Identifying Acquisition Patterns of Failure Using Systems Archetypes

Finding the Root Causes of Acquisition Problems

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Purpose of this Presentation

To show how Systems Thinking and the Systems Archetypes can help to avoid common counter-productive behaviors in software acquisition and development programs

Agenda

- Systems Thinking
- Feedback Loops and Causal Loop Diagrams
- Selected Systems Archetypes
  - Fixes that Fail
  - Shifting the Burden
  - Limits to Growth
- Selected Software Acquisition and Development Archetypes
  - Sacrificing Quality
  - Firefighting
  - The Bow Wave Effect
- Seeing the Bigger Picture and Breaking the Pattern

Why is Software-Intensive Acquisition Hard?

Complex interactions between PMO, contractors, sponsors, and users

Limited visibility into progress and status—hard to comprehend

Significant delays exist between applying changes and seeing results

Unpredictable and unmanageable progress and results

Uncontrolled escalation of situations despite best management efforts

Linear partitioning (“Divide and conquer”) isn’t working well

Exponential growth of interactions as size grows linearly

Acquisition Programs are Dynamic Systems

Complex Interactions: Interactions between acquisition stakeholders are *non-linear*

Non-linear Behavior: Non-linear behavior defies traditional mathematical analysis because of the presence of feedback

Non-deterministic: Complex systems are not deterministic

Sensitivity to Initial Conditions: Results may vary greatly due to seemingly insignificant differences in the starting point(s)

Organizational: Key issues in software acquisition are management and organizational—*not* technical

Partitioning: Not possible with complex interactions between components

What is Systems Thinking?

Systems Thinking developed from work done by Jay W. Forrester at MIT while modelling electrical feedback effects

- Also exists in economic, political, business, and organizational behaviors

Uses feedback loops to analyze common system structures that either spin out of control, or regulate themselves

Helps identify a system's underlying structure, and what *actions* will produce which *results* (and *when*)

Systems Thinking teaches us that:

- *System behavior is greater than the sum of component behaviors*
- "Quick fix" solutions usually have side-effects that make things worse
- Improvement comes only from changing the underlying system structure

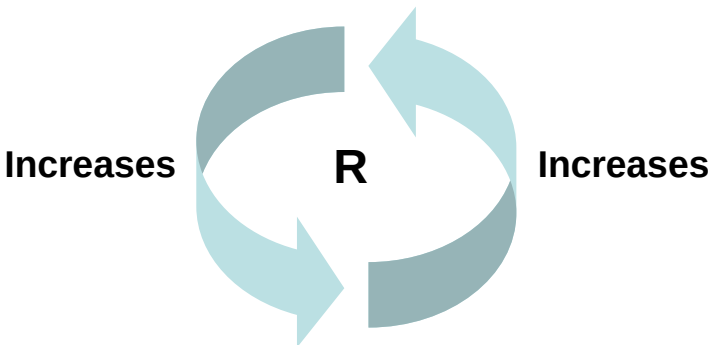
Causal Loop Diagrams (CLDs)

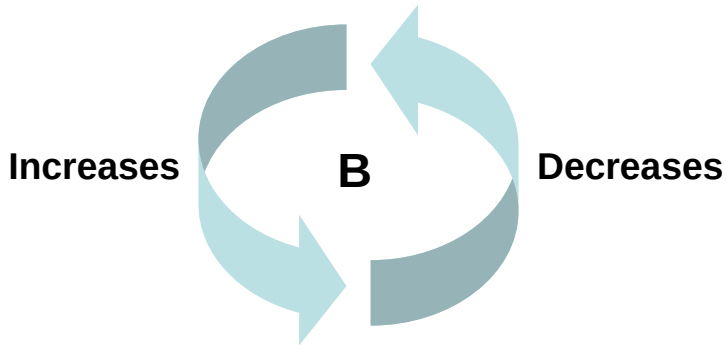
Depict qualitative "*influencing*" relationships (increasing or decreasing) and time delays between key variables that describe the system

Show relationship direction by labelling them **S**ame (**+**) or **O**pposite (**-**) to indicate how one variable behaves based on the previous variable

Consist primarily of two types of feedback loops:

- **R**einforcing – Changes to variables *reinforce*, moving in one direction
- **B**alancing – Changes to variables *alternate*, achieving equilibrium





Time Delays

Much instability and unpredictability of systems is due to time delays

Time delays obscure the connections in cause-and-effect relationships

- Side-by-side causes and effects would be “smoking gun” evidence

People are inherently poor at controlling systems with substantial time delays between cause and effect

Examples:

- Over-steering a large ship that is slow to respond, so it weaves back and forth
- A thermostat controlling a low-BTU air conditioner that’s slow to cool, so the house temperature bounces between too hot and too cold
- Inability to determine which surface, handshake, sneeze, or cough resulted in an infection

What are the Systems Archetypes?

The Systems Archetypes depict the underlying structures of a set of dynamic behaviors that occur in organizations throughout the world

- Each causal loop diagram tells a familiar, recurring story
- Each describes the system structure that causes the dynamic

Archetypes are used to:

- Identify failure patterns as they develop (*recognition*)
- Single out root causes (*diagnosis*)
- Engage in “big picture” thinking (*avoid oversimplification*)
- Promote shared understanding of problems (*build consensus*)
- Find interventions to break out of ongoing dynamics (*recovery*)
- Avoid future counter-productive behaviors (*prevention*)

Systems Archetypes

Over 10 recurring “systems archetypes” have been identified, including:

Fixes that Fail

- A quick fix for a problem has immediate positive results, but its unforeseen long-term consequences worsen the problem.

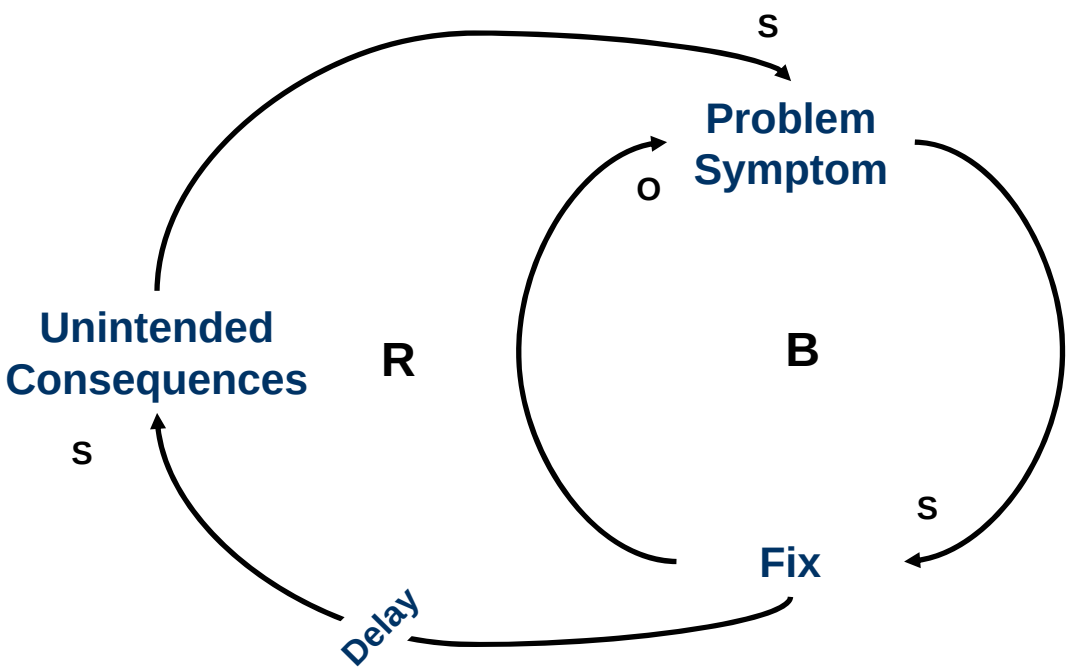
Shifting the Burden

- An expedient solution temporarily solves a problem, but its repeated use makes it harder to use the fundamental solution.

Limits to Growth

- Initially rapid growth slows because of an inherent capacity limit in the system that worsens with growth.

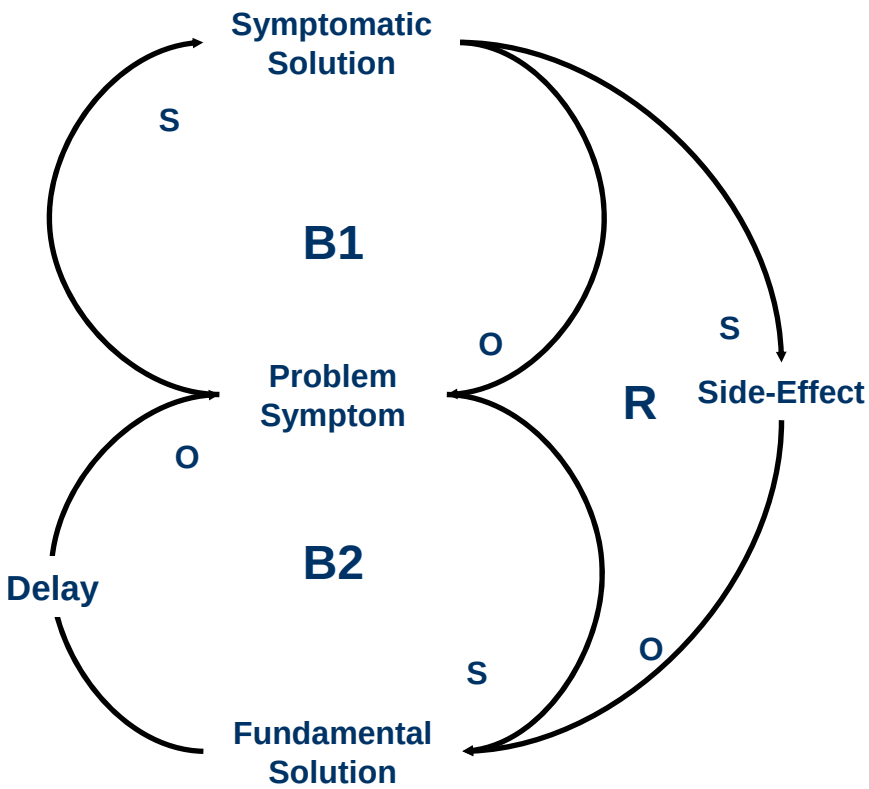
“Fixes That Fail” – Systems Archetype



A quick *Fix* for a *Problem Symptom* has immediate positive results, but also has long-term *Unintended Consequences* that, after a *delay*, worsen the original *Problem Symptom* as the *Fix* is used more often.

based on “Fixes That Fail”

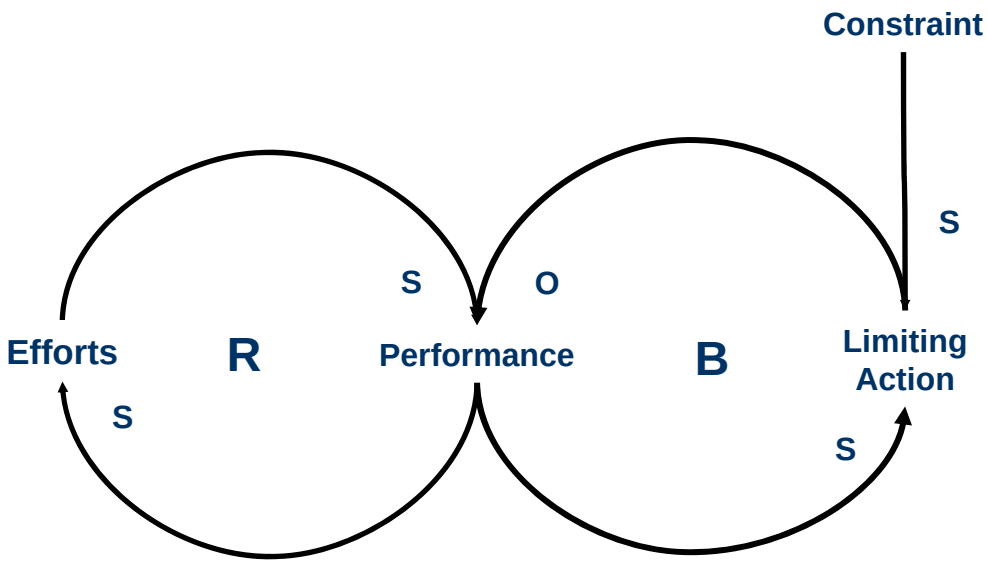
“Shifting the Burden” – Systems Archetype



A *Symptomatic Solution* temporarily solves a *Problem Symptom*, which later recurs. Its repeated use over the longer term has *Side-Effects* that make it less and less feasible to use the more effective *Fundamental Solution*—trapping the organization into using only the *Symptomatic Solution*. Impatience with the delay makes the organization choose the *Symptomatic Solution* in the first place.

Based on “Shifting the Burden”

“Limits to Growth” – Systems Archetype



Initially rapid growth slows because of an inherent capacity limit in the system that worsens with growth. As greater *Efforts* produce better *Performance*, there is a greater *Limiting Action* due to a *Constraint* in the environment, slowing *Performance*.

Based on “Shifting the Burden”

Acquisition Archetypes

There are many recurring patterns of behavior in software acquisition and development that have been modelled using Systems Archetypes and CLDs:

- Sacrificing Quality
- Firefighting
- The “Bow Wave” Effect
- Underbidding the Contract
- Shooting the Messenger
- Robbing Peter to Pay Paul
- Longer Begets Bigger

. . .

- The 90% Syndrome
- Requirements Scope Creep
- Feeding the Sacred Cow
- Brooks’ Law
- PMO vs. Contractor Hostility
- Staff Burnout and Turnover
- The Improvement Paradox

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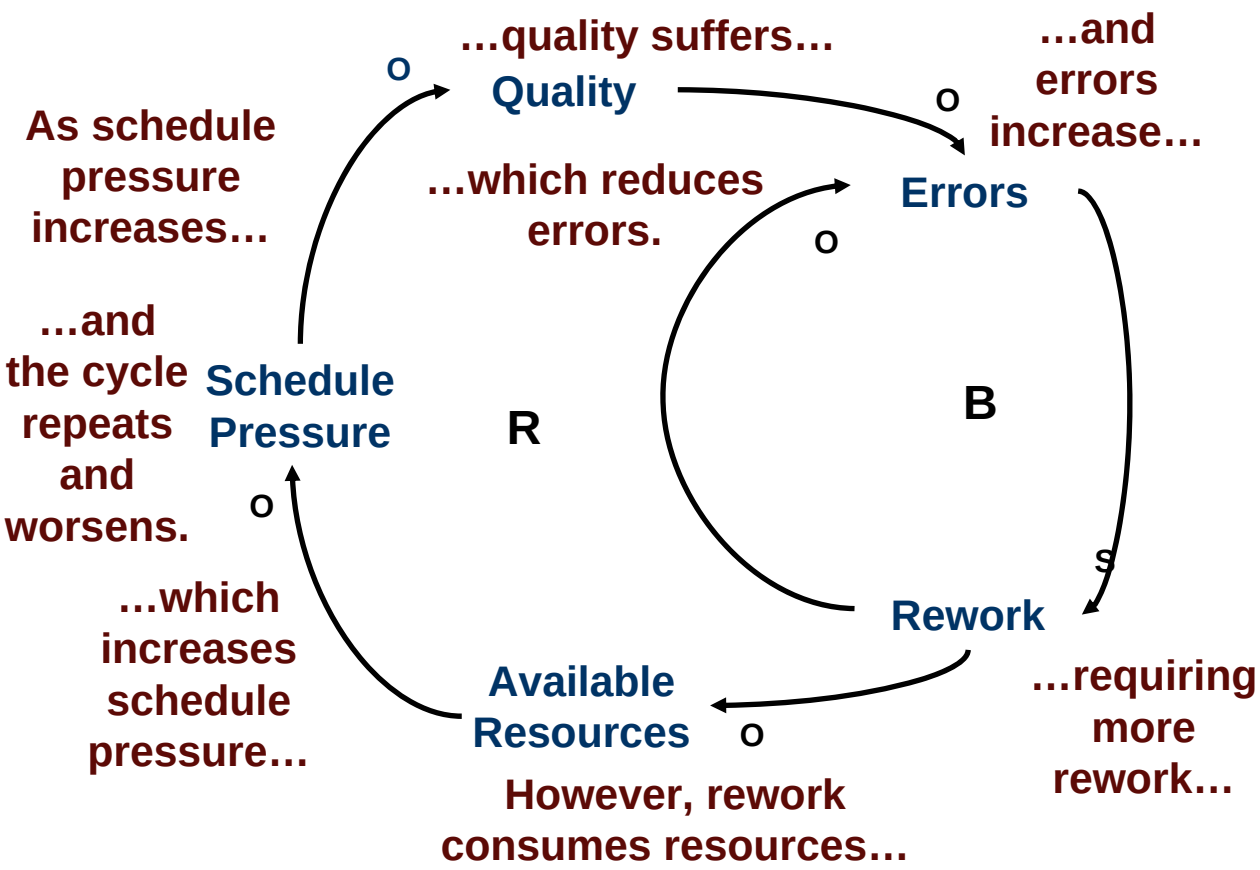
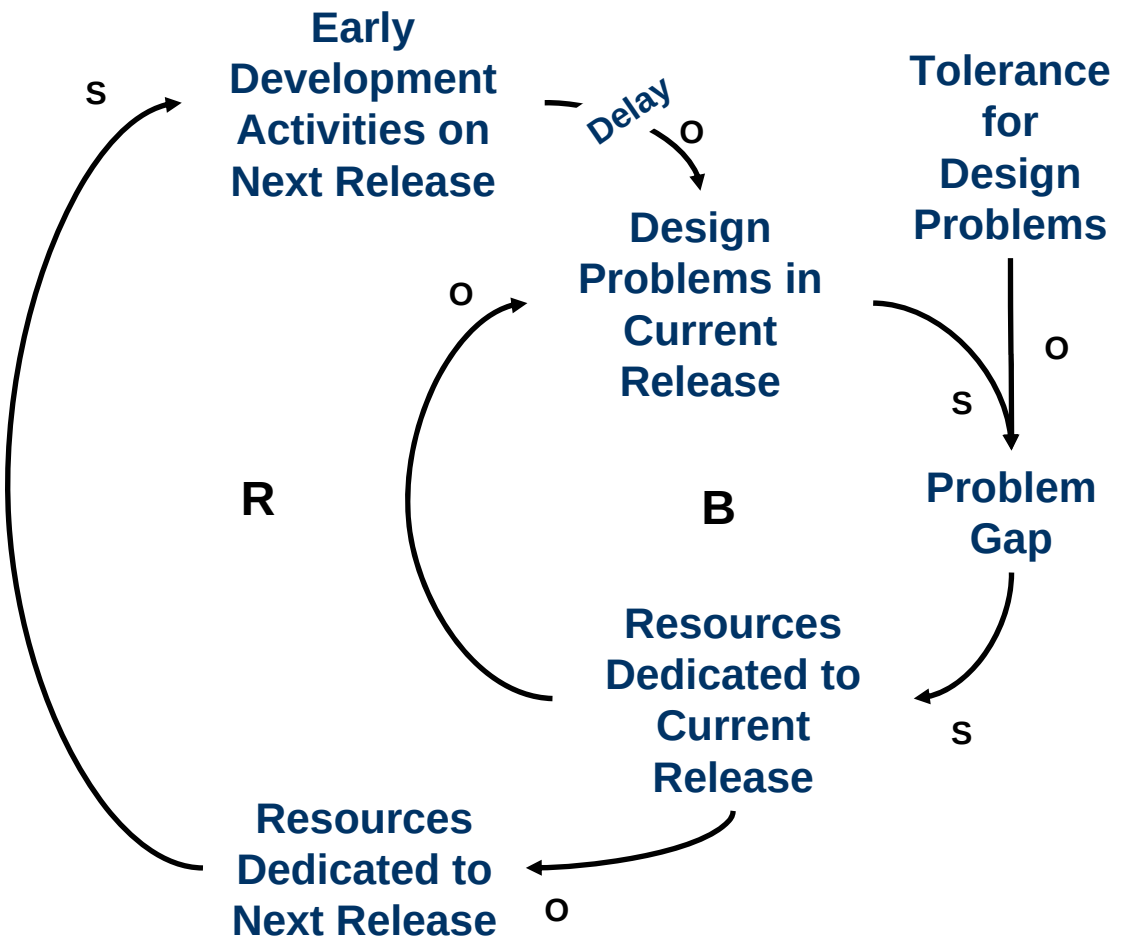
“Sacrificing Quality” – Acquisition Archetype



As schedule pressure increases, processes are shortcut, quality suffers, and errors increase—requiring more re-work. However, re-work consumes resources, which increases schedule pressure, and the cycle repeats and worsens.

based on “Fixes That Fail”

“Firefighting” – Acquisition Archetype

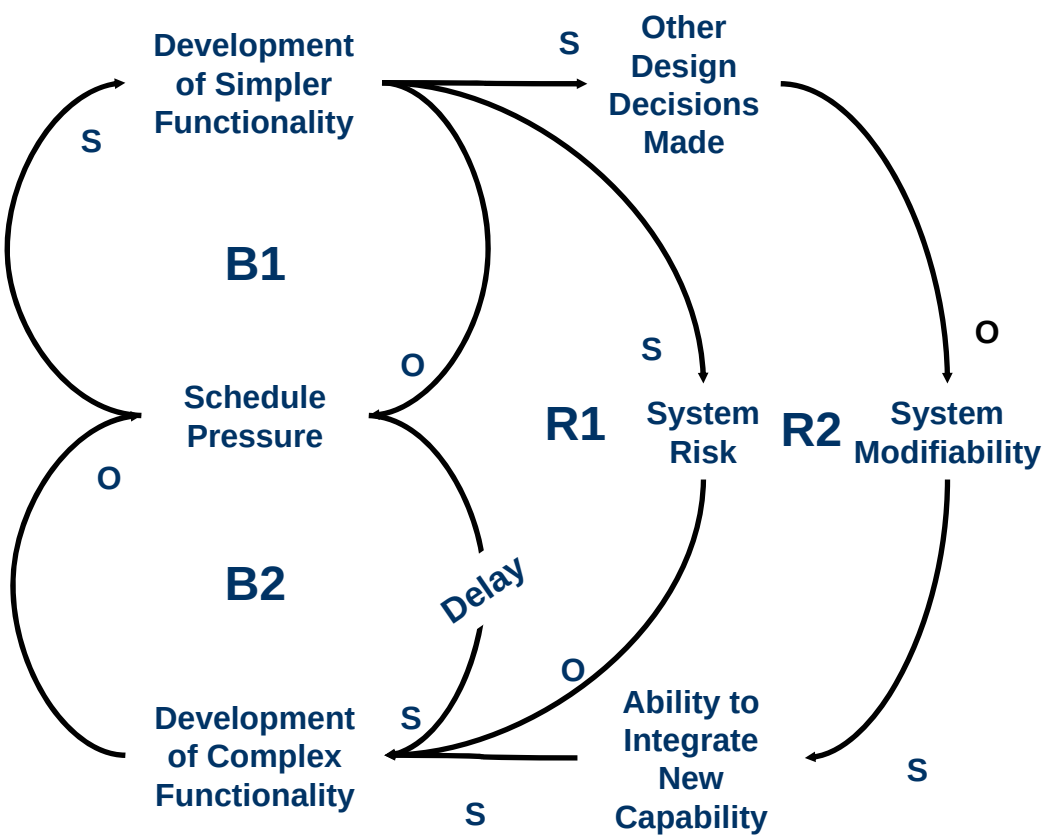


If a design problems in the current release are higher than the tolerance for them, more resources must be dedicated to fix them. This reduces problems, but now fewer resources can work on the *next* release. This undermines its early development activities which, after a delay, increases the number of design problems in the next release.

from “Past the Tipping Point”

based on “Fixes That Fail”

“Bow Wave Effect” – Acquisition Archetype



Risky tasks planned for an early spiral to reduce risk are postponed to a later spiral, making near-term performance look better. This increases risk in subsequent spirals by delaying required risky development for which there is now less available schedule to address potential issues, and less flexibility in the system to accommodate changes needed to integrate the new capability.

based on “Shifting the Burden”

The Bigger Picture/Breaking the Pattern

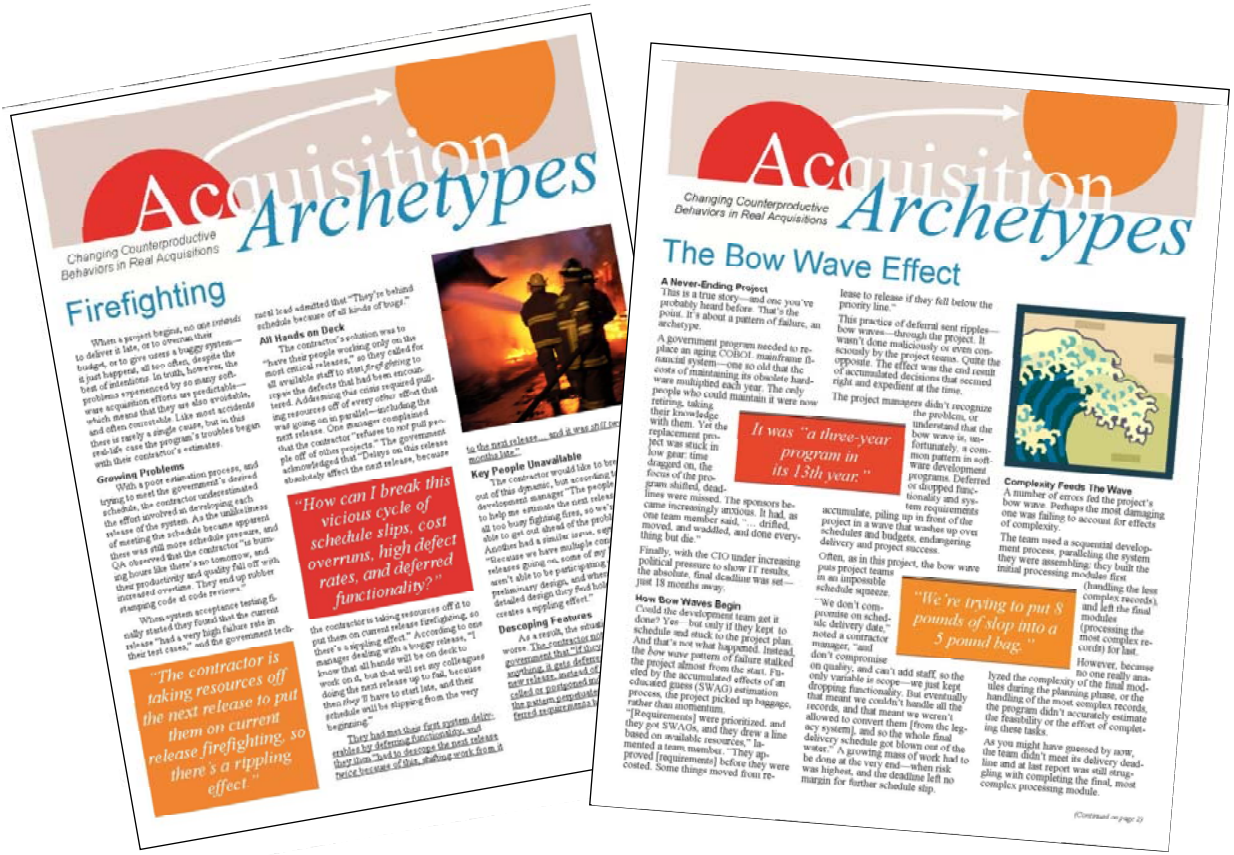
By showing the underlying structure of a dynamic, Causal Loop Diagrams show where best to apply leverage to slow or stop it—for example:

- Change negative dynamics into positive ones by running them backwards
- Slow the acceleration of unwanted reinforcing loops—"*When you're in a hole, stop digging*"
- Change the limiting value a balancing loop approaches or oscillates around to something more acceptable.

Each systems archetype has specific interventions for addressing it

Knowing about the most common counter-productive dynamics is the best way to prevent them

Acquisition Archetype Concept Briefs



SEI is producing a set of "*Acquisition Archetype*" concept briefs, analyzing recurring patterns in actual acquisition programs, and recommending interventions and preventative actions

Next Steps and Further Information

Extend the set of *Acquisition Archetypes*

- Eleven *Acquisition Archetypes* have been described to date
- Plan to identify additional acquisition dynamics and root causes

For additional information

- Visit the SEI website:
  - http://www.sei.cmu.edu/programs/acquisition-support/pof-intro.html
- Upcoming SEI Technical Note: "*Archetypal Patterns of Failure in the Acquisition and Development of Software-Intensive Systems*"
- Planned 2008 Workshop: "*Avoiding Failure in Software Acquisition*"

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