

Systems Thinking & Problem Solving:

(Understanding Our Most Important Messes)

Reinforcing and Balancing Loops
Exponential Improvement
TQM and Systems Thinking

MGM315 4/28/04

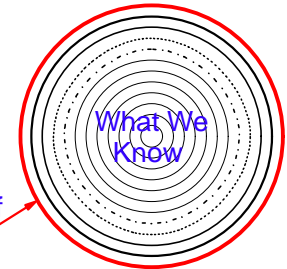
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It Seems Overwhelming

- "There has been an alarming increase in the number of things I know nothing about."

Ashley Brilliant

What We Don't Know



Edge of Awareness of What We Don't Know

M. Scott Peck, *The Road Less Traveled*, 1978, p. 137

Systems Thinking: Fad or Enduring Practice?

- Enduring Practice:
it's based on principles fundamental to the nature of reality
- ➔ feedback (... feedback is ubiquitous)
- ➔ nature integrates (... does integral calculus)
- ➔ primacy of the whole (... systems have emergent properties)
- ➔ our instincts fail us when we face dynamically complex problems (... multiple feedbacks with delays)
- ➔ the generative power of language (languages and tools change the user)
- ➔ reality is objective and subjective (... not everything that's important can be measured, e.g., creativity, morale, burnout, ...)
- ➔ interdependence and the collective nature of self (we exist both as individuals and as part of community).

... but it's not as risky as this ...

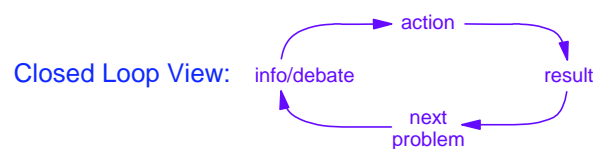
Indeed:
"The ability to learn faster than your competitors may be the only sustainable competitive advantage."
Peter Senge, quoting Arie de Geus, in *The Fifth Discipline*, 1990

Feedback Loops & the Building Blocks: Reinforcing and Balancing Loops

Language Helps Us Think

The way we think about the world depends on our language.

Open Loop View: info/debate → action → result

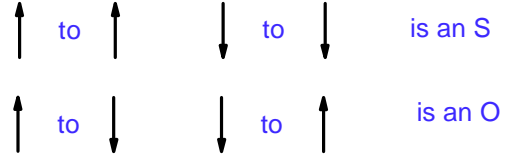


Feedback Loops

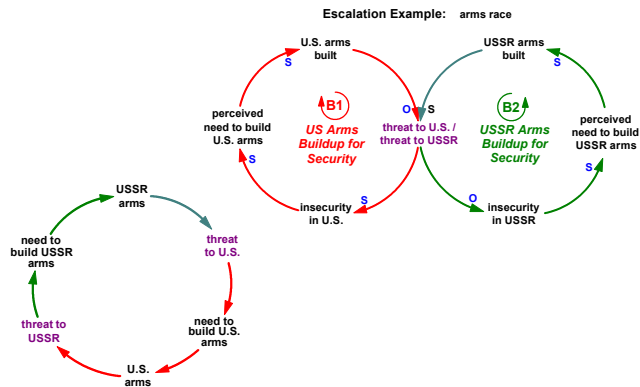
- **Reinforcing loops (R loops with an even # of Os)**
 - scientifically known as **positive feedback**
 - virtuous & vicious cycle behaviors
- **Balancing loops (B loops with an odd # of Os)**
 - scientifically known as **negative feedback**
 - goal seeking, stabilizing, growth limiting behaviors

Remember: Link polarities (the Ss & Os) are about

- the relationship between variables
- whether the increase or decrease of one variable
 - adds to or has a **positive multiplier effect** on the influenced variable
 - OR
 - subtracts from or has a **negative multiplier effect** on the influenced variable

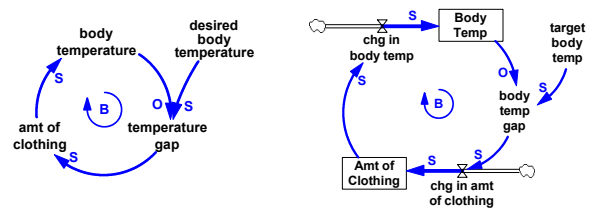


The "arms race" ... a dynamically complex problem

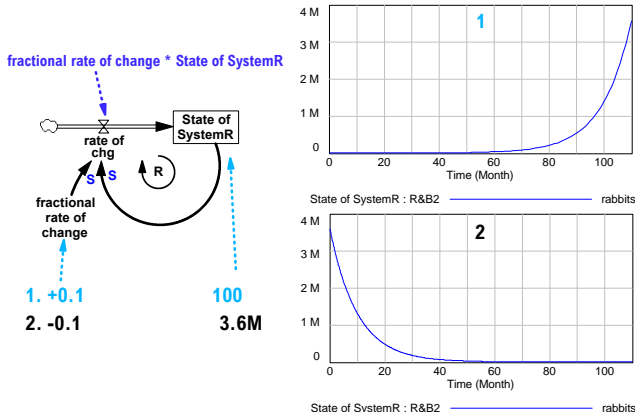


Comparing CLD and S&F Diagrams

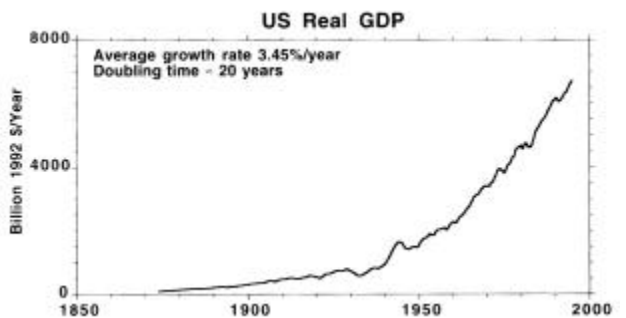
5D - p 84 ... modified "adjust clothing" to "amt of clothing"



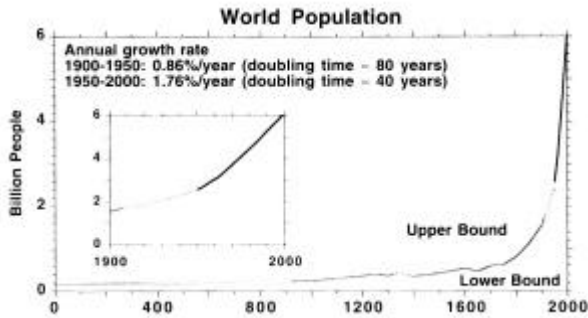
Reinforcing Feedback (positive):



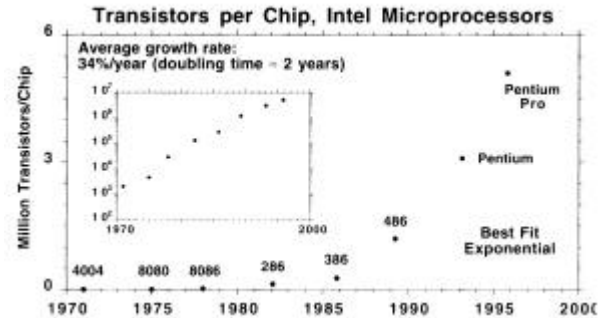
Reinforcing Feedback: U.S. Real GDP



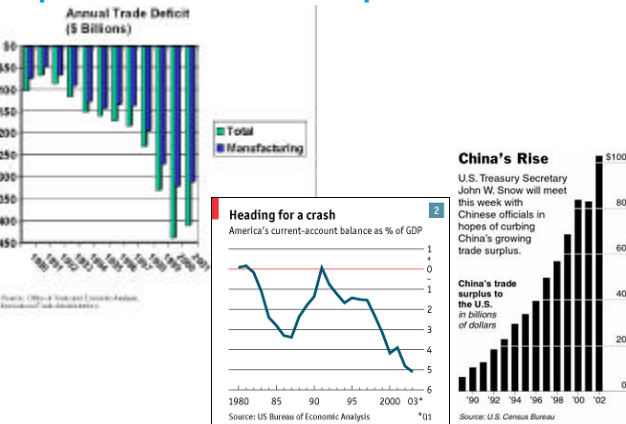
Reinforcing Feedback: World Population



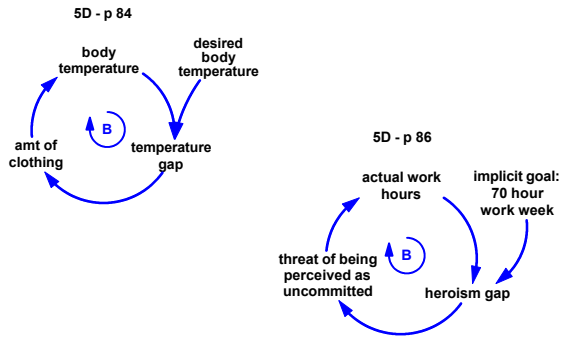
Reinforcing Feedback: Moore's Law



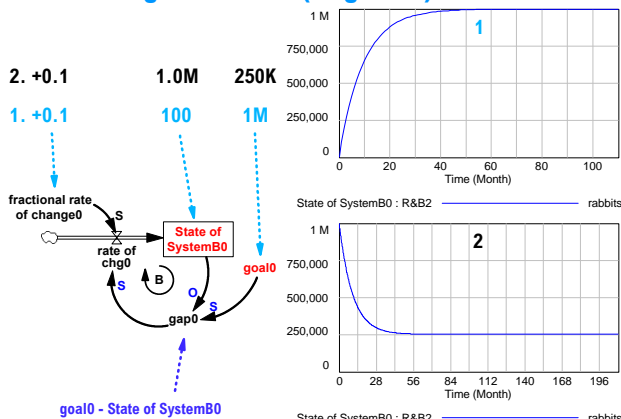
Exponential Increase Examples



Balancing Loops



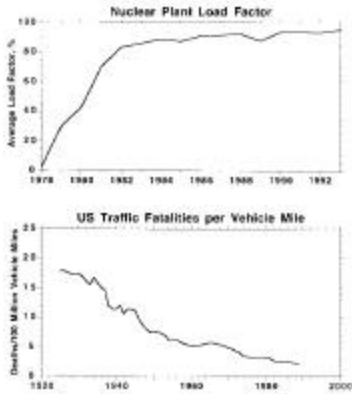
Balancing Feedback (negative):



Balancing Feedback Examples: TQM & TV Advertising Share



Balancing Feedback Examples: Nuclear Plant Load & U.S. Traffic Fatalities



Feedback Loops

- **Reinforcing loops (R loops with an even # of Os)**
 - scientifically known as positive feedback
 - virtuous & vicious cycle behaviors
- **Balancing loops (B loops with an odd # of Os)**
 - scientifically known as negative feedback
 - goal seeking, stabilizing, growth limiting behaviors

Long-Lived Systems

- In a long-lived system, are there
- more reinforcing (positive) feedback loops?
- OR
- more balancing (negative) feedback loops?

Exponential Improvement

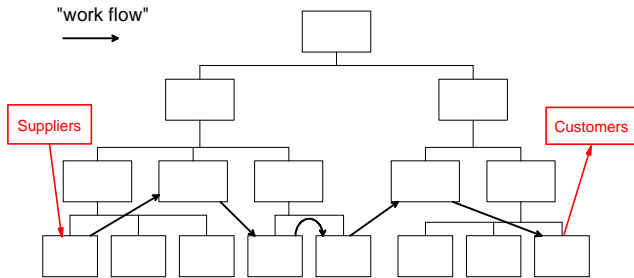
Getting Quality the Old-Fashioned Way

Improvement: Why We Favor the Short-term

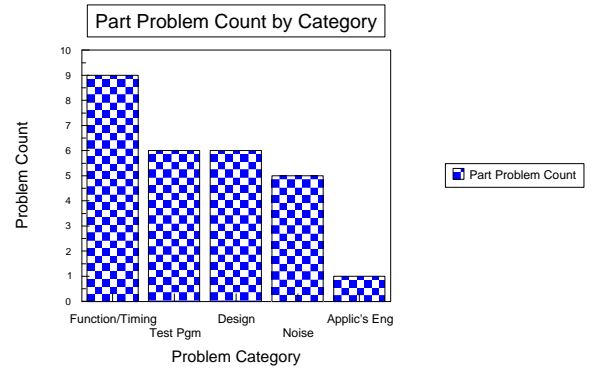
- "Getting Quality the Old-Fashioned Way:
Self-Confirming Attributions in the
Dynamics of Process Improvement"

Nelson Repenning and John Sterman
Sloan School of Management
<http://web.mit.edu/jsterman/www/>

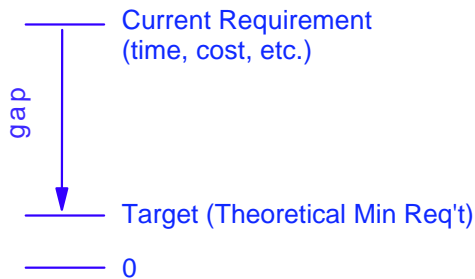
Work Flow Management



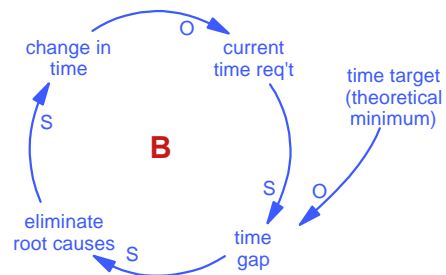
Problem Pareto



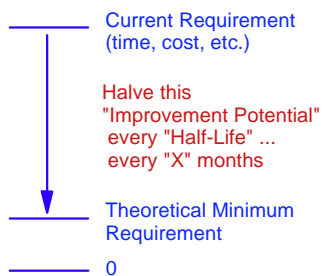
Continuous Improvement Potential



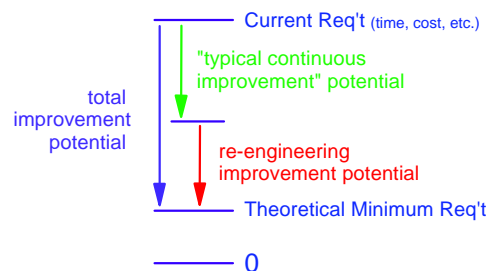
Process Improvement Feedback



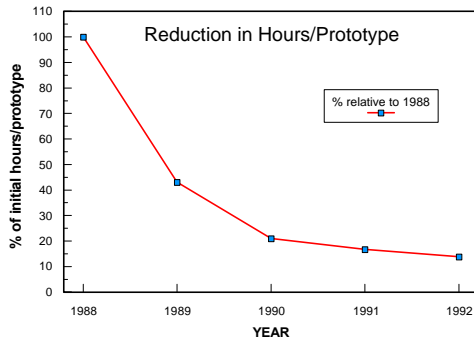
Continuous Improvement Potential



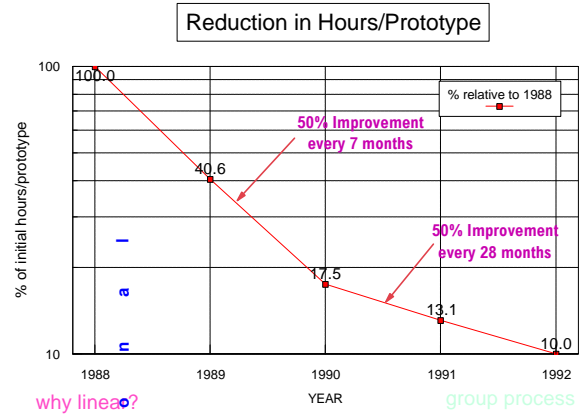
Continuous Improvement Potential



Continuous Improvement Results



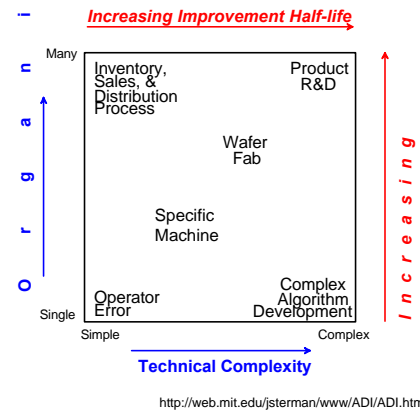
Half-Life Plotting Technique



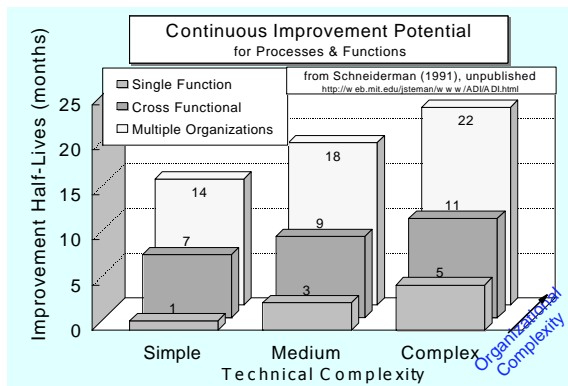
Simultaneous with Hours Reduction

- Designs meeting proto spec with no intervention from 20% to 93%
- Designs meeting production spec with no intervention from 10% to 63%
- On-time delivery from 55% to 100%
- Designs without timing problems from 50% to 96%
- Simulated technology speed increased by an average of 43%

Effects of Complexity



Improvement Half-Life Potential



Exponential Improvement to Make the Invisible Visible

- Identify "process complete" activities, measures
- Estimate process technical and organizational complexity
- Determine Current Value and Theoretical Minimum
- Set Half-Life Targets
- Practice continuous improvement (w/checklists)
- Track progress on Half-Life plots
- Reward based on performance to Half-Life goal
- Shift primary emphasis to other activities on nearing theoretical minimum

Management

- "Management is 85% of the problem."

W. Edwards Deming

Why Fire-Fighting?

- "The problem is that we've never been able to figure out how to reward people for preventing the disasters that never happened."

Bob Powell, 1993

Total Quality Management Compared to Systems Thinking

Total Quality Management & Systems Thinking

Aspect	TQM	Systems Thinking
Type of Learning	Single-loop	Double-loop
Questions	How?	Why?
Facilitates	Adaptation	Creation
Changes	Processes	Structures, Policies
For Changes in	Ways of doing things	Mental Models
Cause & Effect	Linear	Closed Loop Feedback
Type of Data	Hard, Measurable	Soft, Quantifiable
Type of Inquiry	Analysis	Synthesis

Total Quality Management & Systems Thinking

Aspect	TQM	Systems Thinking
Scope of Problem	Isolate & Solve Problems	Understand & Address Messes
Type of Improvement	Incremental Improvement	Breakthrough Improvement
Direction of Process	Standardized, Convergent	Testing Assumptions, Divergent
People Enhance	Quality of Doing	Quality of Thinking
Develop Understanding	Focus and Convince Using Science	Question and Inquire to Understand
Practitioners Are	Facilitators, Trainers, Teachers, Resources	Theory Builders, Researchers