

# **Rethinking Robustness: Uncertainty is Not the Enemy**

**Lean Kanban Central Europe 2014  
Hamburg, Germany  
November 12, 2014**

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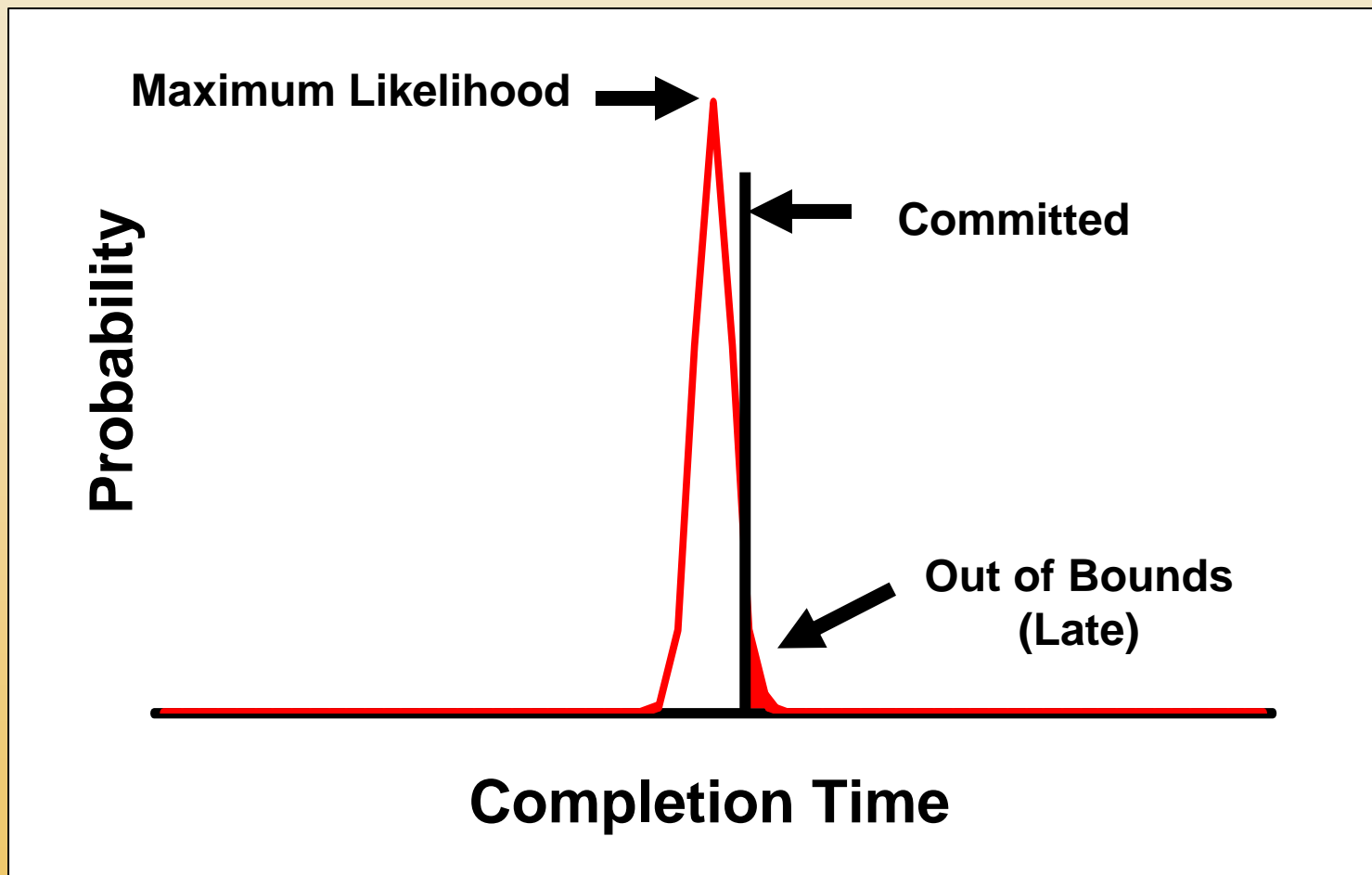
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# **All Variability is BAD**

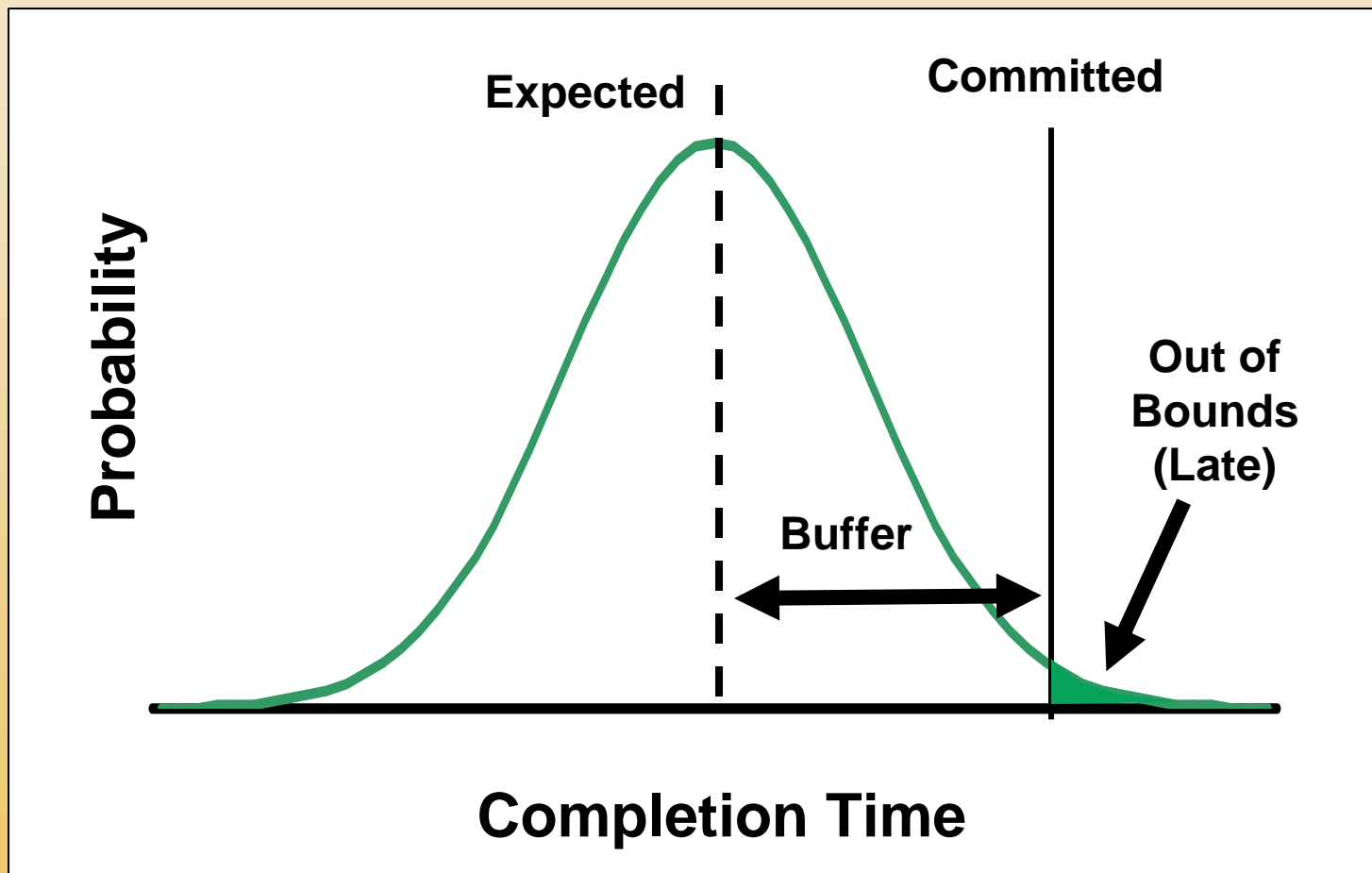
# **We Should Minimize Variability**

- **The world is stochastic; outcomes will vary.**
- **We can protect ourselves from the unfavorable tail of bad outcomes by:**
  - **Explicitly making low variability choices**
  - **Making high variability choices, but only committing to conservative achievement by:**
    - **Under-commitment on performance**
    - **Padded schedules**
    - **Padded budgets**
- **Are these good economic choices?**

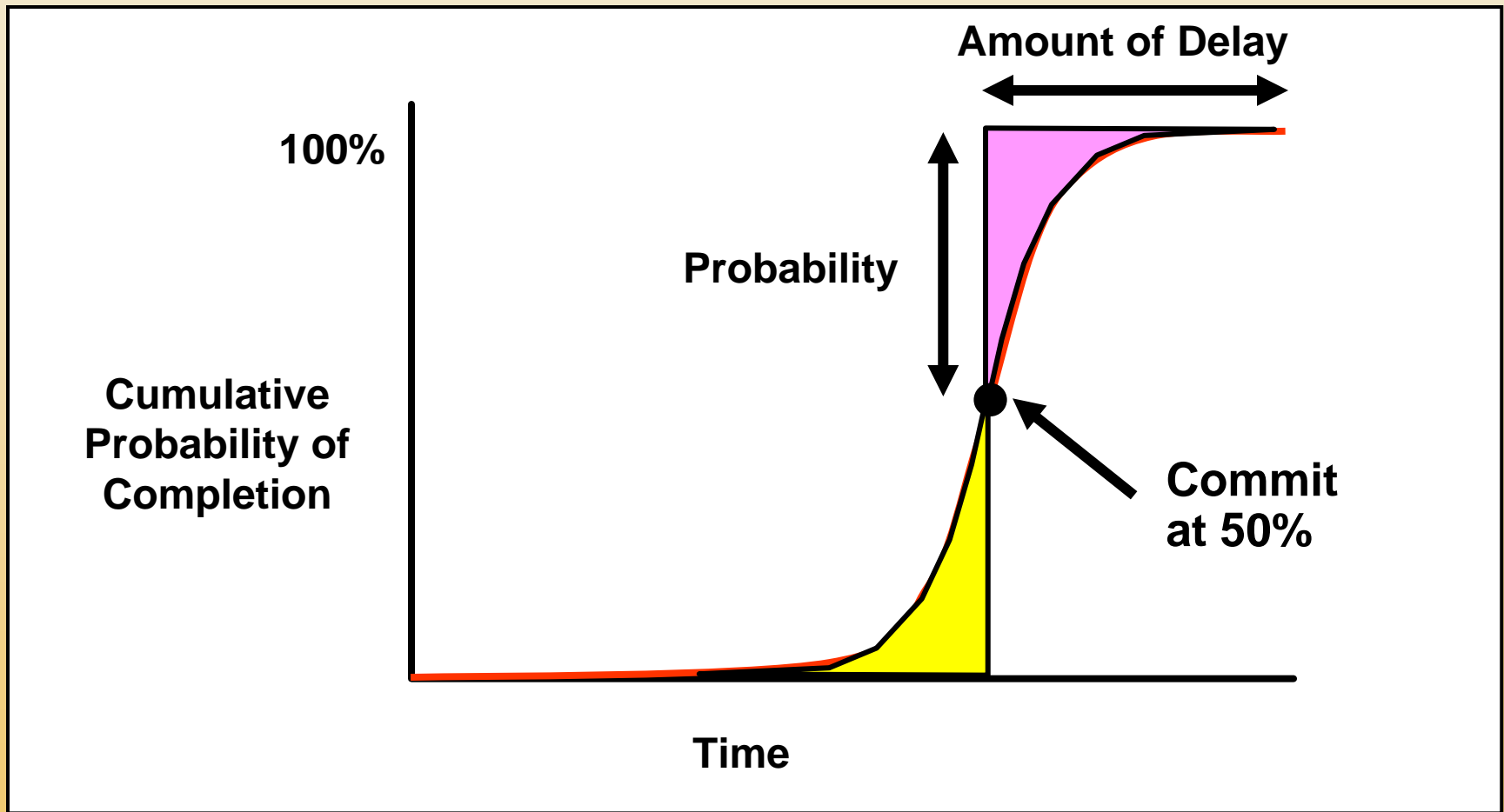
# Make the Tail Small



# Hide the Variability with a Buffer



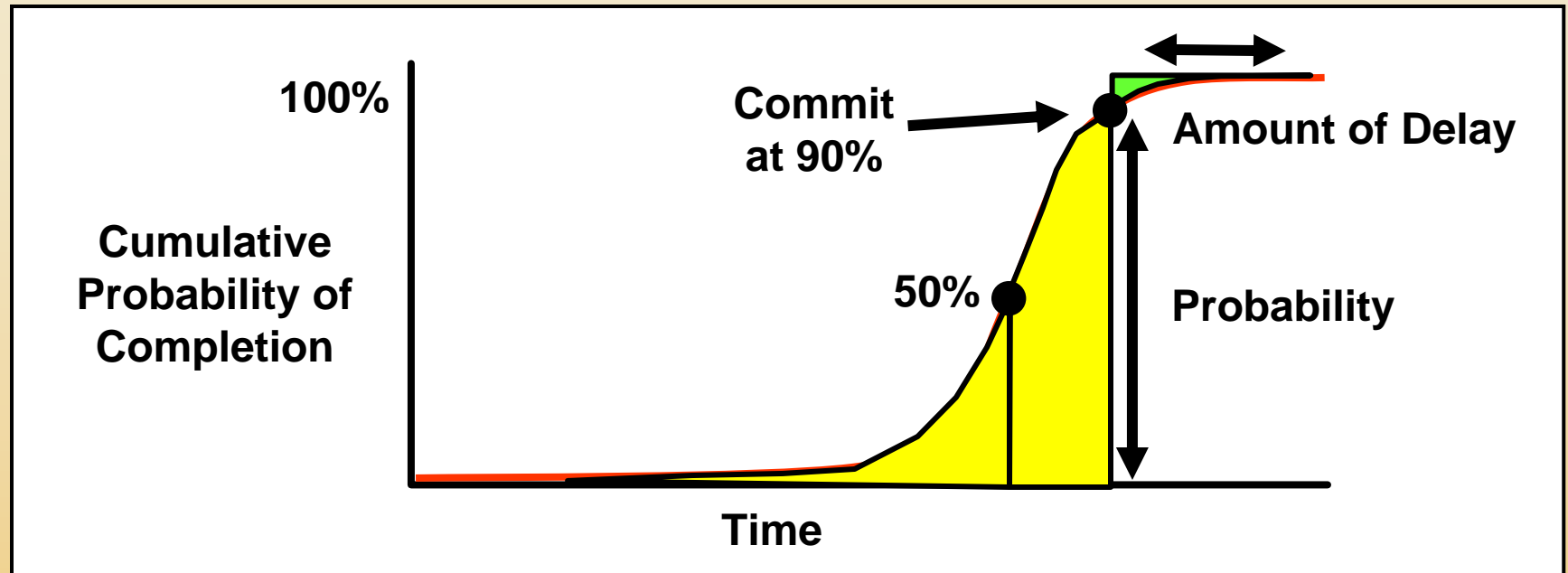
# Without a Buffer



— Inherently Uncertain Schedule

□ Expected Delay at 50% Confidence Schedule

# Buffering Variability



— Inherently Uncertain Schedule

■ Expected Delay 90% Confidence Schedule

■ Schedule Margin or Buffer

**Time buffers trade cycle time for reduced variability in cycle time.**

# **Robustness is GOOD**



# Passive Robustness

- **Structure the system so that it intrinsically resists the forces that perturb it.**
  - **Reduce the consequences of disruption.**
- **Dissipate and absorb the perturbation.**
  - **Increase margin.**
  - **Increase inertia.**
  - **Increase redundancy.**
- **Passive Robustness is not free.**



# NZL32 and America's Cup 1995

- Winds are variable.
- Strong winds can capsize your boat.
- Boats that capsize lose the race.
- If you expose less sail area you are less vulnerable to capsizing.
- If you expose less sail area you go slower.
- Boats that go slow lose the race.

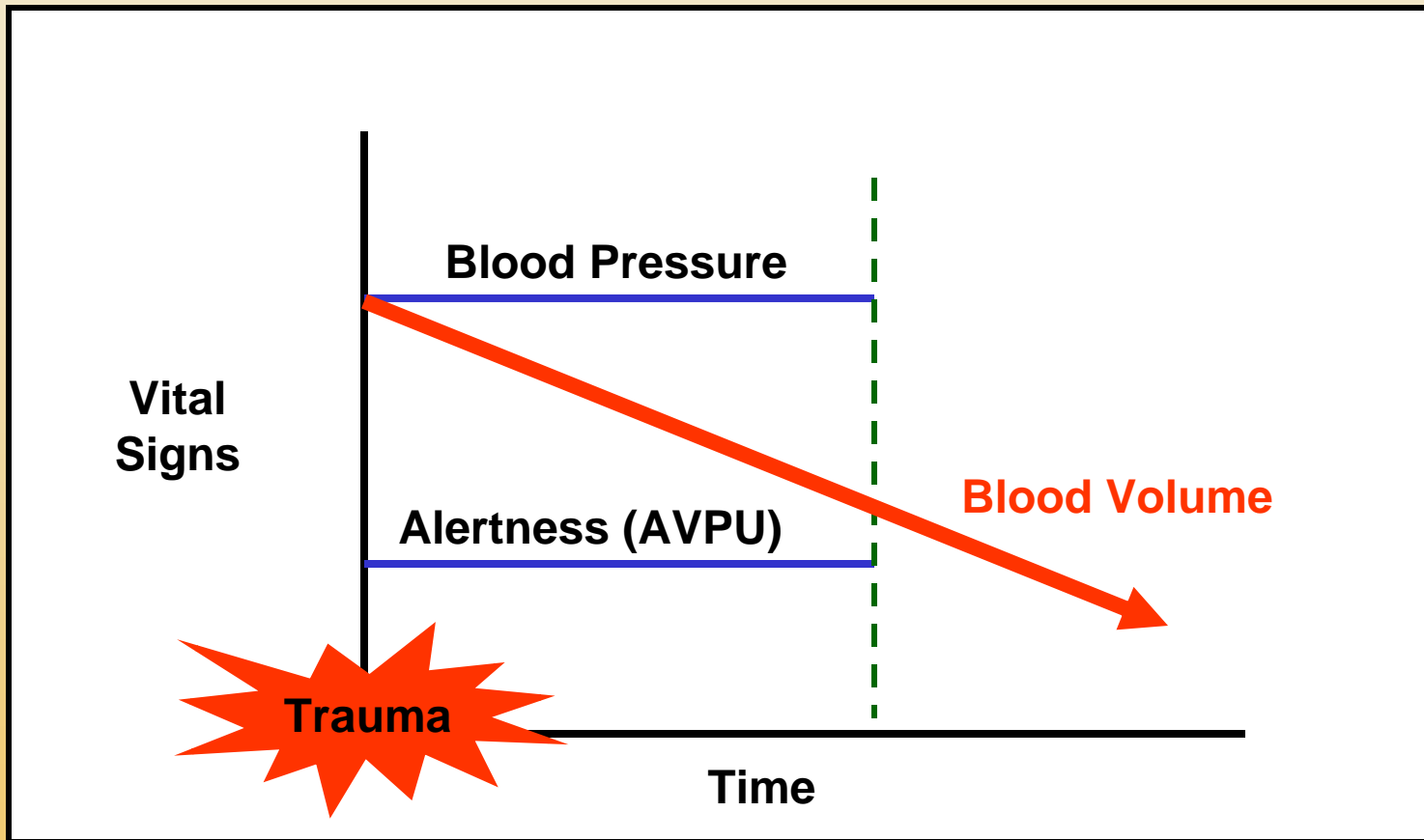
# Active Robustness

- **We use active feedback loops to maintain system conditions.**
- **This achieves stability, but it can mask the deterioration of the system.**
- **Masking deterioration causes us to assume that perturbations are doing no harm.**
- **This can lead to overconfidence and a belief that it is okay to take no action.**

# Homeostasis during Shock

- **The human body compensates for loss of blood volume by increasing heart rate, stroke volume, and respiration rate.**
- **This maintains the flow of blood to critical organs like the brain.**
- **If shock progresses without resuscitation it can become decompensating.**
- **At this point, the outcome can be death.**

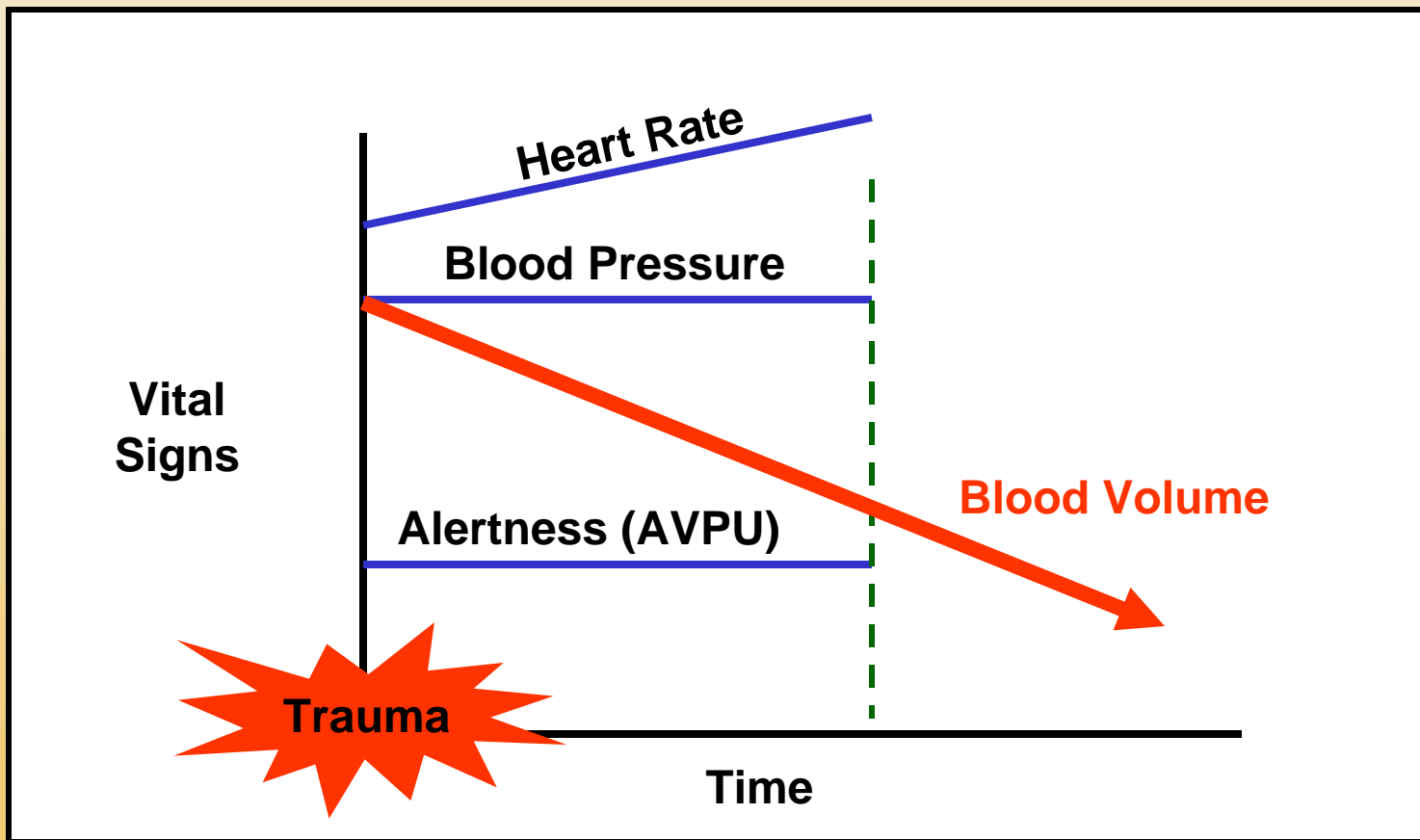
# Hypovolemic Shock



# Compensated Shock

- **Our body tries to maintain blood flow to vital organs.**
  - **Heart stroke volume increases.**
  - **Vascular resistance increases. (Vasoconstriction)**
  - **Heart rate increases. (Tachycardia)**
  - **Respiration rate increases. (Tachypnea)**
- **This maintains blood pressure and mental function.**

# Hypovolemic Shock

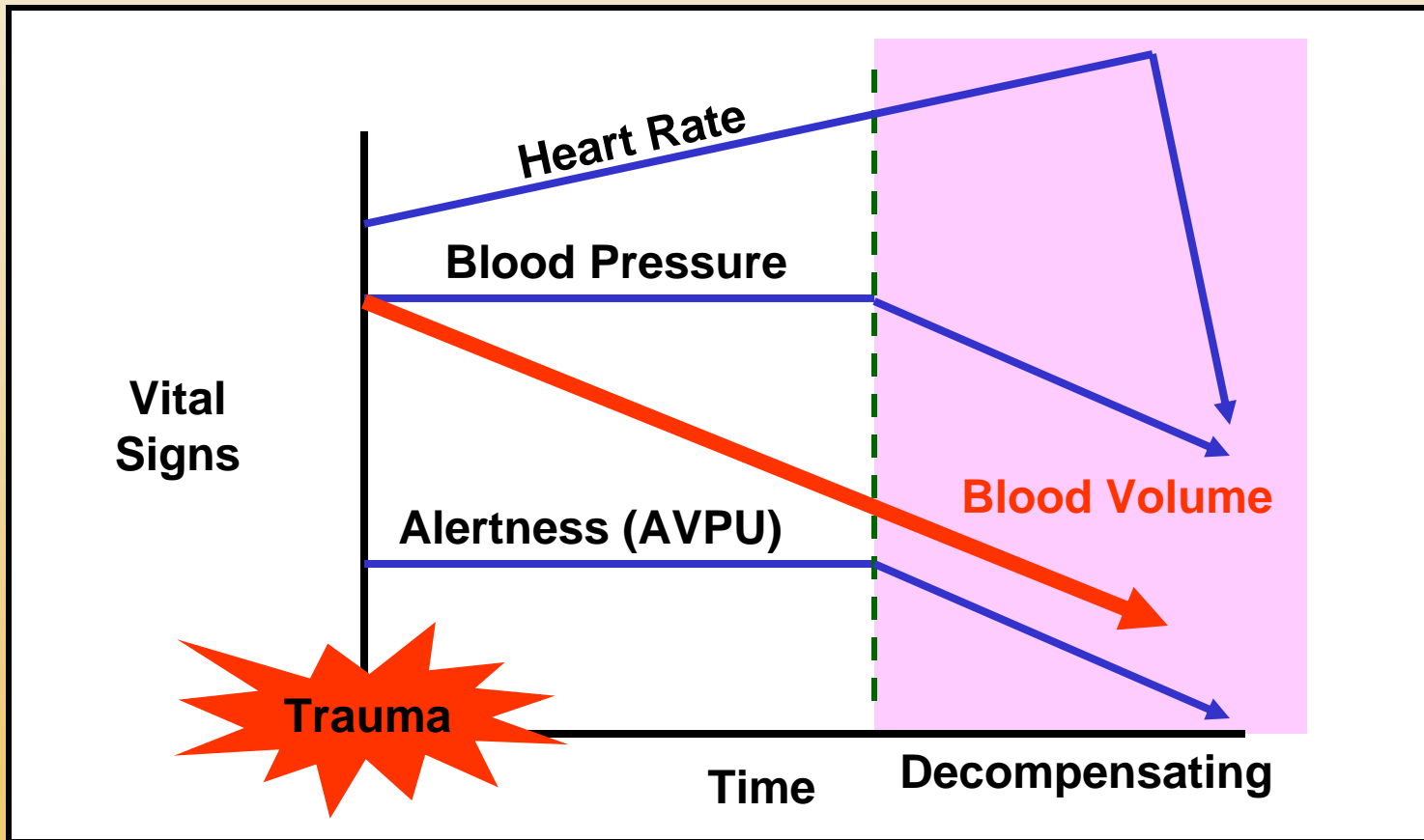


# Uncompensated Shock

- **Body is no longer able to maintain blood flow to vital organs: brain, heart, lungs, liver, kidneys.**
- **Heart rate drops, breathing slows, alertness disappears.**
- **Deterioration is rapid and often irreversible.**
- **GAME OVER**



# Hypovolemic Shock

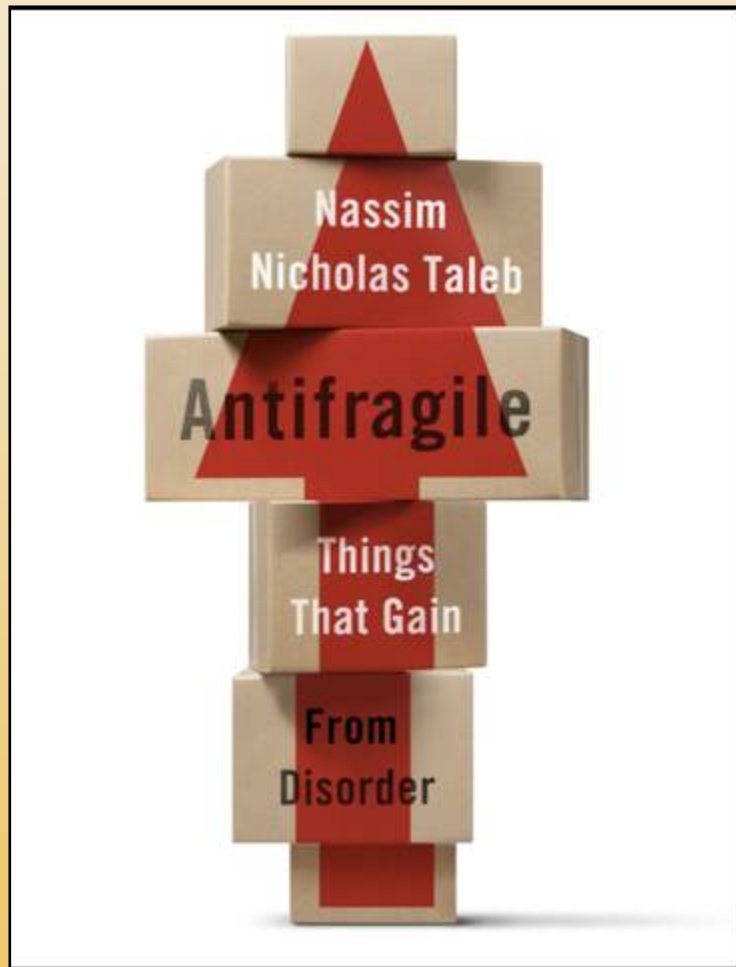


# Overcoming Masking Effects

- **There are always indicators of deteriorating operational margin.**
- **Under normal circumstances these indicators appear to convey no useful information.**
  - **They are uncorrelated to performance.**
  - **They produce weak signals.**
- **We need to monitor these indicators of operational margin in addition to our indicators of performance.**

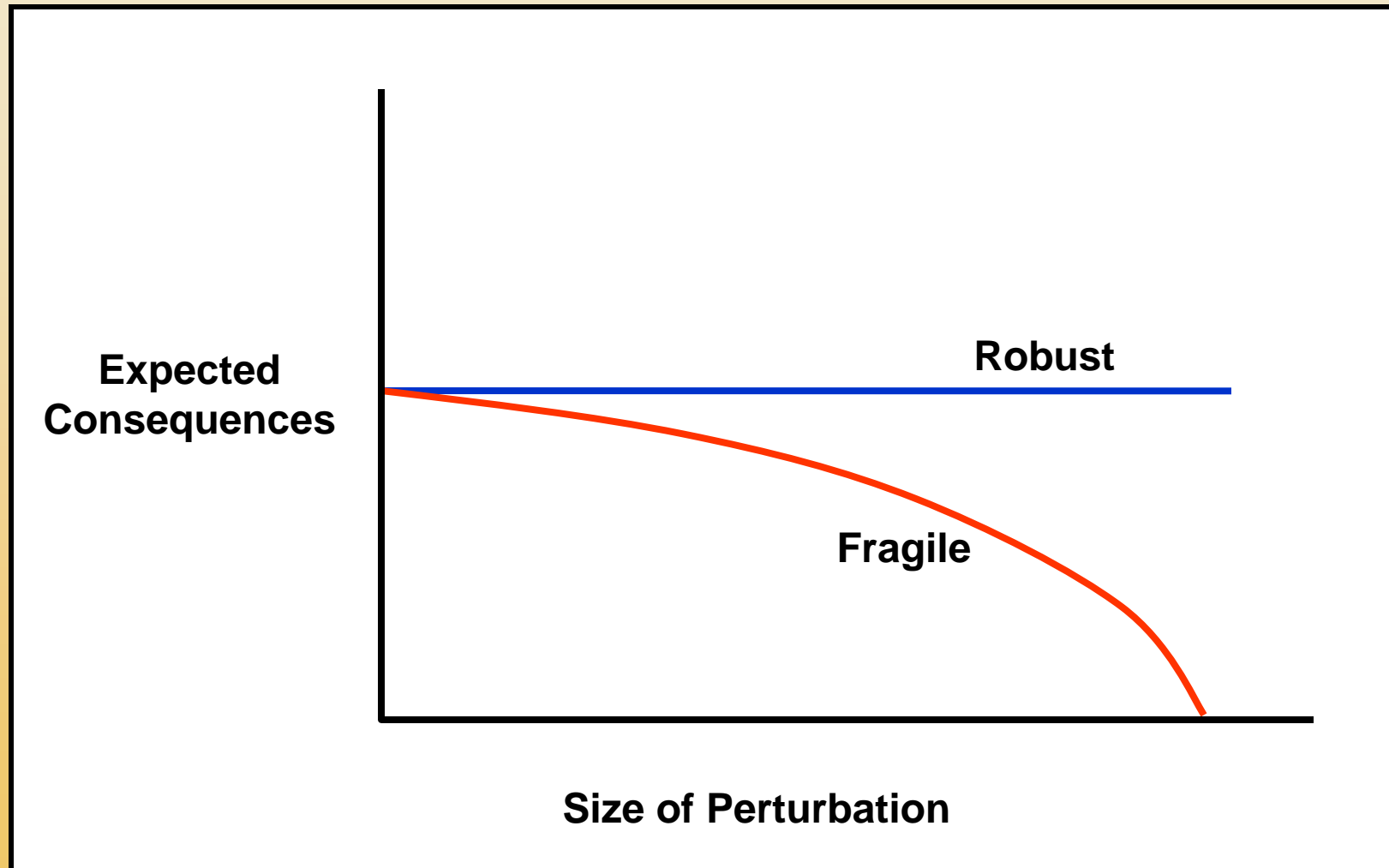
# Anti-Fragility

# Nassim Taleb

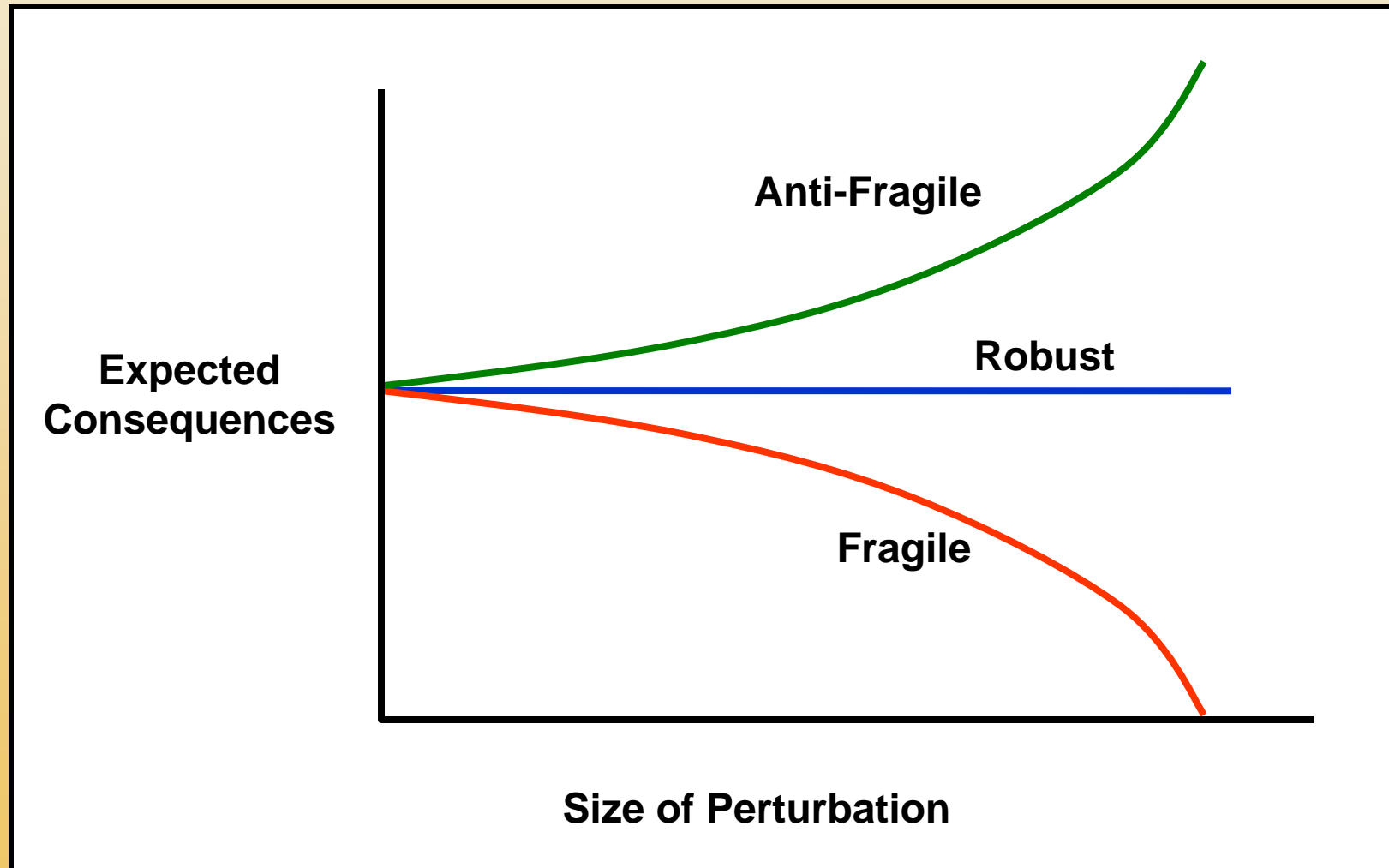


- Coined term **Anti-Fragile**
- Several excellent books on uncertainty.
  - *Fooled by Randomness.*
  - *The Black Swan*
  - *Antifragile*

# Fragility

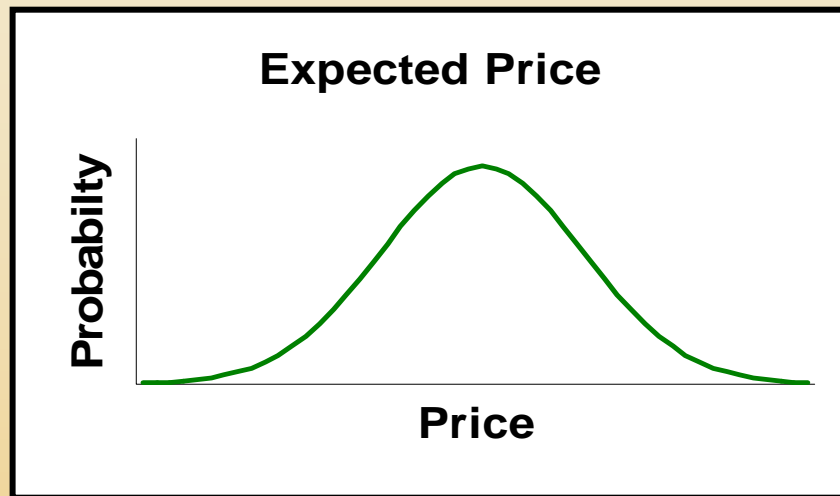


# Anti-Fragility

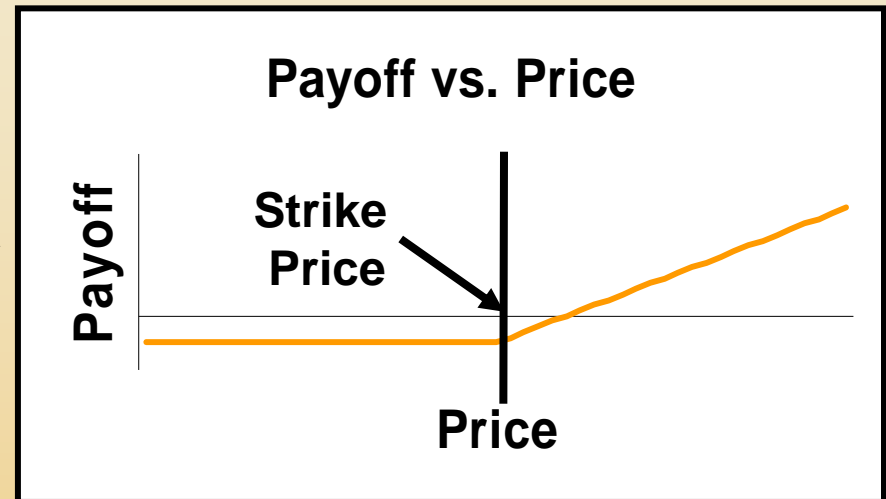


# The Role of Options

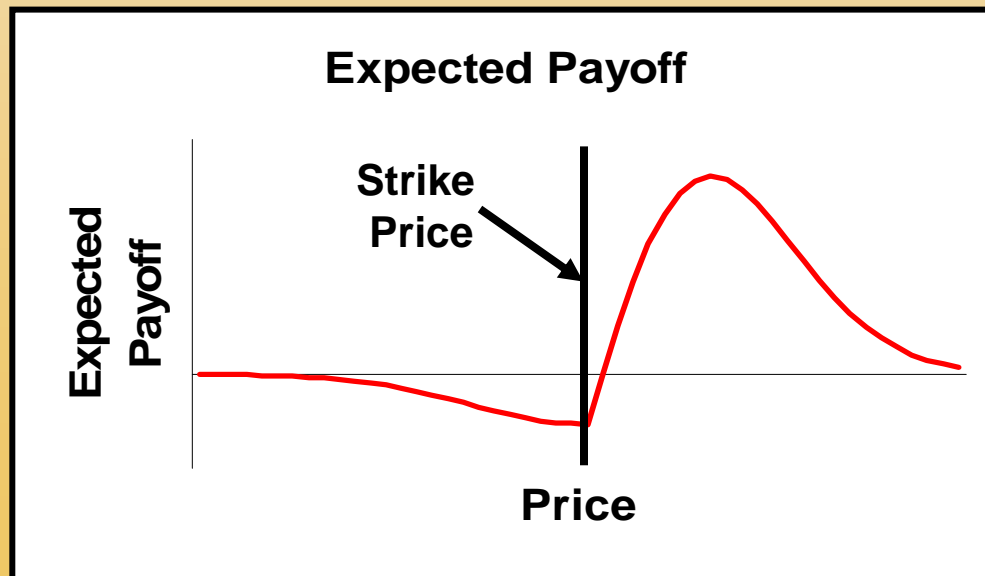
# Asymmetric Payoffs and Option Pricing



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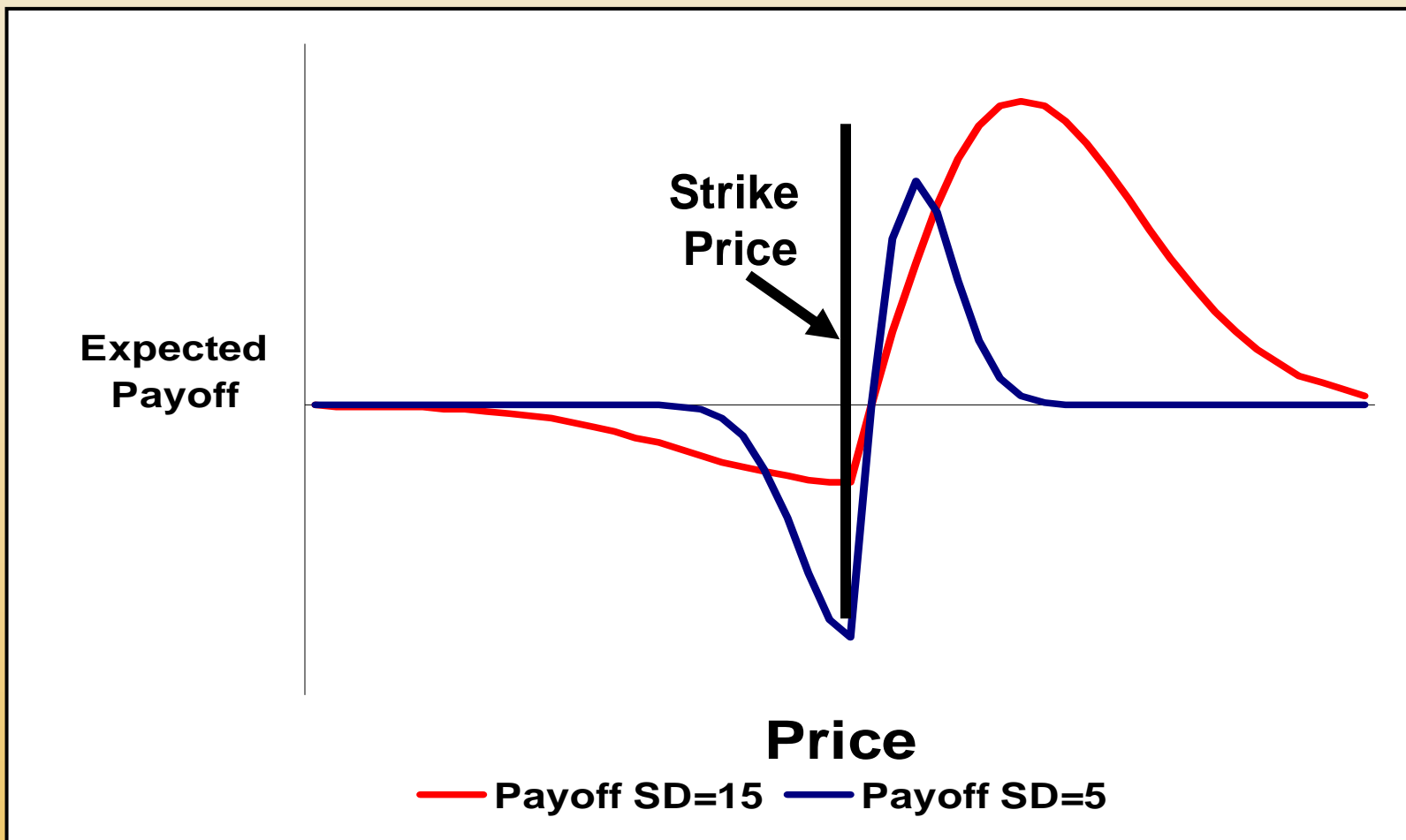


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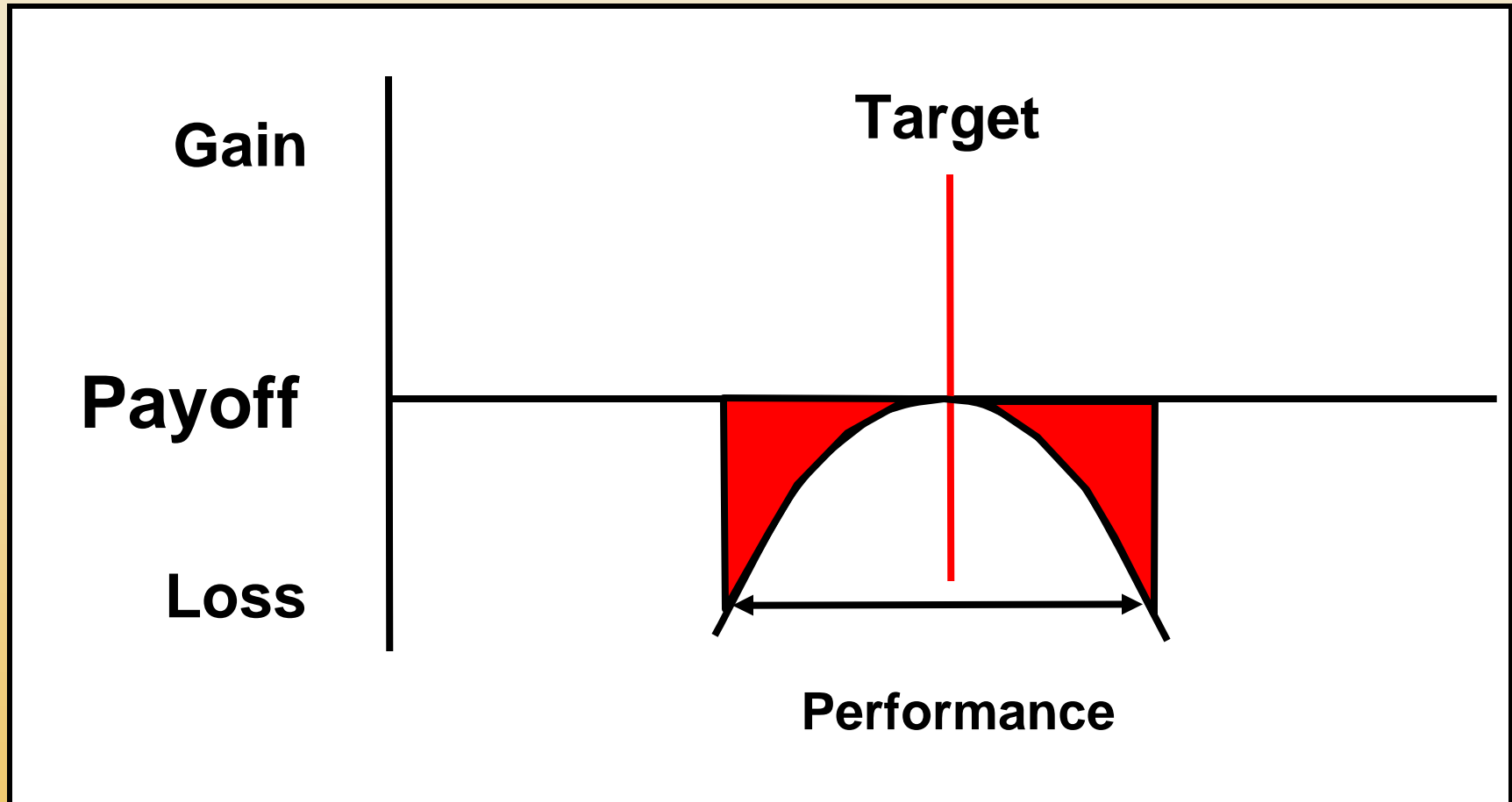


# Higher Variability Raises This Payoff



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

# Manufacturing Payoff-Function\*

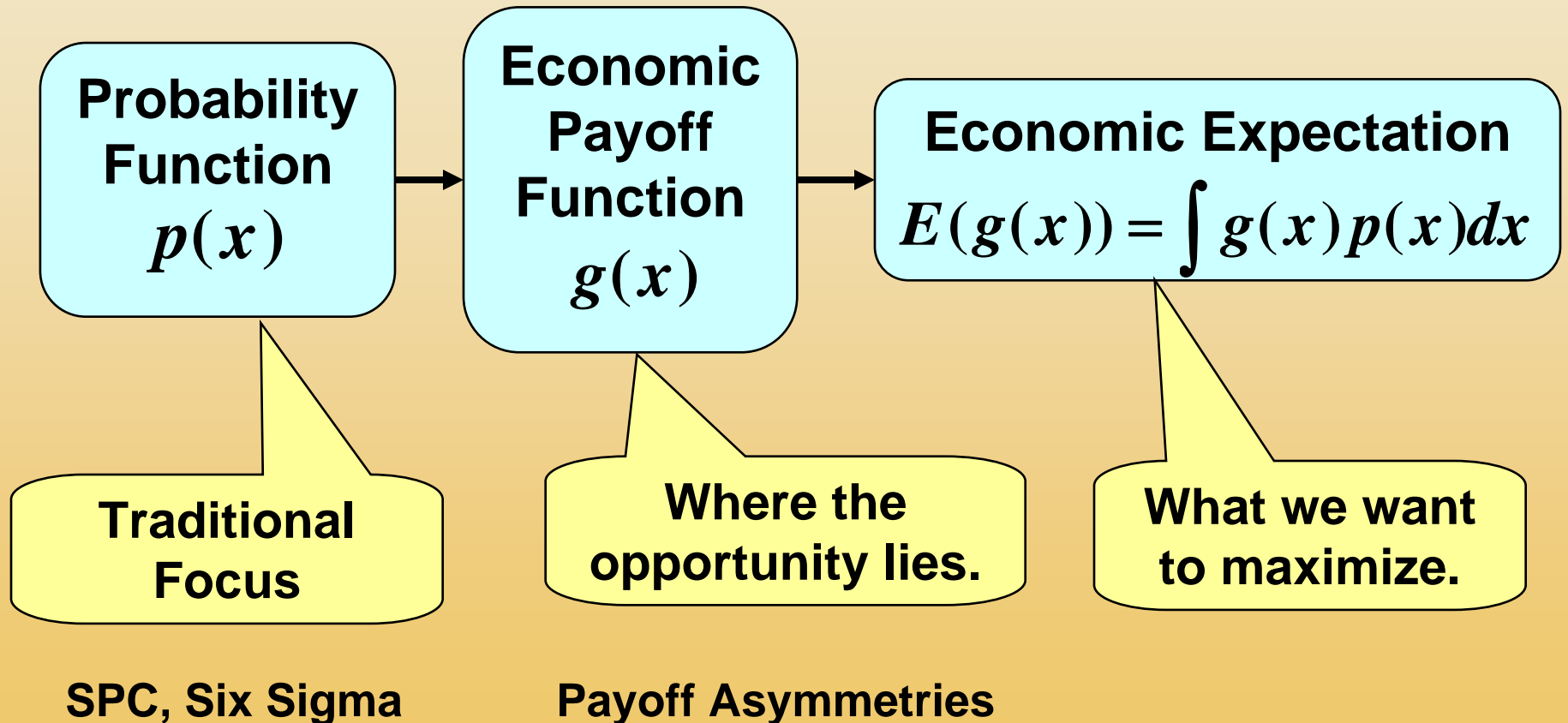


**Larger Variances Create Larger Losses**

**\*The Taguchi Loss Function**

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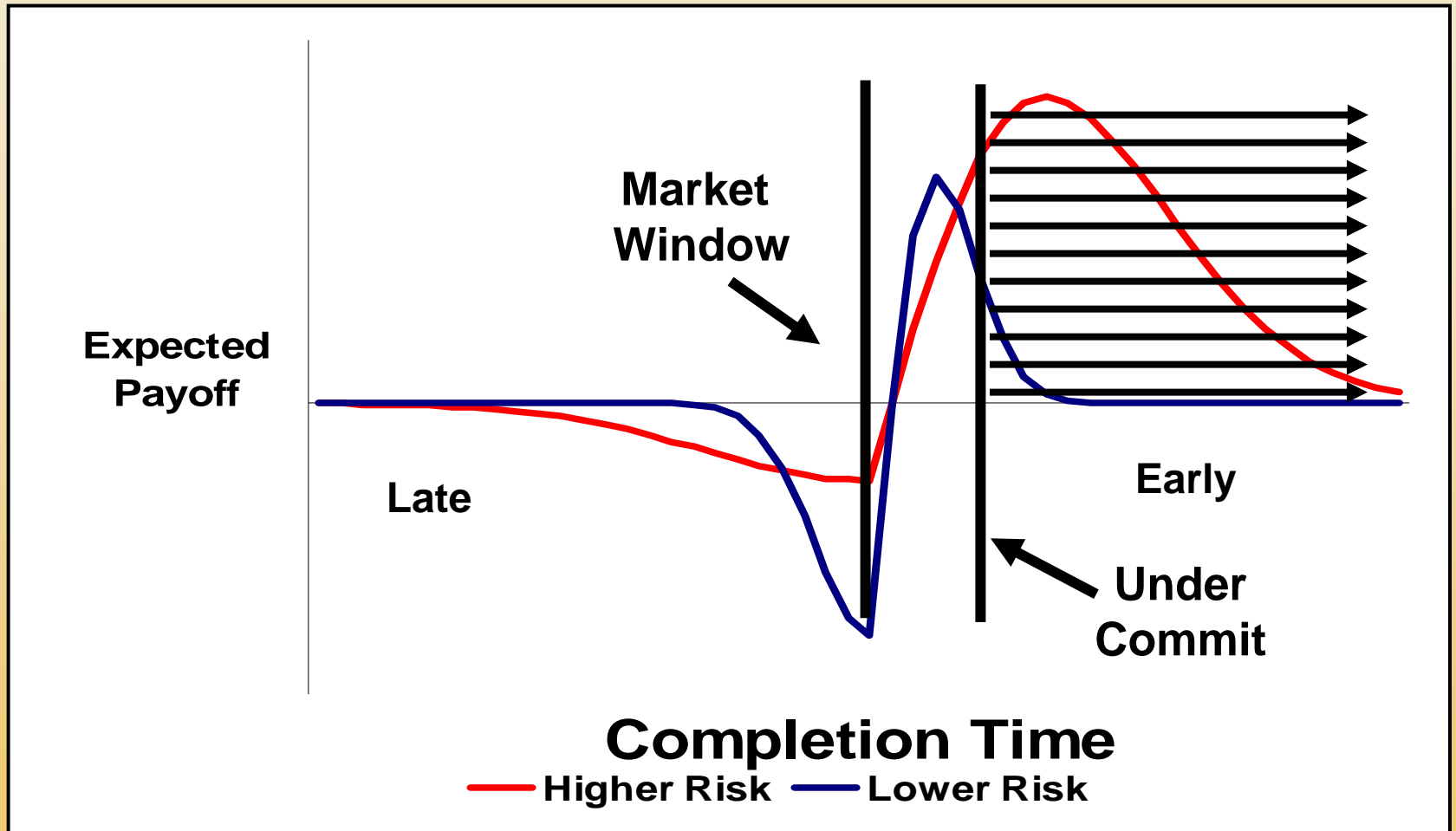
# Making Good Economic Choices



# Managing Payoff Functions

- **Avoiding uncertainty can make the high payoff tail smaller.**
- **Buffering uncertainty reduces our chance to exploit the high payoff tail.**
- **We can safely do things with inherent uncertainty in their outcomes if we manage our payoff functions.**

# Avoiding Uncertainty Affects Payoffs

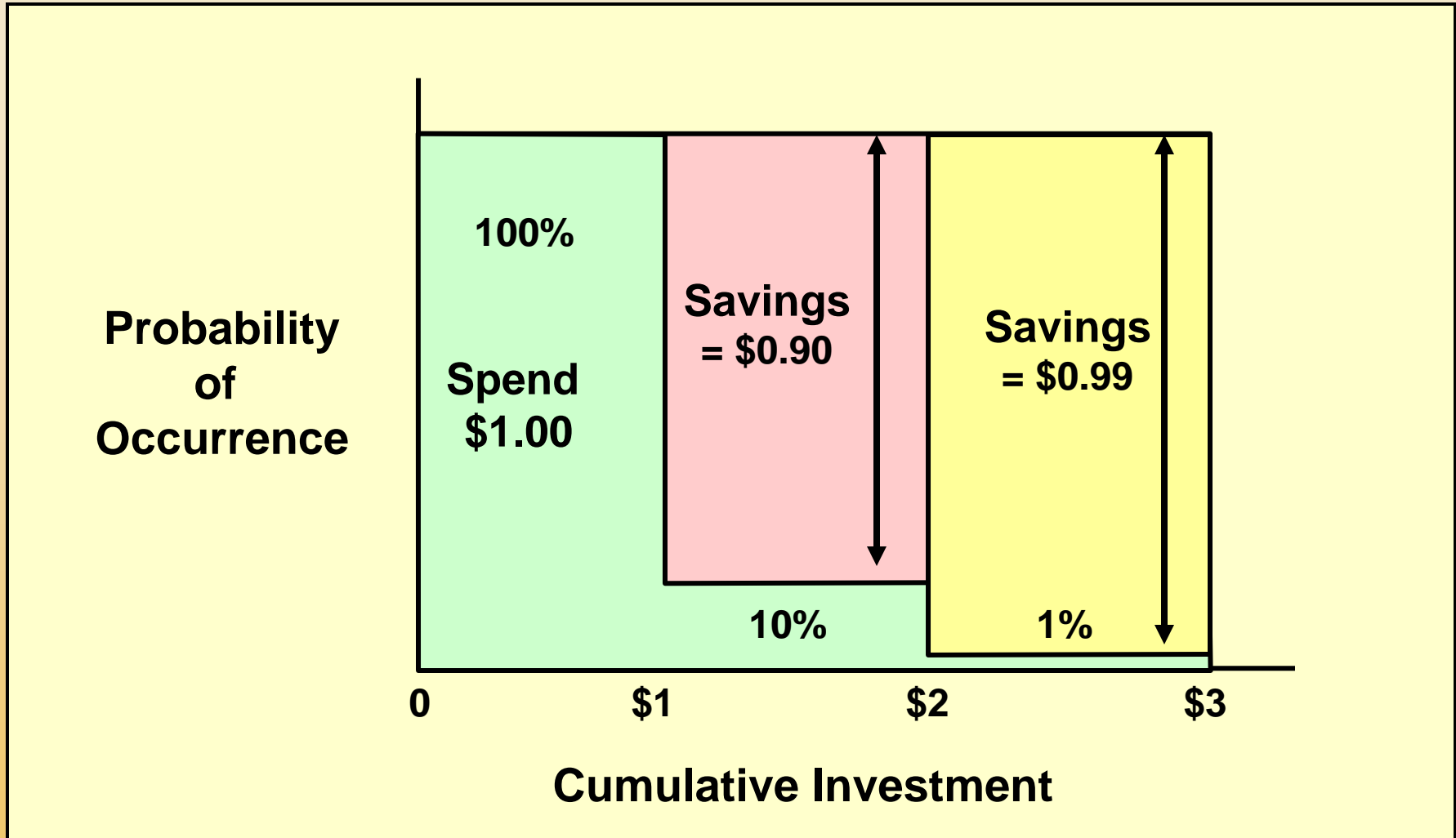


# Fast Feedback

# 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.
- How does this change the economics?

# Value of Feedback

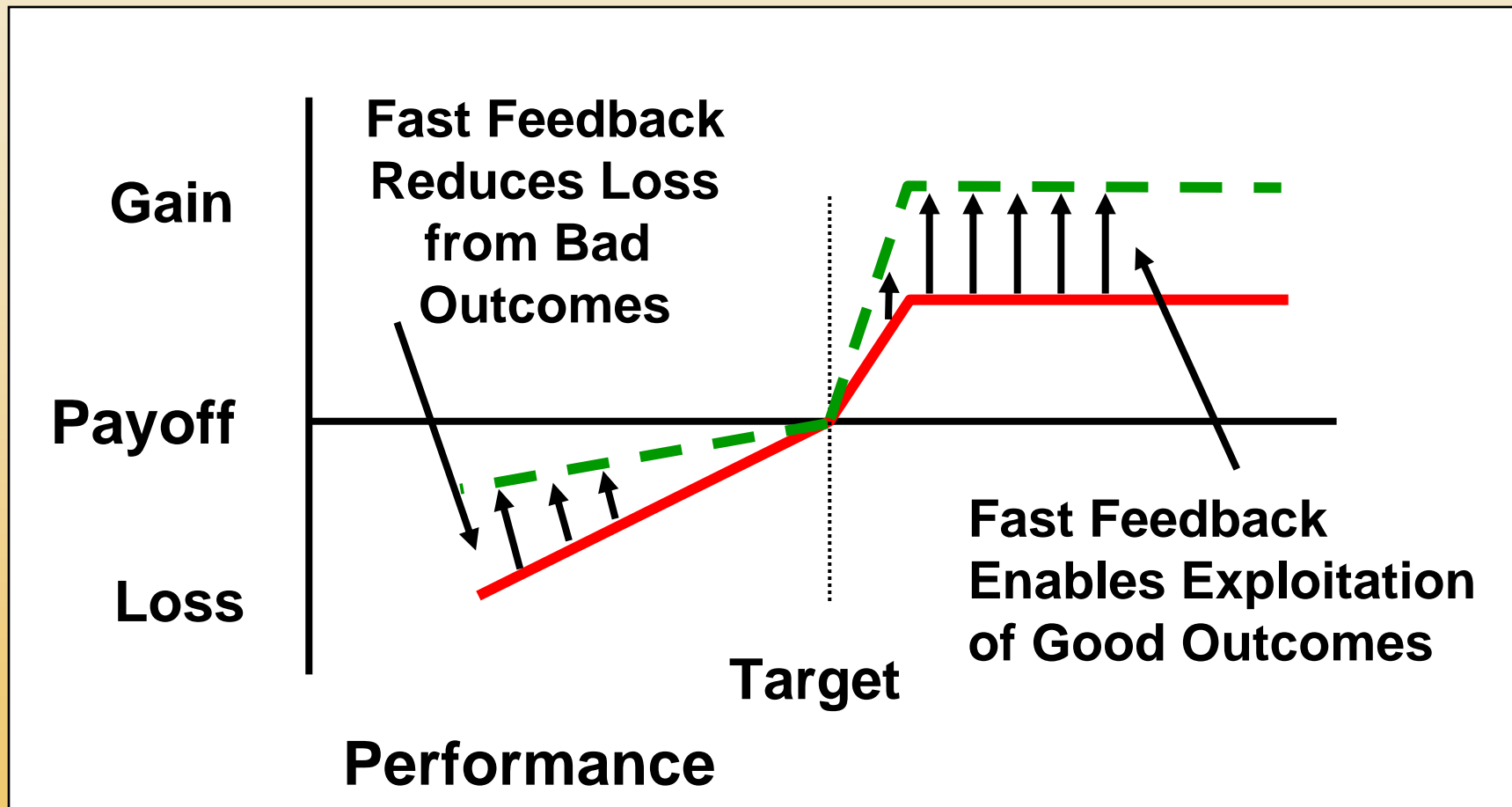


**In this case, accelerated feedback reduces required investment by 63 percent.**





# We Can Change Payoff Functions



# Creating Asymmetries

- **Anti-fragility comes from creating payoff asymmetries.**
  - **Truncate the downside of bad outcomes.**
  - **Amplify the upside of good outcomes.**
  - **...even outcomes that you cannot predict.**
- **Quickly recognize changing facts and respond.**
- **Payoff asymmetries are not accidental, they are a consequence of management choices.**

# Use Batch Size to Create Options

- **Batch size reduction creates low cost options for: sequencing, routing, and termination. Options to invest more or less.**
- **It is like being able to change your bet on a horse race after it has started.**
- **Creating and using payoff asymmetries is largely ignored in Lean Manufacturing.**
- **It is exploited in Lean Startups.**

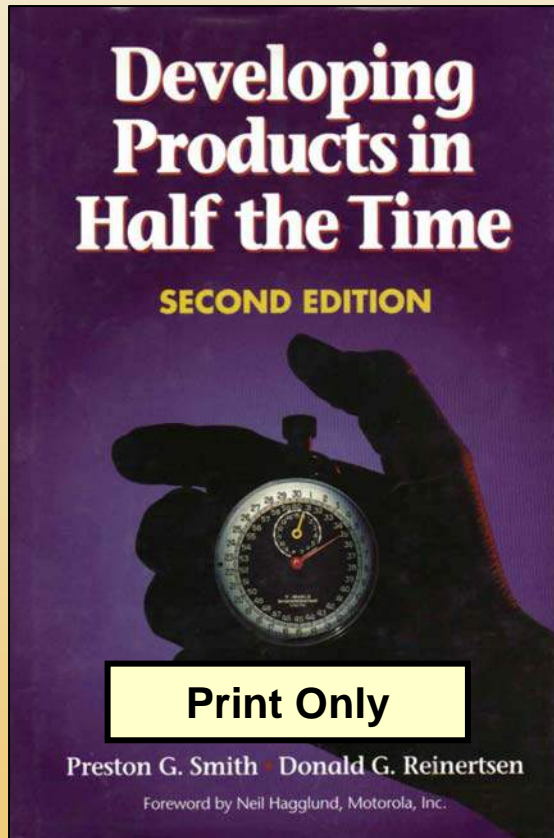
# A Few Take-Aways

- 1. Don't fear variability.**
- 2. Buffer with care.**
- 3. Monitor your safety margins.**
- 4. Focus on payoff functions, not probabilities.**
- 5. Accelerate feedback loops.**
- 6. Buy information in small batches.**
- 7. Think like a smart gambler.**
- 8. Create options to bypass obstacles and exploit opportunities.**
- 9. Shut down unproductive paths early.**
- 10. Value good economic choices over conformance.**

# Two Views of Variability

<b>Variability is</b>	<b>Always Bad</b>	<b>Exploitable</b>
<p><b>Conformance to Plan</b></p> <p><b>Type of Planning</b></p> <p><b>Timing of Planning</b></p> <p><b>Attitude towards Risk</b></p> <p><b>Commitments</b></p> <p><b>Use Robustness to</b></p> <p><b>SPC/Six Sigma</b></p> <p><b>Role of Options</b></p> <p><b>Use Batch Size to</b></p> <p><b>Control Strategy</b></p>	<p><b>Always Good</b></p> <p><b>Heavy, Long Horizon</b></p> <p><b>Upfront</b></p> <p><b>Avoid All Risks</b></p> <p><b>Always Under-commit</b></p> <p><b>Reduce all variation</b></p> <p><b>Miracle Cures</b></p> <p><b>None</b></p> <p><b>Raise Efficiency</b></p> <p><b>Centralized</b></p>	<p><b>Plans Must Change</b></p> <p><b>Short Horizon</b></p> <p><b>Just-in Time</b></p> <p><b>Take Rational Risks</b></p> <p><b>Change Dynamically</b></p> <p><b>Dampen Bad Outcomes</b></p> <p><b>Potentially Toxic</b></p> <p><b>Critical Tool</b></p> <p><b>Accelerate Feedback</b></p> <p><b>Decentralized</b></p>

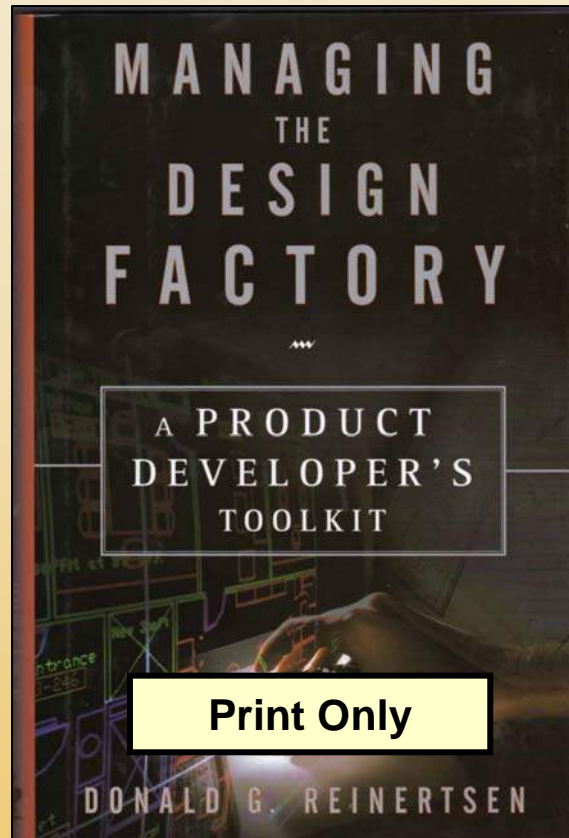
# Going Further



1991 / 1997



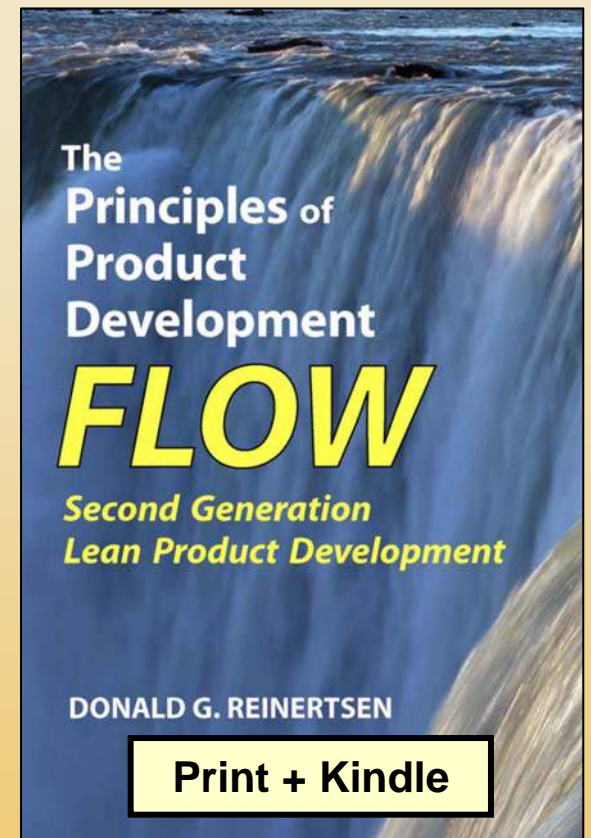
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1997



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2009

