cia

Systems Thinking:
It's more than you think.SM

Continuous Improvement Associates

The Diffusion of Innovation

Concerned you won't get the most out of your Product Life Cycle?

Here's a medical technology example: How to understand, monitor & foster it

What is systems thinking?
Seeking to understand system behavior by examining "the whole" … instead of by analyzing the parts.

Extending model structure

The classic Bass model (see **The Product Life Cycle**) takes into account the conversion of nonadopters to adopters by word-of-mouth and advertising. This model has a solid foundation based on observed market behavior and shows the typical S-Curve of market growth.

However, Bass did not explicitly discuss the feedback structure that creates the operational processes responsible for this behavior. That's where system dynamics is useful; it allows examining the specific structure of the company and market and extending the structure to fit particular situations.

This is an overview of extensions to fit two examples for medical technologies based on a 1987 paper by Jack Homer.* The products are a pacemaker and an antibiotic.

How does this help?

Homer's research gives good confidence that his extensions to structure, when simulated, show close to the observed behavior.

Extending the structure to fit specific situations allows tentatively identifying feedback loops that can influence product success or failure. An organization can identify how different groups and individuals can foster loop operation to promote success.

Different groups involved in a loop can define how they'll exchange information and work together to improve loop operation (see **From Causal Loops to Action**). Feedback loops are essentially stories of how the influences play out in the system.

The pacemaker stories

Figure 1 shows the primary pacemaker loops. The loop stories (with link colors) are (follow the arrows):

R1: Word of Mouth (red, blue). A greater market fraction leads to an even greater market fraction.

R2: Product Improvement (blue). Improving the product leads to more capability, better performance, and greater market fraction, purchases and revenue to invest in product improvement.

R3: Extent of Applications (orange, blue, brown). A wider variety of applications leads to increased purchases.

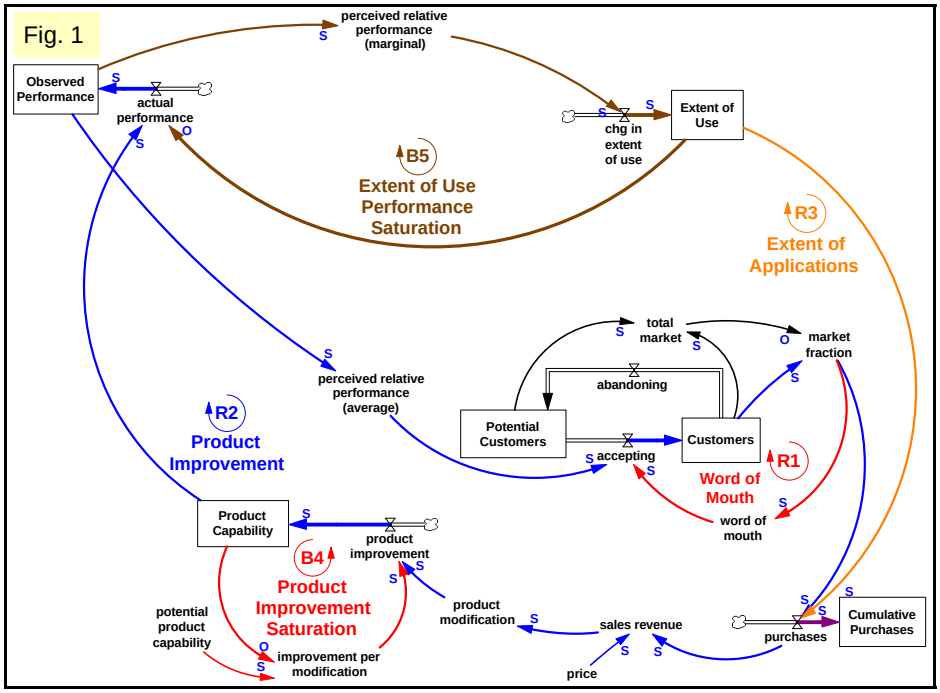
B4: Product Improvement Saturation (red, blue). Additional product improvement creates less incremental capability.

B5: Extent of Use Performance Saturation (brown). The wider the variety of uses, the less marginal benefit obtained.

The antibiotic stories

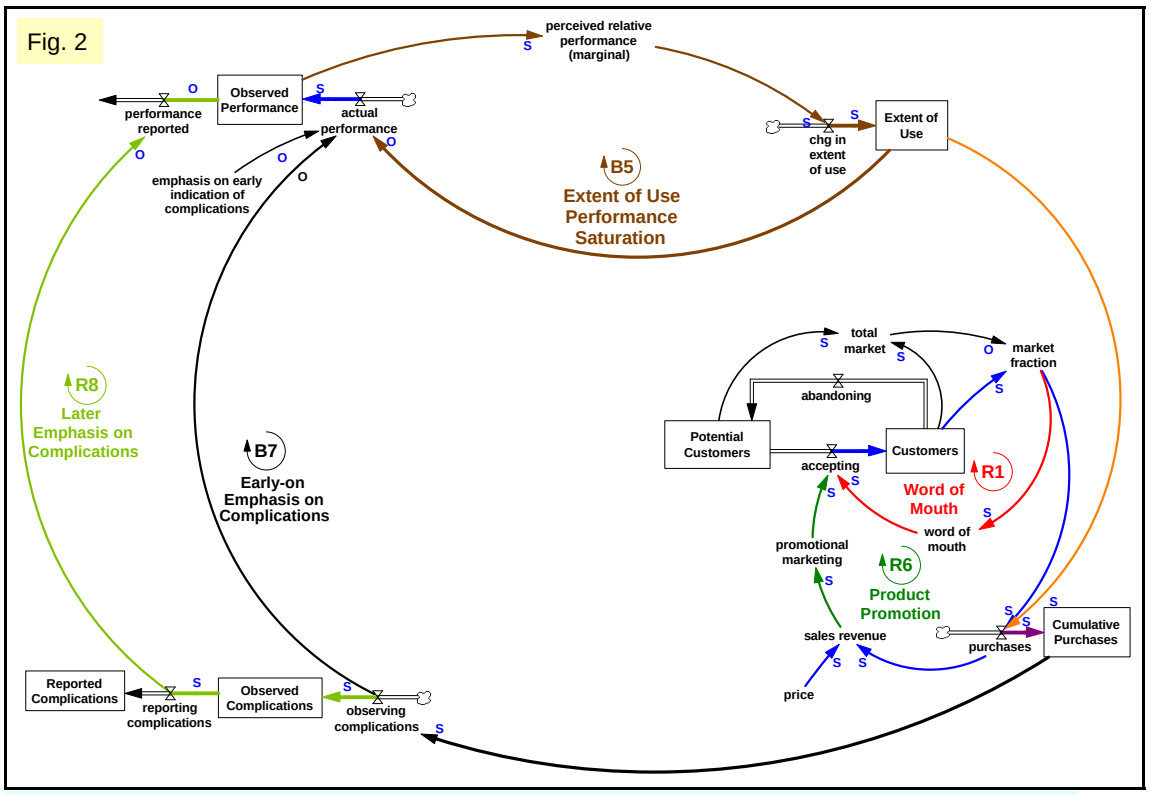
Figure 1 shows the primary antibiotic (clindamycin) loops. Two are the same as in the pacemaker case. The additional

Fig. 1



Primary pacemaker loops: Positive Word of Mouth (R1) builds awareness. Product Improvement (R2) increases purchases, though eventually the product reaches its full capability (B4). Growth from using the product for additional applications (R3) is eventually limited as marginal benefit declines (B5).

*"A Diffusion Model with Application to Evolving Medical Technologies," *Technological Forecasting & Social Change*, 31 (1987), see note on reverse.



Primary antibiotic loops: Positive Word of Mouth (R1) built awareness, then Product Promotion (R6) increased purchases. Overemphasis on initial complications limited purchases (B7), but later, better understanding (R8) allowed addtional growth, especially since product use narrowed (B5) to applications for which it was better suited.

loop stories (with link colors) are:

R6: Product Promotion (green, blue). A portion of sales revenue invested in promotional marketing increases market fraction.

B7: Early-on Emphasis on Complications. As purchases accumulate, complications are observed. Early complications usually get excessively negative attention and limit perceptions of marginal performance. This results in a restriction of Extent of Use and fewer purchases.

R8: Later Emphasis on Complications. More thorough reports on performance reduce the negative perception of performance to again broaden the Extent of Use and purchases.

The sequence of loop dominance

Homer described, based on his simulations that reproduced historical patterns of behavior along all dimensions of comparison, the sequential role of the key feedback loops operating within a unique set of external conditions for each product.

Pacemaker case: First, R1: Word of Mouth generated increasing product acceptance, with R2: Product Improvement further building acceptance. This fueled increases in R3: Extent of Applications. Later, B4: Product Improvement Saturation and B5: Extent of Use Performance Saturation took hold.

Antibiotic case: Initially, R1: Word of Mouth and R6: Product Promotion generated rapid acceptance. Then sales fell off rapidly due to early discouraging reports (B7). Next, reassessments in subsequent reports led to increased perceived performance (R8). Reducing Extent of Use (B5) led to better performance in the narrower applications in which the product was used.

Conclusion

Many factors can be considered in modeling. For example, if adopters are lost too quickly, word of mouth is more difficult to maintain; or the stock of potential customers may be growing. The model must be specific to the product, the company and the industry. Every organization can benefit from understanding, monitoring and fostering their primary market feedbacks.

> "A model that integrates a wide range of real-world concerns can be a powerful tool for policy analysis." Jack Homer

Feedback is Power - Tap It

Models can be tricky. It's tempting to maintain that a model is "valid" because it has an excellent fit to historical data. But a statistically valid fit is possible for entirely different models. So that's insufficient. And changing internal and external conditions may activate feedback loops that have historically lain dormant.

What's important is to understand potential feedbacks, have measures to determine whether they're activated, and contingency plans for how to address them.

The Importance of Causal Structure

Only models that capture the causal structure of the system will respond accurately as conditions change and policies are implemented.

John Sterman in *Business Dynamics, Systems Thinking and Modeling for a Complex World,* 2001

Workshop Benefits

Explicitly examining structure, taking into account the specifics of an organization's situation, is a valuable group learning opportunity. The major benefit is that management teams get to think at a higher level about their product and market to reach an explicit and shared understanding.

Teams can move to action using a strategy matrix of organizational functions versus key success loops and driving forces (see **From Causal Loops to Action**).

Continuous Improvement Associates

Bob Powell, Ph.D., MBA
6992 Blackhawk Place
Colorado Springs, CO 80919
Phone: (719) 599-0977
Website: exponentialimprovement.com
E-mail: scuba@usa.net

Note: Homer's paper is included in *Modelling for Management II: Simulation in Support of Systems Thinking*, edited by George Richardson 1996