



# A Systems Thinking Model for Cost Growth Mitigation: Finding the Leverage Points

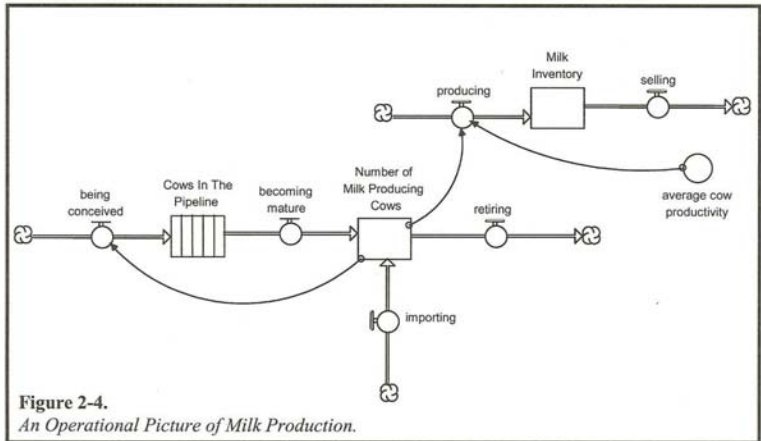


Figure 2-4.  
An Operational Picture of Milk Production.

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## Overview

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# Goal of Presentation

- **Provide an intuitive feel for what Systems Thinking is and how it can be applied on the job**
- **Demonstrate a simple Systems Thinking model for mitigating cost growth**



# What is Systems Thinking?

- **Systems Thinking is:**

- A methodology for analyzing the *interactions* among the parts making up a system
  - Does not study the parts individually
- Looks behind events to the patterns or structure that drive them
  - A wide-angle/big picture view of reality



A system is something that maintains its existence and functions as a whole through the interaction of its parts.

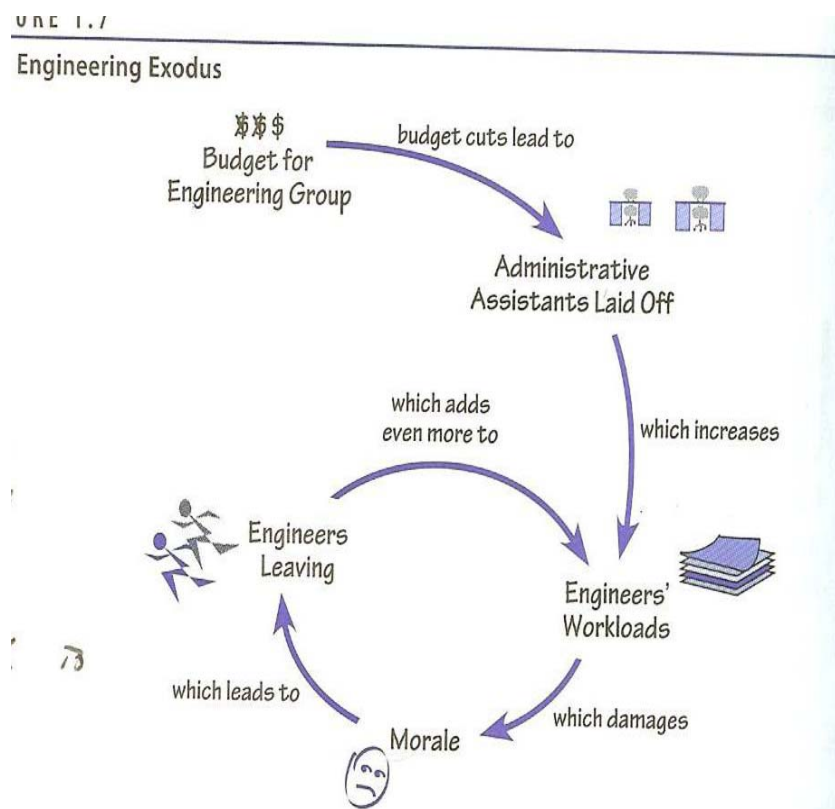
**“You are a system, living in a world of systems.”—The Art of Systems Thinking, by Joseph O'Connor and Ian McDermott, 1997, page 4.**

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# Systems-Thinking Tools – Influence Diagrams, Chart 1 of 2

- **Informal Systems-Thinking models simulate behavior by using Influence Diagrams**
  - They show the cause and effect relationships at work that are driving the behavior.



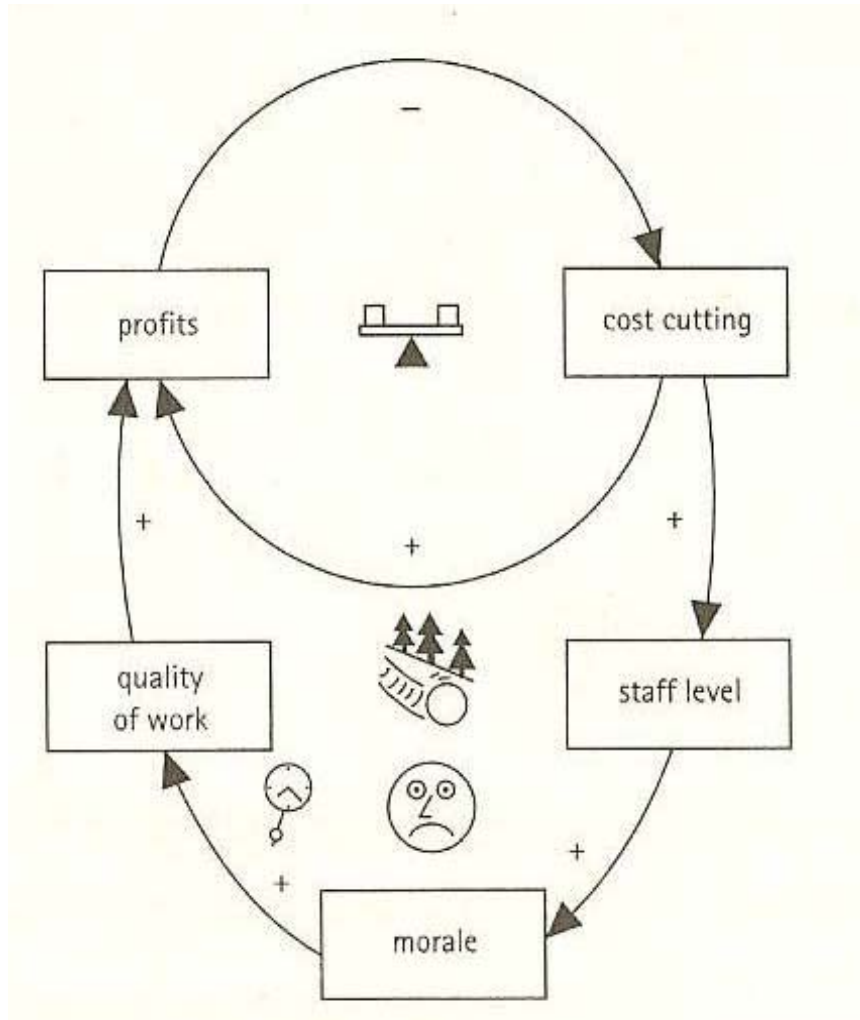
**Engineering Exodus Due to Budget Cuts in Administrative Support**

Reference: Systems Thinking Basics: From Concepts to Causal Loops, by Virginia Anderson and Lauren Johnson, 1997, Page 8.

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# Systems-Thinking Tools – Influence Diagrams, Chart 2 of 2



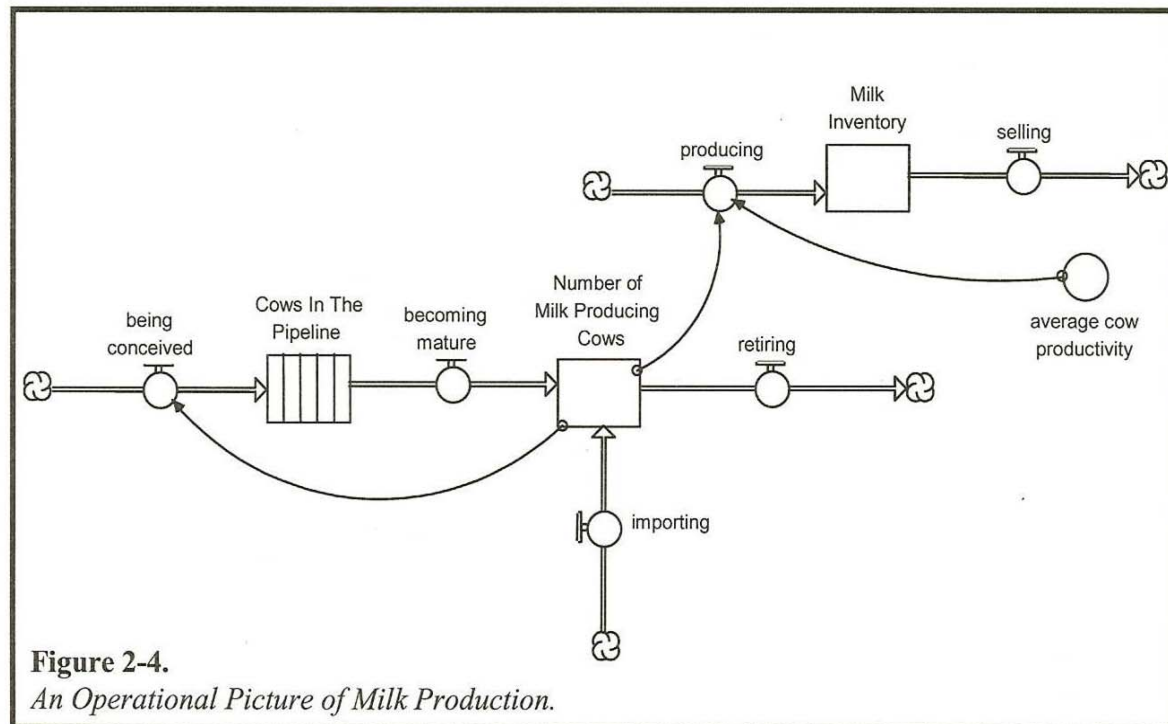
Do cutting costs necessarily make a firm more competitive in the long run?

Reference: The Art of Systems Thinking: Essential Skills for Creativity and Problem Solving, by Joseph O'Connor & Ian McDermott, 1997, page 197.



# Systems-Thinking Tools – Software

- **Formal Systems-Thinking models simulate behavior by using stocks, flows, and feedback**



Reference: An Introduction to Systems Thinking, by Barry Richmond, 2004, page 19.

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# Systems-Thinking Examples from the News: Hurricane Katrina - Army Corps of Engineers



- "We . . . have not done as good a job as we should be doing on understanding the interaction of that project and other projects and other dynamics in a watershed...
- One of the lessons the Corps learned from...Hurricane Katrina is that *the agency tended to treat each component as an individual project, rather than as an integrated whole.*" — "Chain Reaction," Brian Friel, *Management Matters*, Nov 1, 2006.

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# Systems-Thinking Examples from the News: Iraq



"Everything is connected"—Dr.  
James L. Ritchie-Dunham

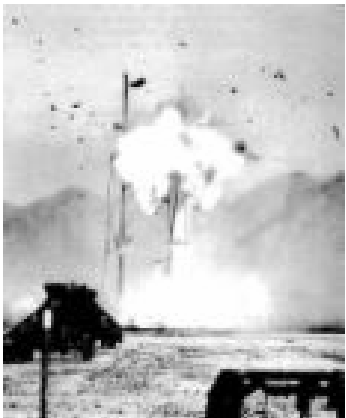
- **“When the U.S. invaded Iraq, American optimists invoked Germany and Japan as models for their democratization project,**
  - **but Iraq didn’t have the cultural cohesion or national identity of those countries...**
    - **Nearly half of Iraqis were married to their first or second cousins...**
    - **Members of these tightly knit Iraqi clans don’t look on society as a collection of individuals working for the common good of the nation.”— “One Nation Divisible,” John Tierney, *New York Times*, Oct 24, 2006.**

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# Why Do We Need Systems Thinking?

- **Today's world is too complex for the mind to handle on its own\***
  - Our mind must *simplify* reality in order to respond to it
  - We package our simplifications into mental models
  - We simulate these models when we are analyzing for decision making
  - Unfortunately our mental models are overly simplified
    - They do not take all the dynamic consequences into account
      - As a result we are constantly living with the unintended consequences of our prior decisions
        - » e.g., acid rain, global warming, drug-resistant antibiotics



**“The incompleteness and inconsistencies of our ideas become clear only during implementation.”—Dorothy Sayers**

\*Reference: “Systems Thinking Defined in a 30-Second Elevator Ride....,” by Barry Richmond.

<http://www.iseesystems.com/Community/STArticles/SystemsThinking.aspx>

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# Some Systems-Thinking Archetypes, Chart 1 of 2

- **Fixes that Fail**

- **A short term, band-aid solution sets in motion an unintended consequence which boomerangs back and exacerbates the original problem**
  - **e.g., A company trims its high cost employees in order to decrease costs and increase profits. This results in an exodus of experience out the door. As a result, productivity declines and costs rise again.**
  - **“Not this again!”**

- **Shifting the Burden**

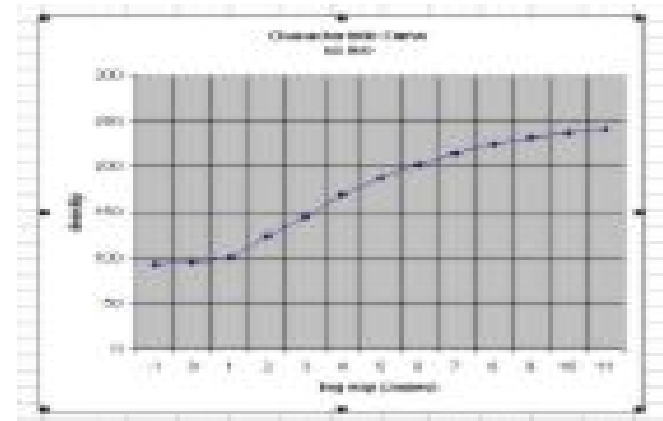
- **Your solution is now someone else’s problem**
- **e.g., Building higher smokestacks for power plants in the Ohio Valley was done to eliminate the soot problem. The soot was carried to the Northeast and Canada and became acid rain.**

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# Some Systems Thinking Archetypes, Chart 2 of 2

- **Limits to Success**
  - “This used to be so easy!”
  - A reinforcing loop meets a balancing loop
    - Simply applying more of the same effort won’t solve the problem
    - e.g., Reaching a plateau in dieting
- **Success to the Successful**
  - “It takes money to make money.”
  - e.g., The best professional athletes also get the best endorsement deals.
- **Accidental Adversaries**
  - You both work for the same organization; but your goals are in conflict.
  - e.g., You need to visit your client as soon as possible and want to take a direct flight. However, your company’s accounting office requires you to take a cheaper, less direct, more time consuming flight.





# iThink Demo – Cost Growth Mitigation

- **The Situation**
- **Independent Review Team (IRT) Observations**
- **IRT Recommendations**
- **Display and Exercise of Software**



# iThink Demo – Cost Growth Mitigation The Situation



- **Sick Acquisition Program**

- It has been one year since the end of source selection and Program X is behind schedule and significantly over cost

- **An IRT has been convened**

- Direction - find out why the program is so sick and come up with a “cure”

**“We are very short of money, so we must begin to think.”—Lord Rutherford**





# iThink Demo – Cost Growth Mitigation IRT Observations, Chart 1 of 2



- **Original cost, schedule, and technical projections were overly optimistic**
  - **The Conspiracy of Hope has triumphed again!**
- **A lack of historical data has resulted in a superficial assessment of risk**
  - **As a result, cross checks against contractor proposals and estimates were largely superficial**





# iThink Demo – Cost Growth Mitigation IRT Observations, Chart 2 of 2

**[The “Conspiracy of Hope] “Encourages instability at the very beginning of acquisition programs and occurs when industry is encouraged to propose unrealistic cost, optimistic performance and understate technical risk estimates during the acquisition solicitation process and the Department is encouraged to accept these proposals.” —*Defense Acquisition Performance Assessment Report*, Jan 2006, page 102.**

- **How the “Conspiracy” plays out**
  - “...the prospective seller quite naturally wants to submit a lower bid than any of its competitors in order to win...;
  - ...the purchaser wants the price to be low
  - Congress wants to appropriate as little money as possible
  - Finally, the customer’s contracting department wants to demonstrate that it is a tough negotiator and thus further drives down the contractor’s estimate.”—Augustine’s Laws, Norman R. Augustine, Viking Penguin Inc., New York, New York, 1983, page 332.

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# IRT Observations - Influence Diagram

## Step 1 – Lay Out the Players

**Schedule Growth**

**Cost Growth**

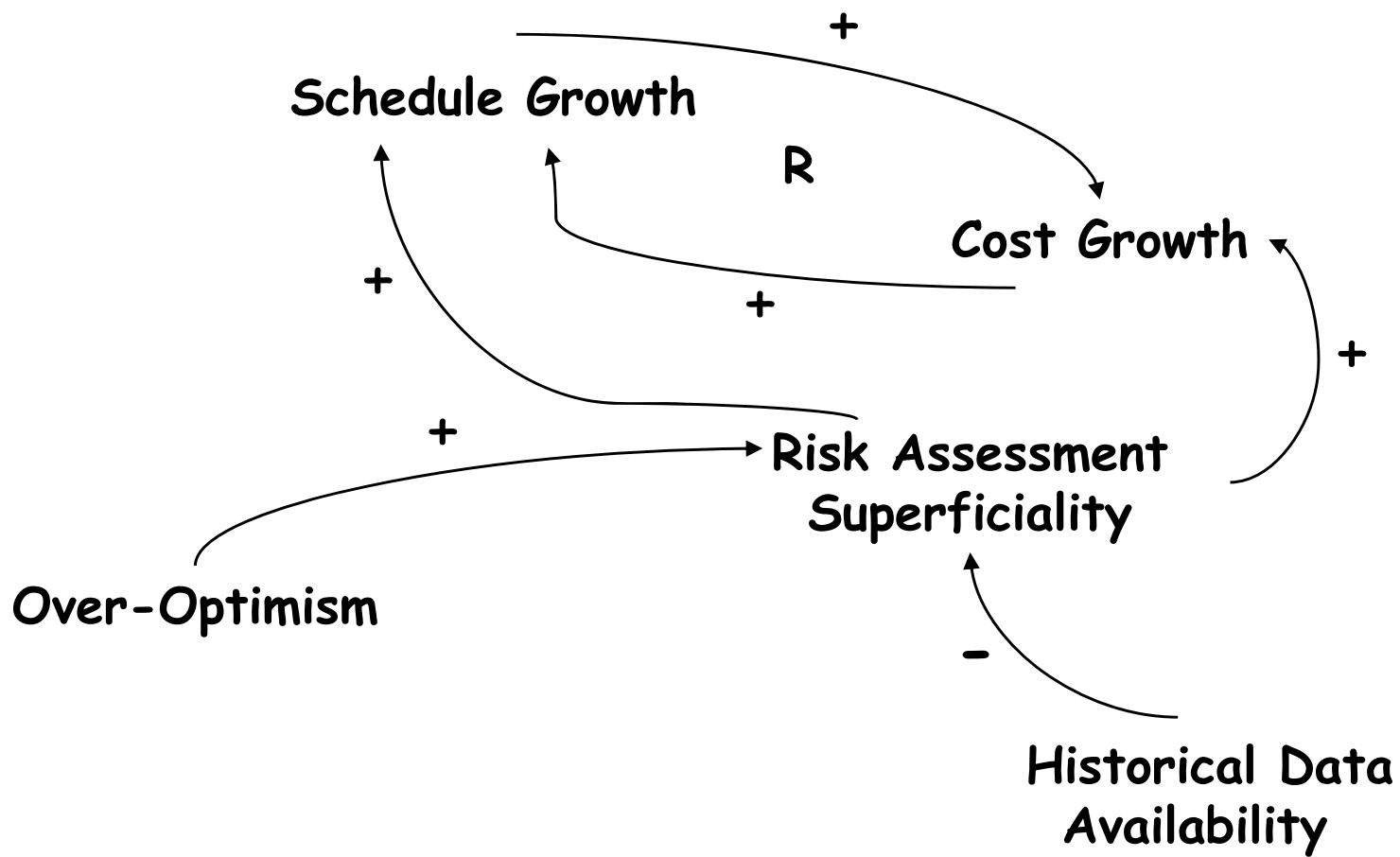
**Risk Assessment  
Superficiality**

**Over-Optimism**

**Historical Data  
Availability**



# IRT Observations - Influence Diagram Step 2 – Define the Relationships





# Think Demo – Cost Growth Mitigation IRT Recommendations



- **Recommendation #1 - Establish Accountability for Execution**
- **Recommendation #2 - Establish a Viable Historical Data Collection Program**



# IRT Recommendation #1, Chart 1 of 3

## Establish Accountability for Execution

- **Establish accountability for execution**
  - **Reward or penalize the contractor based upon ability to perform within cost and schedule**
    - **Should counteract over-optimism and increase realism in program planning and execution**
  - **Follow the contracting strategy employed by the State of California in rebuilding the Santa Monica Freeway after the Northridge Earthquake in 1994**
    - **Reward for early delivery and penalize for late delivery**
    - **Make the \$ large enough so you get the contractor's A-Team**





# IRT Recommendation #1, Chart 2 of 3

## Santa Monica Freeway Reconstruction\*

- **Economics dictated that it be rebuilt/reopened ASAP**
  - The nation's busiest highway
  - Was hemorrhaging an estimated \$1M per day in lost wages and productivity
- **Contract awards were determined using an incentive-based formula known as A&B contracting**
  - Contractors submitted bids based upon projected construction costs - "A" - and the estimated number of days - "B" - to completion
  - The State had set a ceiling requirement for "B" at 140 days
  - The contractor's guaranteed payment was only for the "A" amount

\* "Government Can Work: The Santa Monica Story," by Michelle Cottle and Sherri Eisenberg, *Washington Monthly*, 1 May 1997.

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# IRT Recommendation #1, Chart 3 of 3

## Santa Monica Freeway Reconstruction

- **The incentive**
  - For every day that the contractor came in early from its time estimate, it would receive \$200K
  - For every day that it came in late, it forfeited a penalty of \$200K
- **C.C. Myers won the contract with a bid of \$14.9M**
  - The freeway reopened 66 days after contract award— 74 days ahead of schedule
  - They collected their \$14.9M bid plus an incentive of \$14M



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# IRT Recommendation #2, Chart 1 of 4

## Establish a Viable Historical Data Collection Program

- **History is an antidote against our cognitive predisposition towards optimism and overconfidence\***
  - **“Delusional Optimism”** We overemphasize projects’ potential benefits and underestimate likely costs
    - Spin success scenarios while ignoring the possibility of mistakes
  - **The Planning Fallacy**
    - The tendency to hold confident the belief that one’s own project will proceed as planned, even while knowing that the vast majority of similar projects have run late

\* The psychological theory and research behind this recommendation are referenced in the bibliography at the end of this briefing. It is hard to call out each reference individually, as they are so intertwined.



## IRT Recommendation #2, Chart 2 of 4 Be Aware of Probable Bias

- **When planning we tend to take the inside view**
  - **People generate estimates by constructing detailed future success-oriented scenarios with few references to past experience, unless prompted**
  - **Unprompted references to past experiences tend to recall past successes, and past failures are regarded as non-applicable to the situation at hand**
- **Optimistic bias is multiplied when new technology or financial incentives are involved**



# IRT Recommendation #2, Chart 3 of 4 Benefits

- **Cost history provides an outside view of the situation**
- **A more credible and accurate estimate or analysis results from a balance of inside and outside views**
  - **Recent studies have shown that when people are asked simple questions requiring them to take an outside view, their forecasts become significantly more objective and reliable—however, they are still optimistically biased**
- **Balancing the inside and outside views enhances credibility**
  - **If the cost estimate is optimistic by historical standards**
    - **What new ways of doing business will be applied?**
    - **What lessons learned and best practices will be applied?**

**“Hope is a good breakfast, but a bad supper.”—Francis Bacon**





# IRT Recommendation #2, Chart 4 of 4 Specifics

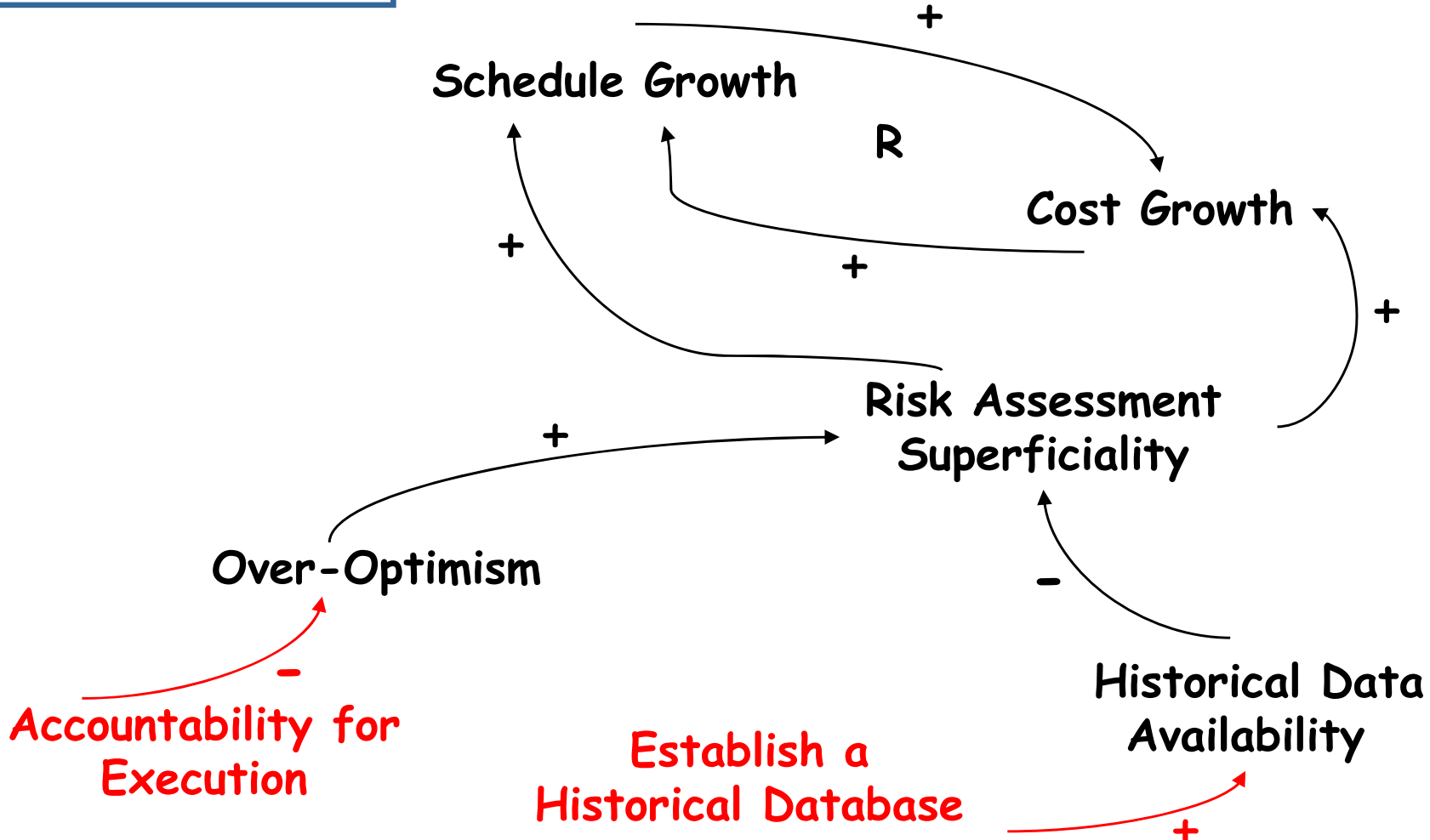
- **Establish an easily accessible, fully staffed, data repository**
- **Institute a continuous cost, technical, schedule and programmatic historical data collection process**
  - **Dedicate full time resources toward collecting, normalizing, organizing, storing, and distributing the data**
  - **Require project teams to provide new program data that was collected as part of the project**
    - **Must be fulfilled before the team disbands**
    - **Also provide a list of future cost research/data collection that the project generated a need for but did not have the time to pursue**





# IRT Observations and Recommendations: Influence Diagram

- Observations
- Recommendations



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# IRT Observations and Recommendations: iThink\* Software Demo

## Live demonstration of the software and simulation of results

\* iThink is marketed and maintained by isee systems  
<http://www.iseesystems.com/>

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# Advantages of Systems-Thinking Software

- **Provides a disciplined process for analyzing a situation and choosing the mitigation strategy**
  - Easier to identify and treat root causes
  - Easier to find leverage points
- **Makes mental models visible for all to see**
  - Creates group focus and synergy
- **Flexible – Can accommodate all points of view**
  - Easy to change assumptions and interrelations and simulate their impacts
- **Can simulate the outcomes of numerous courses of action**
  - Do not have to wait for them to play out in real life
  - **Helps to mitigate unintended consequences**

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# Potential Applications - How Can You Apply Systems Thinking Principles On the Job?

- **Independent Review Teams**
  - Understand the background structure of relationships that drives the problem
  - Simulate potential solutions
- **Process planning and analysis**
  - Especially where a lot of stakeholders are involved
- **Investigate ripple effects of decisions**
  - Are there any unintended consequences?



# Some Lessons Learned, Chart 1 of 2

- **Be sensitive to the fact that everybody models reality differently**
  - And they will let you know when you start diagramming the situation!
- **Look beyond events to the behind-the-scenes structures that are driving the behaviors**
  - Things are not as simple as they first seem
  - Analyzing stories in the media is a good exercise
    - “This story is an example of what archetype?”
    - Many times what is being reported is the event, not the behind-the-scenes structure of relationships that drove it
- **When modeling the situation**
  - *Do not get enamored with the model!*
  - Limit your boundaries to what is relevant
    - e.g., What influences are under your control and what influences aren't?
  - Get your relationships down first and then start your formal modeling





# Some Lessons Learned, Chart 2 of 2



- **Expect pushback from other methods that are threatened by your solution**
- **When planning, run all the scenarios in order to limit unintended consequences**
  - **Gathering a diverse team brings many points of view to the situation**
  - **Be sure to include “outsiders” with experience on other programs and technical areas**
  - **Diversity builds strength**
- **Look for the leverage points**
  - **e.g., weak link in the chain**
  - **Big pay off for little \$ or effort**



# Summary/Conclusions

- **Systems Thinking is a disciplined process for analyzing the interactions among the parts of a system**
  - It enables you to see relationships and patterns that you would normally miss
- **It provides visibility into the structure of relationships that drive an event**
- **Is an excellent group analysis tool as it makes mental models visible for all to see and is flexible enough to accommodate all points of view**
- **Enables the simulation of results**
  - Avoiding unintended consequences



# Bibliography

1. Buehler, Roger, with Dale Griffin and Michael Ross, "Exploring the 'Planning Fallacy': Why People Underestimate Their Task Completion Times," *Journal of Personality and Social Psychology*, Vol. 67, No. 3, pp. 1-16, 1994.
2. Buehler, Roger, with Dale Griffin and Heather MacDonald, "The Role of Motivated Reasoning in Optimistic Time Predictions," pp. 238-247, *Personality and Social Psychology Bulletin*, Vol. 23, No. 3, March 1997.
3. Buehler, Roger and Dale Griffin, "Planning, Personality, and Prediction: The Role of Future Focus in Optimistic Time Predictions," *Organizational Behavior and Human Decision Processes*, Vol. 92, pp. 80-90, 2003.
4. Lovello, Dan and Daniel Kahneman, "Delusions of Success: How Optimism Undermines Executives' Decisions," *Harvard Business Review*, July 2003.



# Further Reading

- **Dubelko, John D., USAF, “A Systems Dynamics Approach to Modeling Aircraft System Production Break Costs,” MS Thesis, AFIT/GAQ/ENV02M-06, March 2002.**  
<http://stinet.dtic.mil/cgi-bin/GetTRDoc?AD=A400551&Location=U2&doc=GetTRDoc.pdf>
- **Purvis, Christopher D., USAF, “Estimating C-17 Operating and Support Costs: Development of a Systems Dynamics Model,” MS Thesis AFIT/GAO/ENV/01M-10, March 2001.**  
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