SAFETY SOLUTIONS

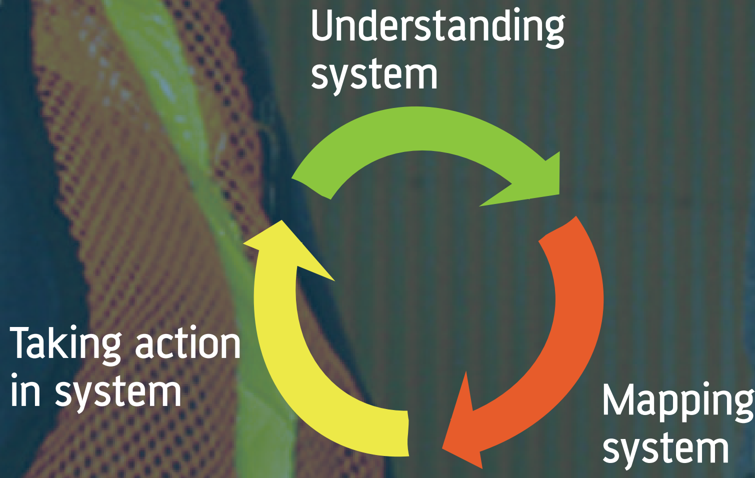
System Modeling for Health and Safety

Think about our most difficult and challenging problems in workplace safety.

Why have we been unable to solve these problems?

Could part of the problem be that we don't understand the system that is producing the problem?

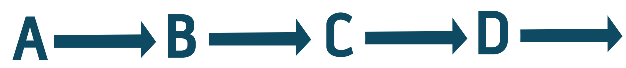
We can't change a process or system until we understand it.

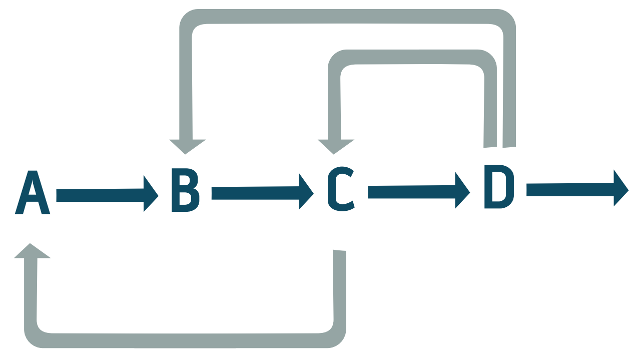


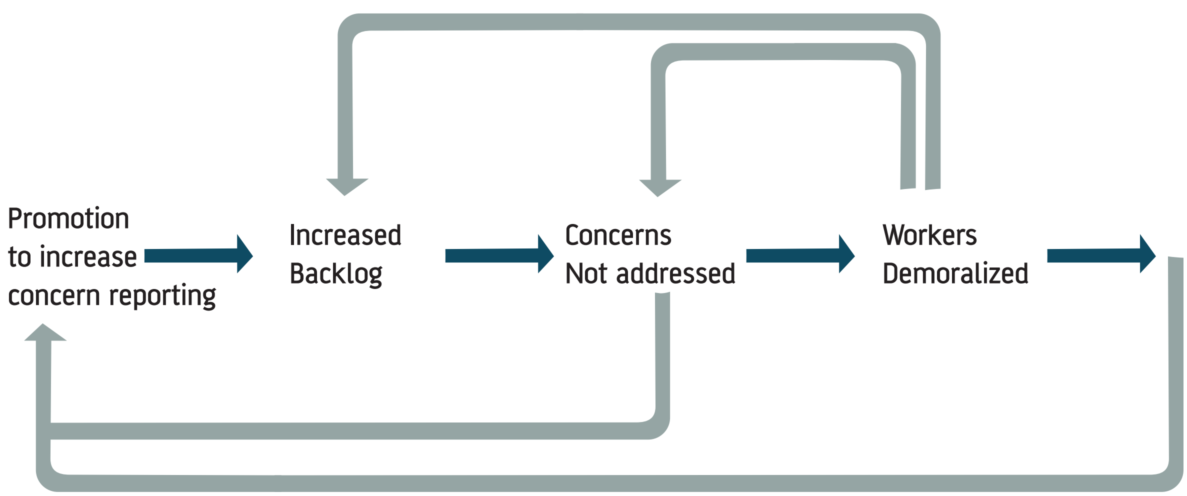
What's wrong with our current thinking?

The traditional linear mental model of the world sees events as a one directional cause and effect chain of events. A causes B which causes C which causes D. So, if I want to change D all that I have to do is change A. Right? Wrong.

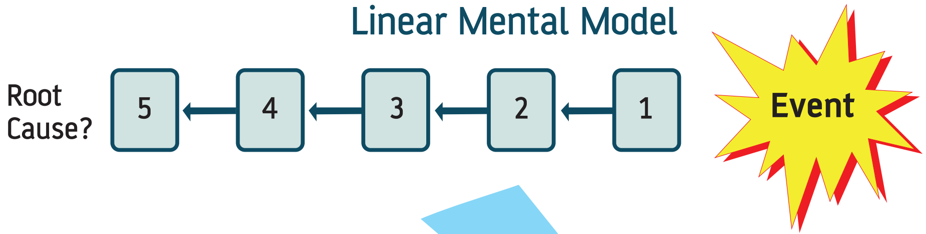
The fundamental flaw lies in our inability to recognize the way changing the B affects A. And how changing C changes A and so on. An example may help clarify this concept. A new promotion is launched, intended to encourage front-line workers to submit concerns and recommendations. That's A. The submitted concerns and recommendations create a backlog (B) of pending work. Some of the concerns are addressed but others remain. The backlog continues to build. As concerns are submitted and changes are not made (C) front-line workers become discouraged (D). As workers become demoralized they submit fewer concerns increasing the need for a new promotion program or enhancement of the current program. Worker demoralization also results in reduction of the backlog, and so on.



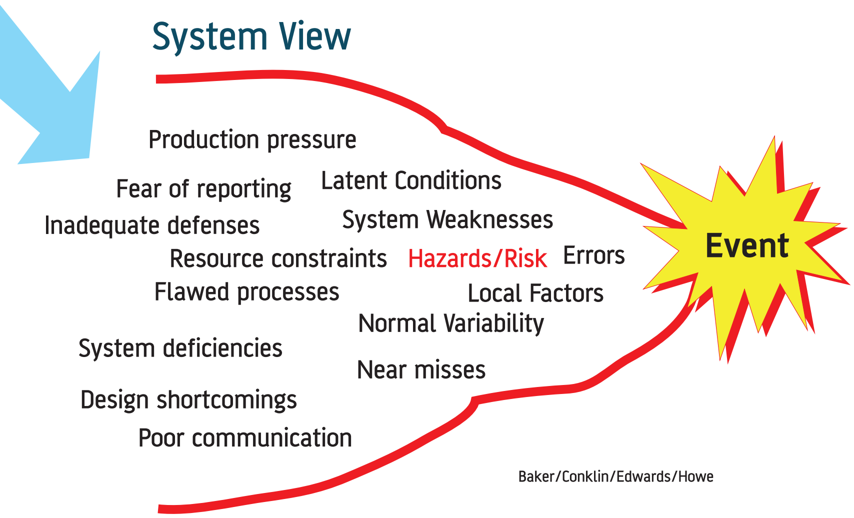




Non linearity example

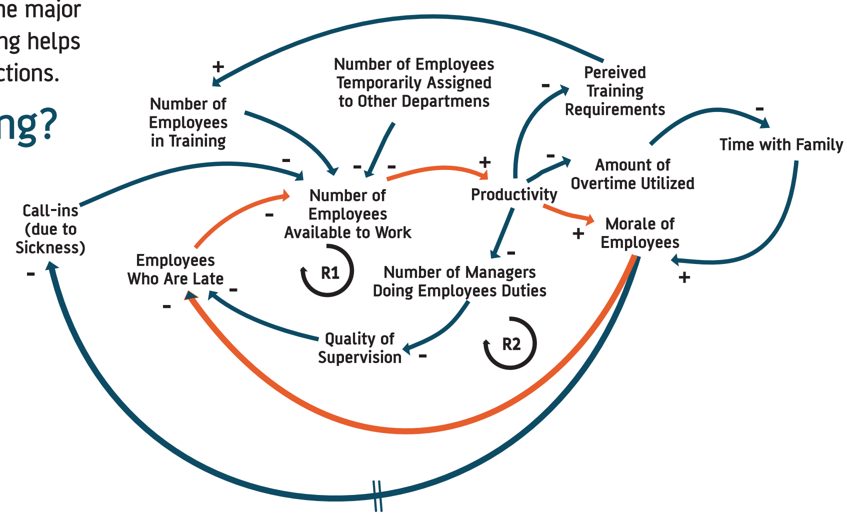


We need to move from a linear mental model to one that appreciates the dynamics nonlinear manner in which multiple variables co-contribute to the system outcomes.



System Modeling

System modeling is a powerful method to visually represent the major elements of a system – the influencers of the system. Modeling helps us understand the elements and their relationships and interactions.



What is the Goal of System Modeling?

Helps us

- → Understand the whole (system, variables and relationships)
- → Understand causes and effects – interactions of system variables
- → Transition our thinking away from linear over-simplification
- → Understand potential unintended consequences of proposed solutions
- → Identify high leverage points for making changes

(adapted from Bridgeway Partners)

When to Use a Systems Approach

→ The problem is chronic and has defied people's best intentions to solve it
→ Diverse stakeholders find it difficult to align their efforts despite shared intentions
→Groups try to optimize their part of the system without understanding their impact on the whole
→Stakeholders' short term efforts might actually undermine their intentions to solve the problem
→People are working on a large number of disparate initiatives at the same time
→Promoting particular solutions (e.g. best practices) comes at the expense of engaging in continuous learning
(from Bridgeway Partners)

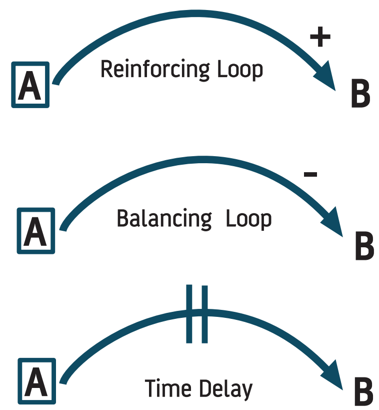
Modeling Basics

System models are often called causal loop diagrams because they map the multiple interdepent variables within a system. After selecting the problem or the subject of the model, it is necessary to identify the variables or influencers. Examples of variables include time constraints, workload, training, resources, communication, learning, culture, skill, lift equipment, patient safety, injury rate, back injuries and fatigue.

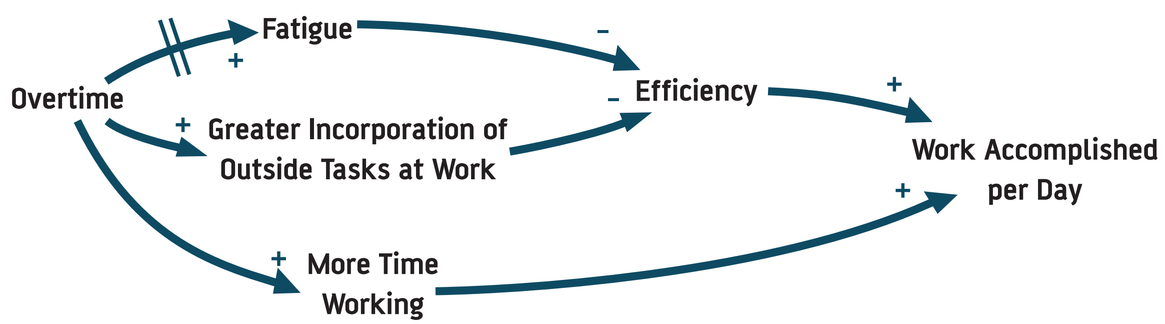
Lines are drawn between variables to define relationships. The influence of one variable on the other is denoted with a "+" if the variable causes change in the same direction - known as a reinforcing loop. The more I turn up the heating thermostat, the more the temperature increases. The more money I deposit, the more money will be in my savings account. The arrow on one end of the line denotes the direction of the influence. If a variable causes change in the opposite direction a "-" is used. We call these balancing loops. The relationship between fatigue and efficiency is an example of a balancing loop in the model below. The greater the fatigue the lower the efficiency. The variables change in opposite directions.

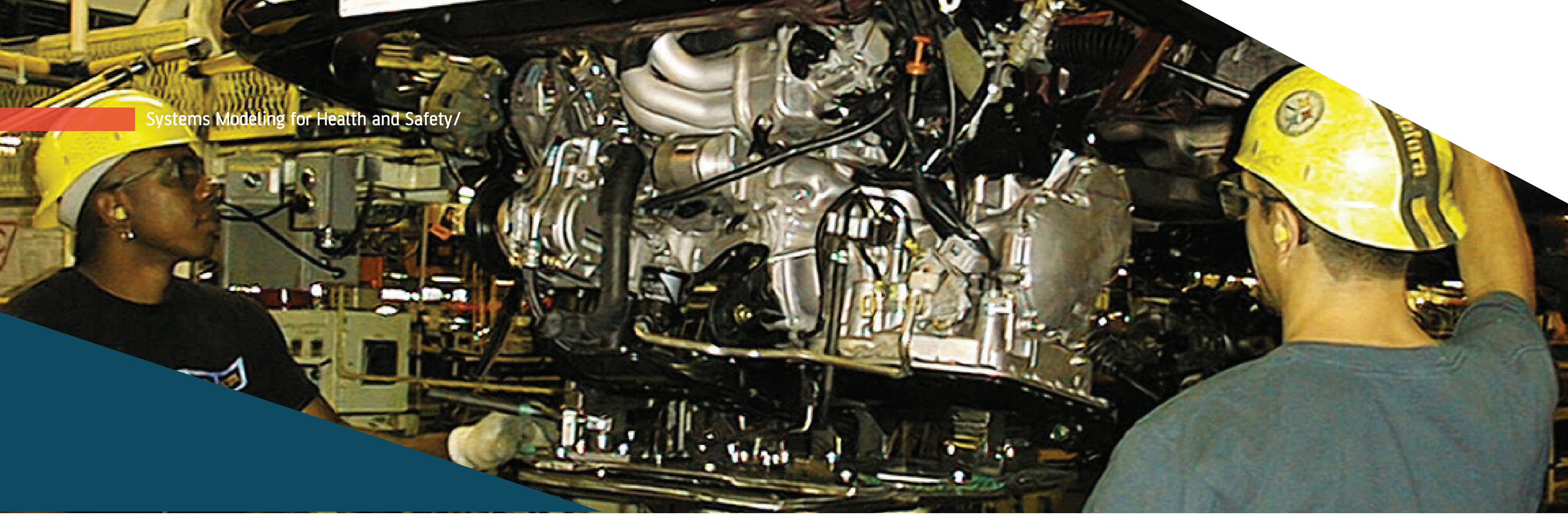
If the effect of one variable on another is ambiguous or uncertain, try to identify intermediate variables.

SYSTEM MAPPING: BASIC ELEMENTS



HEALTH MODELING AND SYSTEM MAPPING





If one variable affects another variable but its effect takes time, weeks, months or even years, the time delay is signified on the relationship arrow line with two lines.

Examples of time delays could be a reduced maintenance budget that decreases availability of serviceable equipment, but the change does not occur immediately. It is time delayed. Gradually the amount of available equipment is reduced.

Steps to Create a System Model

It's best to use a whiteboard or post-its on a large wall. You will be making a lot of changes.

→ Form a small group of colleagues with knowledge and an interest in the issue. (individuals with diverse opinions and points of view)

→ Start by identifying what you want to understand – be specific. E.g. reporting of near misses, accident report quality, engagement of frontline workers during inspections. Brainstorm a list of the major variables that affect the problem in both positive and negative ways.

→ Write the problem in two or three words on the board. Write one of the variables that influence the problem. Draw an arrow and mark the end of the arrow "+" or "–" to denote the impact of one variable on the other. "+" denotes that the variable affects the other variable in the same direction – as one increases the other increases. "–" denotes that one of the variables affect the other variable in opposite directions – as one increases the other decreases or vice versa.

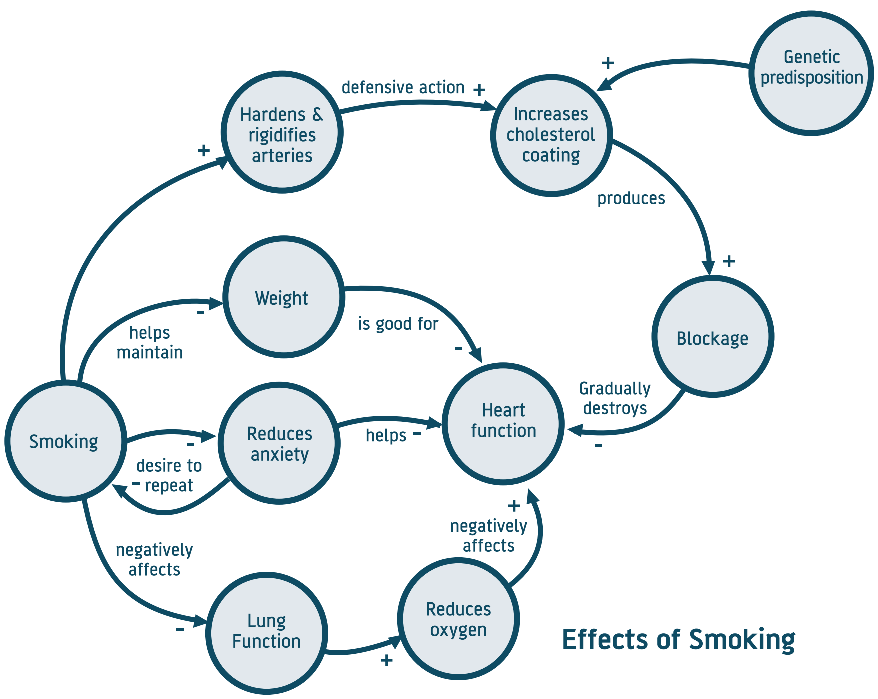
→ Add other variables and draw lines. Resist the temptation to draw a horizontal linear cause and effect chart. Scatter the elements and draw curved lines. Remember most variables influence another variable and then in turn are influenced by other variables.

→ Think of additional variables that influence variables and add them.

→ Think about how the variables influence one another.

→ As you brainstorm potential improvements (changes), consider the possible unintended consequences.

→ Identify the points of high leverage. Remember changing mental models (the way we think about things) and the system structure can lead to major lasting change.



Effects of Smoking

Unintended consequences caused by our solutions

Peter Senge's first law of systems thinking is, "Today's problems are the result of yesterday's solutions." Well intentioned initiatives are implemented by individuals and groups intending to improve things. Unfortunately, without an understanding of the system dynamics unintended consequences can occur. Remember, there is really no such thing as "unintended consequences". There are only system or process consequences. When we call tham "unintended", we are really describing our system understanding deficiecies.

After the model is created and solutions are being proposed. we need to ask ourselves, "what unintended consequences can occur if we make the change?" The question gets to how the system will adapt to our proposed change. Systems always adapt and compensate in response to changes. Another way to think about it is to ask, "Can our change make things worse?"

Continual Learning

Developing a systems model should not be considered an end point. Remember the model is not reality. Only reality is reality. As the old saying goes, "All models are wrong, but some are useful". When possible it's best to consider the system model of the process or problem a living document that is periodically revised as the understanding of the system improves. When changes are proposed, if possible carry out pilot initiatives or micro experiments to test the model and better understand how the system will adapt.

System Modeling

PROS	CONS
Creates a basic model of the structure, identifies the major variables of the systems (influencers)	May only identify the major variables and not the less important and less obvious variables.
Reflects multiple perspectives	Takes a more time than an Iceberg Model
Highly effective tool to learn and understand a system, can be used for ongoing learning	Does not identify assumptions and mental models that support the system structure (Iceberg Model does)

Some of the concept in this brochure were influenced by experts in the field of system thinking including Daniel H. Kim, Peter Senge and David Stroh,

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newviewhs.com
jimhowe55@gmail.com

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