Embracing Variability

GOTO 2012
Copenhagen, Denmark
May 23, 2012

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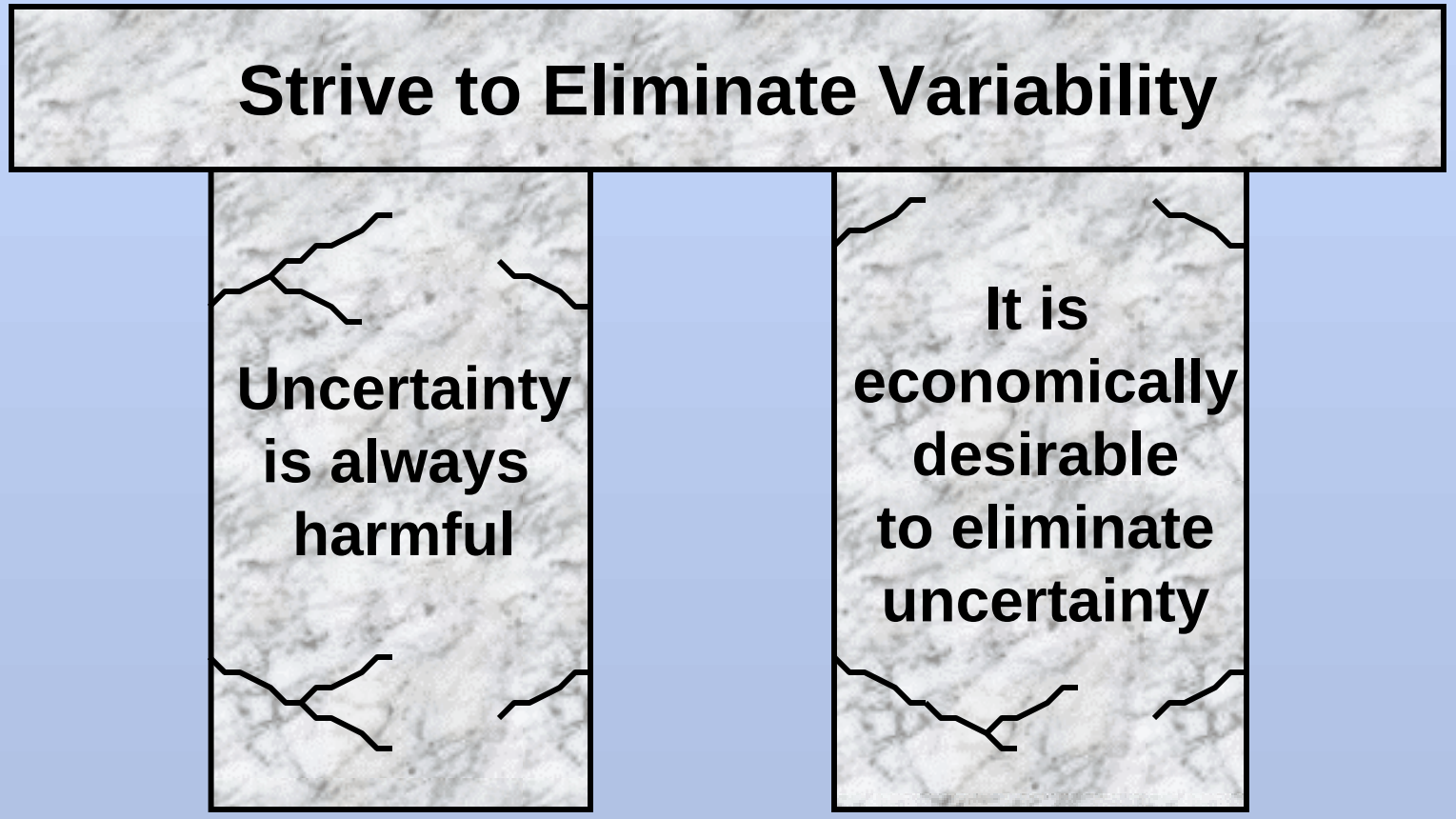
The Pillars of Orthodoxy



The Long War on Variability

- There is a long tradition of trying to eliminate variability in product development:
  - Zero defects programs
  - The quest for repeatability in CMMI
  - The schedule buffers of Critical Chain
  - The use of Lean Manufacturing ideas
- But, as we know, not all wars are based on sound reasoning.

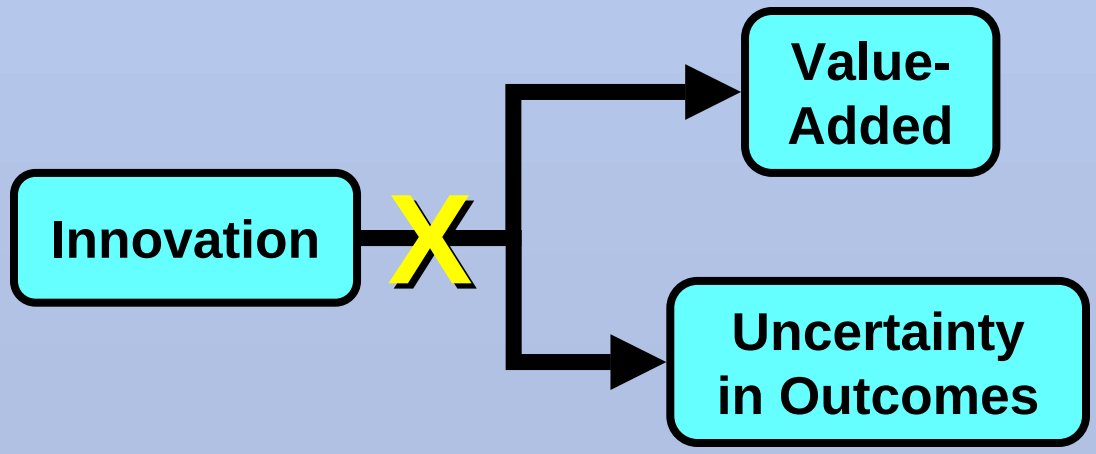
… we have come to value:

Responding to change over following a plan

– ***Manifesto for Agile Software Development***

Why Does This Make Sense?

- **Uncertainty inevitably lies at the heart of how product development adds value.**
- **Agile methods correctly recognize that it may be "better" to change a plan than to conform with it.**
  - **In other words, it has a better benefit to cost ratio.**
  - **And emerging facts may change the best path.**
- **Lean Start-up Methods also recognize this.**

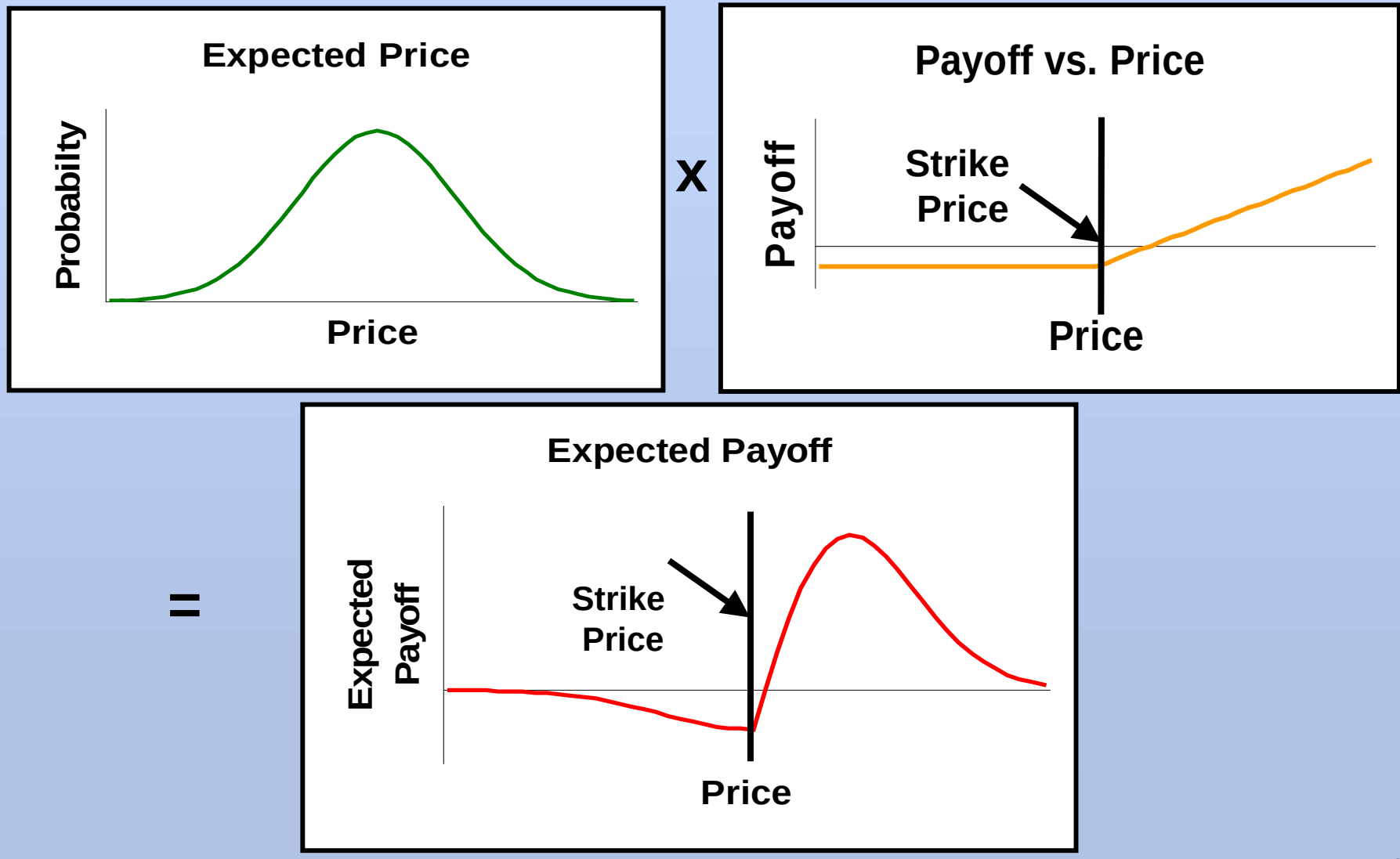


Let's Explore A Few Questions

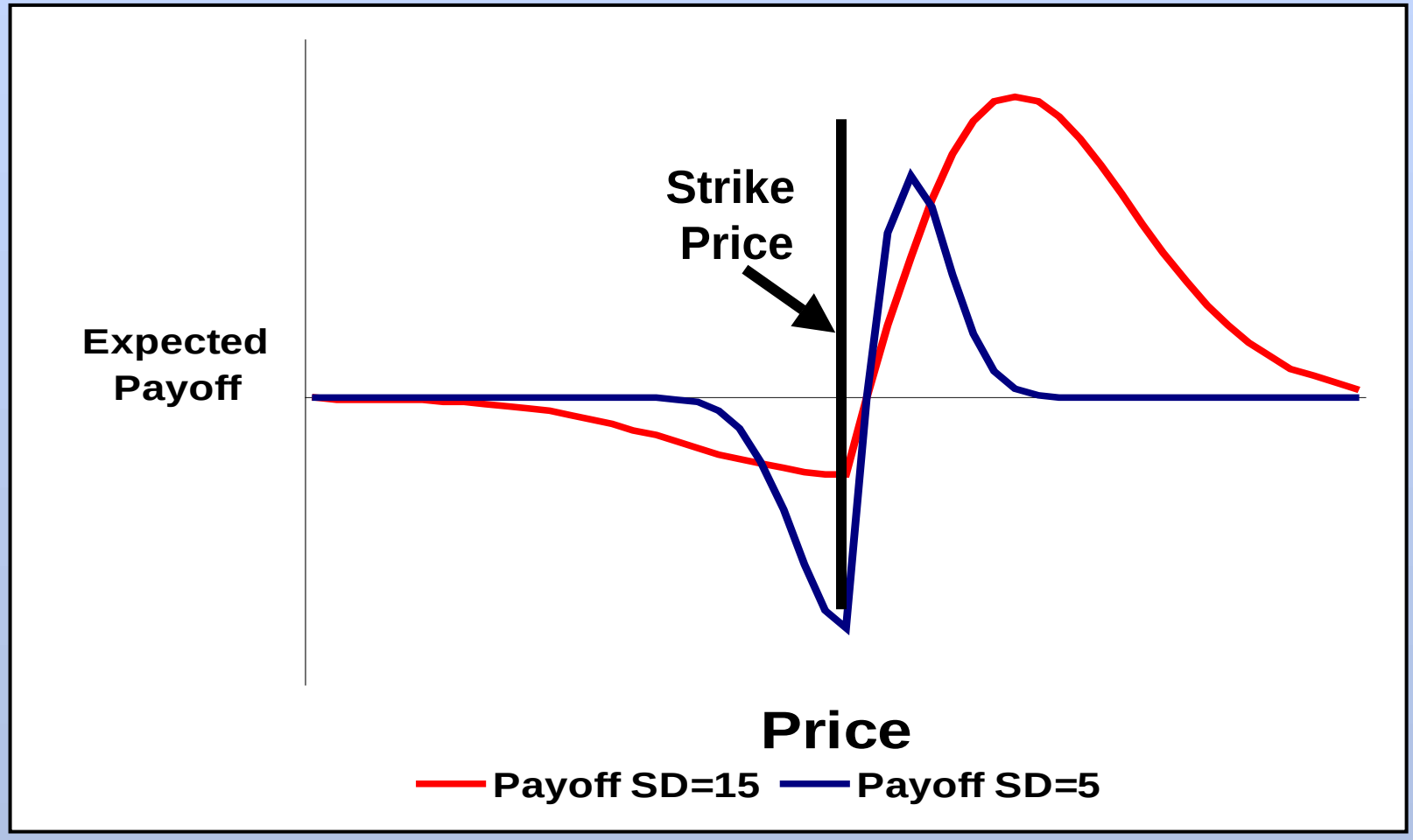
1. Is variability always harmful?
2. Should we focus on prevention?
3. How can we make variability less harmful?
4. How do we efficiently reduce uncertainty?
5. Should we react to random variation?
6. Can we plan for uncertainty?

Is variability always harmful?

Asymmetric Payoffs and Option Pricing



Higher Variability Raises This Payoff

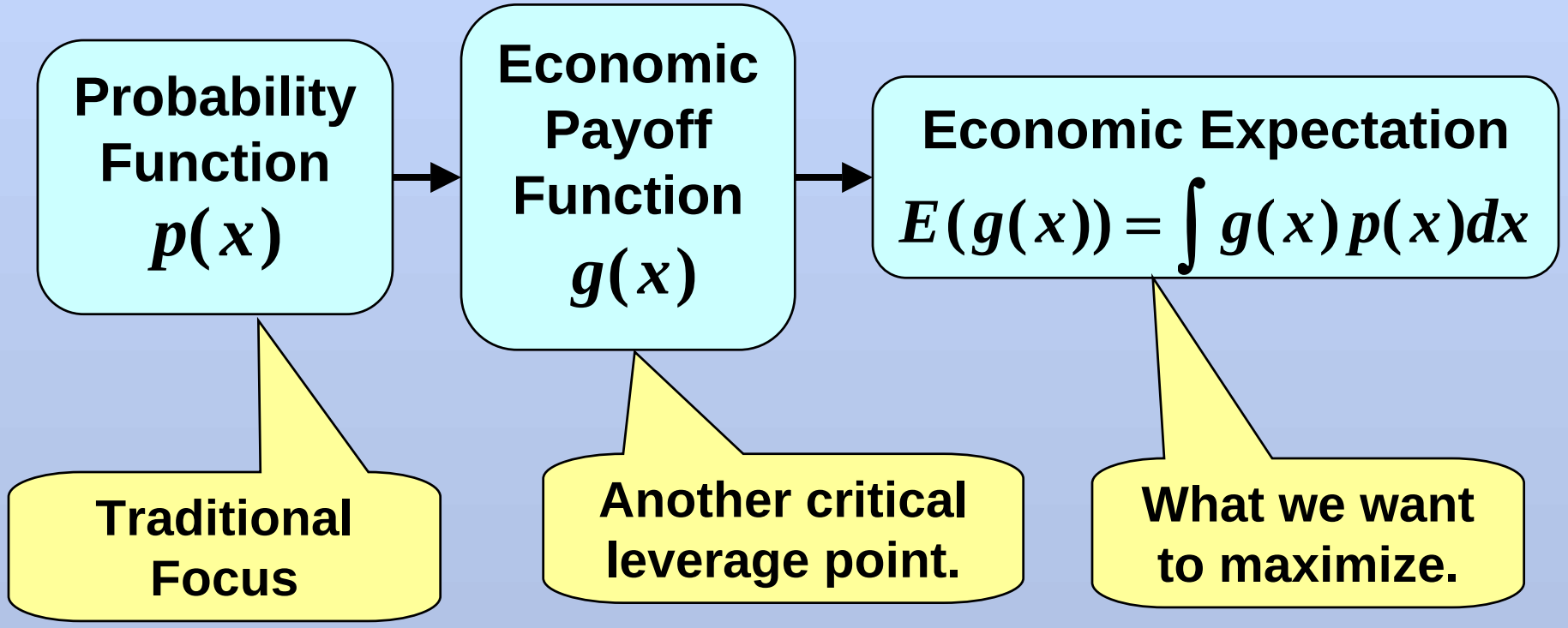


Option Price = 2, Strike Price = 50,
Mean Price = 50, Standard Deviation = 5 and 15

Variability Is NOT Evil

- **Variability is not intrinsically good or evil.**
- **It effect depends fundamentally on the economic payoff function that it acts on.**
- **When this function is asymmetric variability can be very beneficial.**
- **Most importantly, it is possible for us to alter this payoff function.**

Making Good Economic Choices



Should we focus on prevention?

The Cult of Prevention

- **Is it always better to prevent problems than it is to find and fix them?**
- **NO.**
- **Just compare the cost of preventing problems to the cost of finding and fixing problems.**
- **Implications:**
  - **Minimizing the cost of failure is always a local optimization.**
  - **Minimizing failure demand is always a local optimization.**

How can we make variability less harmful?

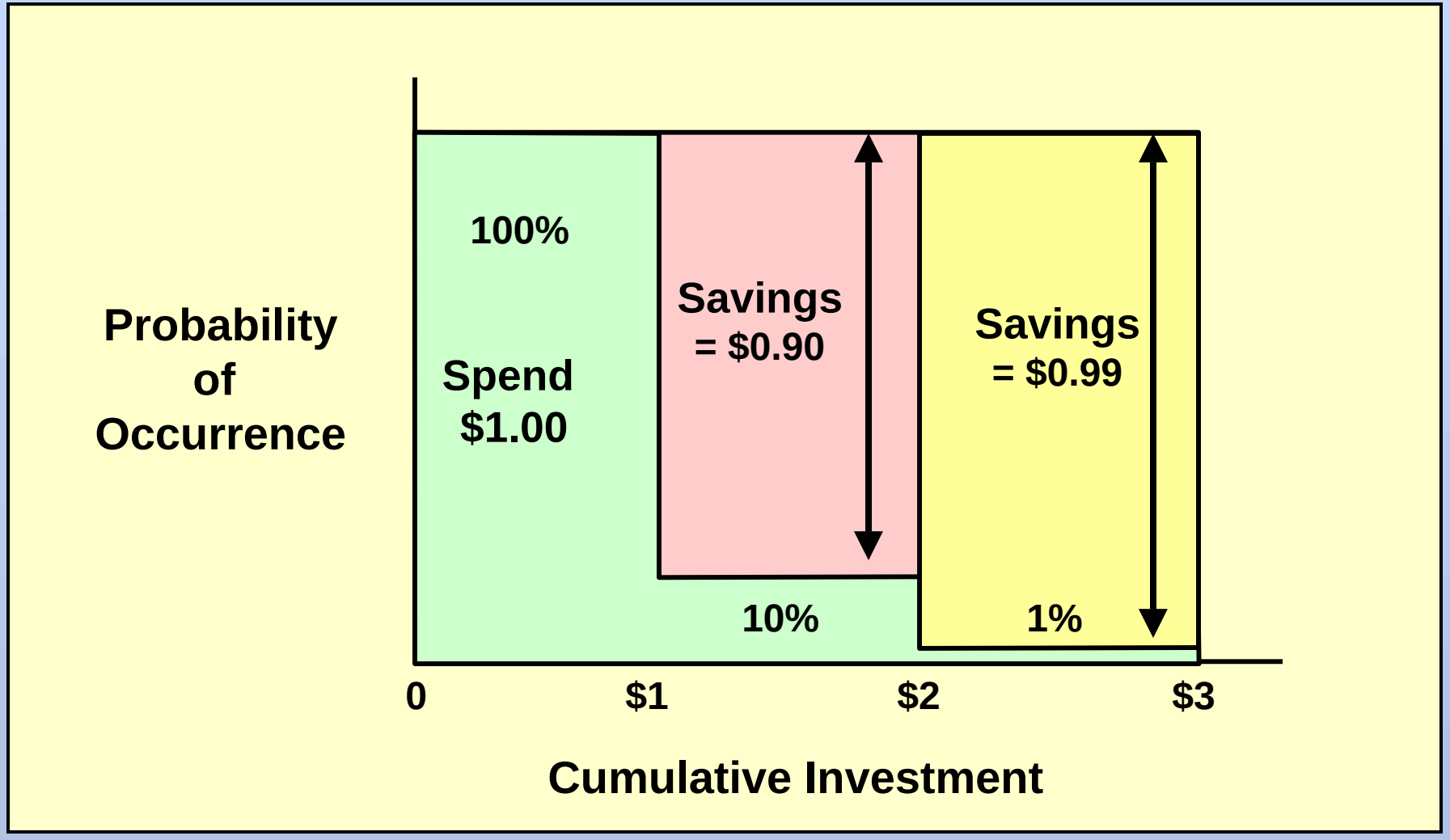
Change the Payoff Function

- We can alter payoff functions:
  - By reducing downside.
  - By increasing upside.
- The key method is fast feedback.
- Fast feedback is enabled by using small batches and reducing queues.
- This is precisely what we do with lean methods. (Both Lean/Kanban and Lean Start Up.)

The Front-Loaded Lottery

- **A lottery ticket pays $3000 to the winning three digit number.**
- **You can pick the numbers in two ways:**
  - **Pay $3 to select all three digits at once.**
  - **Pay $1 for the first digit, find out if it is correct, then choose if you wish to pay $1 for the second digit, and then choose if you wish to pay $1 for the third digit.**
- **Which approach has better economics?**
- **Why?**

Value of Feedback



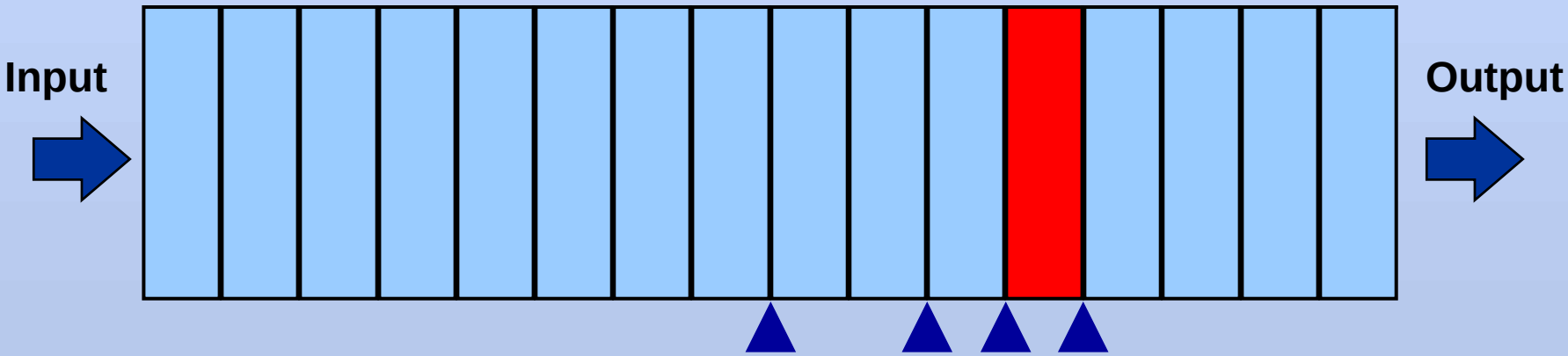
In this case, accelerated feedback reduces required investment by 63 percent.

Using Fast Feedback

- We get information faster when we:
  - Eliminate queues.
  - Buy it in small batches.
- We can buy it in small batches when we reduce our transaction cost.
- We create enormous economic efficiencies when we develop the ability to truncate unproductive paths quickly.
- But, how to we get more information?

How do we efficiently reduce uncertainty?

Learning Efficiently



16 Modules with 1 defective

How many probes should it take to find the defective module?

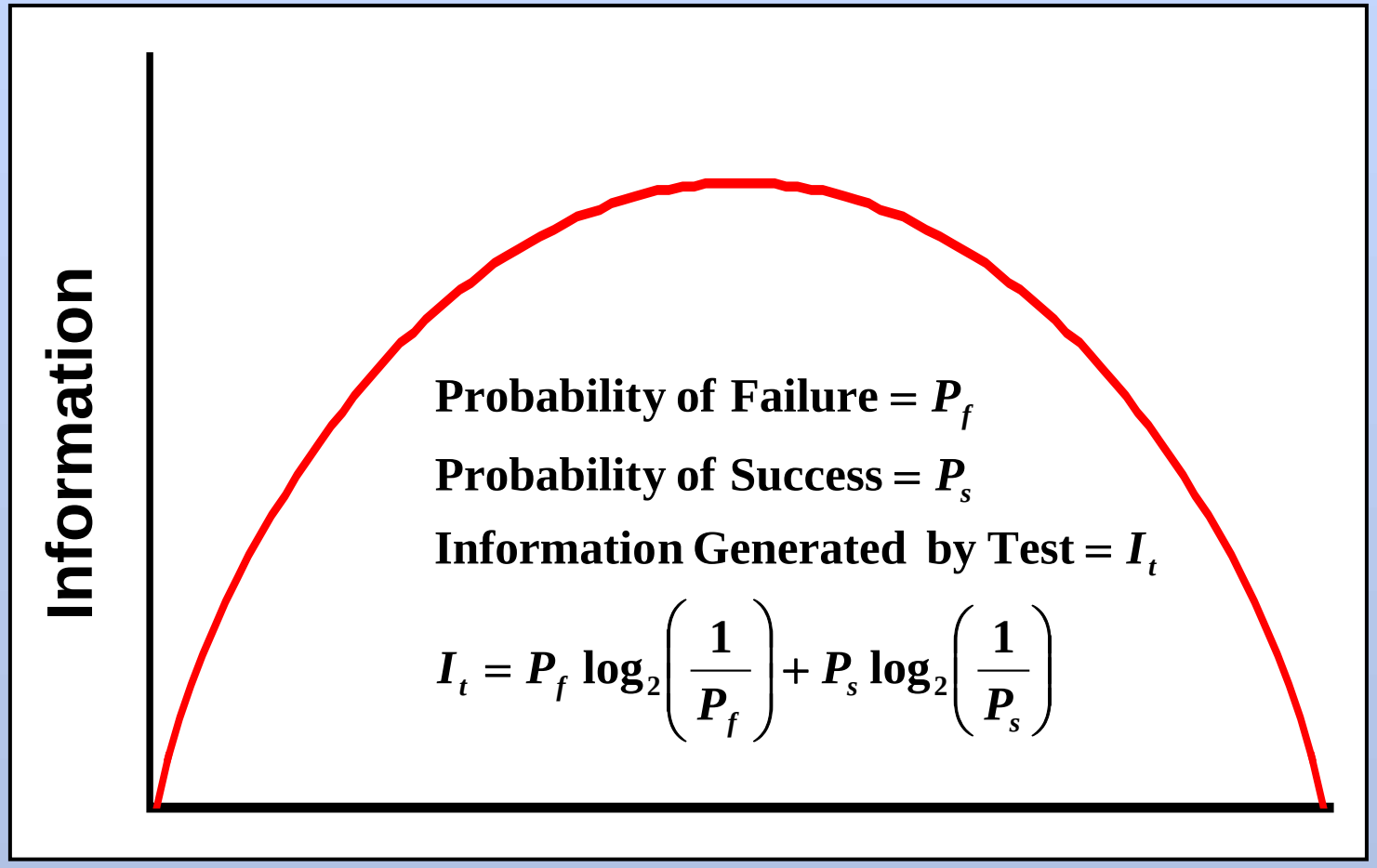
Information

The information contained in an event is:

$$= \log_2 (1/P_e)$$

$$= - \log_2 (P_e)$$

Information and Testing

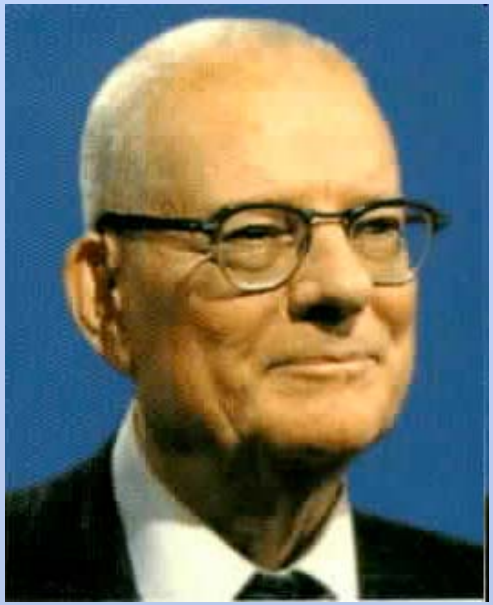


Generating Information Efficiently

- **Product development can be viewed as a process that reduces risk.**
- **We do this by generating information.**
- **We generate information most efficiently at an optimum failure rate.**
- **The failure rate that maximizes information generation does so by maximizing variability in the outcomes.**

Should we react to random variation?

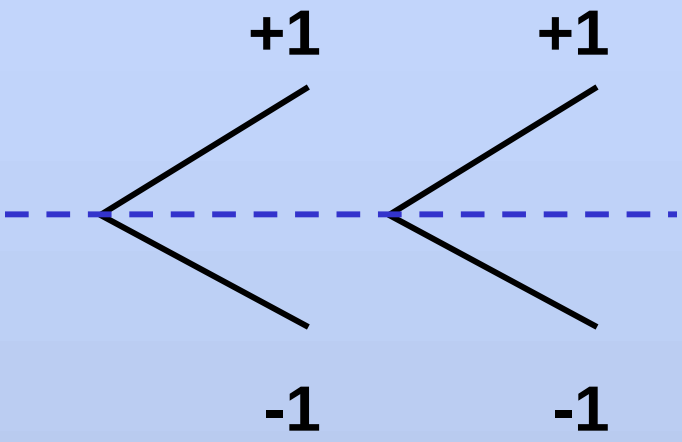
Reacting to Variation



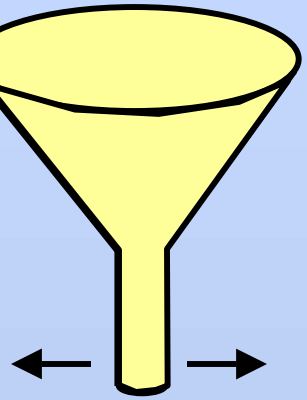
1900-1993

- Deming advises us NOT to respond to random variation.
- He is smart and his advice is well-reasoned.
- It is the correct answer in manufacturing.
- Sadly, it is the wrong answer for product developers.

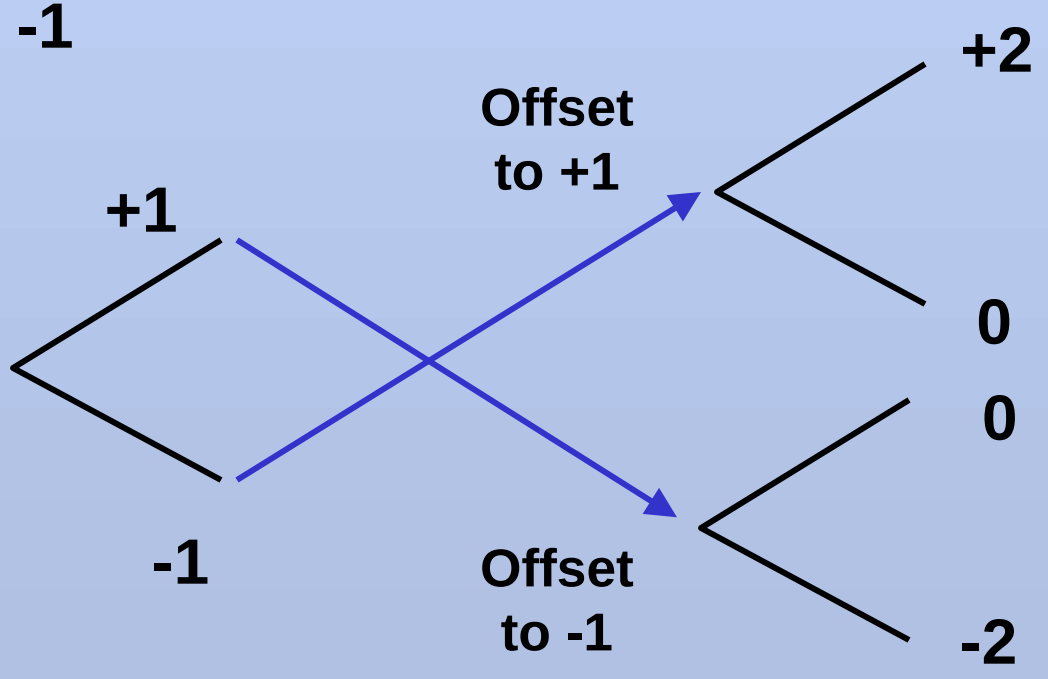
Deming's Funnel



No Adjustment
Variance = 1



Offsetting
Adjustment
Variance = 2

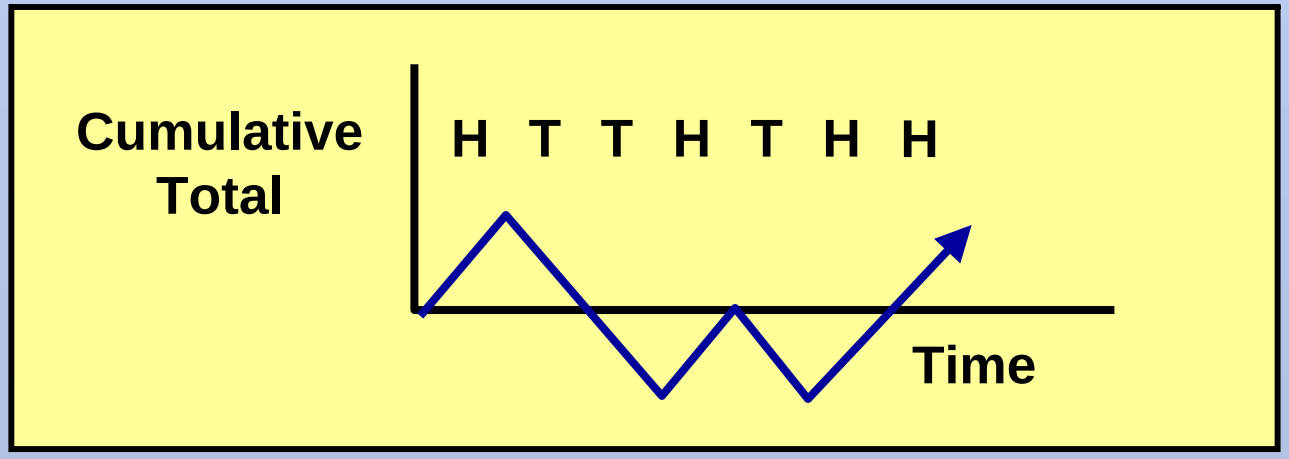


Deming's Frame of Reference

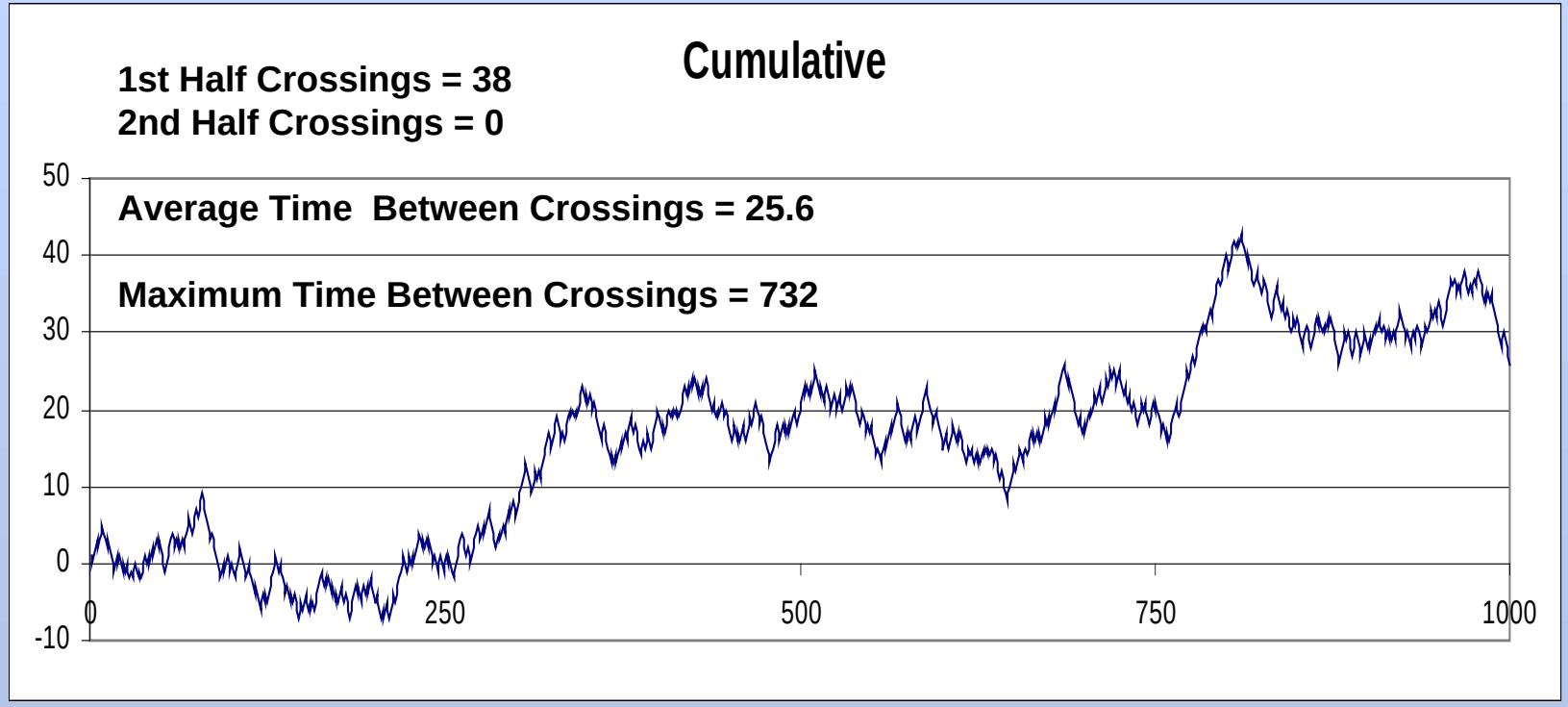
- **Deming lives in a world where each outcome as an independent identically distributed (IID) random variable — this is the classic statistics of random sampling.**
- **But, what would happen if we had a Markov Process, where the outcome was a function of both the current state and a random variable.**
- **This is very common in product development, e.g. when a second stochastic activity can't start until the first one finishes.**

A Random Walk

- **We flip a coin 1000 times, add 1 for each head, subtract 1 for each tail, and keep track of our cumulative total.**
- **How many times the cumulative total will return to the zero line during the 1000 flips?**

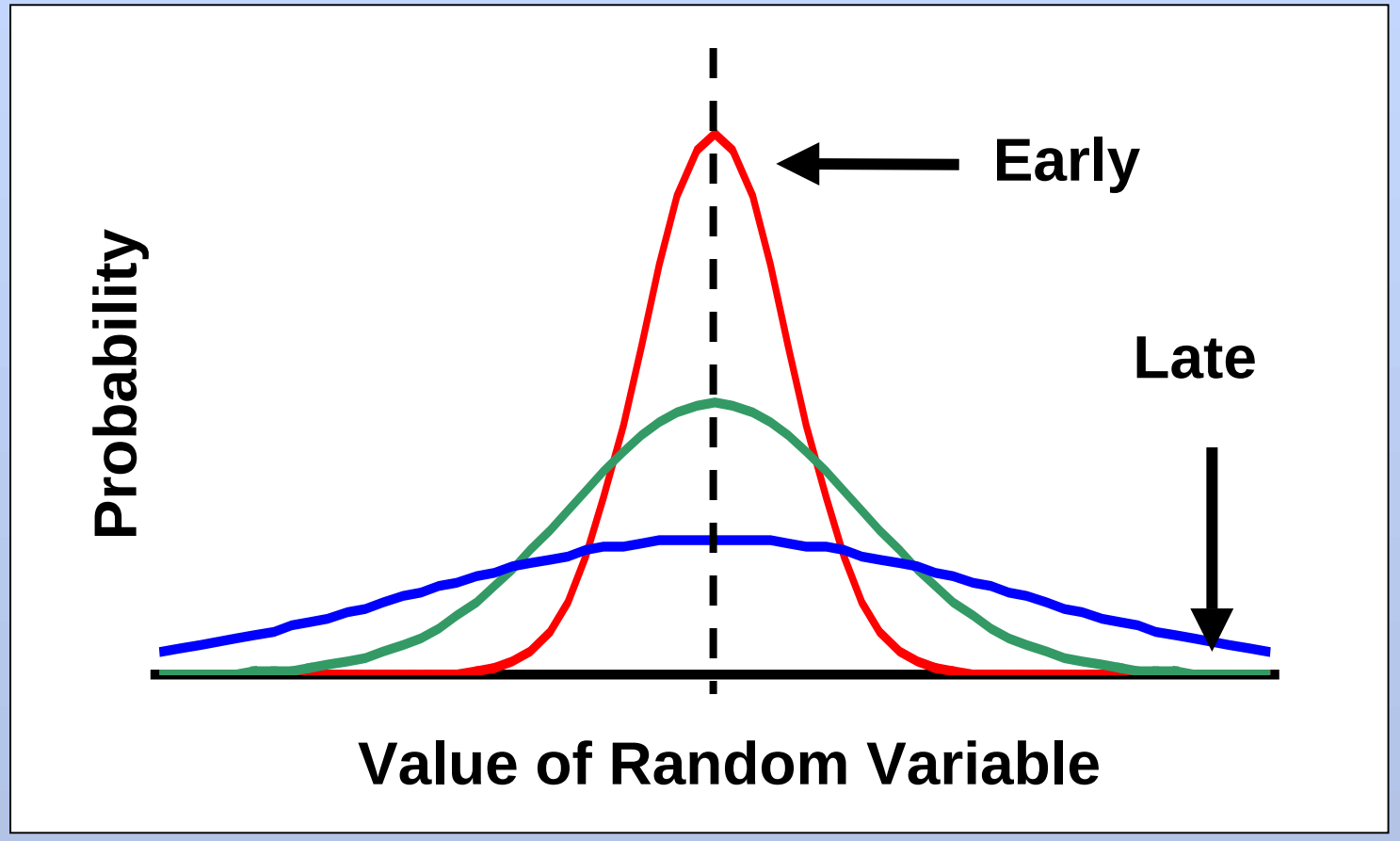


One Thousand Coin Tosses



Note: +1 for each head, -1 for each tail
Based on example from "Introduction to Probability Theory and Its Applications", by William Feller. John Wiley: 1968

Cumulative Totals Diffuse



Notes:

1. Zero is always most probable value.
2. But, it becomes less probable with time.
3. For large N a binomial distribution approaches a normal distribution.

Product Development Is Not Deming's Funnel

- **We must intervene quickly and decisively when variance accumulates, even if it is solely of random origin.**
- **Just because randomness causes the problem does not mean randomness will fix the problem in a reasonable amount of time.**
- **And when we intervene we should return to the center of the control range not its edge.**
- **Think of it as a Drunkard's Walk on top of a skyscraper without a guardrail.**

We Already Use This

- **Solving this problem of accumulating variance is one of the big successes of:**
  - **Scrum — which uses timeboxes prevent accumulation of variance.**
  - **Lean/Kanban — which uses WIP constraints to do the same thing.**
- **It is useful to understand *WHY* methods work.**

Can we plan for uncertainty?

Planning for Uncertainty

- There is a long tradition in engineering of designing systems that must function in the presence of uncertainty.
- While this includes reacting to change, it also places great emphasis on:
  - Anticipating likely change vectors.
  - Designing products and processes that function well in the presence of variability.
- For example, sometimes you need margin.

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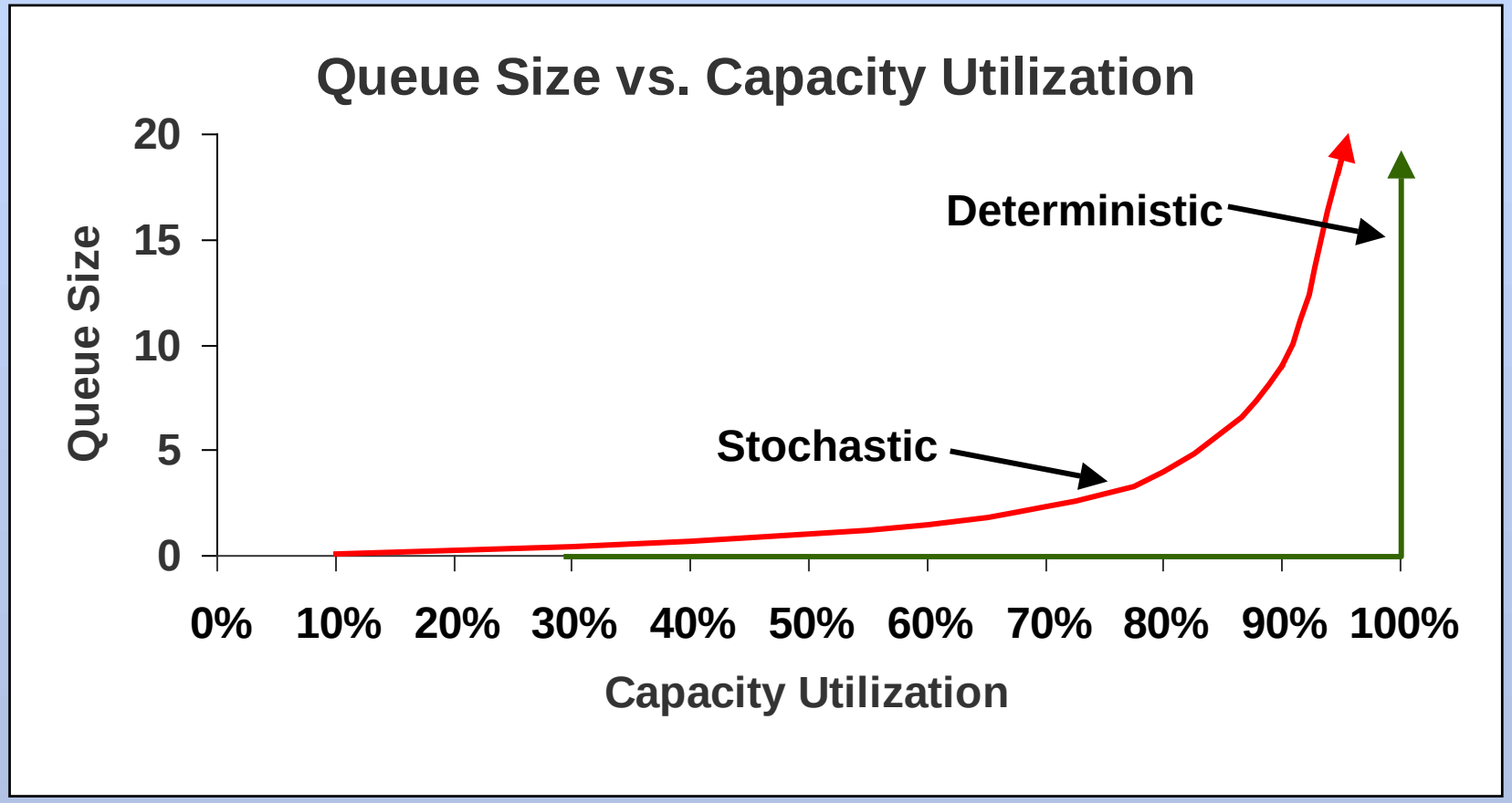
The Effect of Capacity Utilization

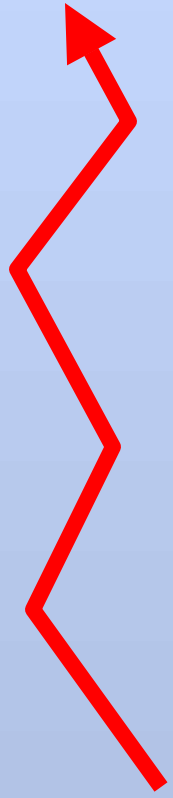


Note: Assumes M/M/1/Infinite Queue

Navigating Between the Rocks

The Dogma of Determinism

- A common view in manufacturing.
- Eliminate all variability.
- Create repeatable outcomes.
- Make performance independent of the operator.
- Anticipate everything.



The Dogma of Chaos

- Variability prevents us from making accurate predictions.
- Only a completely defined process is predictable.
- Therefore, we must rely on reacting to emergent system behavior.

Engineering might be the art of using imperfect information to create useful solutions.

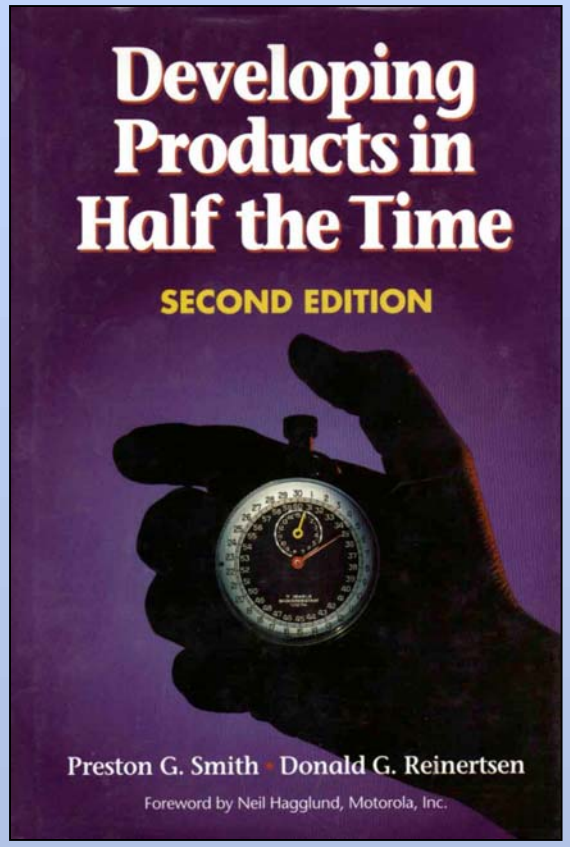
Summary

- **It helps to consider the economics of your choices.**
- **Sound bites like “celebrate failure” or “embrace uncertainty”* are rather silly.**
- **Instead we should learn to get good economic outcomes in the presence of uncertainty.**
- **Our successful practices are frequently more advanced than management theories.**
  - **We often do smarter things than we can explain.**

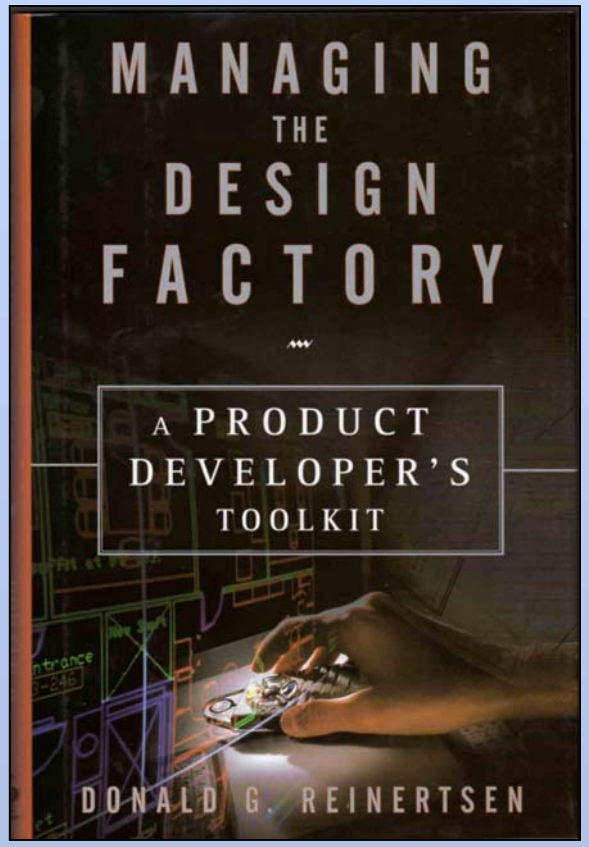
***self-referential**

You may forget about economics, but it won’t forget about you!

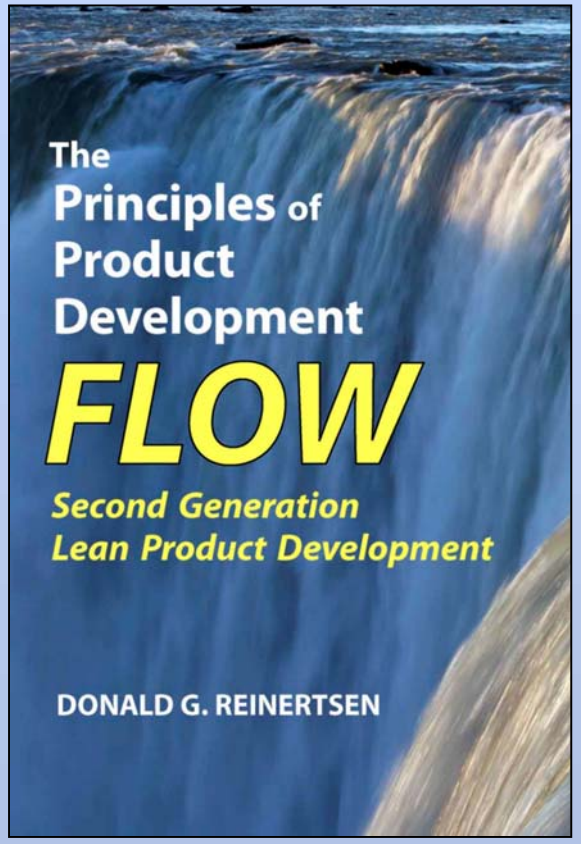
Going Further



1991 / 1997



1997



2009