Lesson 2.1: Behavior Over Time Diagrams

Introduction to Systems Thinking

Overview

Read the material on this page to learn about how boundaries, patterns, and interconnections inform behavior over time (BOT) diagrams.

Article: "Behavior Over Time Diagrams: Seeing Dynamic Interrelationships"

This short article by Daniel Kim shows you what a BOT diagram is and how it figures into systems thinking. Pay special attention to Kim's five guidelines for using BOTs:

1. Select Time Horizon. Identify the desired time horizon for the problem at hand.

2. Define the Problem Dynamically. Draw BOT charts of key variables.

3. Conduct Thought Experiments. Conduct thought experiments by hypothesizing about the time behavior of different variables and inferring the behavior of other related variables.

4. Build Causal Theories. Use causal loop diagrams to build causal theories that draw out the interrelated behavior of variables over time.

5. Validate with Data. Use data analysis tools to help validate the BOTs and causal relationships.

Read "Behavior Over Time Diagrams: Seeing Dynamic Interrelationships."

Key Points

- The BOT diagram is a second tool that systems thinkers use to move past events. These diagrams can help build causal theories, usually done before the data-gathering step.
- Boundaries of a system include time, spatial limitations, and key variables, which can include people.
- When defining a system's patterns of events and behaviors, look for repeating events.
- Interconnections, or interrelationships, in a system are central to understanding how things fit together.
- Kim (2018) states that "an iterative process of going back and forth between theory-building and data analysis [allows a systems thinker to] build a better understanding of what is happening."

The Case of the Curtailed Supplies, Part 1

The new director of Tasha's medical-product design team, Dr. Karen Forrester, started on the first of the month. By midweek, it was pretty clear that Dr. Forrester was a stickler, but that was fine with Tasha. The previous director, Dr. Kim, had been too careless for Tasha's taste and the lab had gotten sloppy. It was time to get the standards back up.

Rodney, who managed the logistics team, felt differently. He, like Dr. Kim, enjoyed a looser, friendlier atmosphere, where people talked to each other instead of filling out all those forms. Tasha thought she might have a bit of an advantage over Rodney with Dr. Forrester.

At the quarter-end staff meeting, as Dr. Forrester was going over the two teams' results, she made two particularly notable comments.

- "We seem to have a shortage of a number of important components in the storage room. Tasha, it's up to you to make sure we have what we need on hand at all times. Get that fixed immediately."
- "At the same time, I don't want to waste our limited budget on items that are nice to have but we don't need to have. Rodney, your team has to monitor those requests. Anything you find on the order list that you think is unnecessary, please remove or talk to me."

Dr. Forrester closed the meeting by stating that she was applying for several new grants and hoped the new funding would allow for more work, including more employees and the potential for several promotions.

nice to have, but not needed idea, it was all important. She figured that the more she ordered, the more likely it was that her team would get what they needed.

Supplies trickled in, but more and more frequently, her purchase orders would come back with "rejected" stamped on them in big red letters. It felt as if the more orders she submitted, the less likely any of them were to be approved. When she asked Rodney about it, he simply shrugged and said, "It's all about the budget. Dr. Forrester is watching it too closely. Sorry."

After a few weeks, Tasha went to the storage room for four common items and only found two of them. Because her team could not proceed to the next round of trials, Tasha was frustrated and put them to work doing the only thing she could think of: cleaning an already clean lab.

Boundaries

Boundaries have to do with the first two of Daniel Kim's guidelines:

1. Select Time Horizon. Identify the desired time horizon for the problem at hand.

2. Define the Problem Dynamically. Draw behavior over time charts of key variables.

That is, it is important to limit a situation to a manageable time and set of variables; not to do so allows the problem to overflow, confounding the systems thinker who is attempting to analyze it. Simply speaking, defining boundaries is the process of stating what is included in the analysis and what is excluded from both a time and a physical perspective.

In the case study, the time period is a few weeks, certainly less than a quarter in corporate language, even though some roots of the issue reach back to the previous director's tenure. For the purposes of analysis of this case study, the timeframe begins with Dr. Forrester's arrival and ends with the events described following the quarter-end meeting.

The key variables in the problem embedded in this case study, the lack of necessary supplies for Tasha's product design team, include budgetary limitations, the needed supplies, the purchase-ordering process, the relationship between Tasha and Rodney, and the potential promotion for which both of them were competing.

Patterns

Defining the patterns in this case is also important, and this is related to Kim's guidelines #3 and #4:

3. Conduct Thought Experiments. Conduct thought experiments by hypothesizing about the time behavior of different variables and inferring the behavior of other related variables.

4. Build Causal Theories. Use causal loop diagrams to build causal theories that draw out the interrelated behavior of variables over time.

Patterns in this case study include these repeating events:

- Prior to Dr. Forrester's arrival, purchase orders had been submitted but not processed in a timely manner. There had also evidently not been a high level of rigor on controlling the budget.
- Dr. Forrester implemented more dependable processes for purchase ordering.
- Tasha requested supplies that might not have been strictly necessary and Rodney often rejected requests in the name of controlling the budget.
- Supplies needed by the design team were often short or missing.

Interconnections

As with the identification of patterns, the identification of interconnections (also called interrelationships) also relies on Kim's guidelines #3 and #4:

4. Build Causal Theories. Use causal loop diagrams to build causal theories that draw out the interrelated behavior of variables over time.

Interconnections in this case study include:

- The relationship between the purchase of supplies and the control of the budget.
- The relationship between approved purchase orders and the arrival of those supplies for the design team.
- The professional relationships among Tasha, Rodney, and Dr. Forrester.
- The relationship between job performance by Tasha and Rodney and the potential promotional opportunity.

Attributions and References

Reference

Kim, D. (2018). *Behavior over time diagrams: Seeing dynamic interrelationships*. The Systems Thinker. https://thesystemsthinker.com/behavior-over-time-diagrams-seeing-dynamic-interrelationships/

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