

Understanding the Magic of Lean Product Development

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**Any sufficiently advanced technology
is indistinguishable from magic.**

– Arthur C. Clarke

Lean Manufacturing

- **Lean Manufacturing is a best practice.**
- **Best practices lead to superior performance.**
- **Why not adopt these best practices in product development?**

The TPS Emergency Room

- **We desire to rigorously imitate the practices of Toyota.**
- **All arriving patients will be processed on a FIFO basis.**
- **We will stop admitting work when we reach our preset WIP limit.**



Thus, since the Toyota Production System has been created from actual practices in the factories of Toyota, it has a strong feature of emphasizing practical effects, and actual practice and implementation over theoretical analysis.

– Taiichi Ohno

From Foreword to 1983 First Edition of *Toyota Production System* by Yasuhiro Monden,

Turning Magic into Technology

Use Some Ideas of
Lean Manufacturing

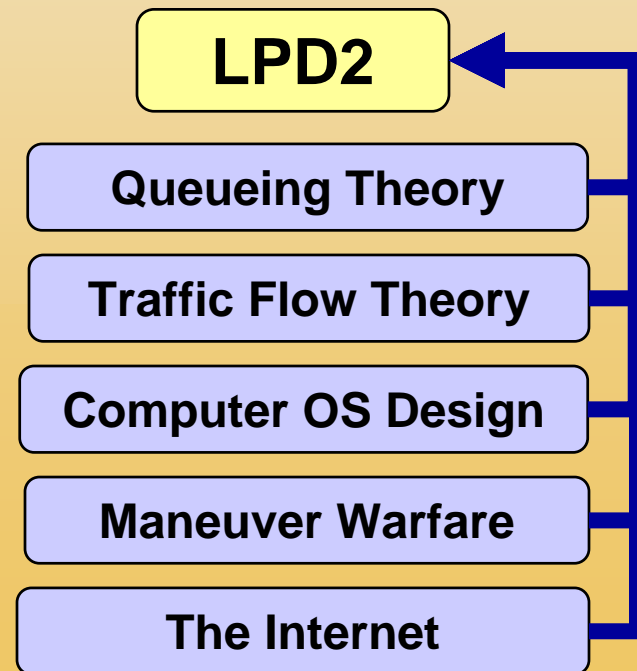
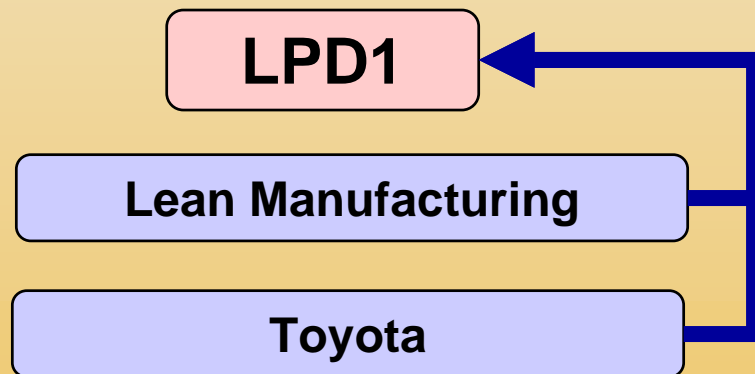
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Add Concepts and Science
from other Domains

DOMAIN

- Repetitive Tasks
- Low Variability
- Homogenous Flows

- Non-Repetitive Tasks
- High Variability
- Non-Homogenous Flows



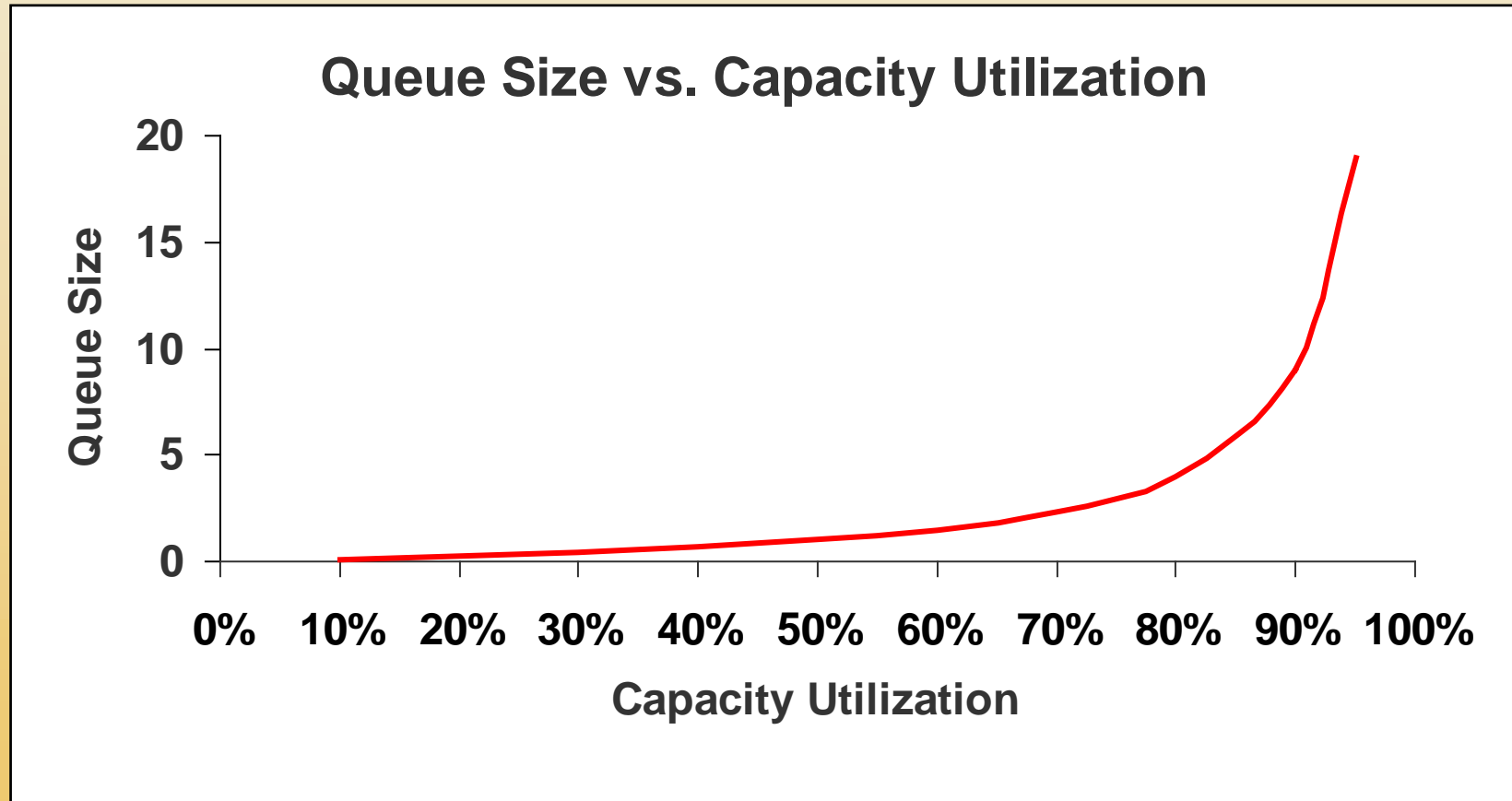
Queueing Theory

Traffic at rush hour illustrates the classic characteristics of a queueing system.

Photo Copyright 2000 Comstock, Inc.

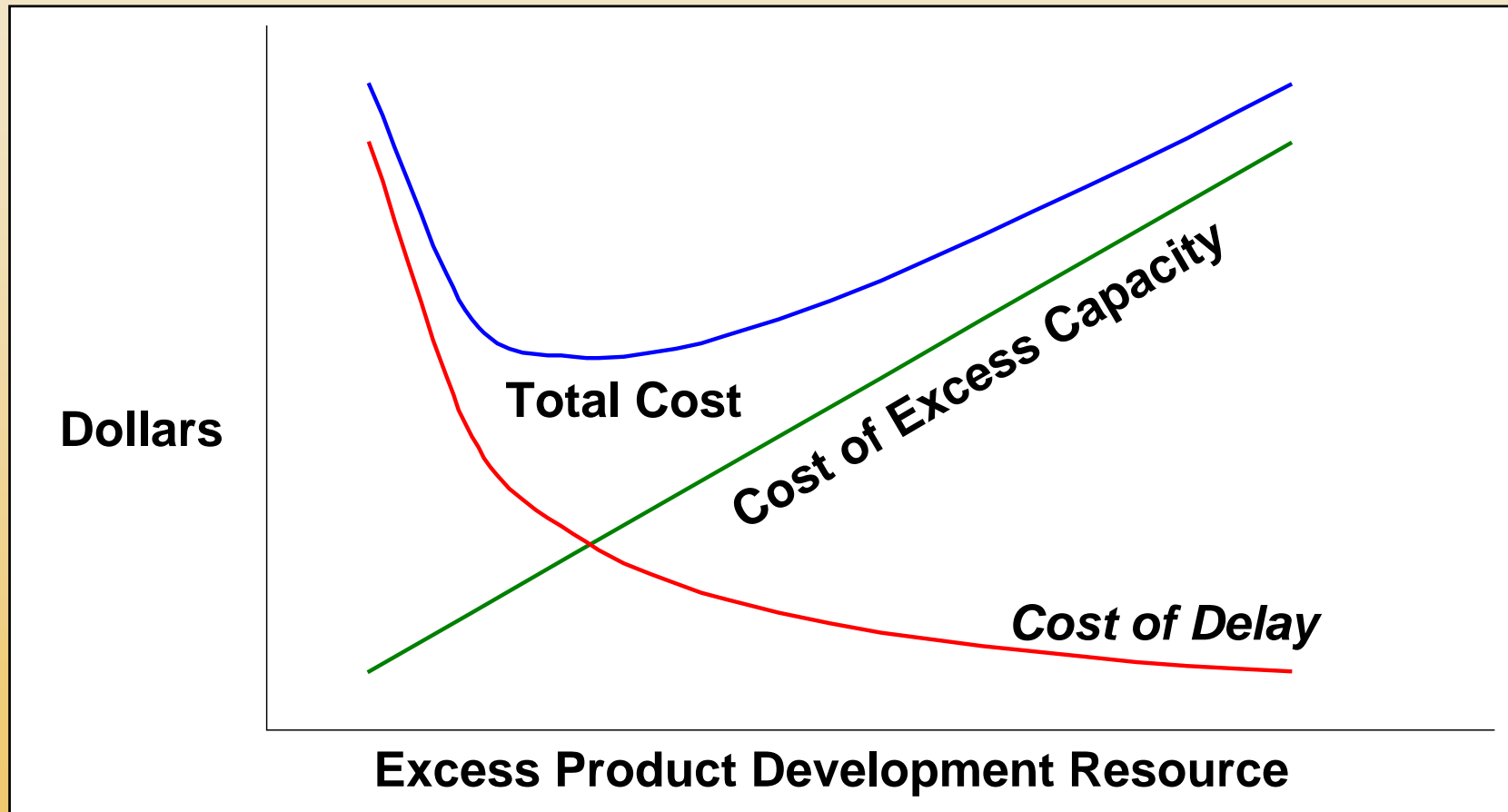


The Effect of Capacity Utilization



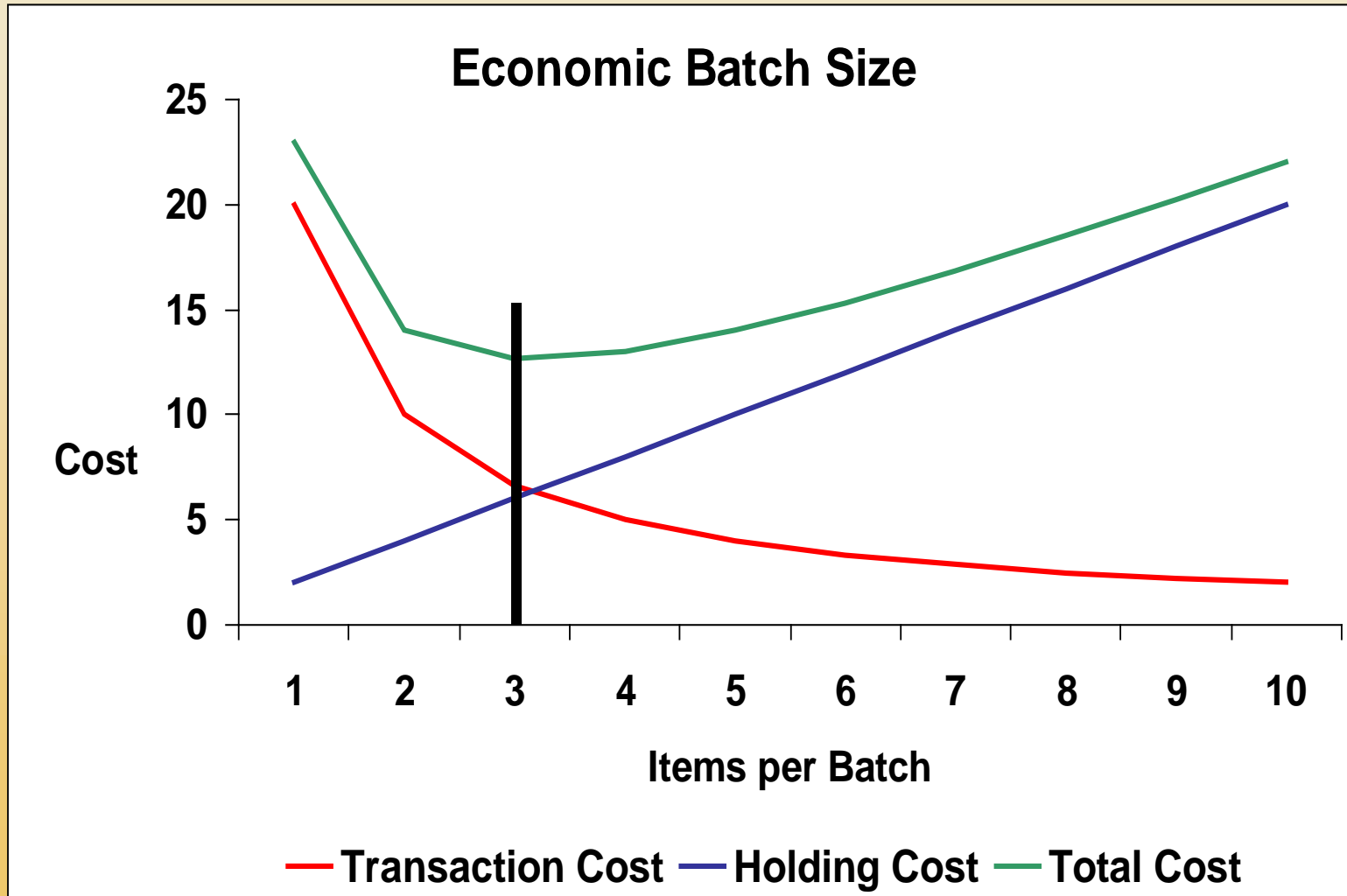
Note: Assumes M/M/1/Infinite Queue

Economics of Queues

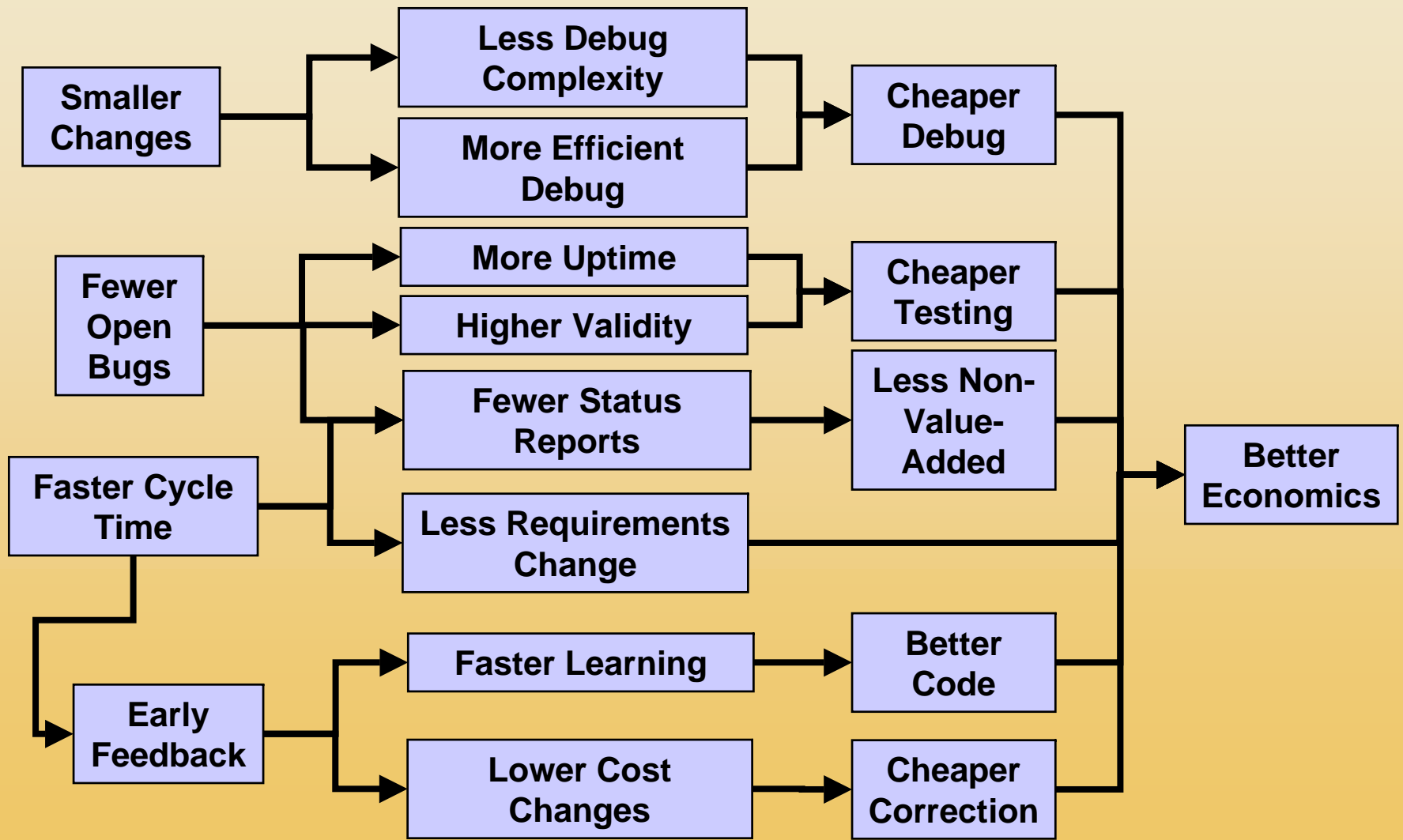


Batch Size

Setting Batch Size



Benefits of Small Batch Testing



WIP Constraints

Little's Famous Formula

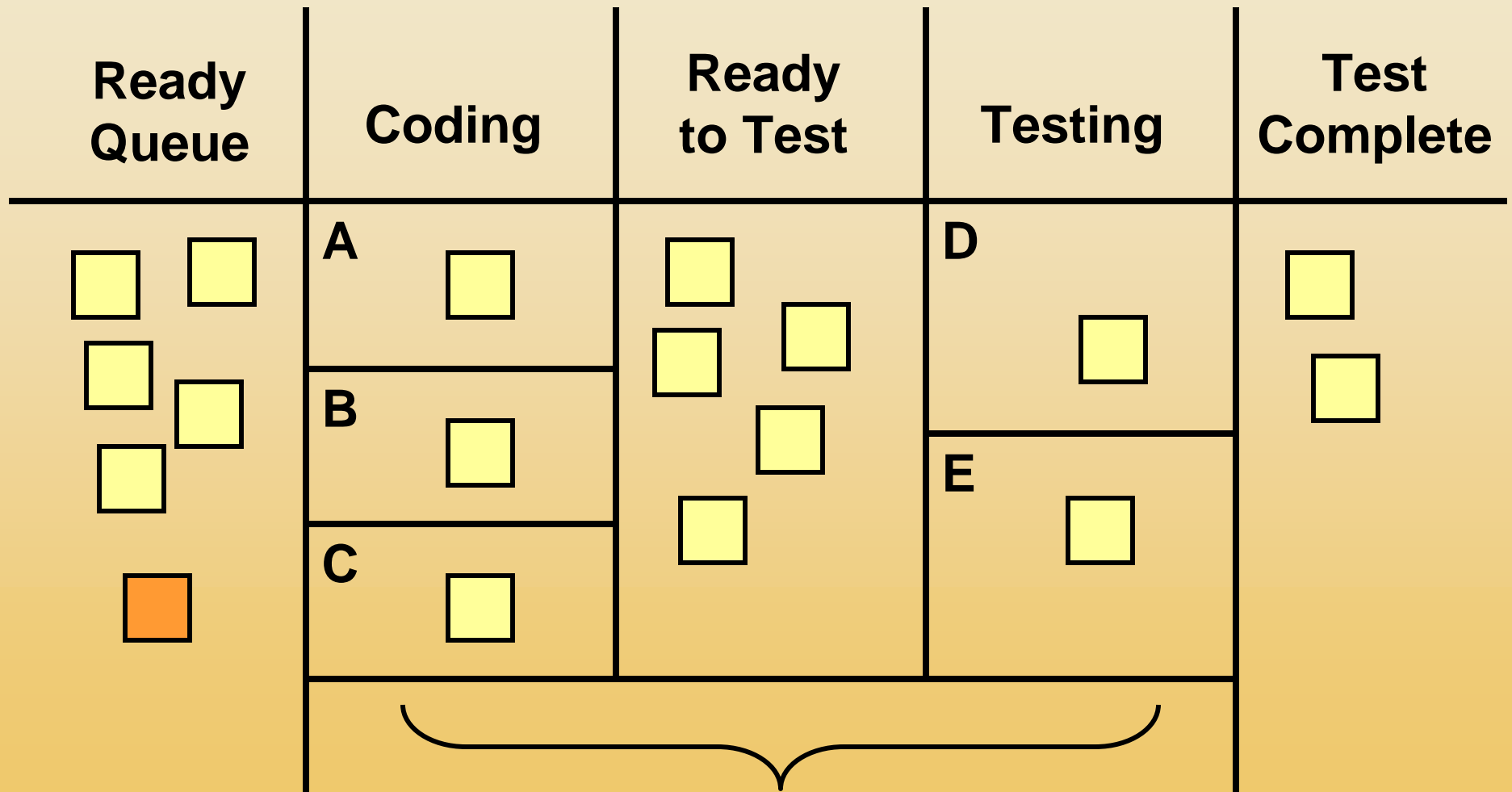
$$W_q = \frac{L_q}{\lambda}$$

Average Wait Time in Queue = W_q

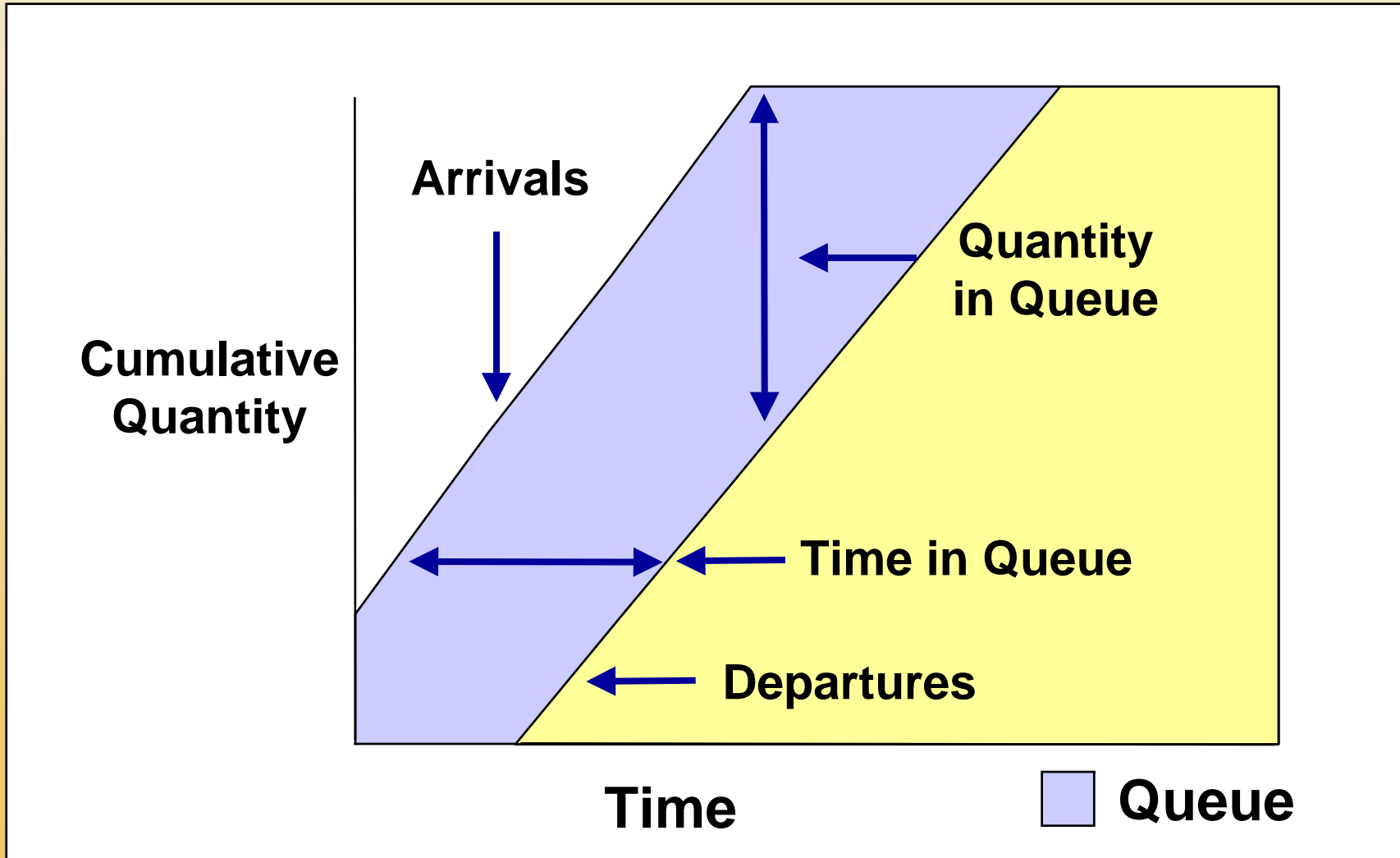
Average Number of Customers in Queue = L_q

Average Departure Rate = λ

Visual WIP Boards



Cumulative Flow Diagram



Synchronized Cadence

Cadenced Purchasing Availability

BEFORE

- One buyer will support you with 10 percent of his time.

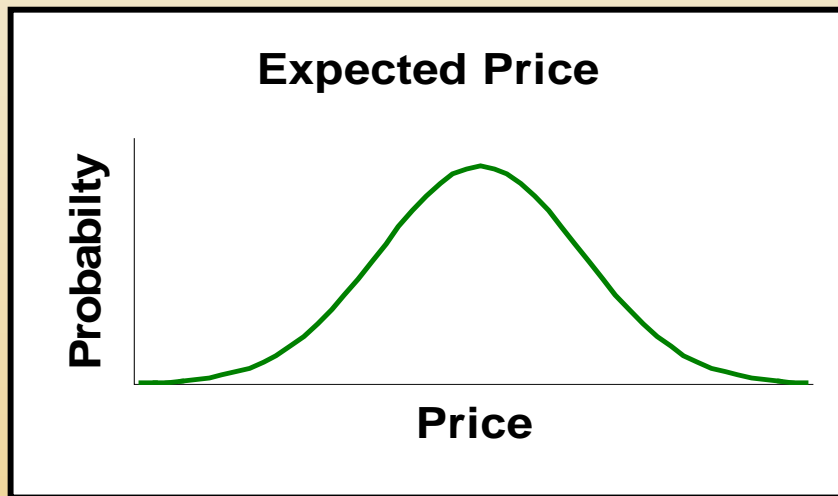
AFTER

- Buyer will be at desk in team area from 8:00 AM to 9:00 AM daily.
- During this period his highest priority is supporting your project.

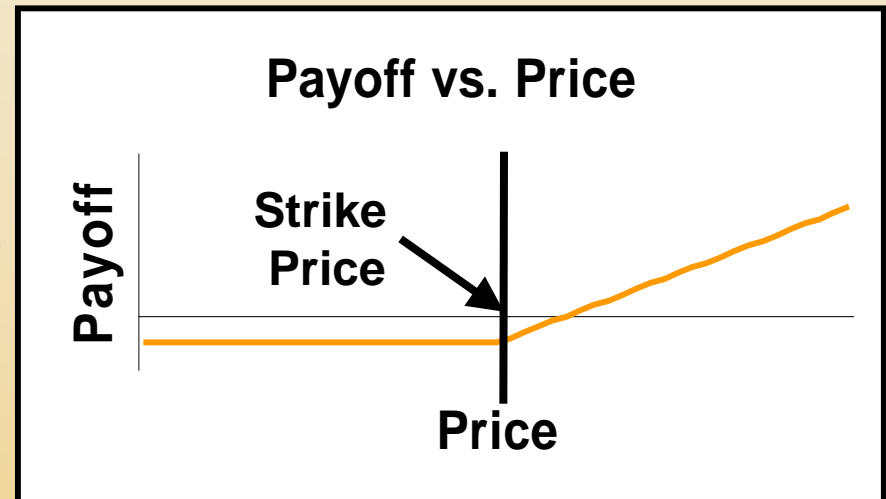
Cadence Establishes an Upper Bound on Waiting Time

Variability

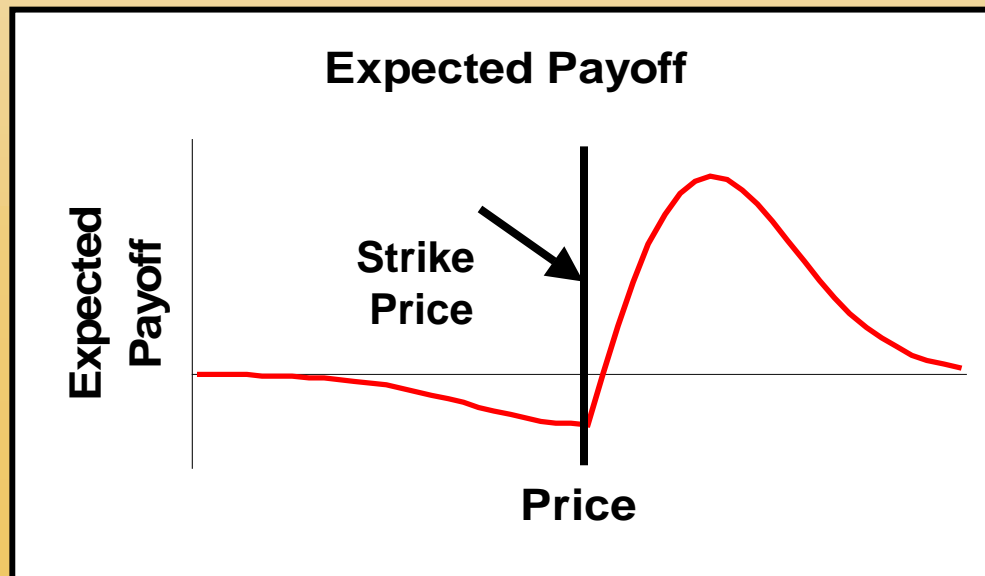
Asymmetric Payoffs and Option Pricing



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Sequencing

Queueing Disciplines

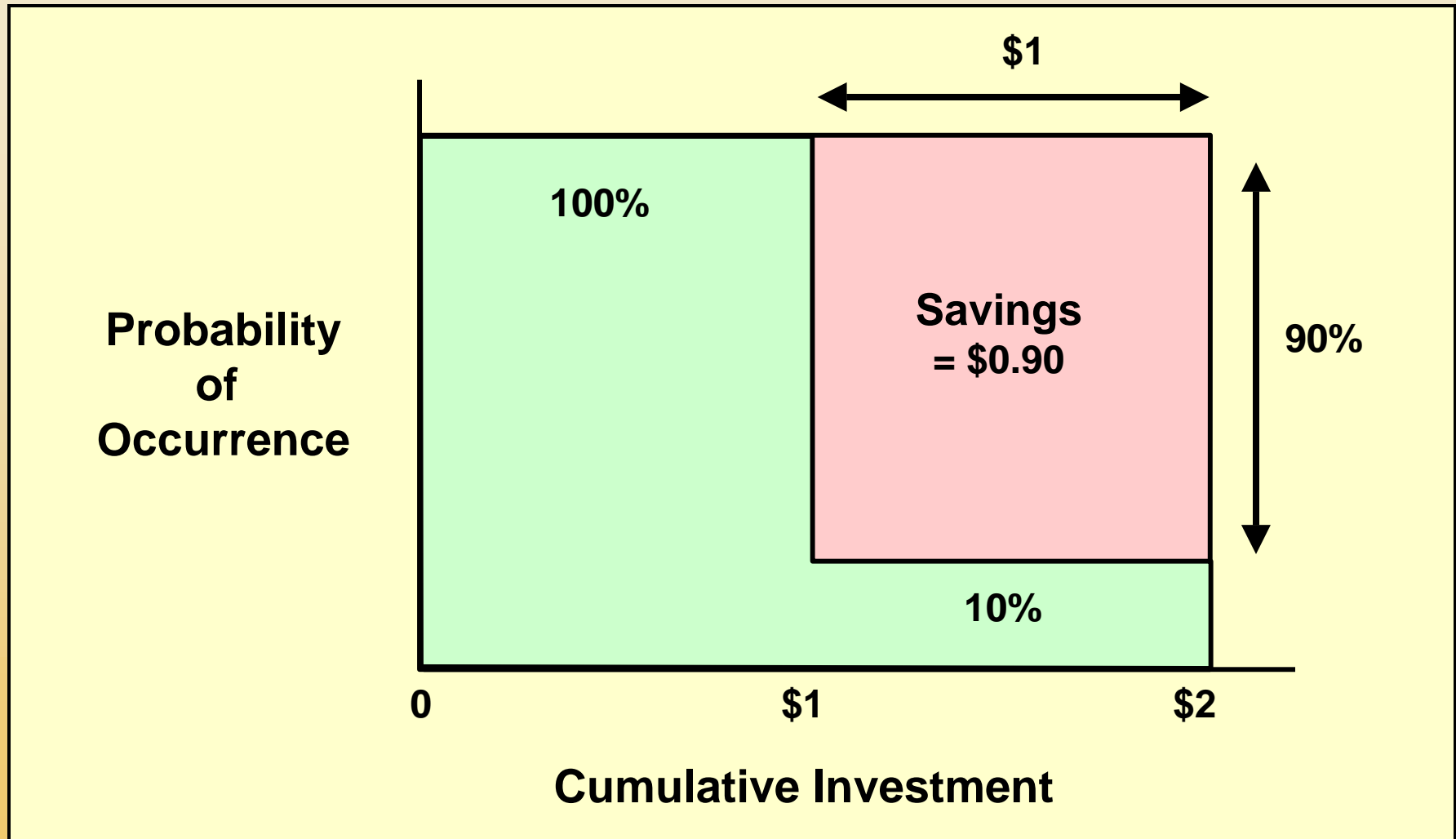
- **FIFO**
- **Highest Profit (or ROI/IRR/EVA) First (HPF)**
- **SJF (FCFS)**
- **High Cost of Delay First (HDCF)**
- **Minimum Slack Time First (MSTF)**
- **Weighted Shortest Job First (WSJF)**

Fast Feedback

Two Lotteries

- A lottery ticket pays \$200 to the winning two digit number.
- You can pick the numbers in two ways:
 - Pay \$2 to select both digits at once.
 - Pay \$1 for the first digit, find out if it is correct, and then choose if you wish to pay \$1 for the next digit.

Value of Feedback



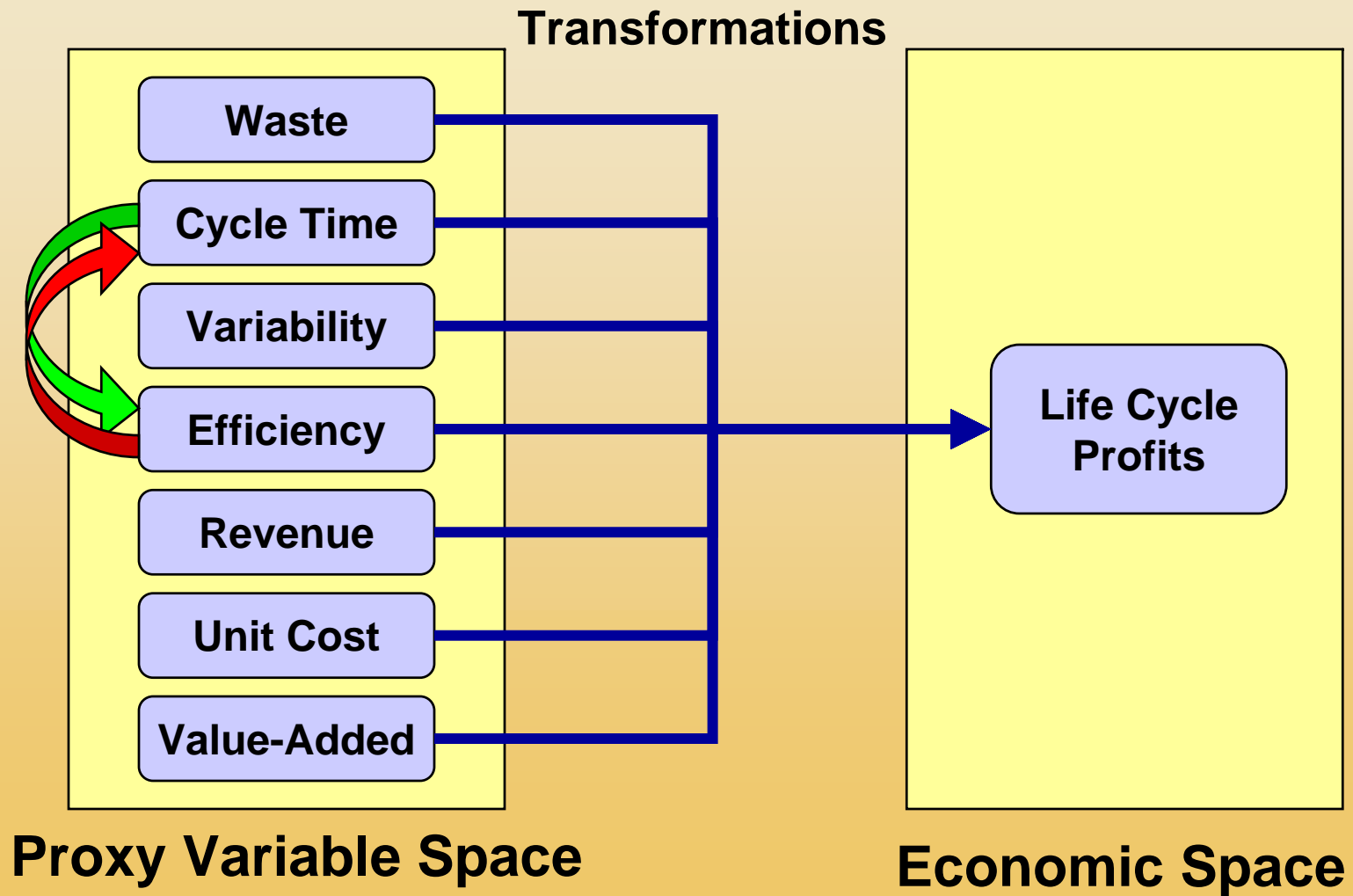
In this case, accelerated feedback is economically equivalent to raising either payoff, or success rate, by 45 percent.

The Importance of Math

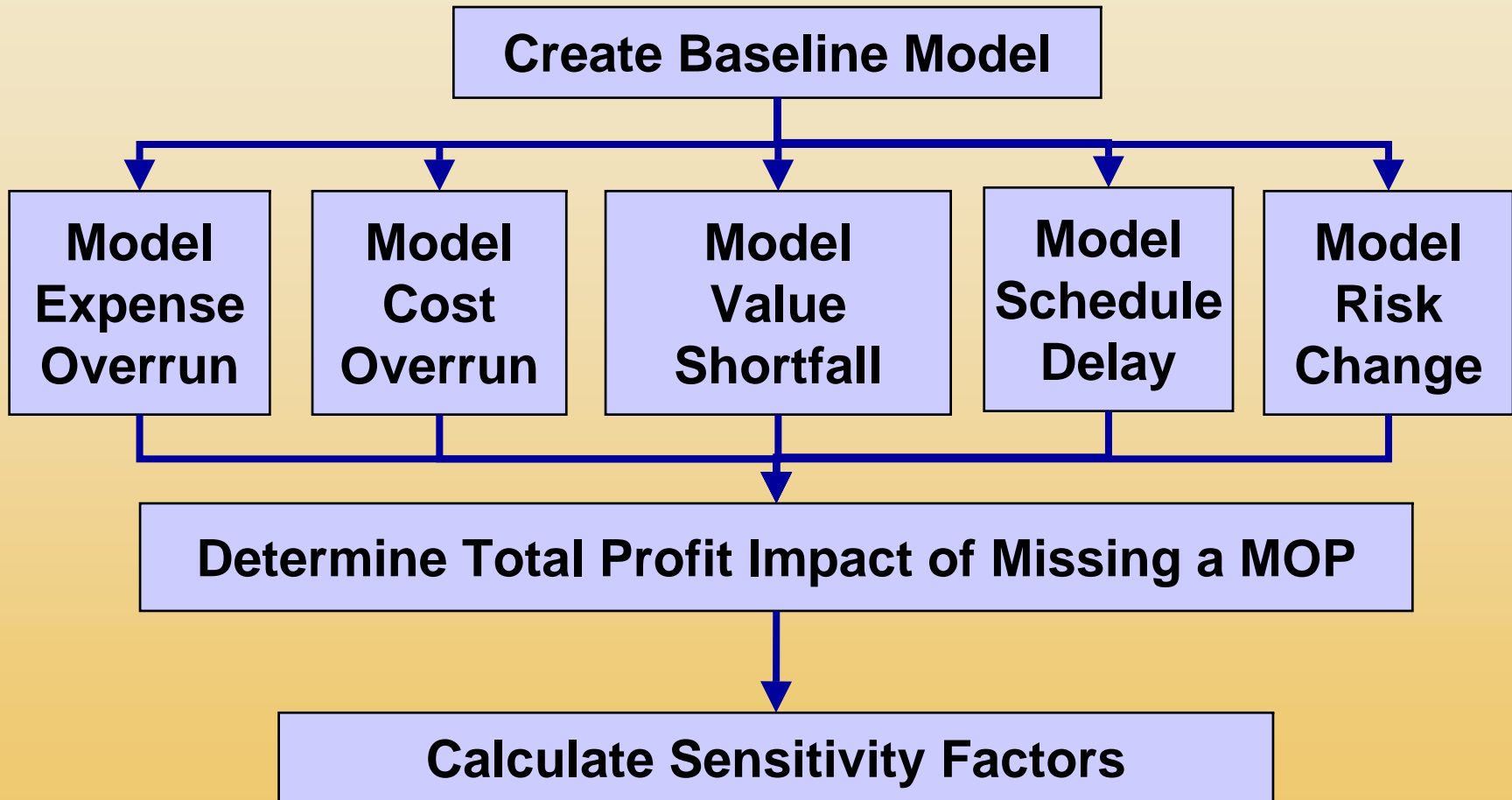
- **There are underlying mechanisms of action behind lean methods.**
- **These mechanisms can be used in LPD.**
- **These methods affect more than one measure of performance, so tradeoffs are necessary.**
- **This requires that you use a common unit of measure for your decisions.**

Economics

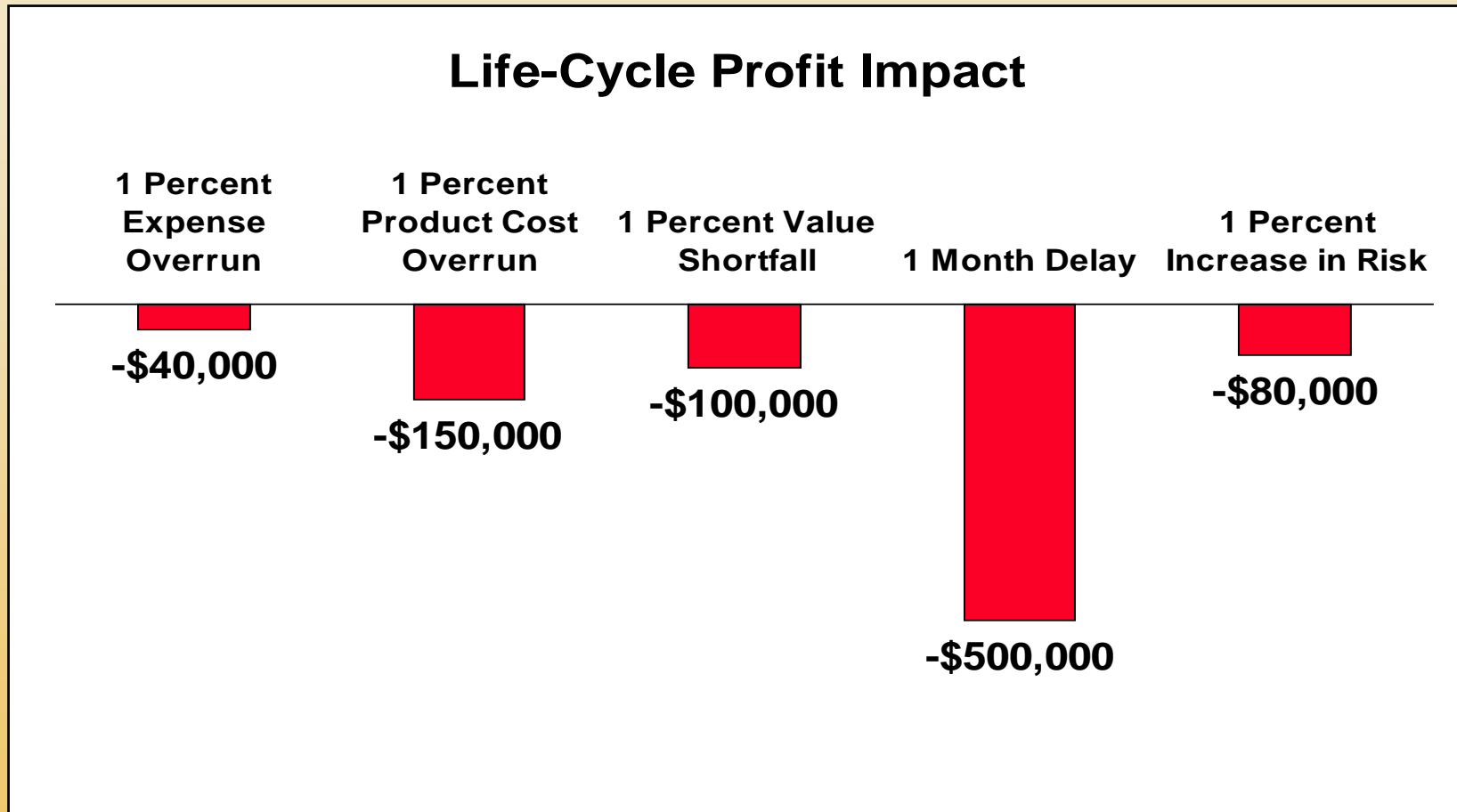
Making Economic Decisions



The Modeling Process

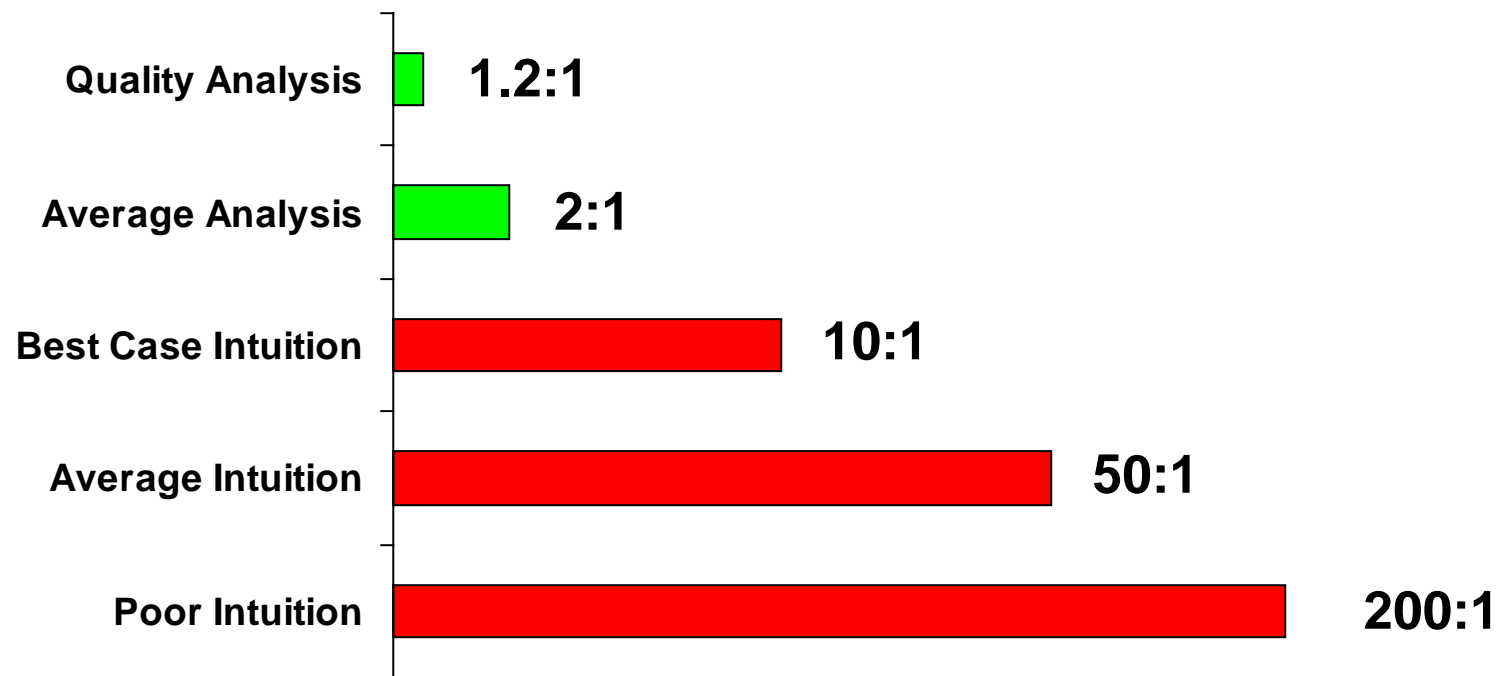


The Model Output



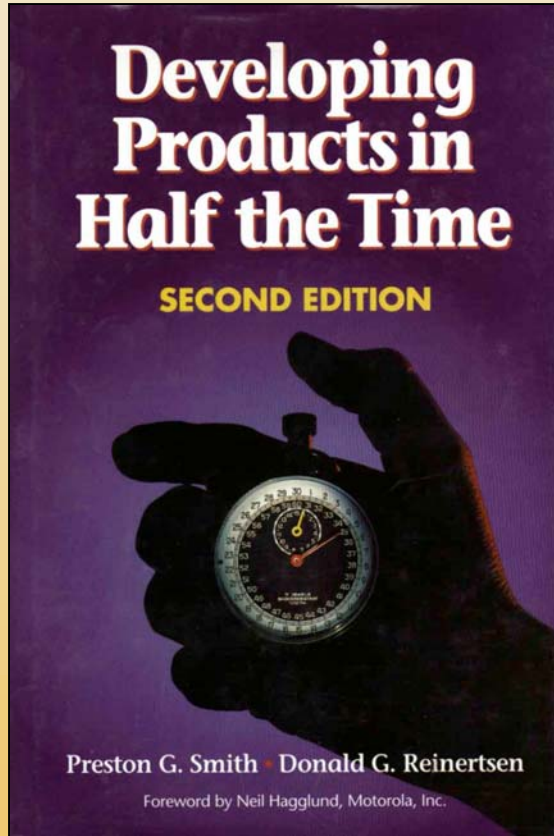
Any Analysis Beats Intuition

Range of Cost of Delay Estimates

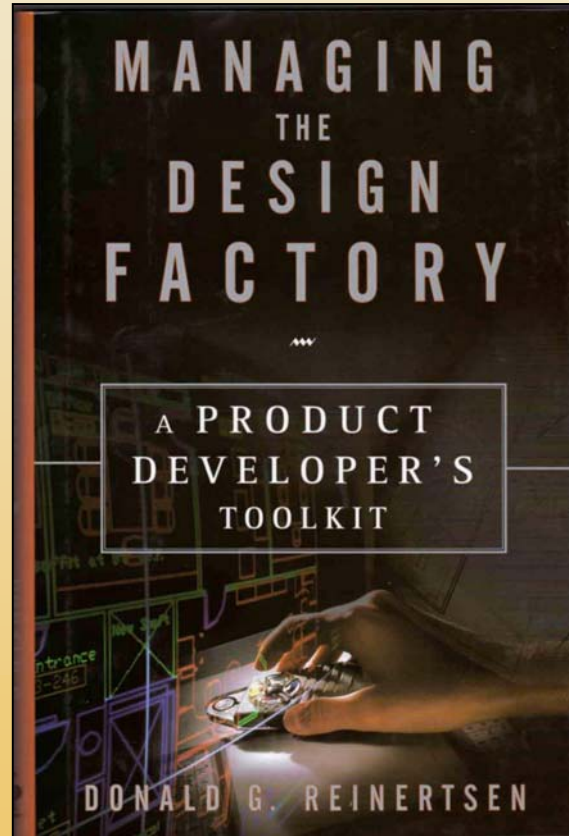


Source: Reinertsen & Associates Clients

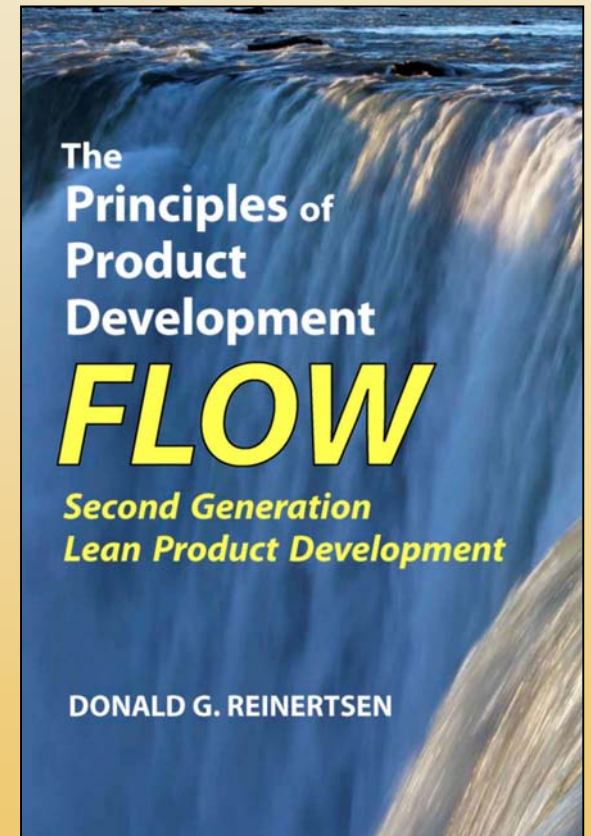
Going Further



1991 / 1997



1997



2009



Seminars in Scandinavia

Copenhagen:



November 30 - December 1, 2011



Stockholm:

2012

