

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

**Lean Kanban Russia 2014  
Moscow, Russia  
October 3, 2014**

No part of this presentation may be reproduced  
without the written permission of the author.

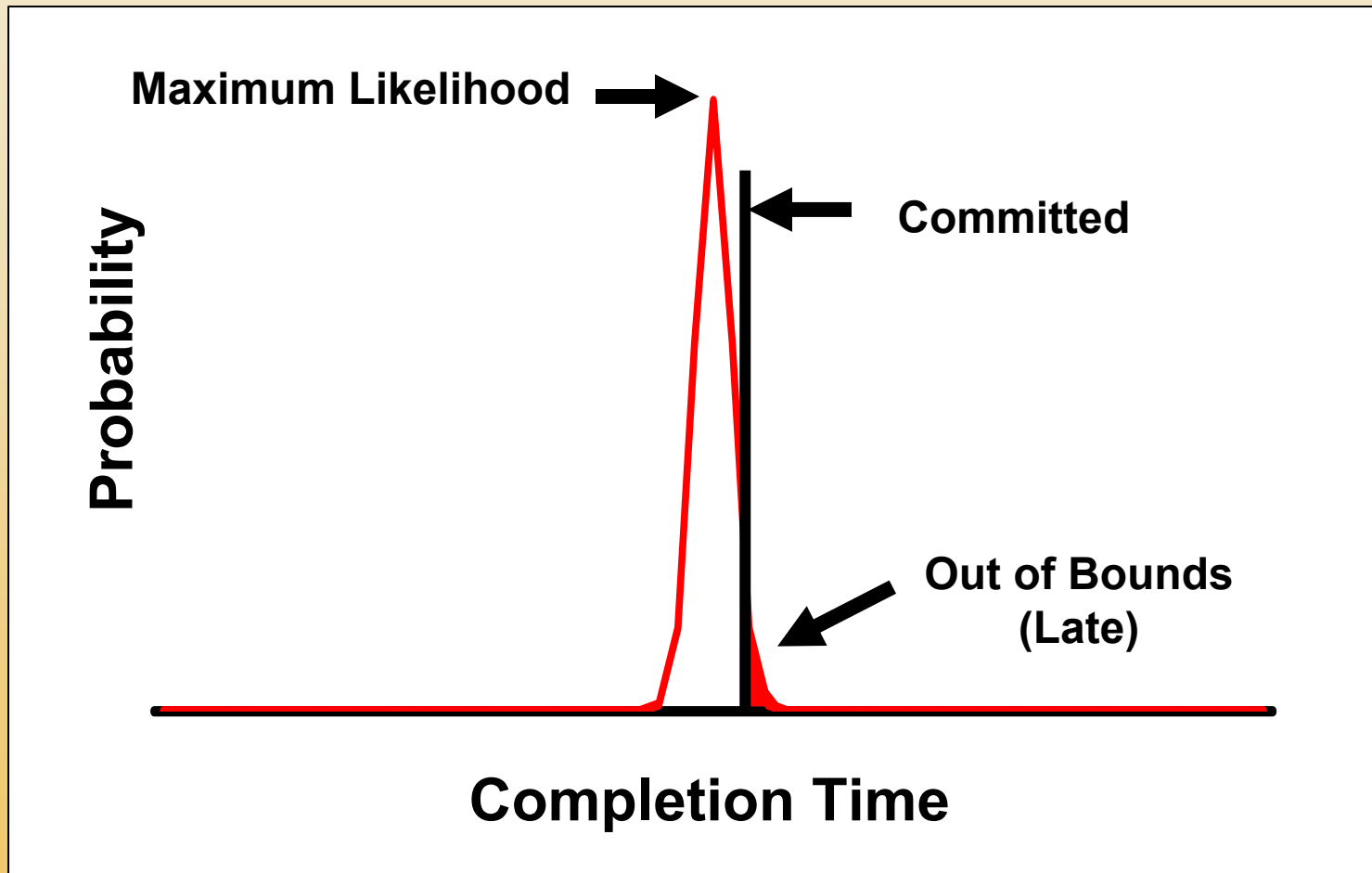
**Donald G. Reinertsen  
Reinertsen & Associates  
600 Via Monte D'Oro  
Redondo Beach, CA 90277 U.S.A.  
(310)-373-5332  
Internet: [Don@ReinertsenAssociates.com](mailto:Don@ReinertsenAssociates.com)  
Twitter: [@dreinertsen](https://twitter.com/dreinertsen)  
[www.ReinertsenAssociates.com](http://www.ReinertsenAssociates.com)**

# Variability is BAD

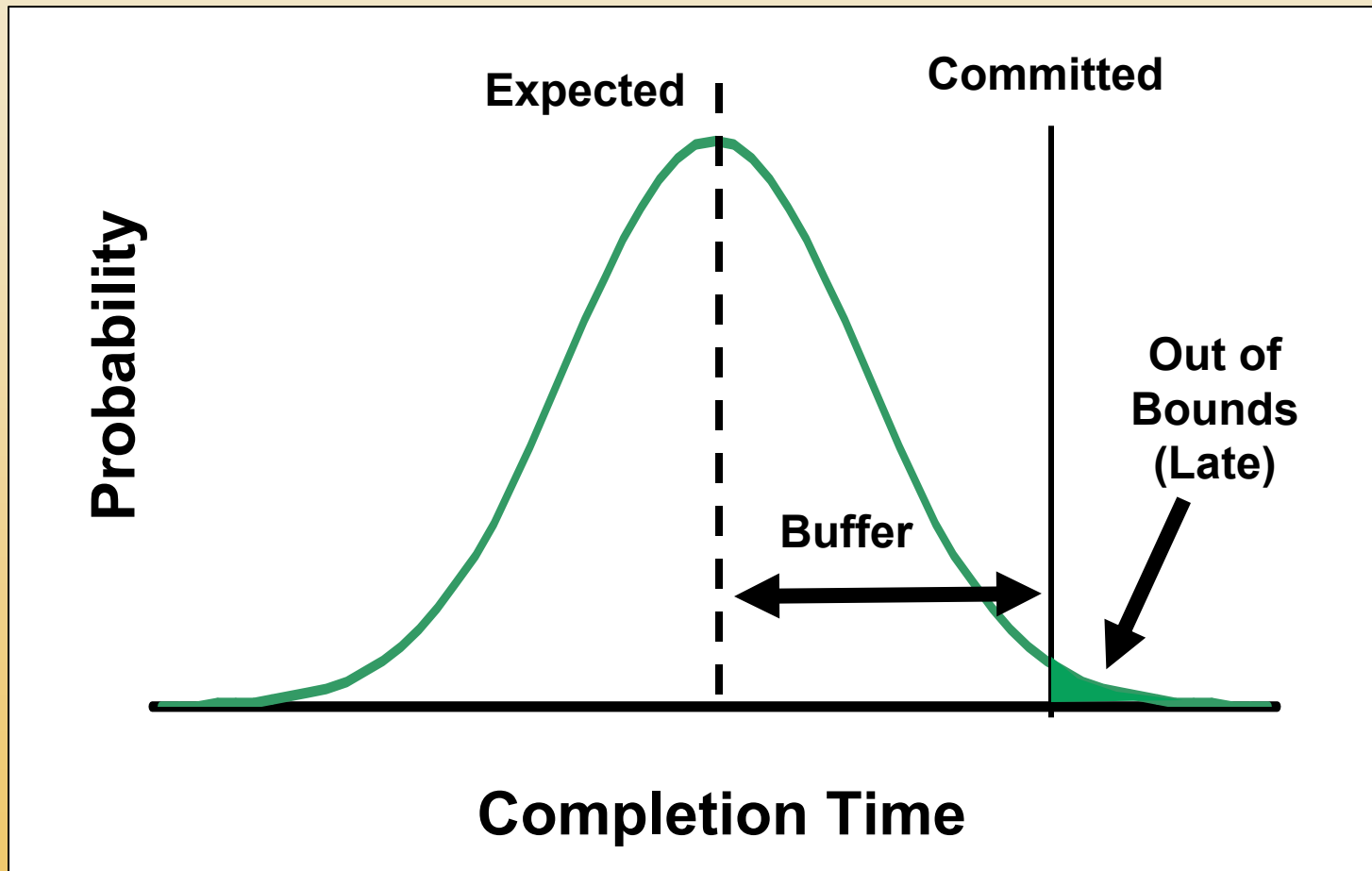
# **We Should Minimize Variability**

- **The world is stochastic; outcomes will vary.**
- **We can protect ourselves from the unfavorable tail 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 such choices in our economic interest?**

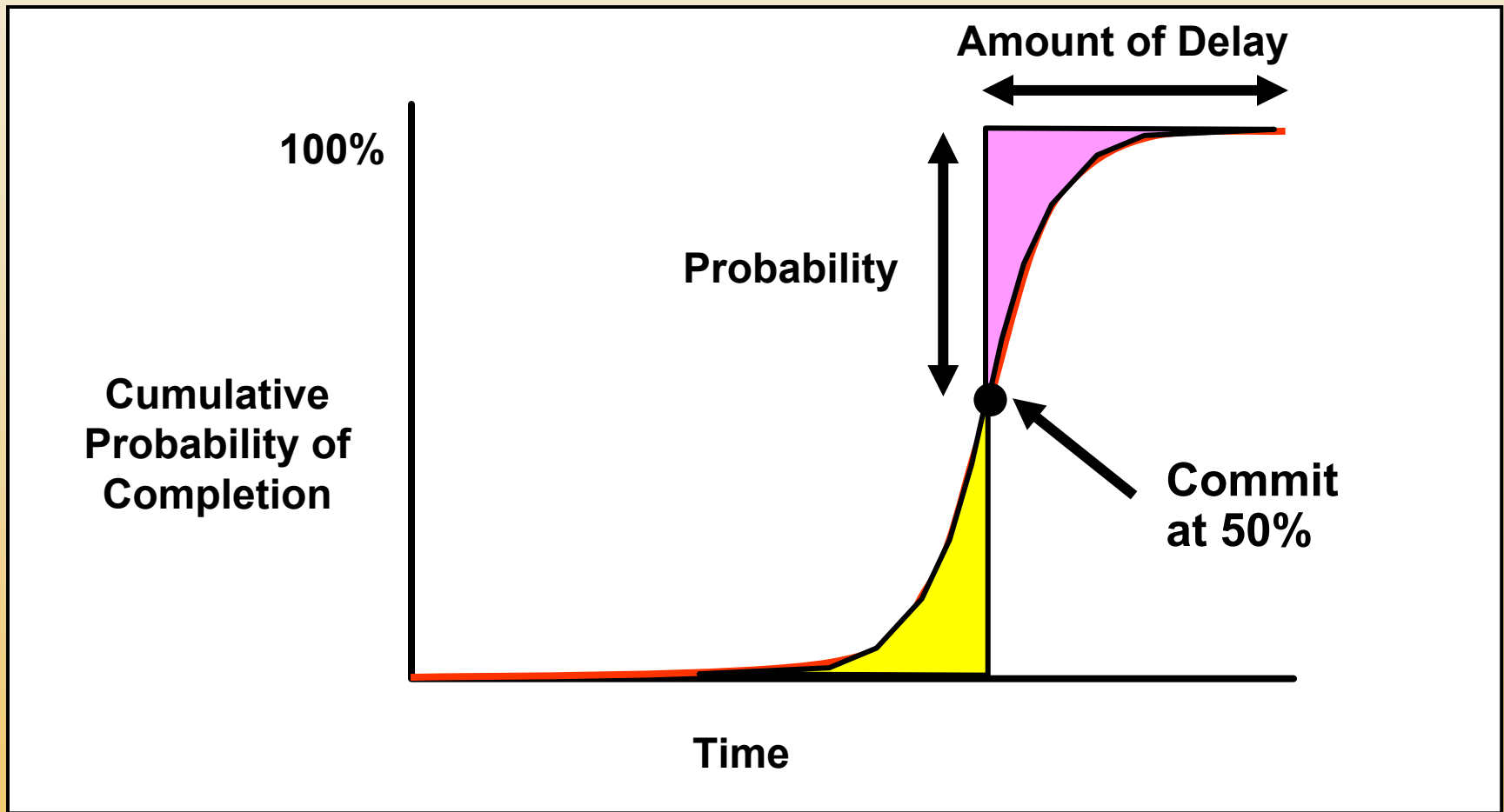
# Make the Tail Small



# Hide the Variability with a Buffer



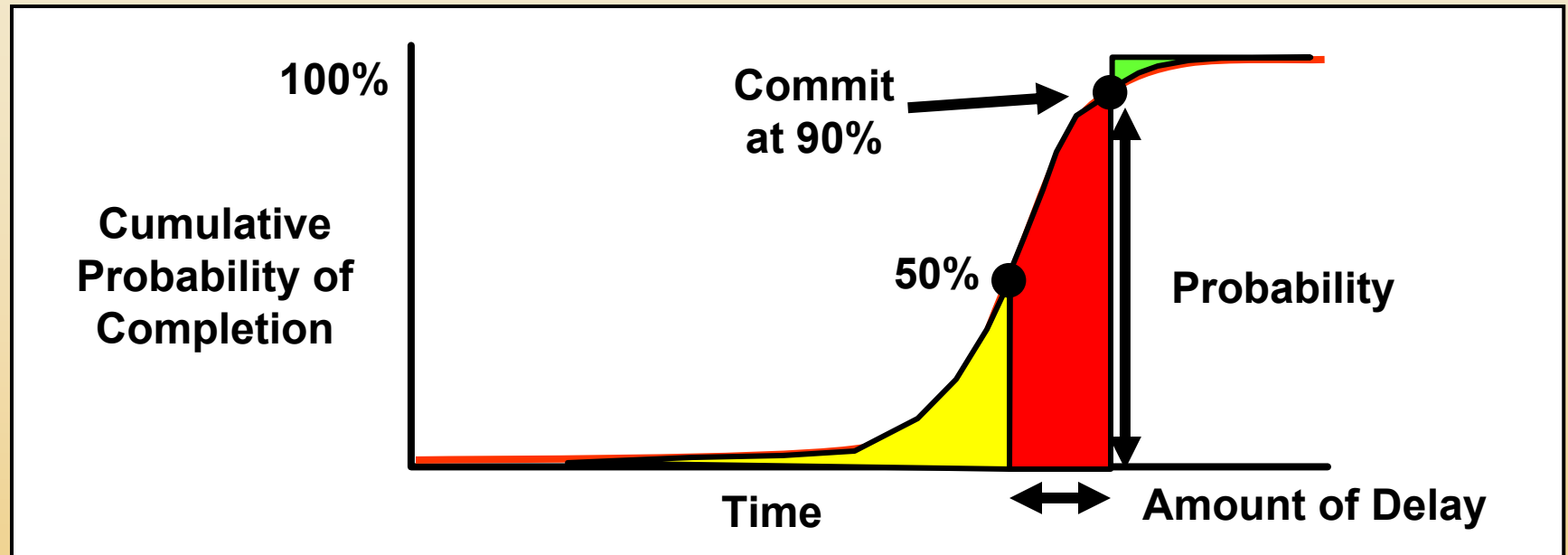
# Without a Buffer

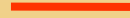


— Inherently Uncertain Schedule

□ 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 reductions in cycle time variability.**

# **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.

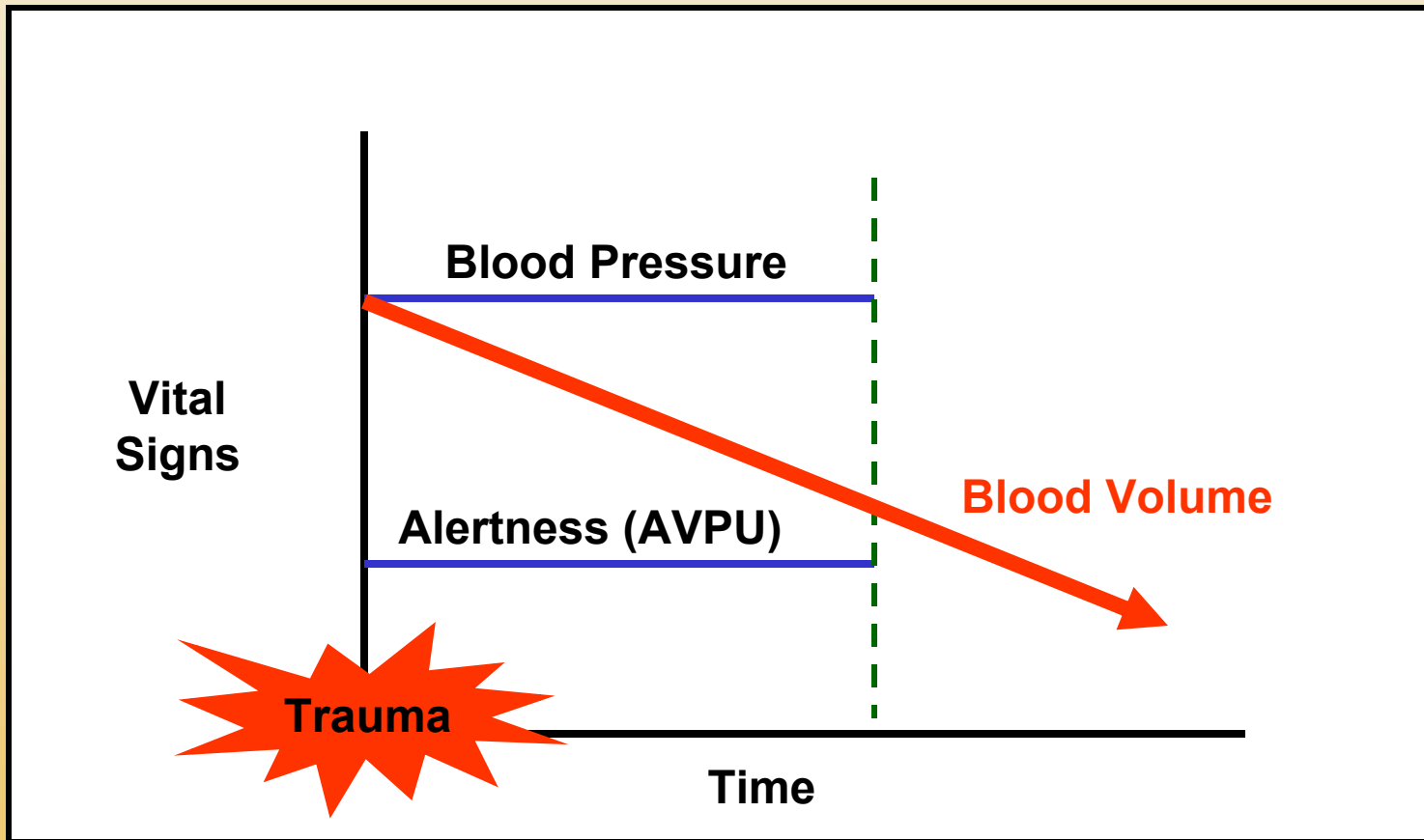
# Active Robustness

- **We use active feedback loops to maintain system conditions.**
- **This achieves stability, but it can mask the deterioration of the system.**
- **And masked 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.**

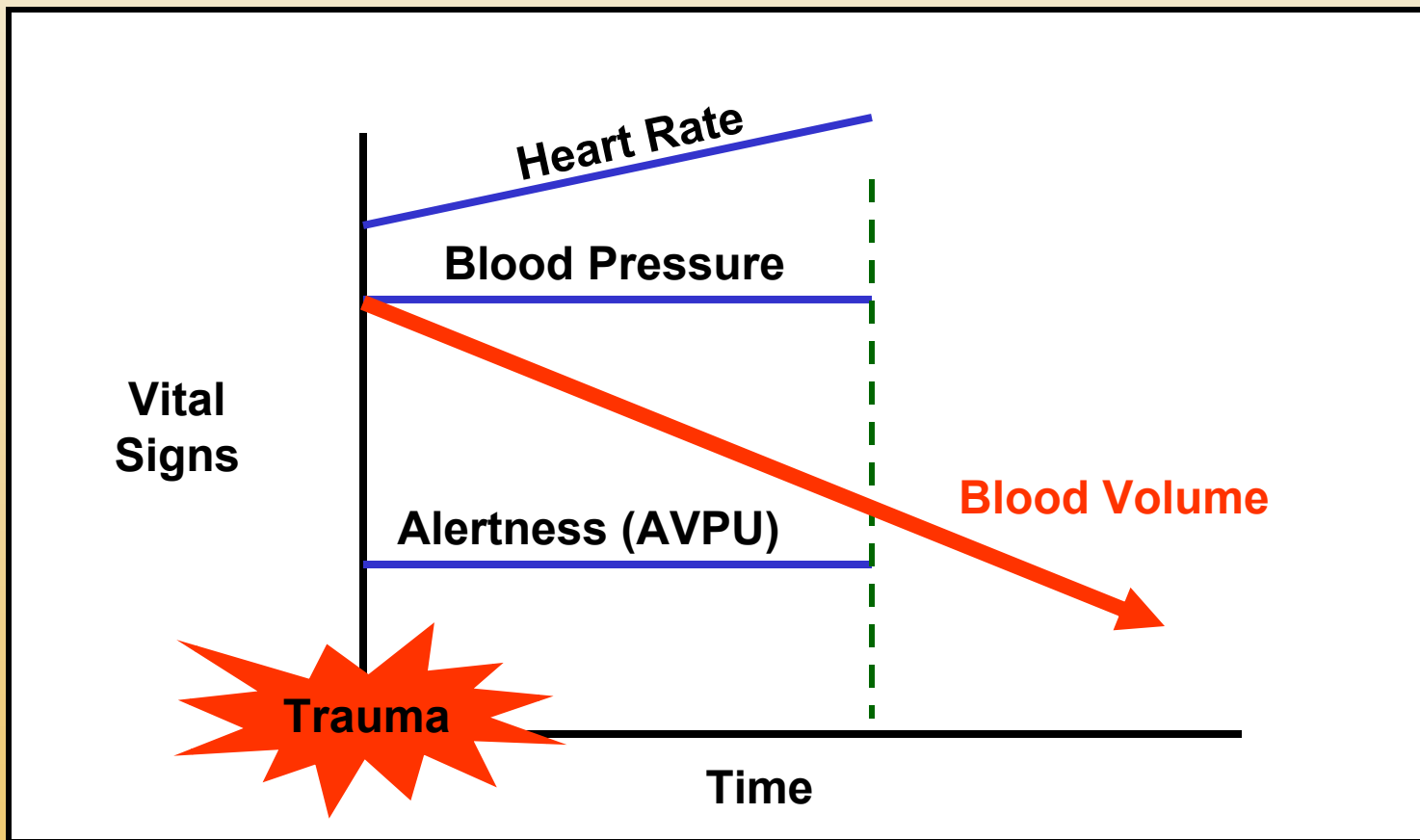
# Hypovolemic Shock



# Compensated Shock

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

# Hypovolemic Shock

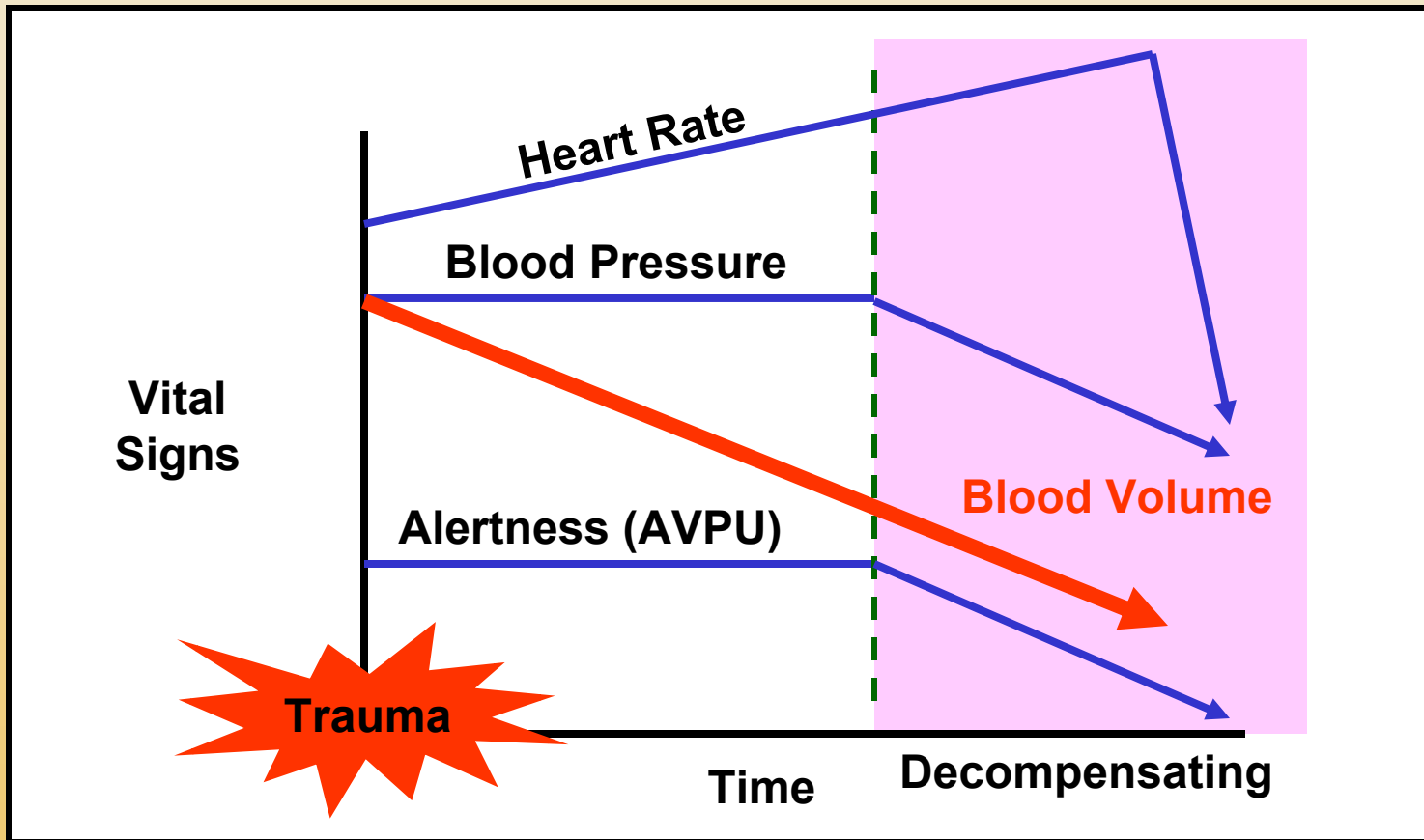


# Uncompensated Shock

- **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

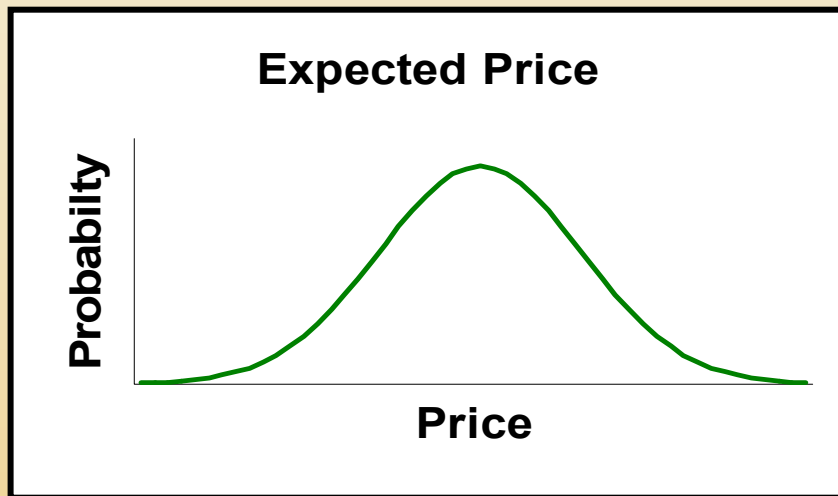


# Overcoming Masking Effects

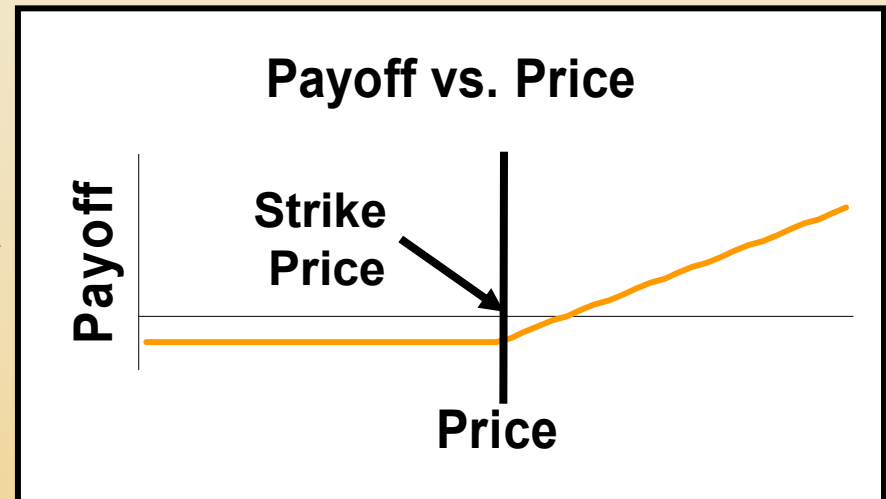
- **There are always indicators of deteriorating operational margin.**
- **Under normal circumstances these indicators appear to convey no useful information.**
  - **They are uncorrelated to performance.**
  - **They produce weak signals.**
- **We need to monitor these indicators of margin in addition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

# **Another Viewpoint**

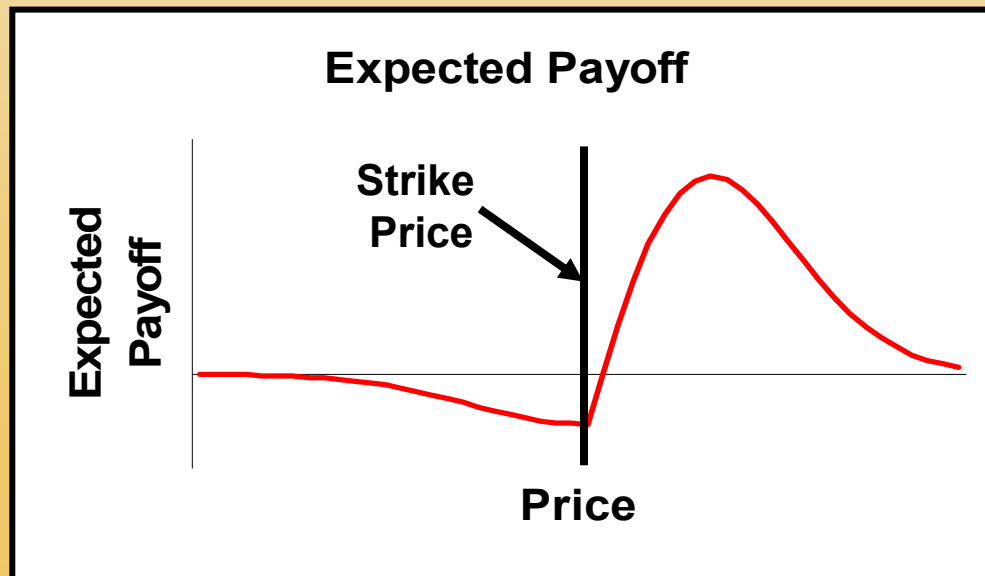
# Asymmetric Payoffs and Option Pricing



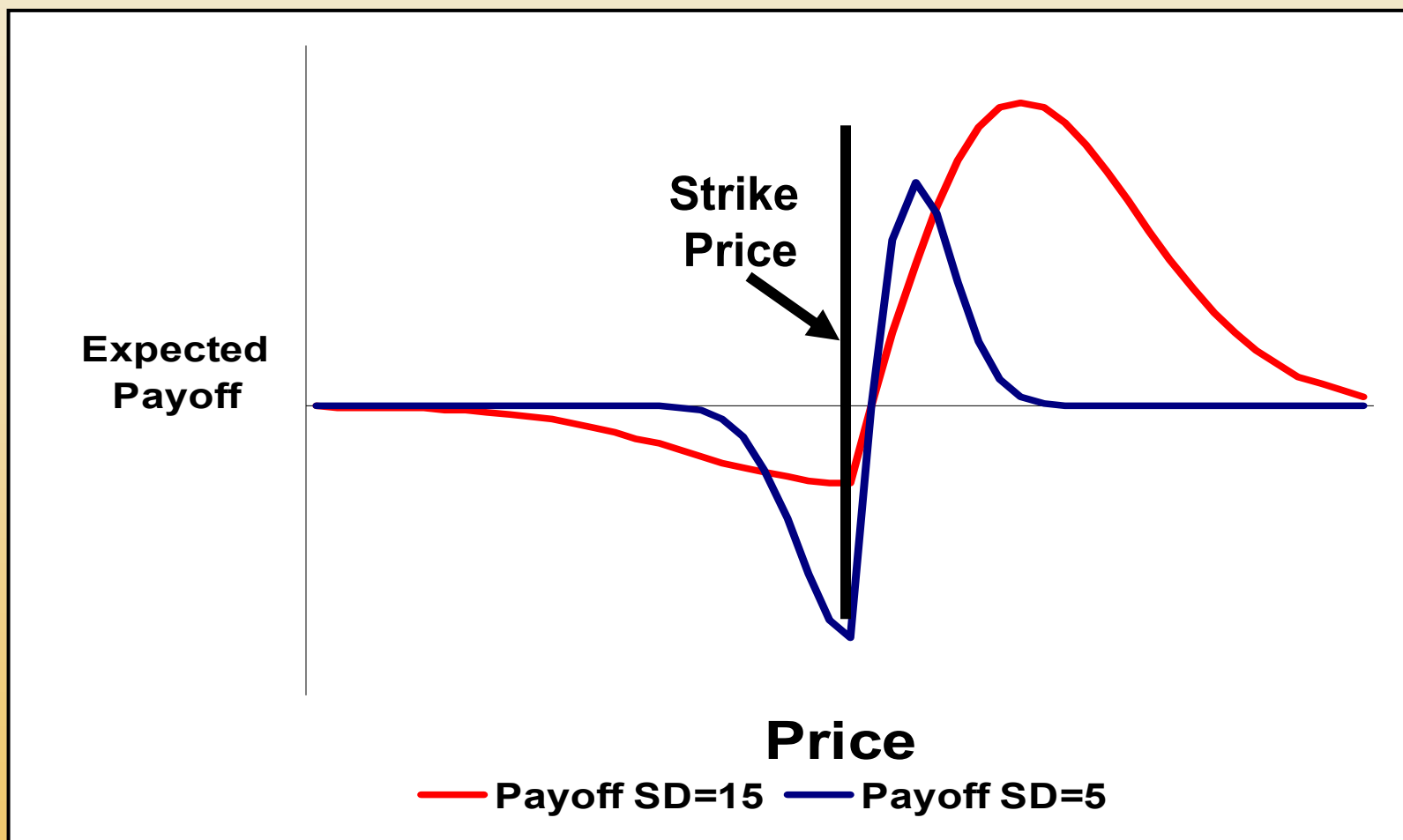
X



||

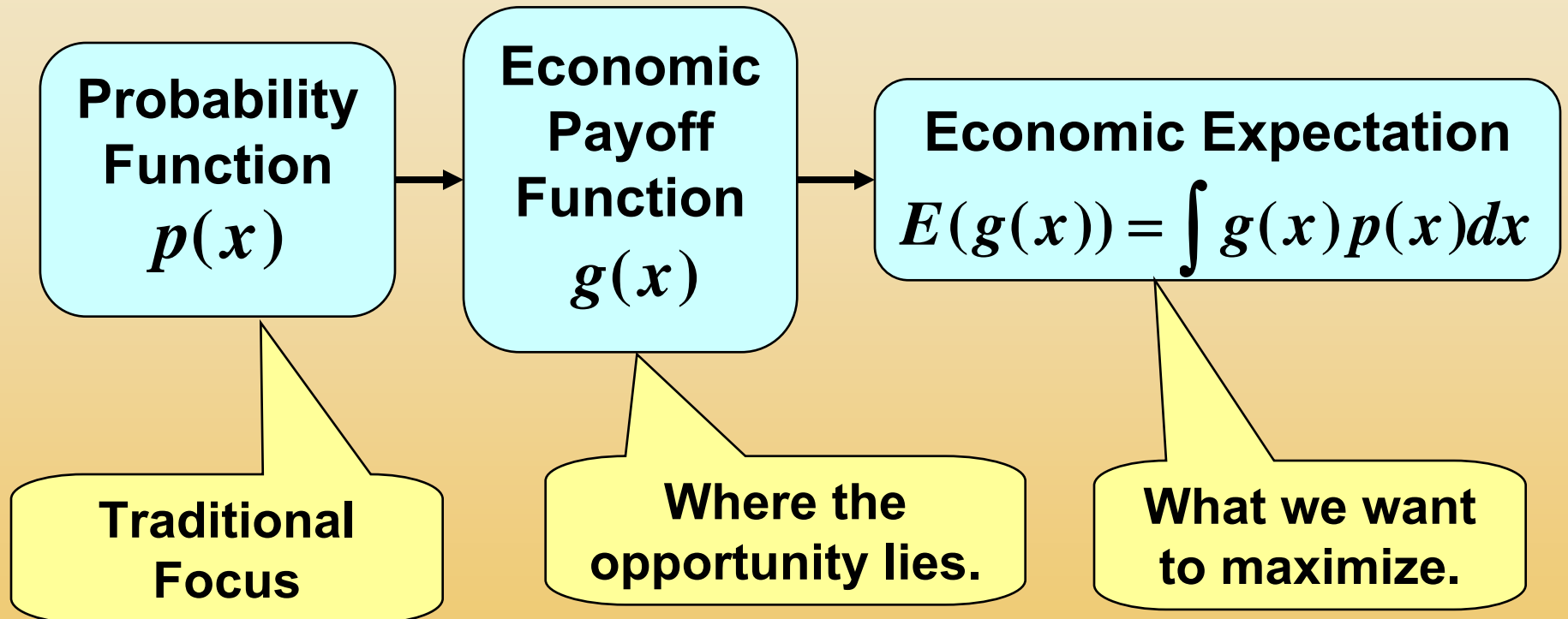


# Higher Variability Raises This Payoff



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

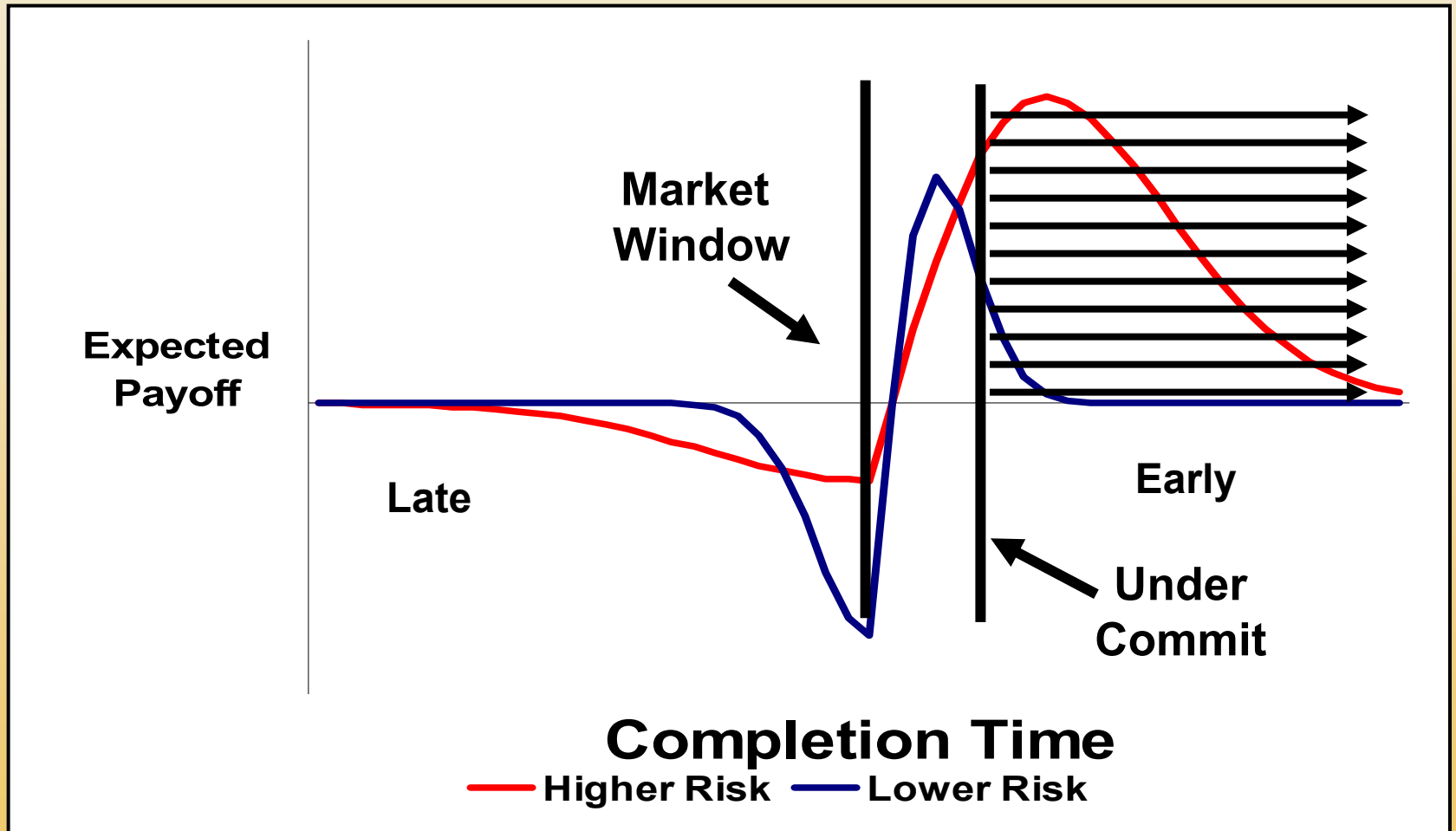
# Making Good Economic Choices



# Managing Payoff Functions

- **We can do things that have inherent uncertainty in their outcomes if we can manage the payoff functions.**
- **Avoiding uncertainty can make the high payoff tail smaller.**
- **Buffering uncertainty can reduce out chance to exploit the high payoff tail.**

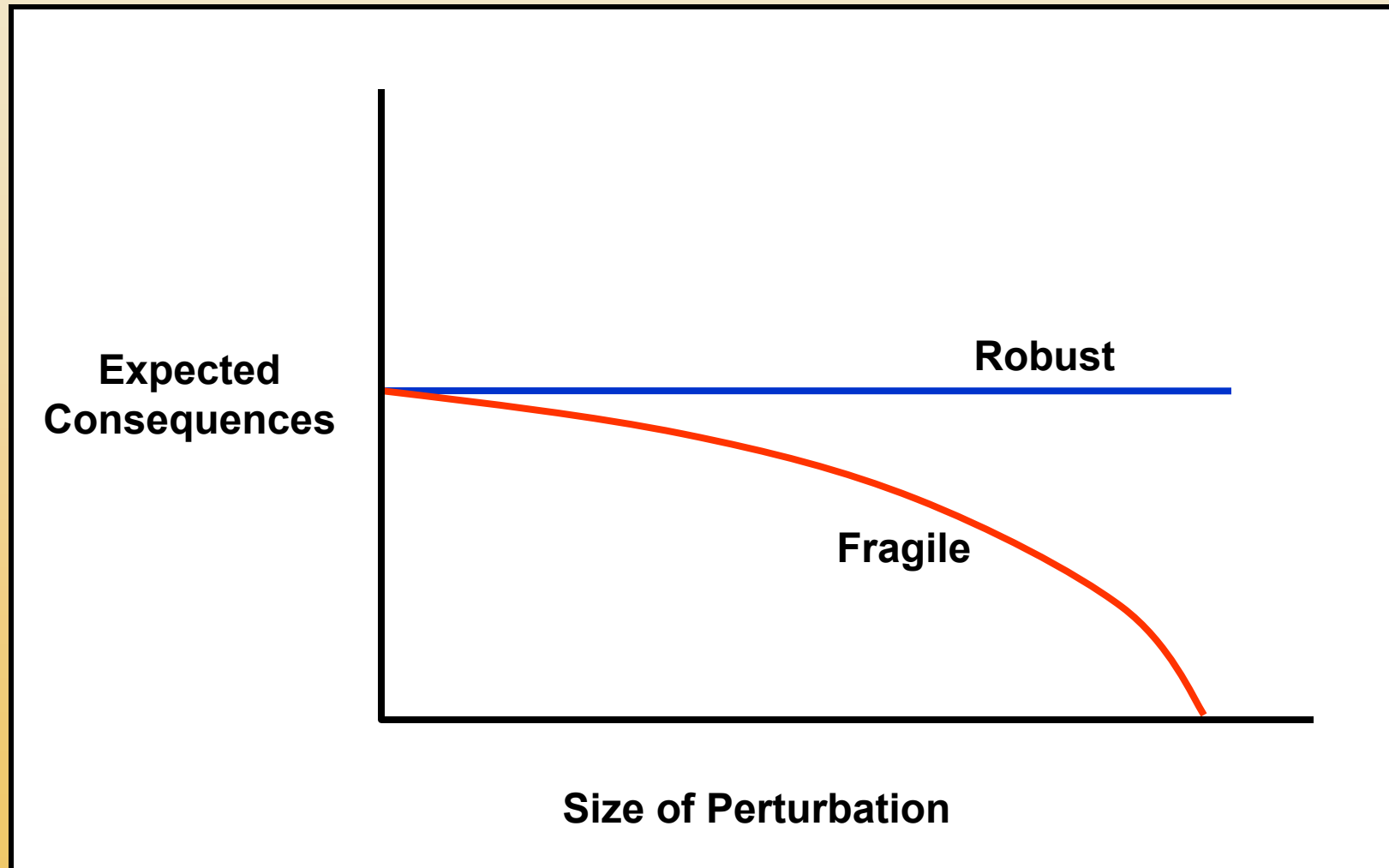
# Avoiding Uncertainty Affects Payoffs



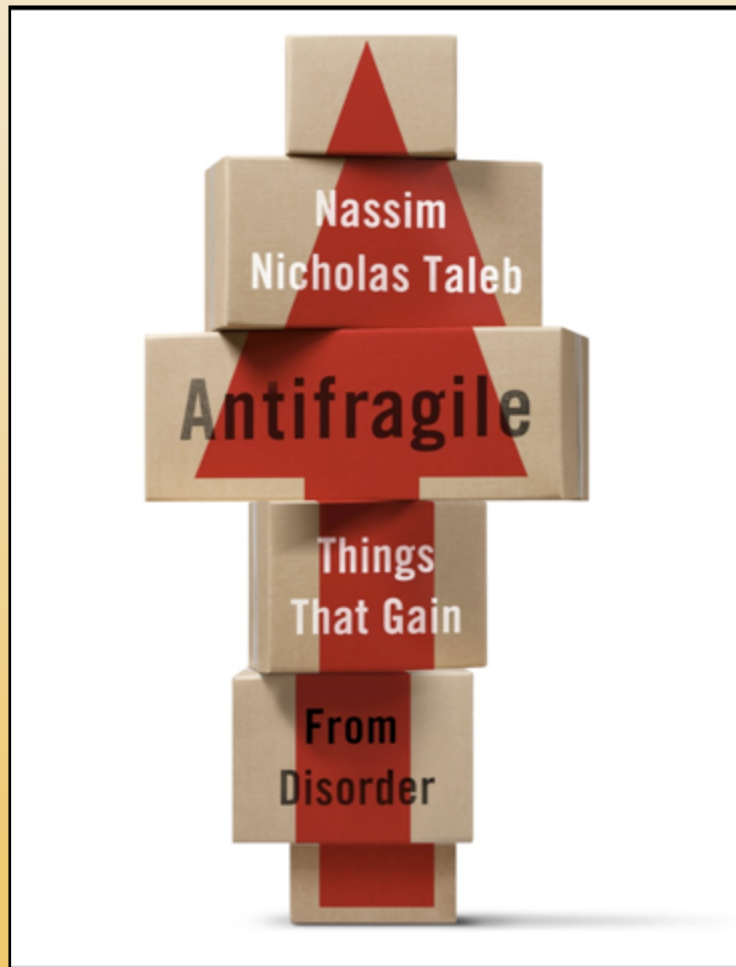


# Fragile Systems

# Fragility

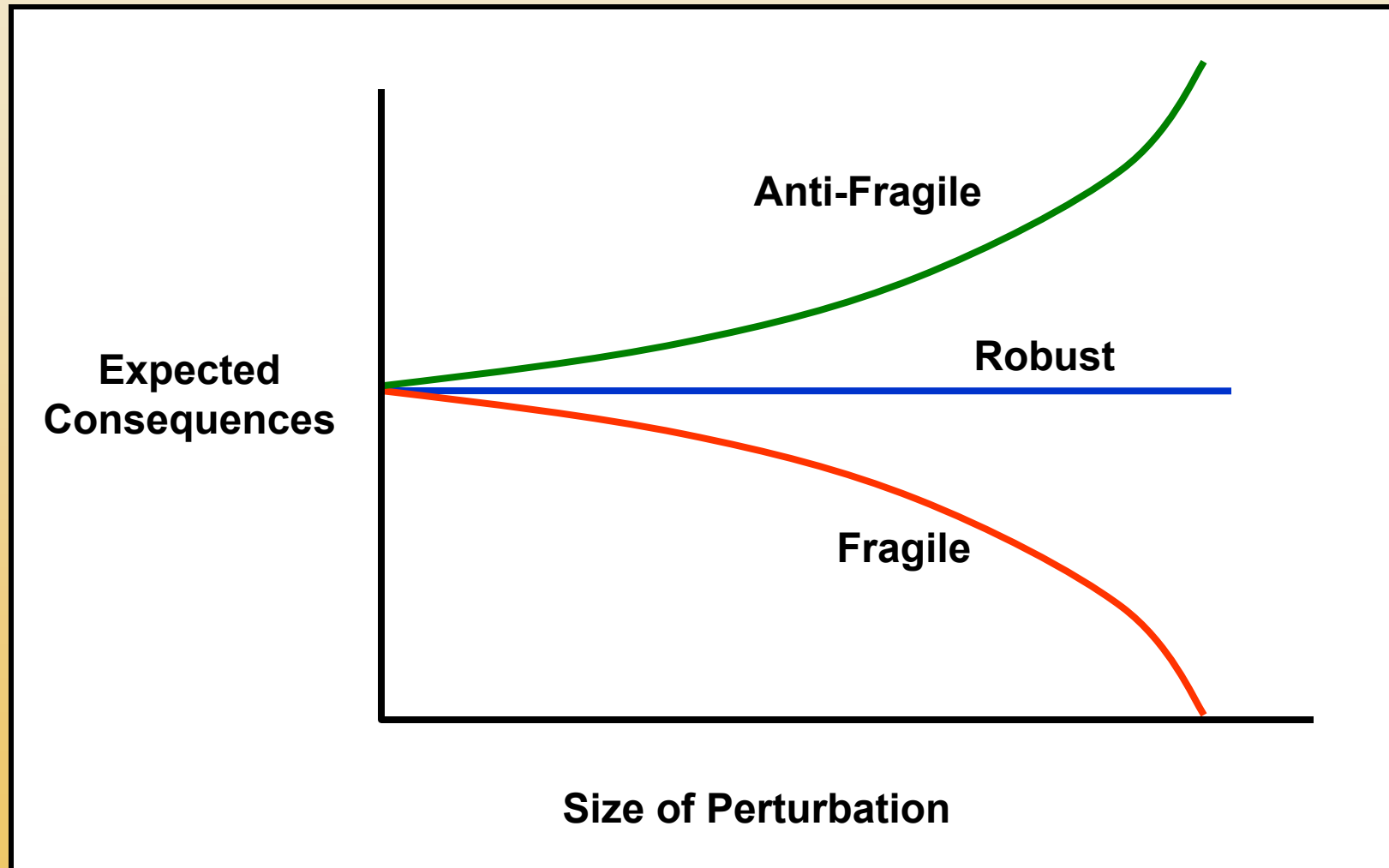


# Nassim Taleb



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

# Anti-Fragility

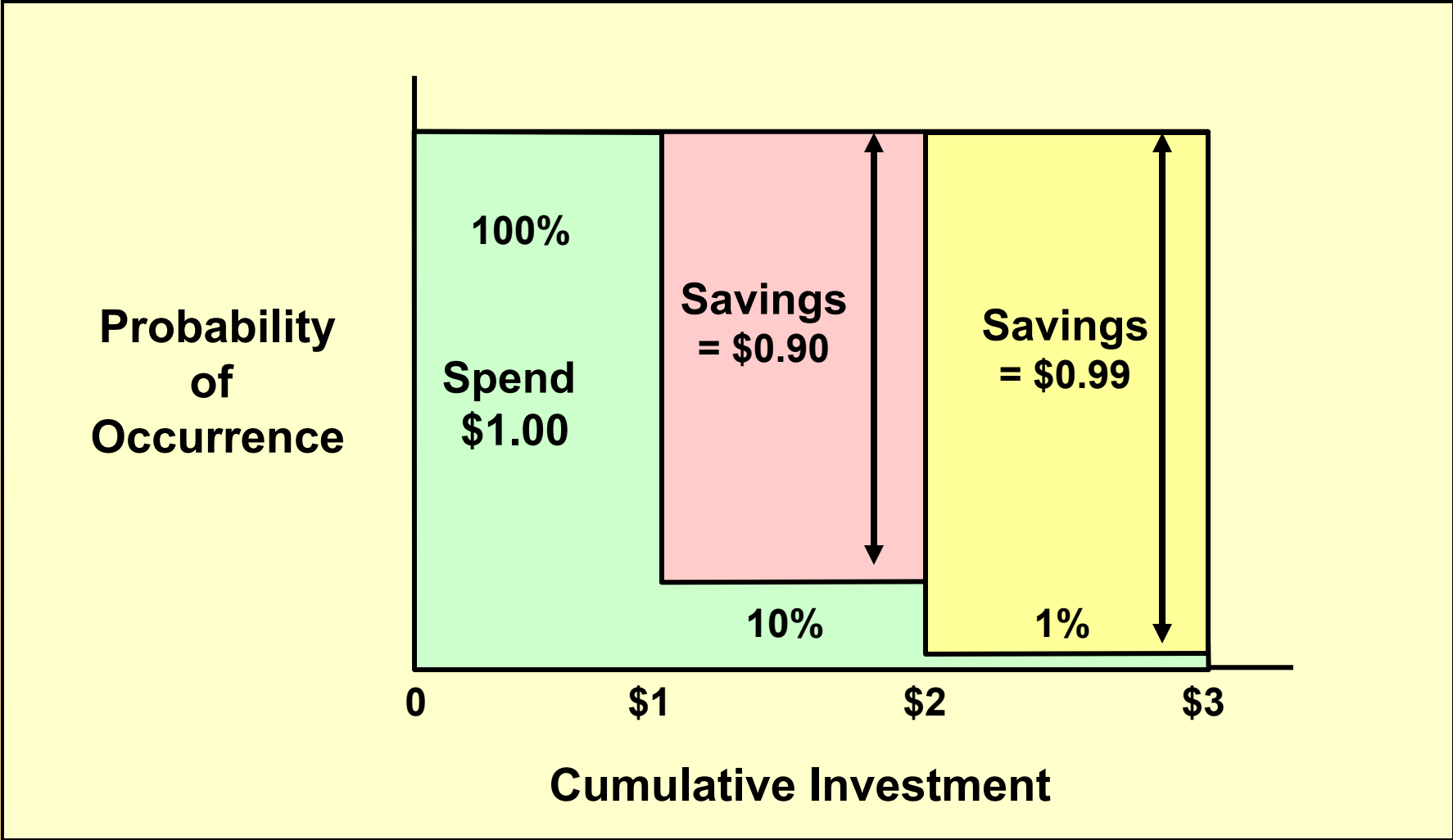


# Fast Feedback

# The Front-Loaded Lottery

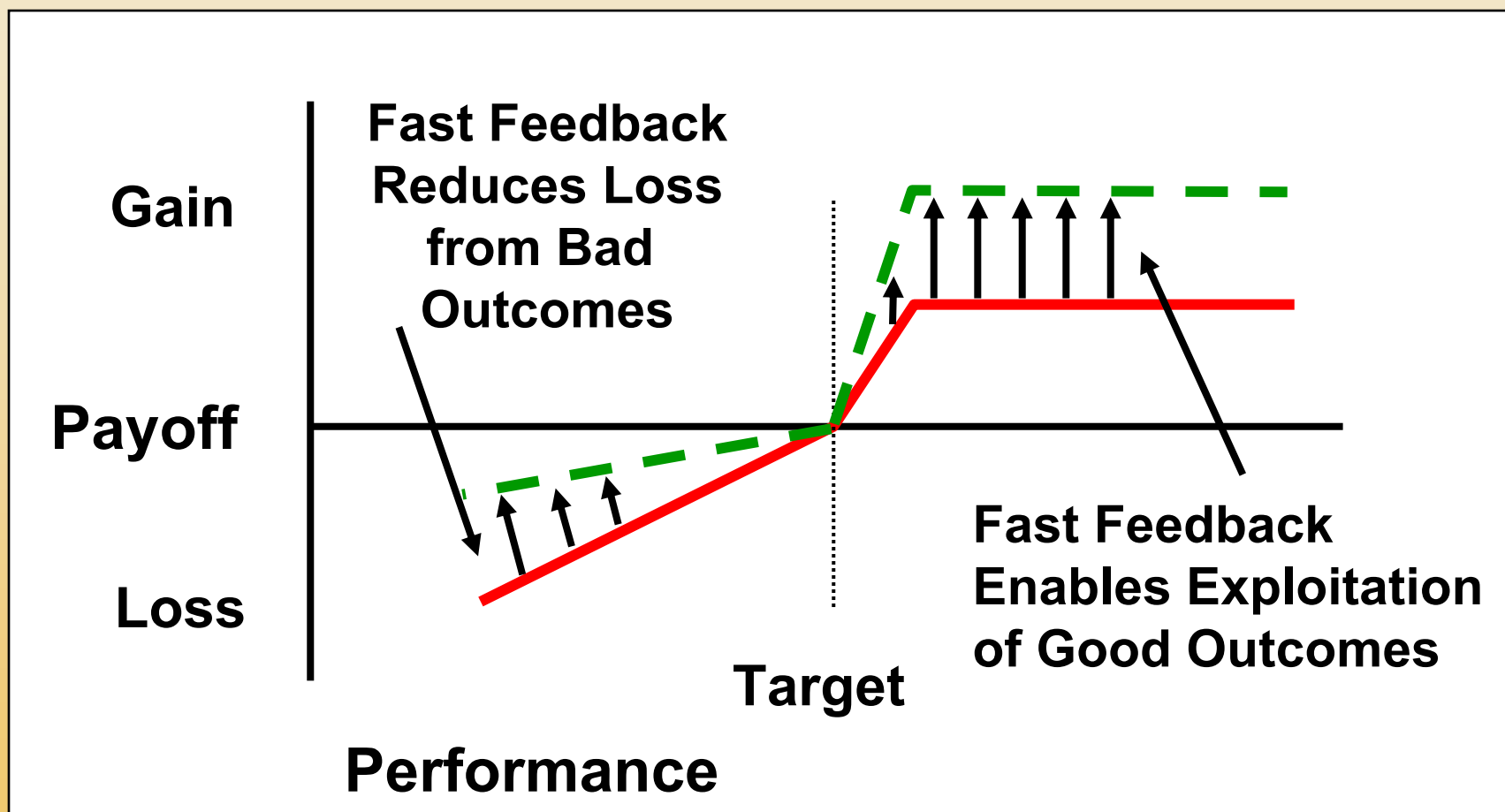
- A lottery ticket pays \$3000 to the winning three digit number.
- You can pick the numbers in two ways:
  - Pay \$3 to select all three digits at once.
  - Pay \$1 for the first digit, find out if it is correct, then choose if you wish to pay \$1 for the second digit, and then choose if you wish to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

# Who Does This?

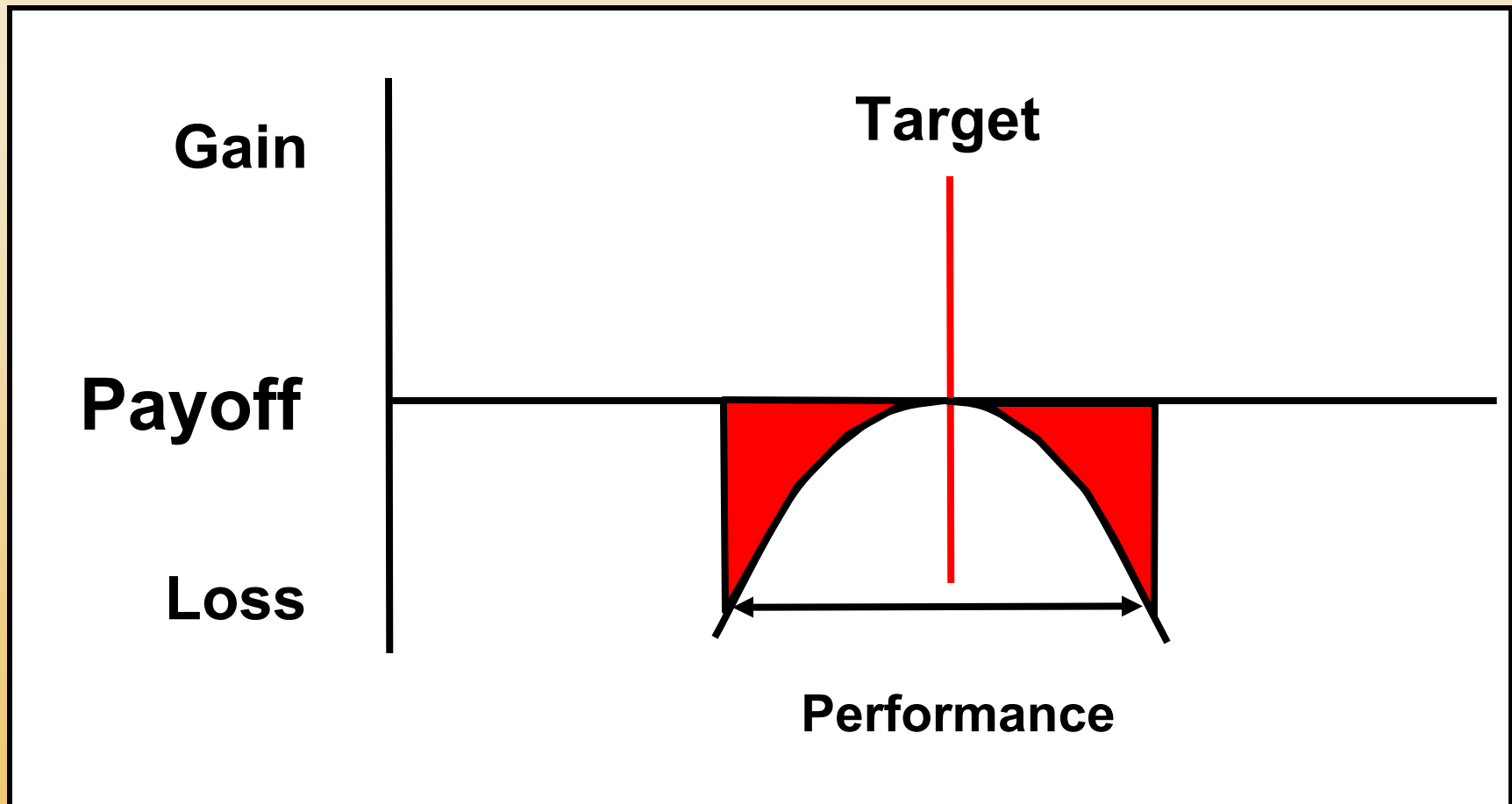
- **This is what modern military doctrine is about.**
  - **Minimize downside by bypassing obstacles.**
  - **Amplify upside by exploiting opportunities.**
  - **(НАПРИМЕР СПЕЦИАЛЬНОГО НАЗНАЧЕНИЯ)**
- **Uncertainty favors the opponent that functions best in the presence of uncertainty.**

# Real Options and Lean

- **Batch size reduction creates low cost options for: sequencing, routing, termination. Options to invest more or less.**
- **This is like being able to change your bet on a horse race after it has started.**
- **Option theory shows the importance of creating such payoff asymmetries, which are ignored in Lean Manufacturing.**
- **But, not in Lean Start-ups.**



# Manufacturing Payoff-Function\*



**Larger Variances Create Larger Losses**

**\*The Taguchi Loss Function**

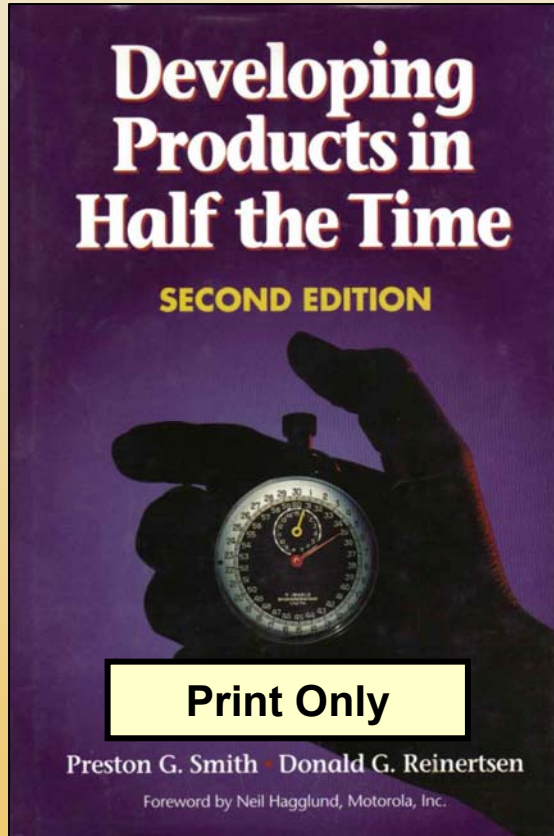
Copyright 2014, Reinertsen & Associates



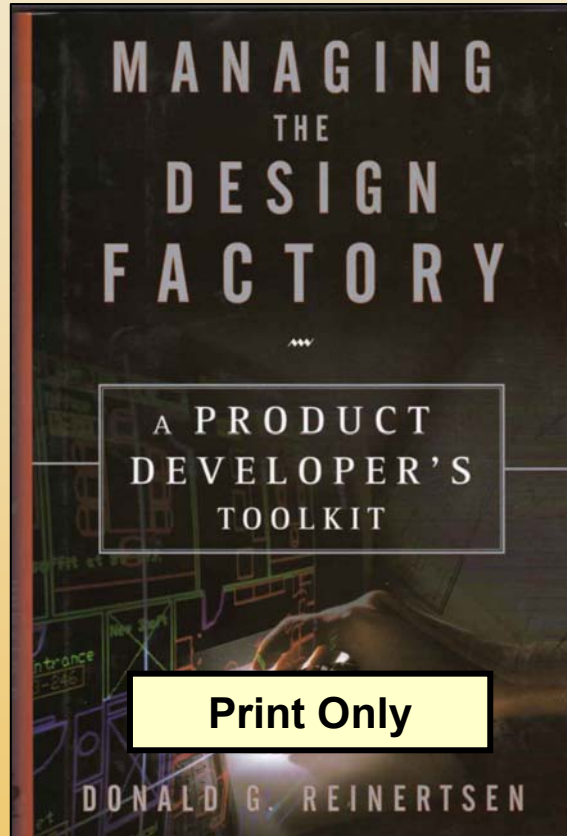
# A Few Take-Aways

- 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.**

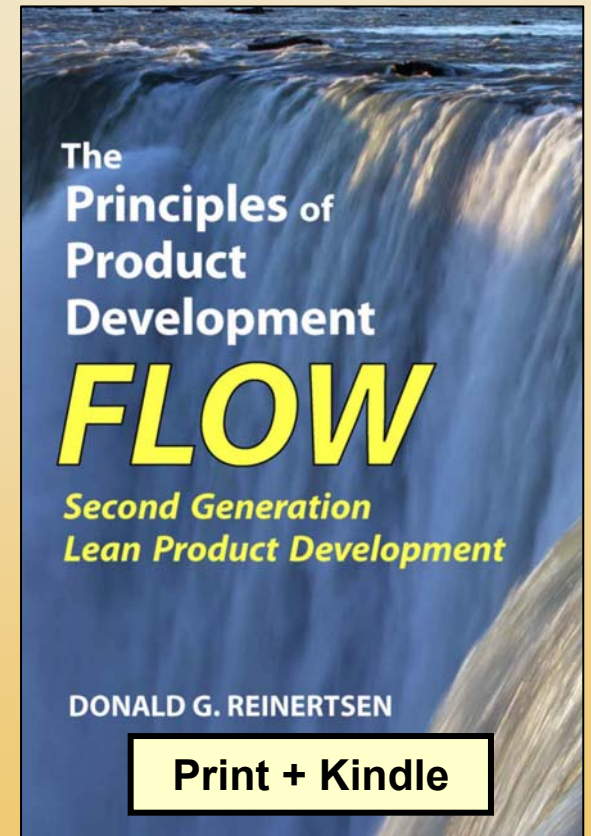
# Going Further



1991 / 1997



1997



2009

