

Beyond Robustness: Thriving on Uncertainty

**GOTO Chicago 2013
Chicago, IL
April 23, 2013**

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

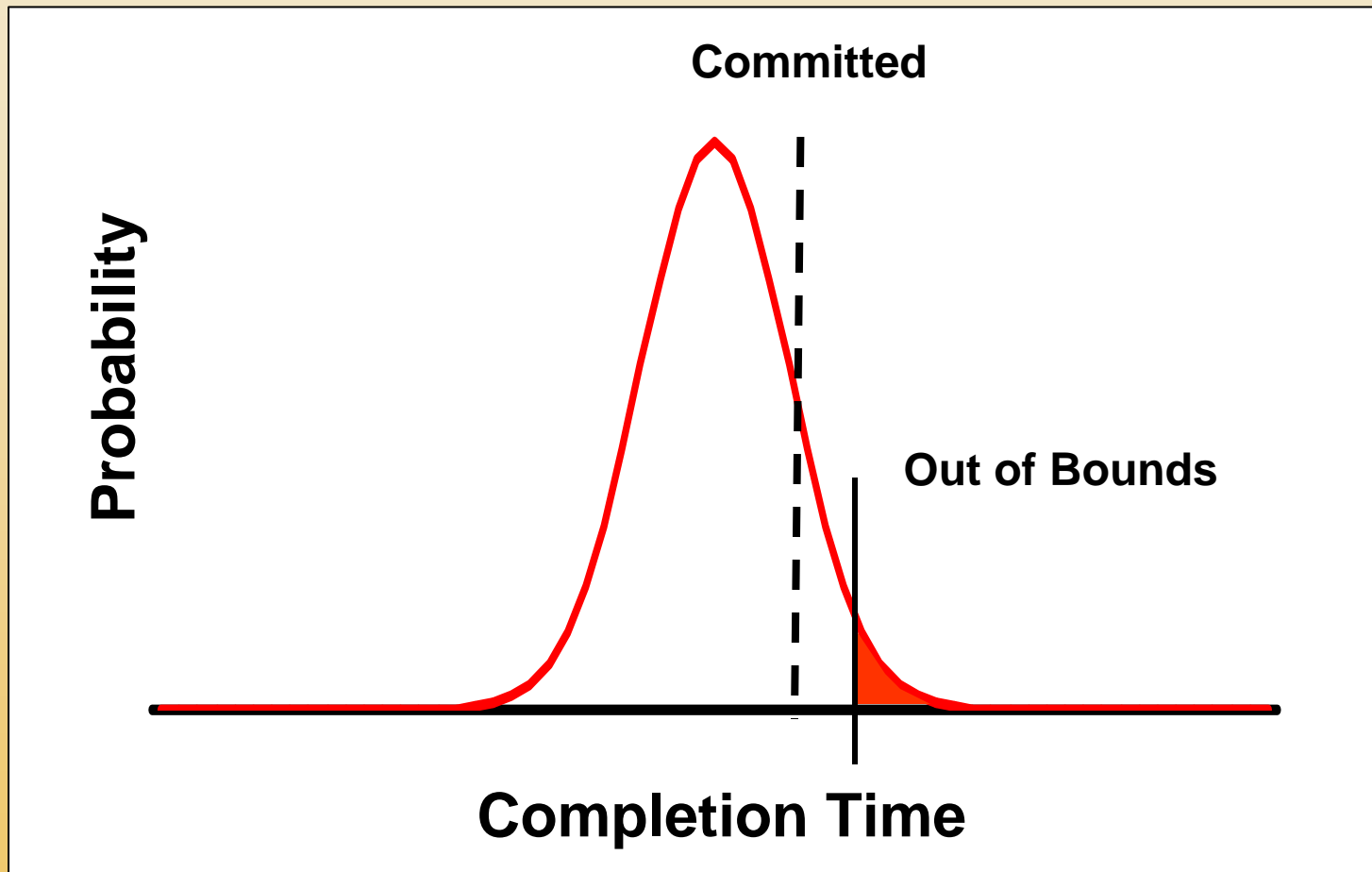
**Donald G. Reinertsen
Reinertsen & Associates
600 Via Monte D'Oro
Redondo Beach, CA 90277 U.S.A.
(310)-373-5332
Internet: Don@ReinertsenAssociates.com
Twitter: [@dreinertsen](https://twitter.com/dreinertsen)
www.ReinertsenAssociates.com**

Variability is BAD

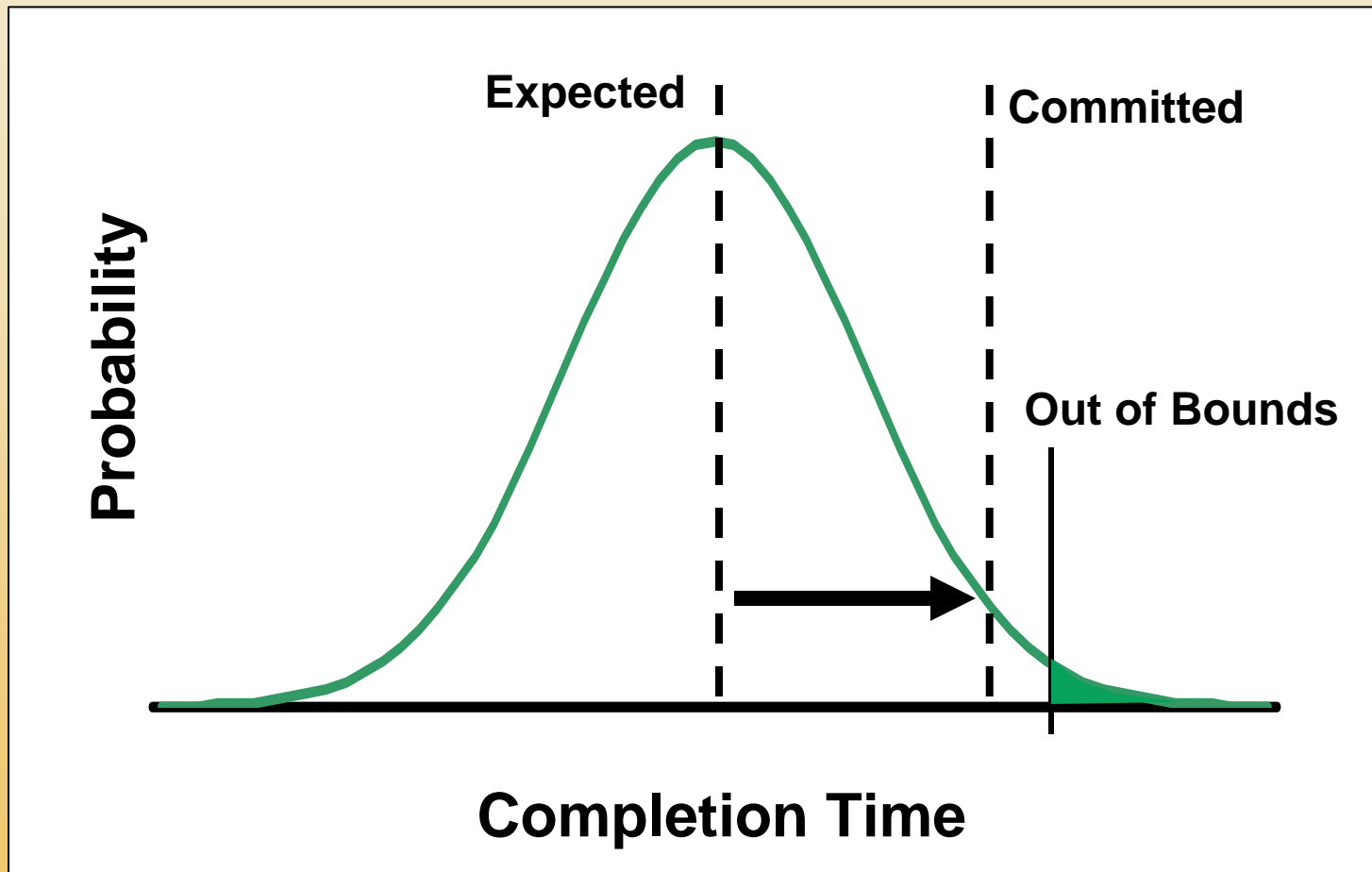
We Should Minimize Variability

- **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 committing to conservative achievement by:**
 - **Under-commitment on performance**
 - **Padded schedules**
 - **Padded budgets**
- **Are such choices in our economic interest?**

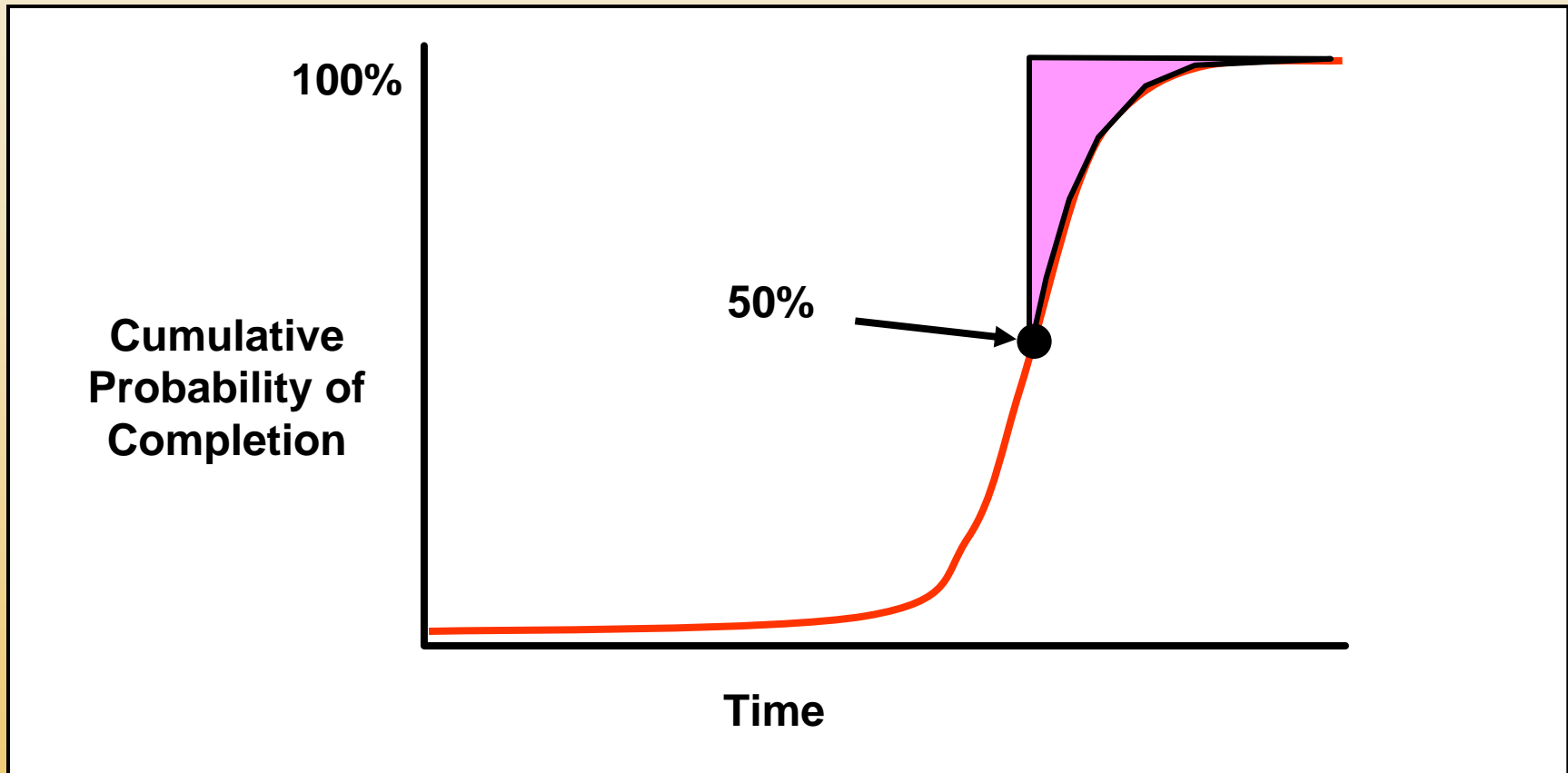
Make the Tail Small



Hide the Variability with a Buffer



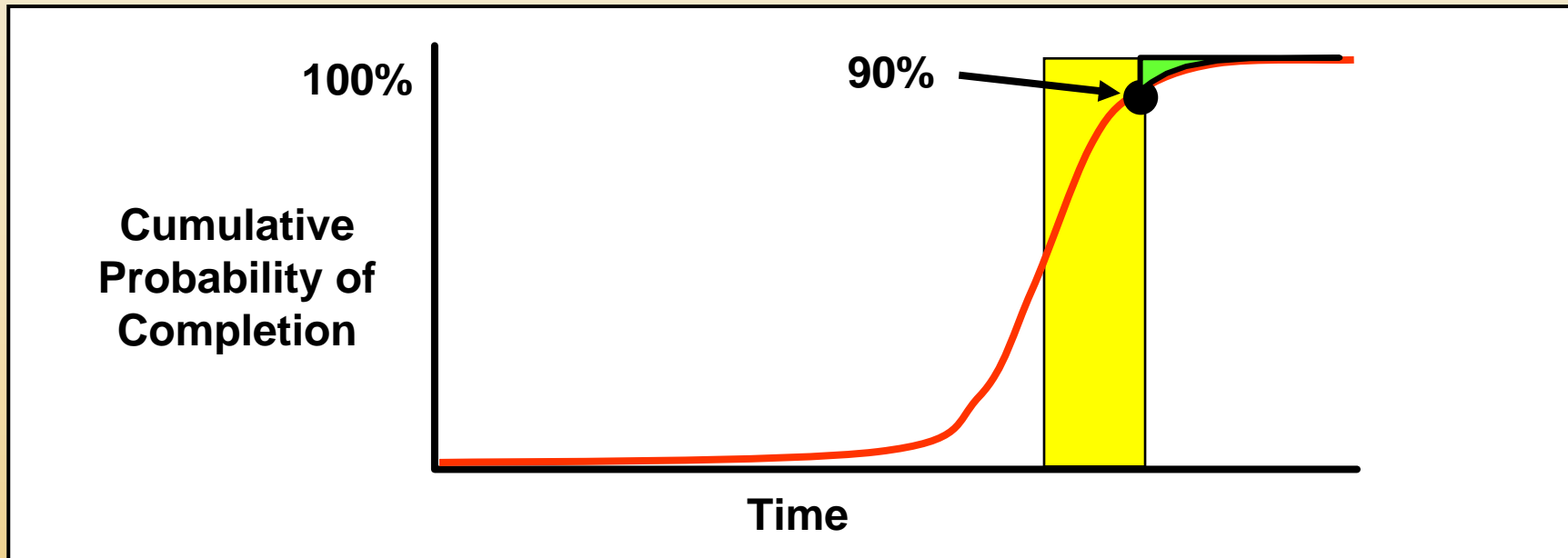
Without a Buffer



— 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.**

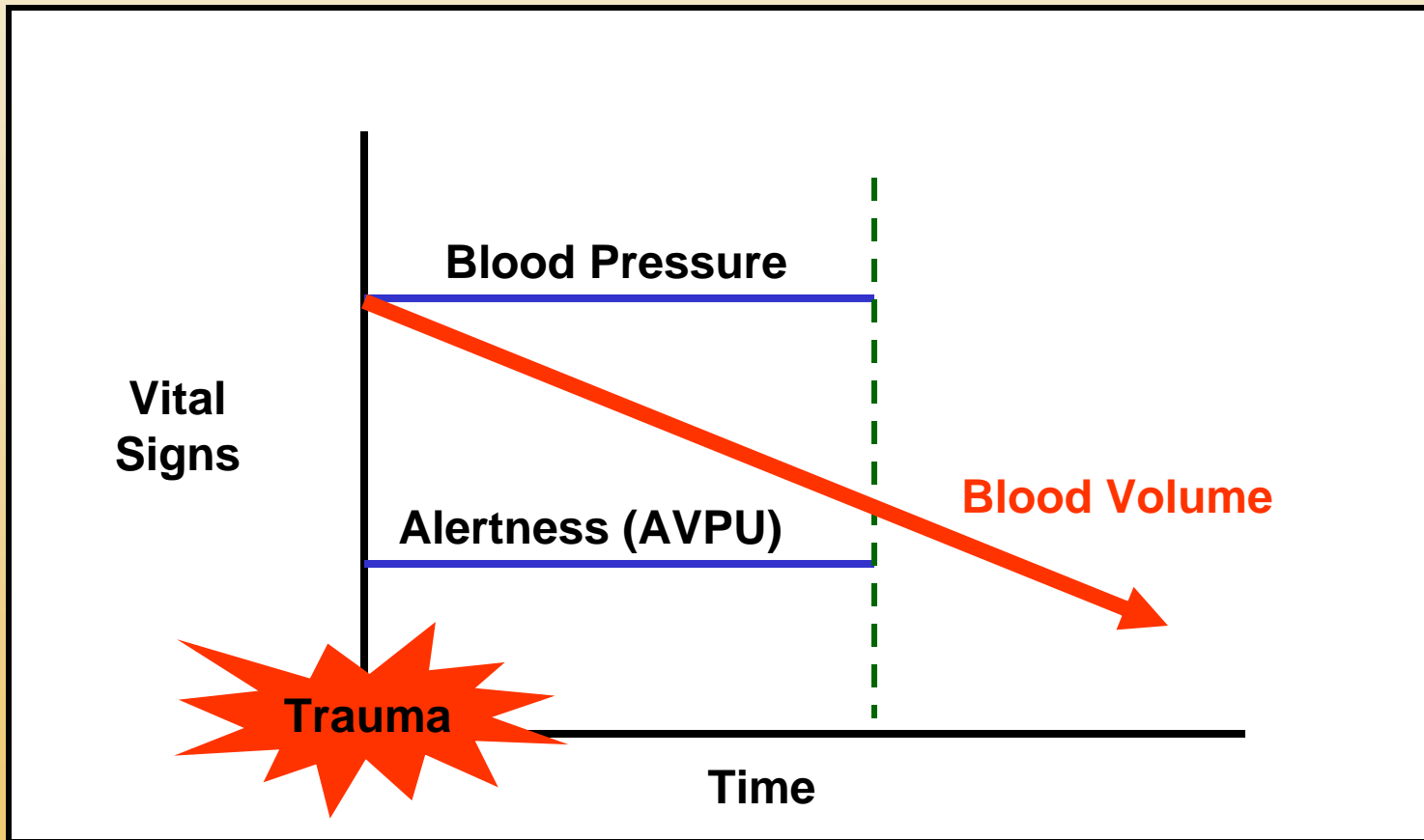
Active Robustness

- **We use active feedback loops to maintain system conditions.**
- **This achieves homeostasis, but it can mask the deterioration of the system.**
- **Masking deterioration leads us to assume that perturbations are doing no harm.**
- **We learn 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 perfusion to critical organs like the brain.**
- **If shock progresses without resuscitation it can become decompensating.**
- **At this point, the outcome can be death.**

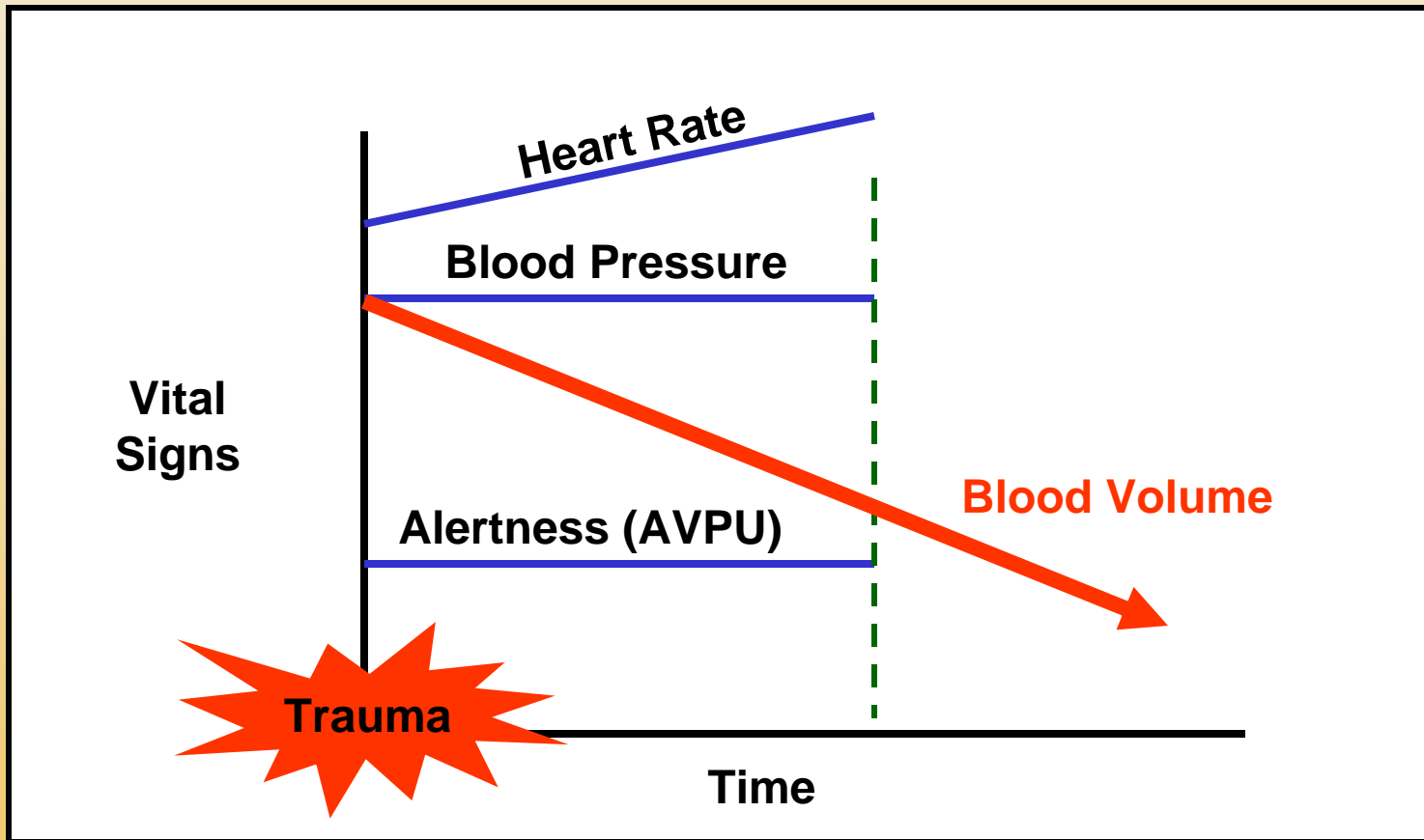
Hypovolemic Shock



Compensated Shock

- **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.**

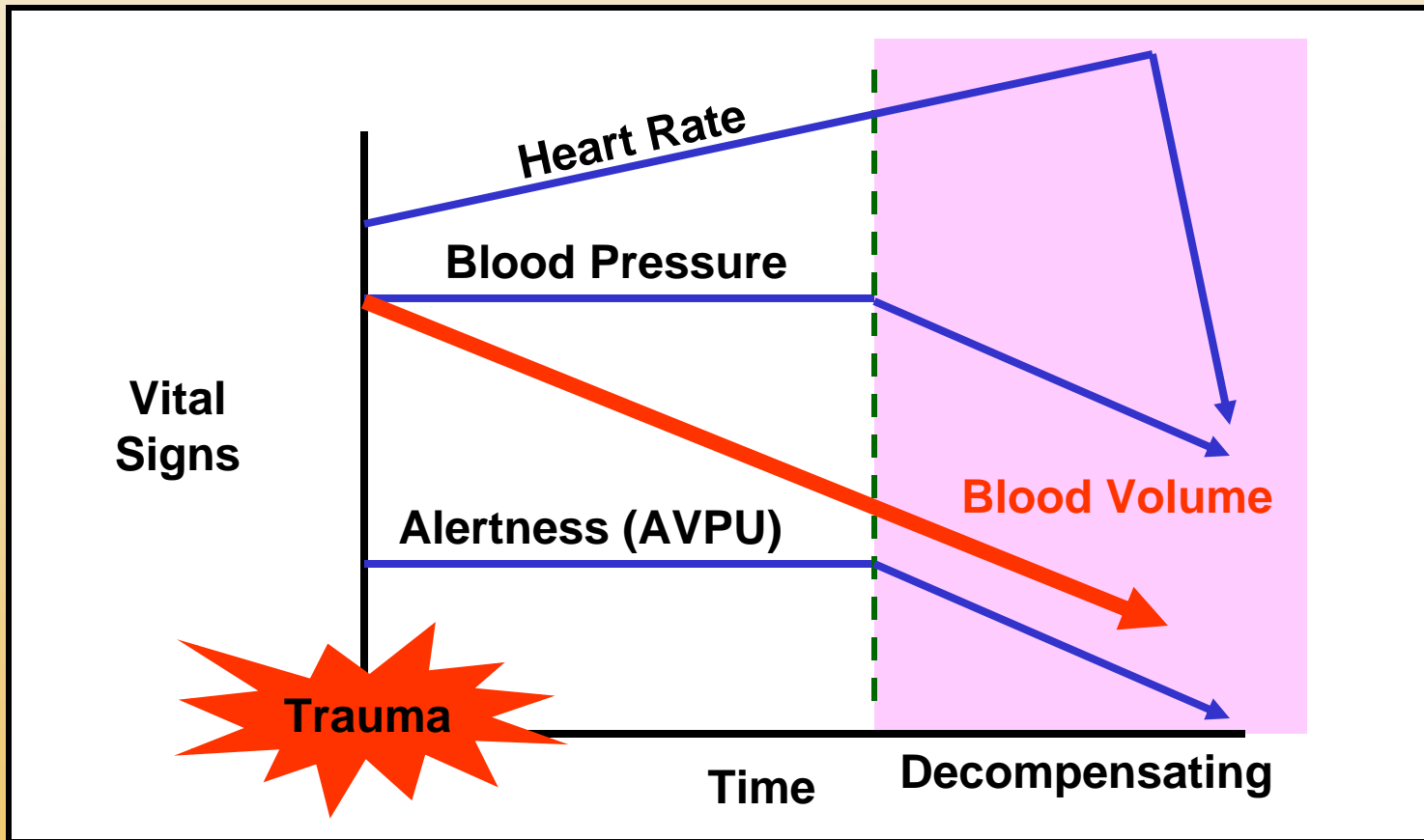
Hypovolemic Shock



Uncompensated Shock

- **Body is no longer able to maintain 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

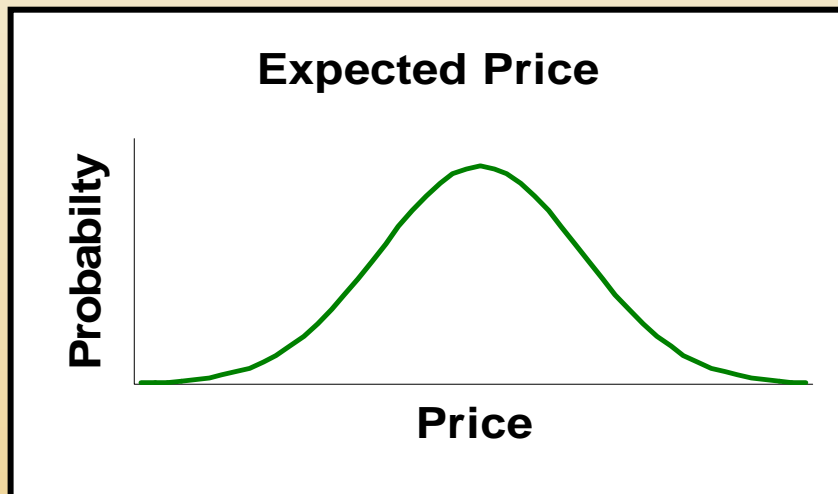


Overcoming Masking Effects

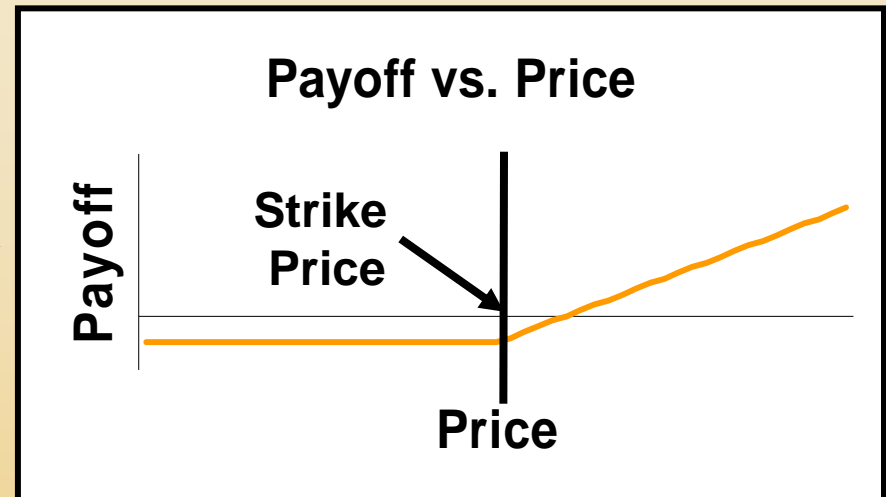
- **There are always indicators of deteriorating margin.**
- **Under normal circumstances these indicators convey no useful information.**
- **They produce weak signals.**
- **We need to monitor these indicators of margin in addition to our indicators of performance.**

Another Viewpoint

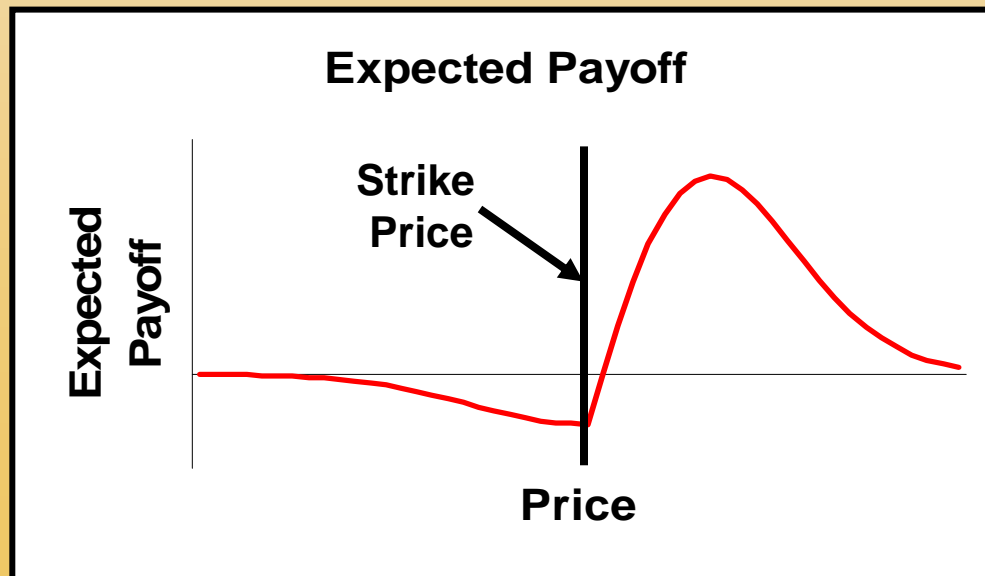
Asymmetric Payoffs and Option Pricing



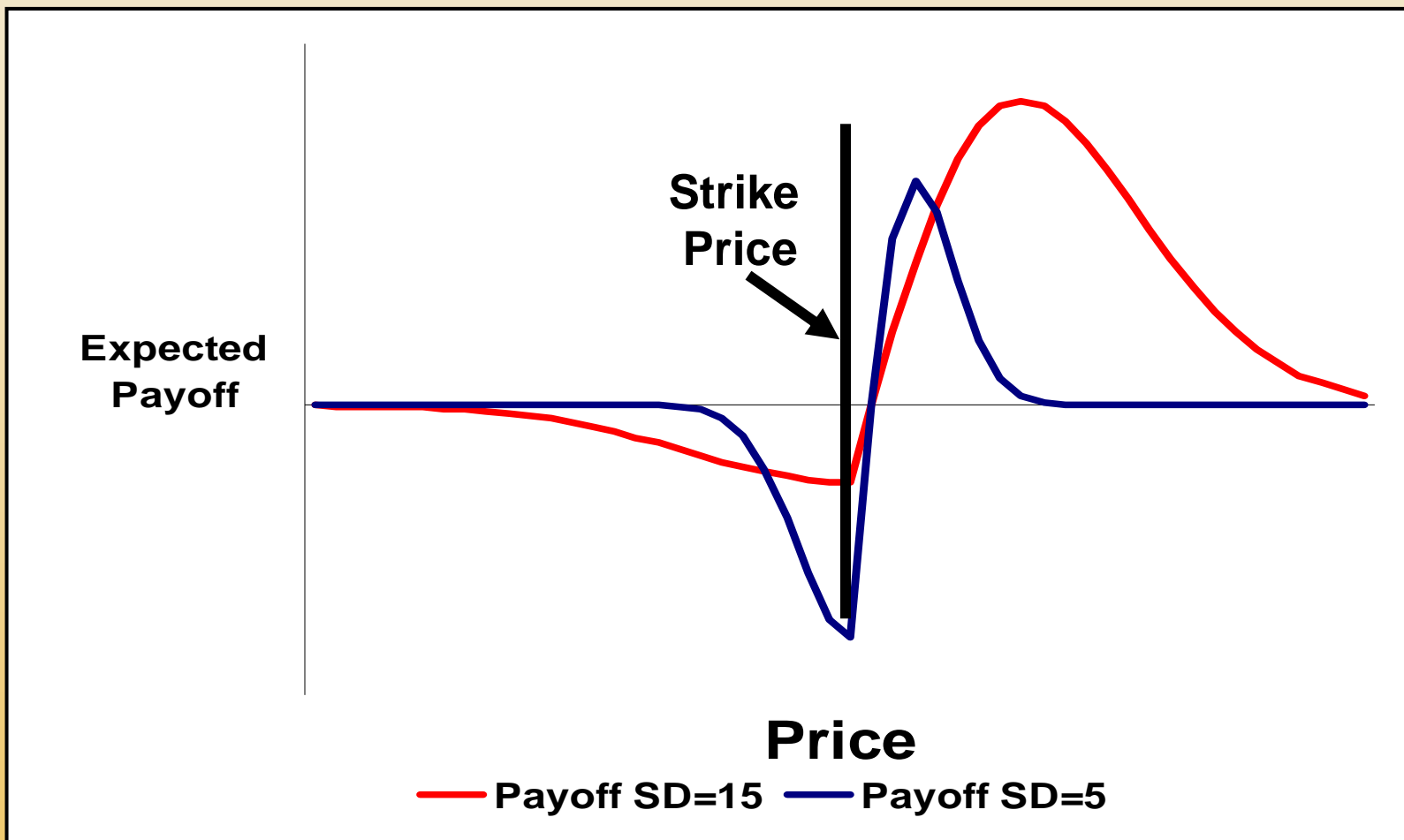
X



||

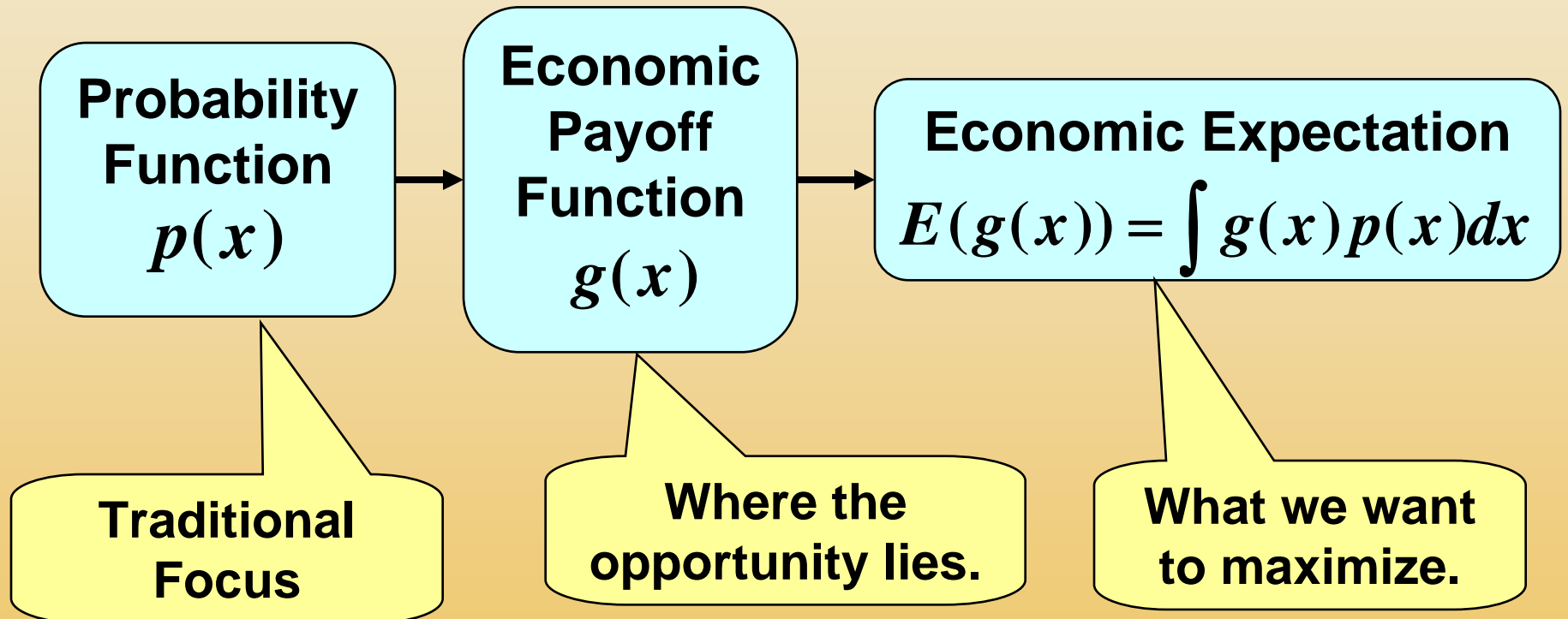


Higher Variability Raises This Payoff



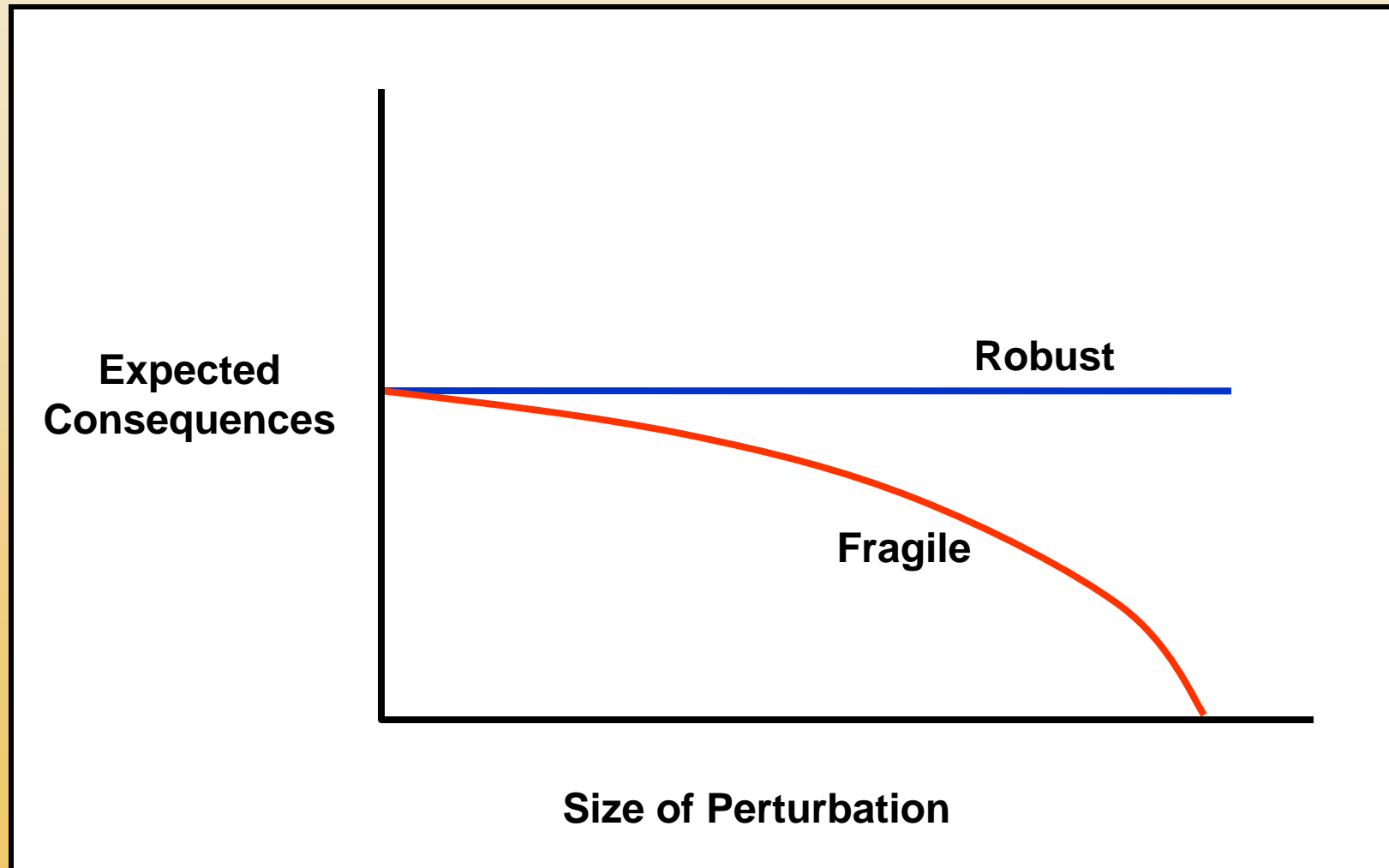
Option Price = 2, Strike Price = 50,
Mean Price = 50, Standard Deviation = 5 and 15

Making Good Economic Choices

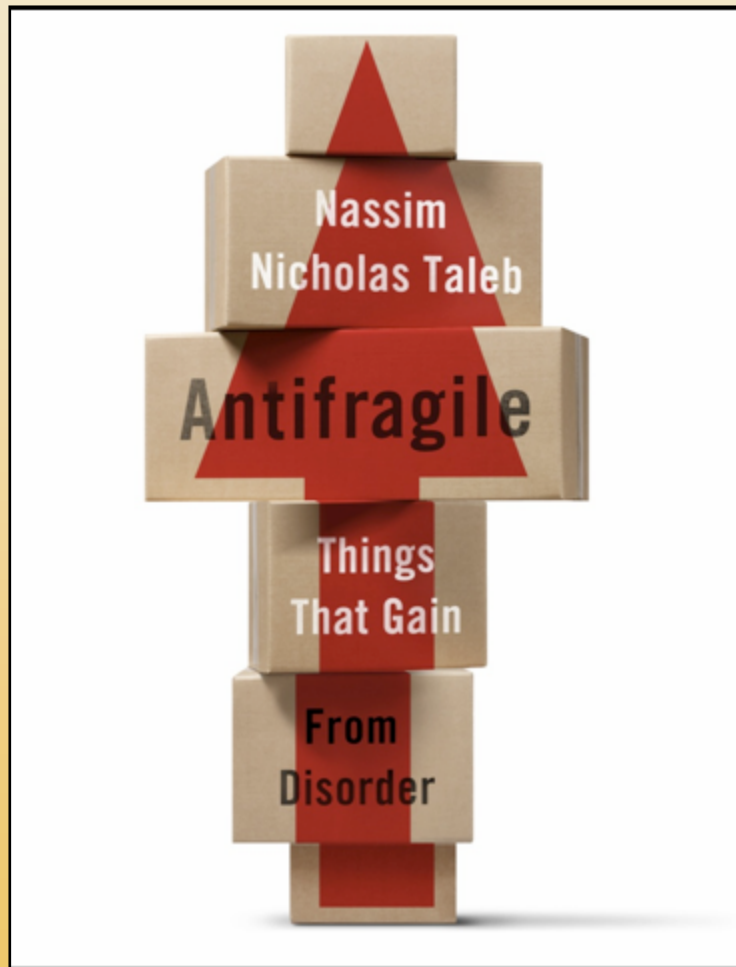


Fragile Systems

Fragility

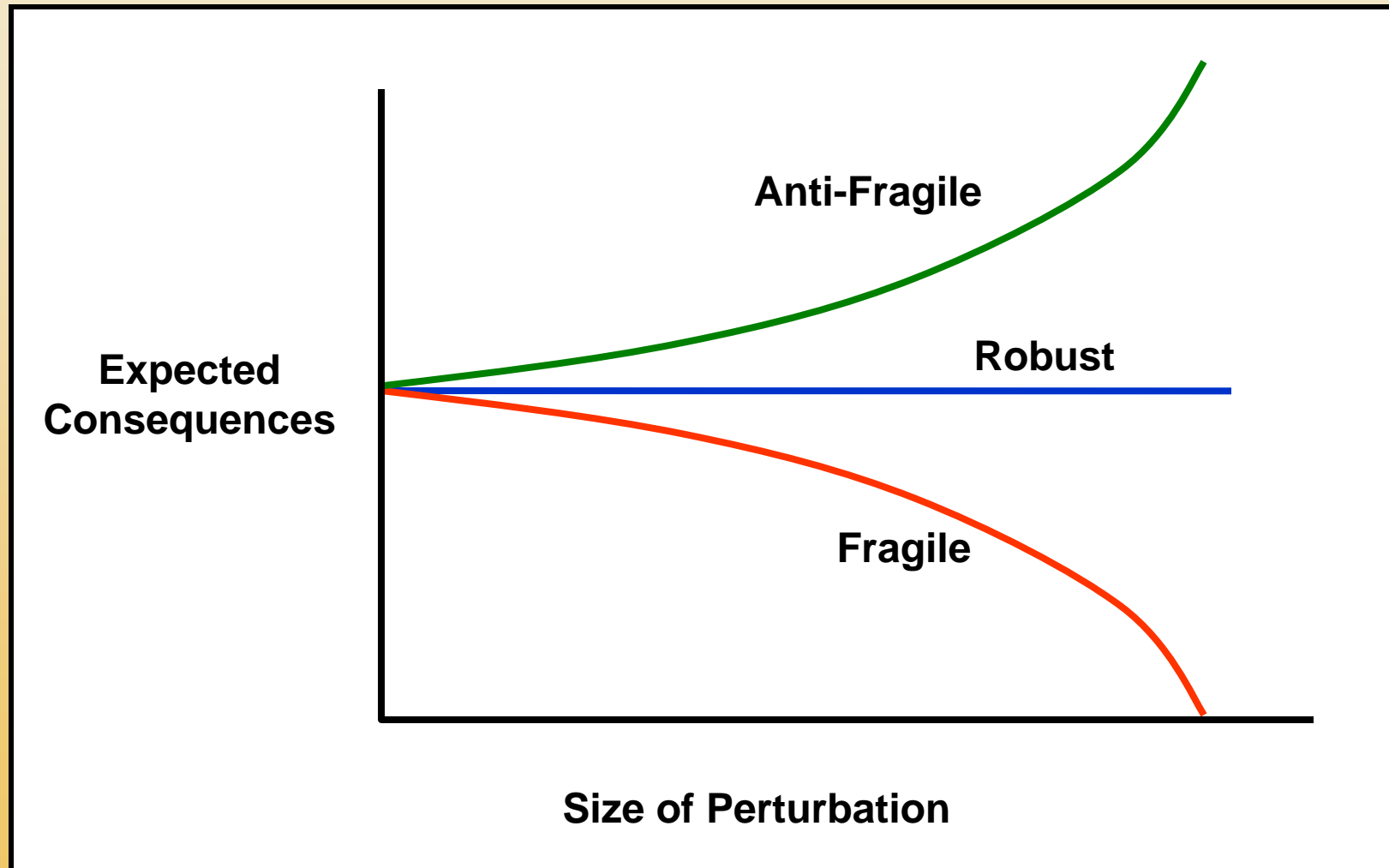


Nassim Taleb



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

Anti-Fragility

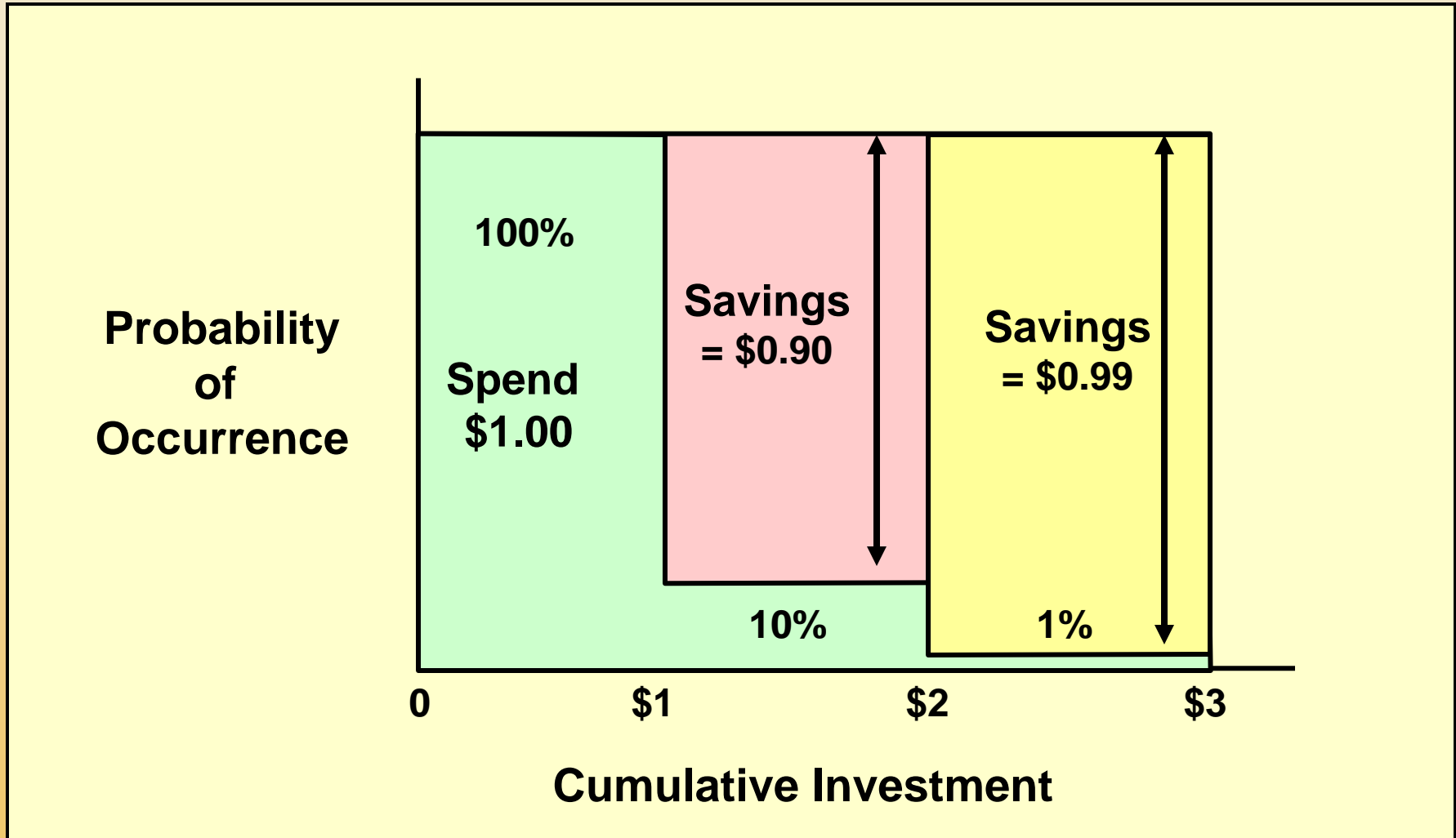


Fast Feedback

The Front-Loaded Lottery

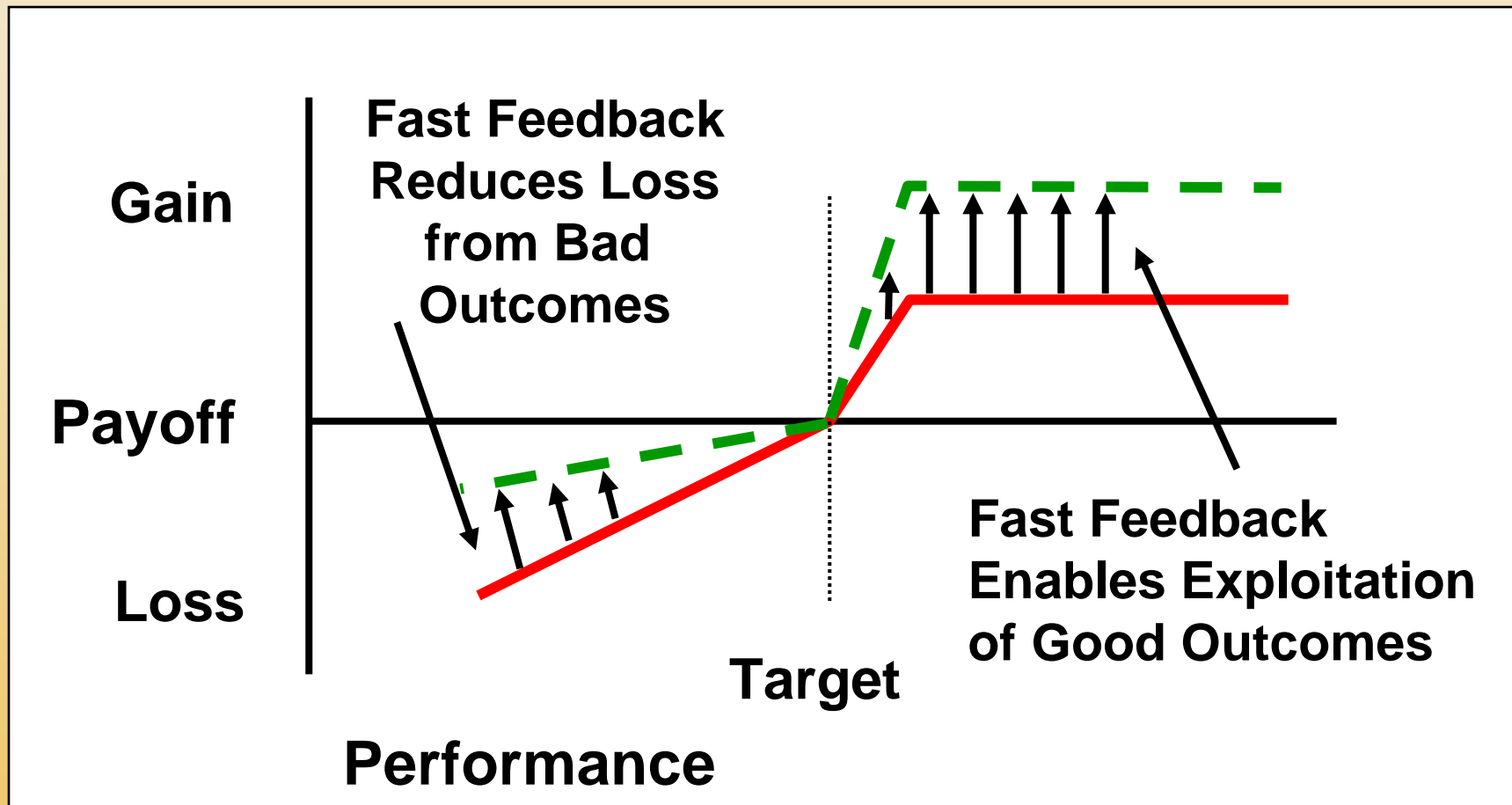
- A lottery ticket pays \$3000 to the winning three digit number.
- You can pick the numbers in two ways:
 - Pay \$3 to select all three digits at once.
 - Pay \$1 for the first digit, find out if it is correct, then choose if you wish to pay \$1 for the second digit, and then choose if you wish to pay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

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 downside of bad outcomes.**
 - **Amplify upside of good outcomes.**
 - **...even outcomes 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.**
- **COL John Boyd's OODA Loop.**
- **Uncertainty favors the side that functions best in the presence of uncertainty.**

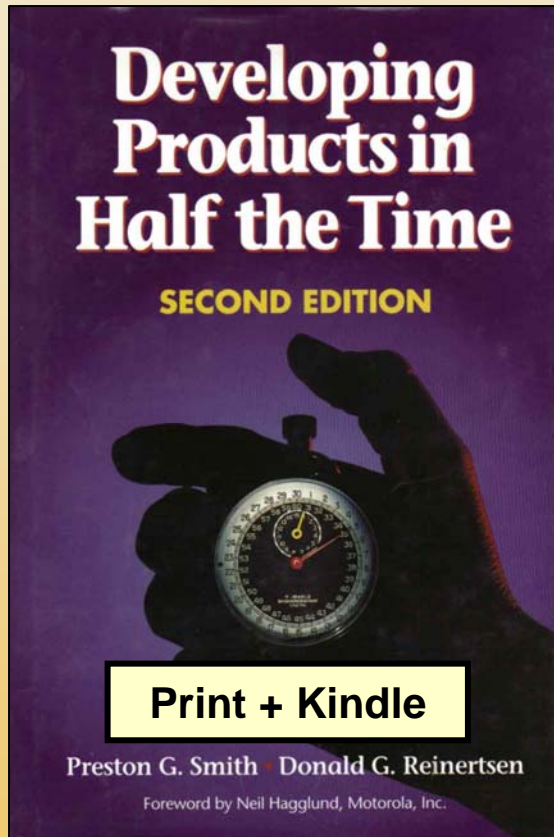
Real Options and Lean

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

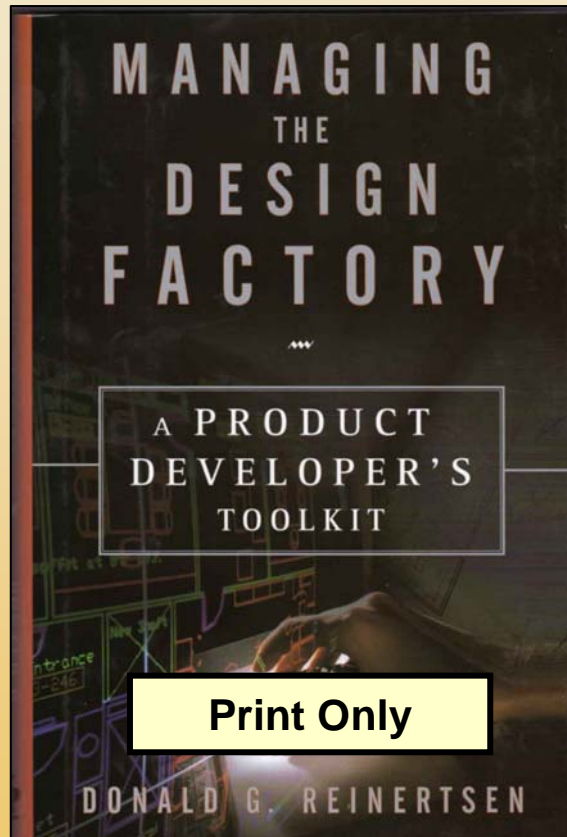
A Few Take-Aways

- 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.**

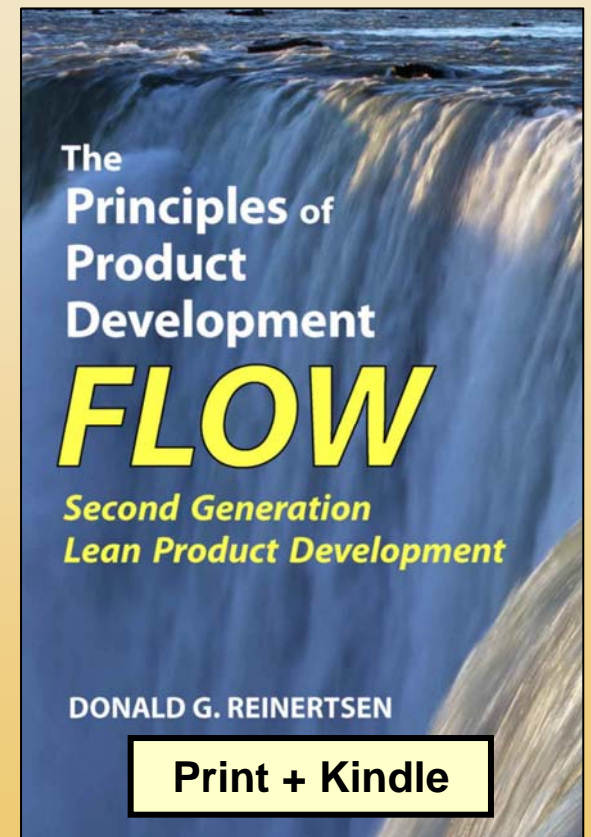
Going Further



1991 / 1997



1997



2009

