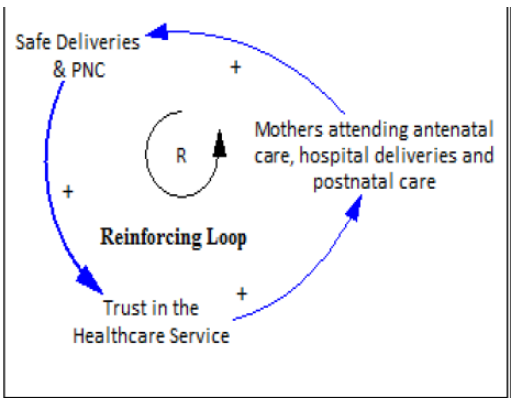
Feedback loops occur when variables are linked circularly. There are two types of feedback loops: Reinforcing loops and Balancing loops. (*These will be described in more detail below.*)

Before we can determine if a feedback loop is a balancing loop or a reinforcing loop, you first need to assess the nature of the relationships between each pair of variables.

Pick a starting variable in your CLD (doesn't matter where you start as you only examine a pair of variables at a time), and assess whether arrows between two variables indicate change in the same or opposite direction. For example, if your two variables are "staff remuneration" and "staff motivation," does getting paid more increase or decrease staff motivation? Since an increase in remuneration typically leads to an increase in motivation, this change is going in the same direction. Label each arrow to indicate the direction of effect. If change is in the same direction use a "+" sign, and if the change is in opposite directions use a "-" sign. Note that some mappers put an "s" by the arrow to indicate same direction and an "o" to indicate opposite direction. You will see both, although the preferred symbols are "+" and "-".

Examine the loops presented below and make sure you correctly identify the nature of the relationships.





Once you have worked through every arrow in the CLD to determine the nature of the relationship between the two variables linked by the arrow, you are now ready to determine the nature of the feedback loops.

Note: If it is difficult to determine the nature of the relationship – it might mean that there are two mechanism through which one variable influences another – and this should be further explored in the system. It might require adding an interim variable or indicating delays.

NB: Please note that not all linkages will be part of a feedback loop. You are only going to examine feedback loops where the arrows are all "flowing" in a circular direction.

The rules for identifying feedback loops for the most part will follow these guidelines:

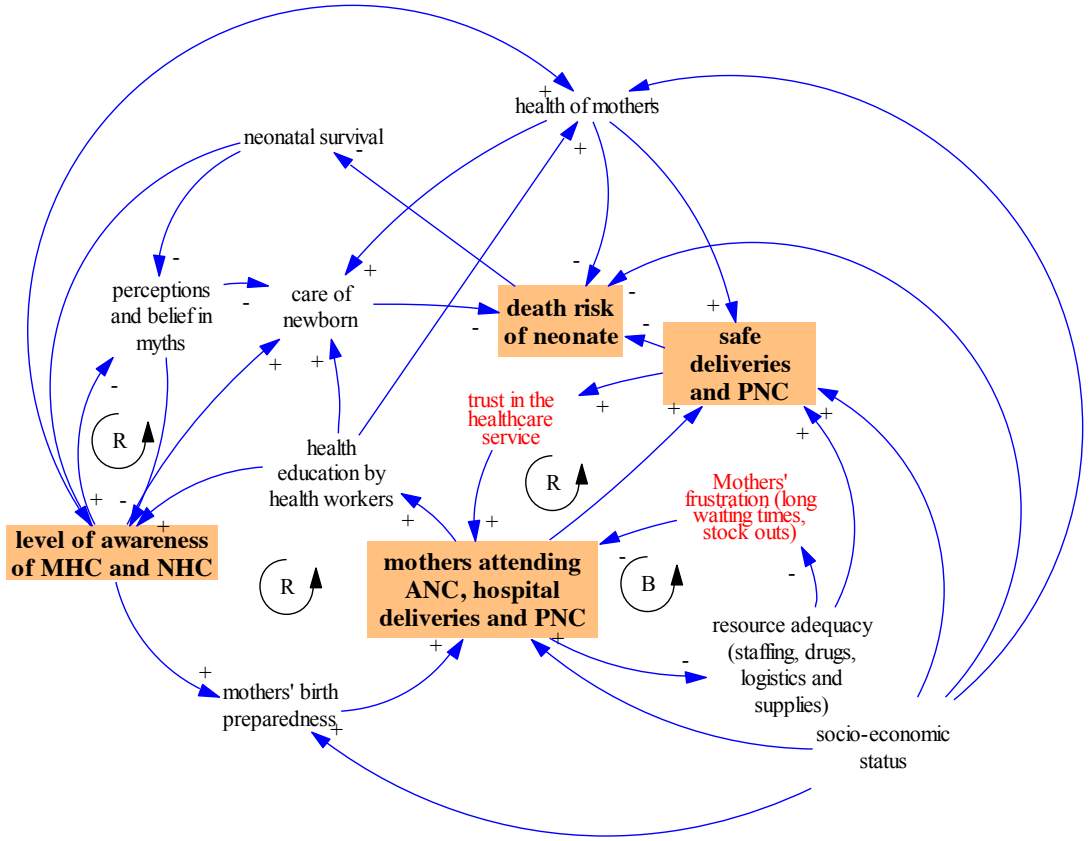
Reinforcing loops:

- If the all the arrows in the loop are "+" OR
- If you have an <u>even</u> number of "-" arrows (irrespective of the number of "+" arrows) – makes sense, think about it!.

Balancing loops:

- If you have an <u>odd</u> number of " -" arrows (irrespective of number of "+" arrows).

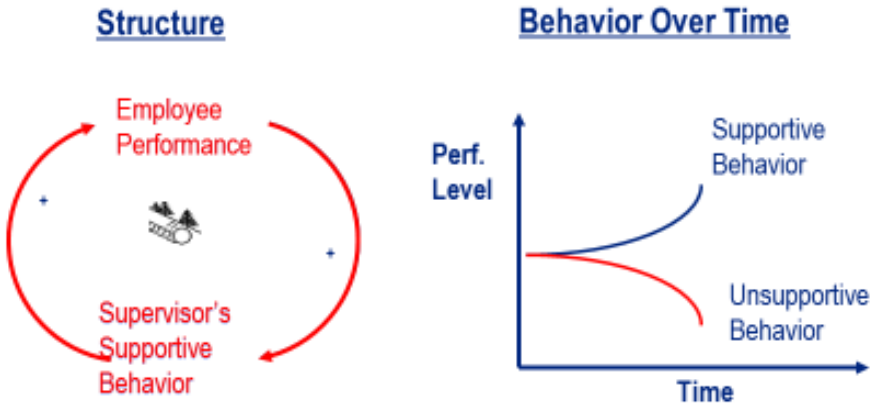
Example—Identifying feedback loops in the CLD for the "Dynamics of Neonatal Mortality in Uganda" case study



UNDERSTANDING THE DIFFERENT TYPES OF LOOPS.

Reinforcing Loops

- A reinforcing loop is one in which an action produces a result which influences more of the same action thus resulting in growth or decline at an ever-increasing rate
- Where feedback increases the impact of a change, we call this a Reinforcing Loop.
- Positive reinforcing loops produce **virtuous cycles**
- Negative reinforcing loops produce **vicious cycles**.

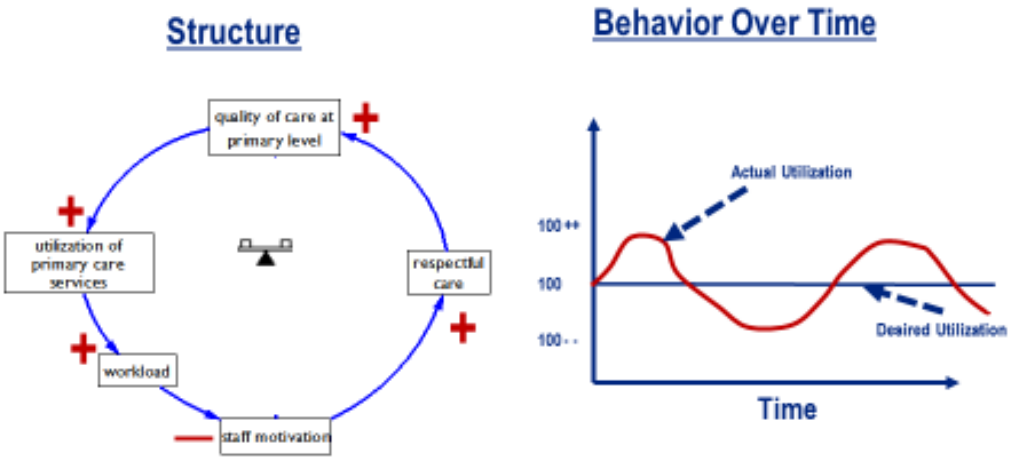


In the example above). As the supervisor supportive behaviour increases so employee performance increases which reinforces supervisor's supportive behaviour which in turn reinforces employee behaviour – a virtuous reinforcing loop. Similarly as Supervisor's supportive behaviour diminishes, employee performance declines, driving worsening supervisor support which further decreases performance – a vicious reinforcing loop.

Balancing Loops

- Balancing processes generate the forces of resistance, which eventually limit growth, maintain stability, and achieve equilibrium
- Balancing loops reduces the impact of a change and are goal seeking

- Shortcut to determining a balancing loop: Count the number of minus signs (-) in the loop: an odd number of minus signs = balancing loop



Examining the example. As the quality of care provided at the primary level changes (for sake of this example we will use an increase in the quality of care) so research shows that utilization of the services will increase, driving an increase in workload. Since there is no compensating increase in staff coverage, the increased workload ultimately drives down staff motivation, which drives down the level of respectful care given, and ultimately diminishes the quality of care provided. This is typical of a balancing loop – despite change in quality of care, utilization is limited because of policy resistance demonstrated by staff behaviour. Without an increase in the number of staff this will continue as a balancing feedback loop

ONGOING REVISION

No CLD is final. Identifying feedback loops, for example, may change your understanding of the situation in a way that compels you to revise the variables and relationships you have included.

CLDs can be used as tools to analyze situations and share insights with others. This process might also lead to an ongoing revision of your CLD as you solicit input from other stakeholders.

Maps—like the real-life systems they strive to represent—are flexible and adaptive things. Continually refer to and revise your CLD to help yourself and others better understand the complexity of the issues on which you work.

LEVERAGE POINTS AND POLICY RESISTANCE

Leverage points are those places where micro changes can result in macro results.

A leverage point is a place in the system's structure when an intervention can be applied. A low leverage point is one where a small level of intervention or change force results in a small change in the behavior of the system. In contrast a high leverage point is one where a small level of intervention/ change force, causes a large change in the system's behavior.

We use these maps to identify potential leverage points for interventions. For more about leverage points I highly recommend Donella Meadow's work. Donella Meadows is the author of Thinking in Systems: A Primer, a Pulitzer Prize nominee, and recipient of a MacArthur Foundation "genius" award and her work, Leverage Points is still considered to be a classic reference for those seeking to implement system change. Donella Meadows died in 2001, but her ideas about leverage points are summarized here: http://www.donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system

A note about Leverage Points

Donella Meadows in her work on leverage points identifies a hierarchy of levers that can be applied to change and strengthen a complex system ranging from low to high. These can be characterised into four groups (low to high levers) – physical, informational, social and conscious summarised in the table below.

- Physical leverage is focused primarily on a change in physical amount of the elements/ variables – focus on changing inputs and physical structures. While this is considered low leverage (and often most proximal to the outcome of interest) most change interventions are spent working with these kind of interventions. She regards this as little more than 'tinkering with a broken system'.

- Informational leverage recognizes that systems can be stabilized / destabilized by rate of change and information flows. Interventions at this level focus on strategies to reduce delays, optimize information flows, manage relationships between feedback loops; address resisting influence of balancing feedback loops, and strengthen reinforcing feedback loops to create virtuous cycles. Strategies to create new loops and connect different system elements are also part of this level of leverage points as they speed up information flows.

- Social leverage seeks to change both the rules and goals of a system – changing what a system seeks to achieve and how. By changing the goal, the rules will change and so the physical and informational structures that lie beneath the goal will also change, altering the system in more fundamental ways. For example shifts in the primary goal from pure economic returns (e.g. focus on health care industry profits) to social ones, will result in financial returns being demoted to the status of a means rather than an end and greater focus placed on ends such as equity, and financial and social risk protection for people accessing health care. But, if the ultimate goal of the health system is to maximize profitability of the health care industry, then all other sub-systems, feedback loops, information flows and behavior within the system will be twisted to conform to that goal. By understanding what is the ultimate goal of the whole system, can assess and understand how all other elements in the system function to conform to that goal. Intervening to shift whole system goal would be a high leverage point that affects change throughout the system.

- Conscious leverage seeks to change the mind-set or paradigm out of which the system arises. To affect this change requires challenging the assumptions about the way things are, and exposing the anomalies and failures in the old paradigm. Systems thinking tools model and expose all the complex system dynamics. This comprehensive view will highlight when there is a need for a fundamental shift in the behaviours driving the system. Strategies and interventions to shift mindsets and paradigms include inserting people with new paradigm mind-sets in places of public visibility and power, and working with active change agents. Challenging social, economic and political norms, and re-examining core-values represent leverage at the highest level, resulting in the largest change but will also face the most resistance from the existing system.

Summary of Leverage Strategies – in ascending order of effectiveness.

TYPE	LEVER	AIM
Physical	• Change physical amount of elements and stocks • Change structure of physical systems e.g.; staffing structures	• Focus on changing inputs • Focus on more proximal drivers Note: Low leverage potential
Informational	• Change rate of system responses • Manage relationships and timing between feedback loops • Create new loops to connect different system elements	• Reduce system delays • Examine stabilizing/ resisting influence of balancing feedback loops • Reinforce virtuous feedback loops • Explore and alter *who* has access to *what* information
Social	• Alter rules of the system (such as incentives, punishments, constraints) to support desired goals • Alter goals of the system - what a system seeks to achieve	• Understand and change what the rules are and who has power over them • Nurture innovation, flexibility, variation and collaboration Note: High leverage potential
Conscious	• Shift mindset or paradigm out of which the system arises	• View whole system functioning and dynamics • Expose anomalies and failures in old paradigm and challenge assumptions • Work with active change agents Note: Highest leverage potential

Exam your CLD, and identify potential leverage points. There are always a number of leverage points in the system, both high and low, and deciding where to intervene would be informed by your sphere of influence, time horizons, resources and the specific characteristics of the dynamics in the system. The table below highlights a number of possible intervention strategies.

System Dynamic	Strategic Intervention
System is stagnant or stalled	Look for constraints
Vicious cycles	Identify "brakes" Examine intervention points to return process to virtuous cycle
Reinforce virtuous feedback cycles	
Find the strongest feedback structure operating then review the implications and generic leverage points.	
Examine each link and consider the consequence of strengthening it or weakening it.	

Mitigating policy resistance: Identification of leverage points and appropriate intervention strategies should be accompanied by an examination of potential areas of policy resistance or unintended consequences that might occur following implementation of selected strategies.. Strategies to mitigate policy resistance include adding new links of loops (new behaviours), breaking, weakening or strengthening a link, changing delays or altering the polarity of a link.

Exploring CLDs.

CLDs are developed to better understand the dynamics driving a particular issue in a given situation. As more and more CLDs are being developed it is important to develop an approach to reviewing CLDs with the intent of using them to understand the system before intervening. Here are some key questions to ask when examining any CLD:

- What is the underlying issue for which this CLD has been developed
- From what reference level/ stakeholder perspective has this CLD been developed:
- What information was used to construct the CLD?
- What process was used to construct the CLD – specifically how were people's mental models and assumptions made explicit?
- What are the key variables of interest/ key outcomes in this CLD?
- What are the main drivers – proximal and distal and how do they link together?
- Can you identify the major feedback loops in this CLD and how do these loops interact to give rise to the system behaviour?
- Thinking about intervening in the system – what is your scope of influence and how does this impact the level of leverage possible (thinking about the Meadows characterization). What are the range of strategic interventions possible and how would these impact the system if successfully implemented.
- What are possible points of policy resistance and how might those be mitigated given the specific system dynamics
- Finally – consider the boundaries of the system – how were these determined? Whose voices are included in the system and who is left out? What additional elements should be included?