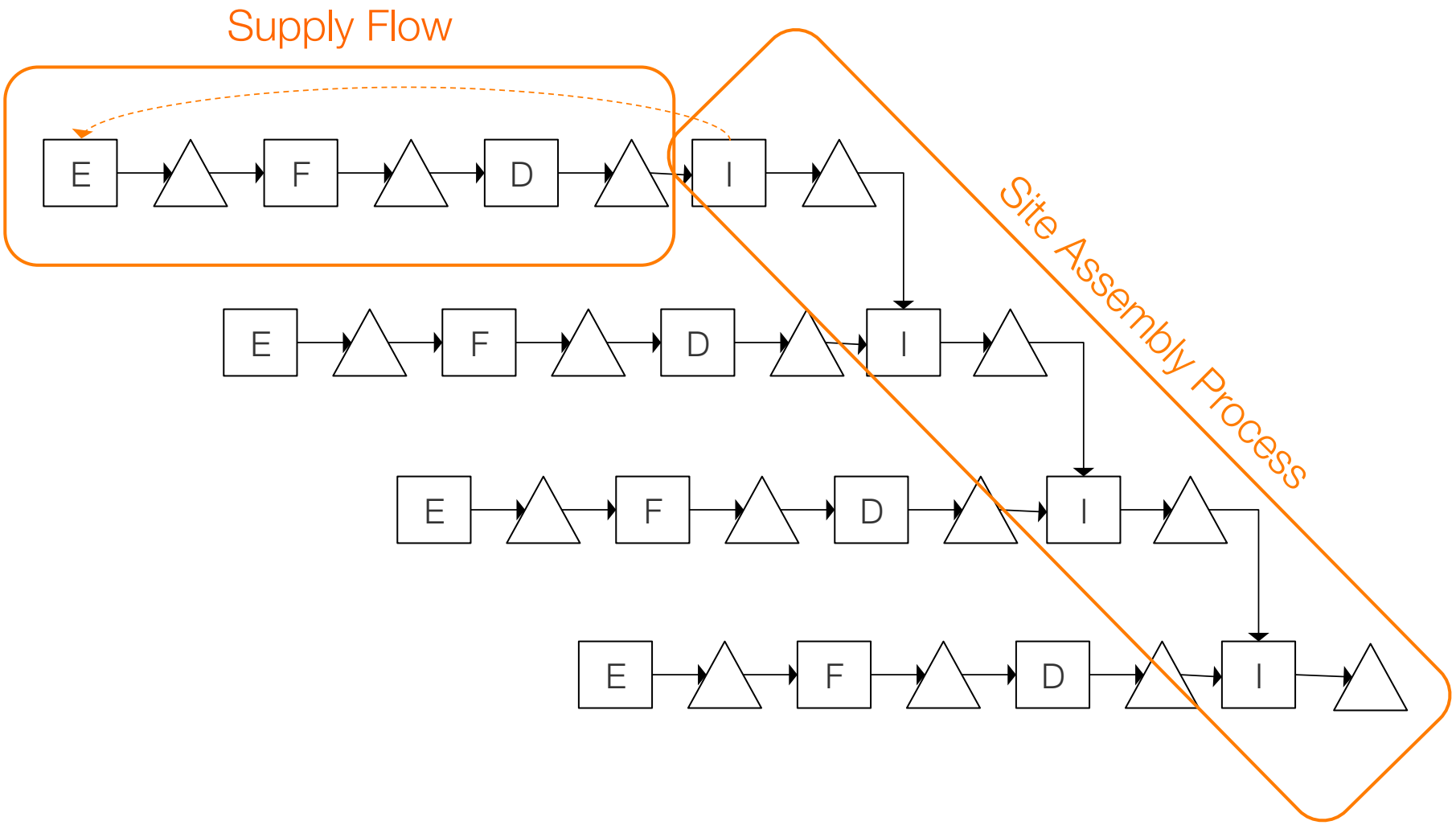
PROJECT PRODUCTION
INSTITUTE

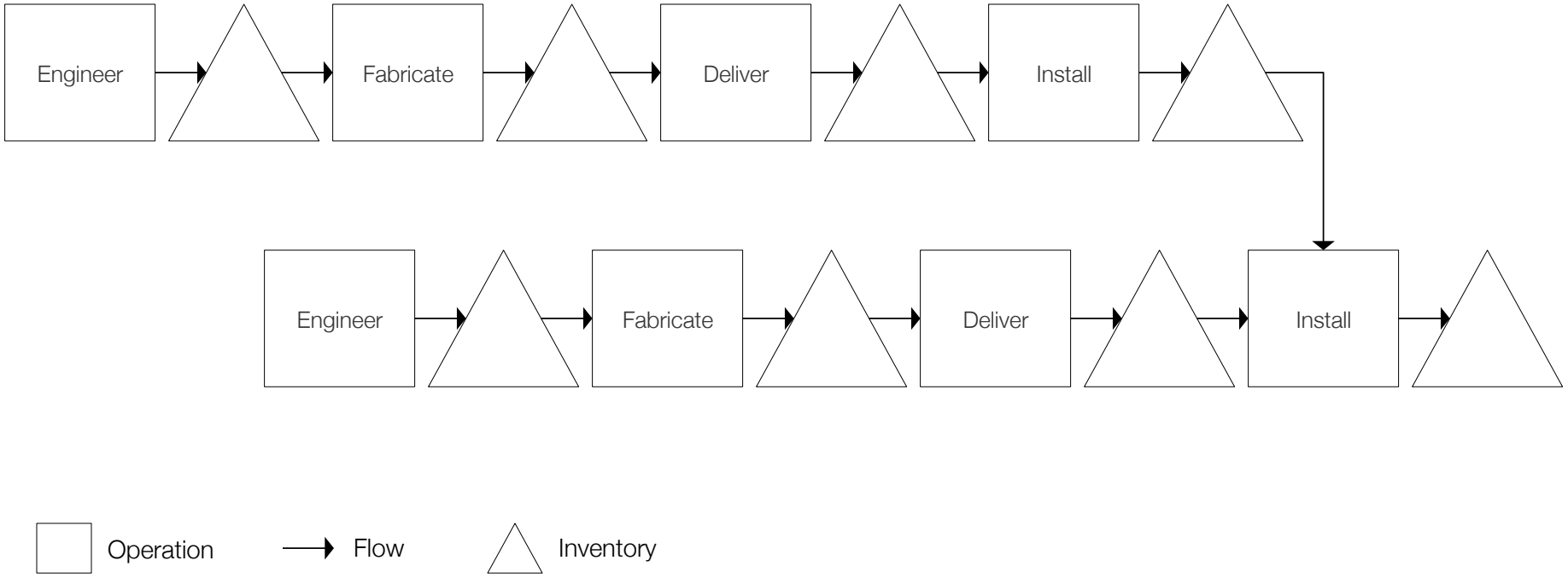
Operations Management Framework for Project Production System Design

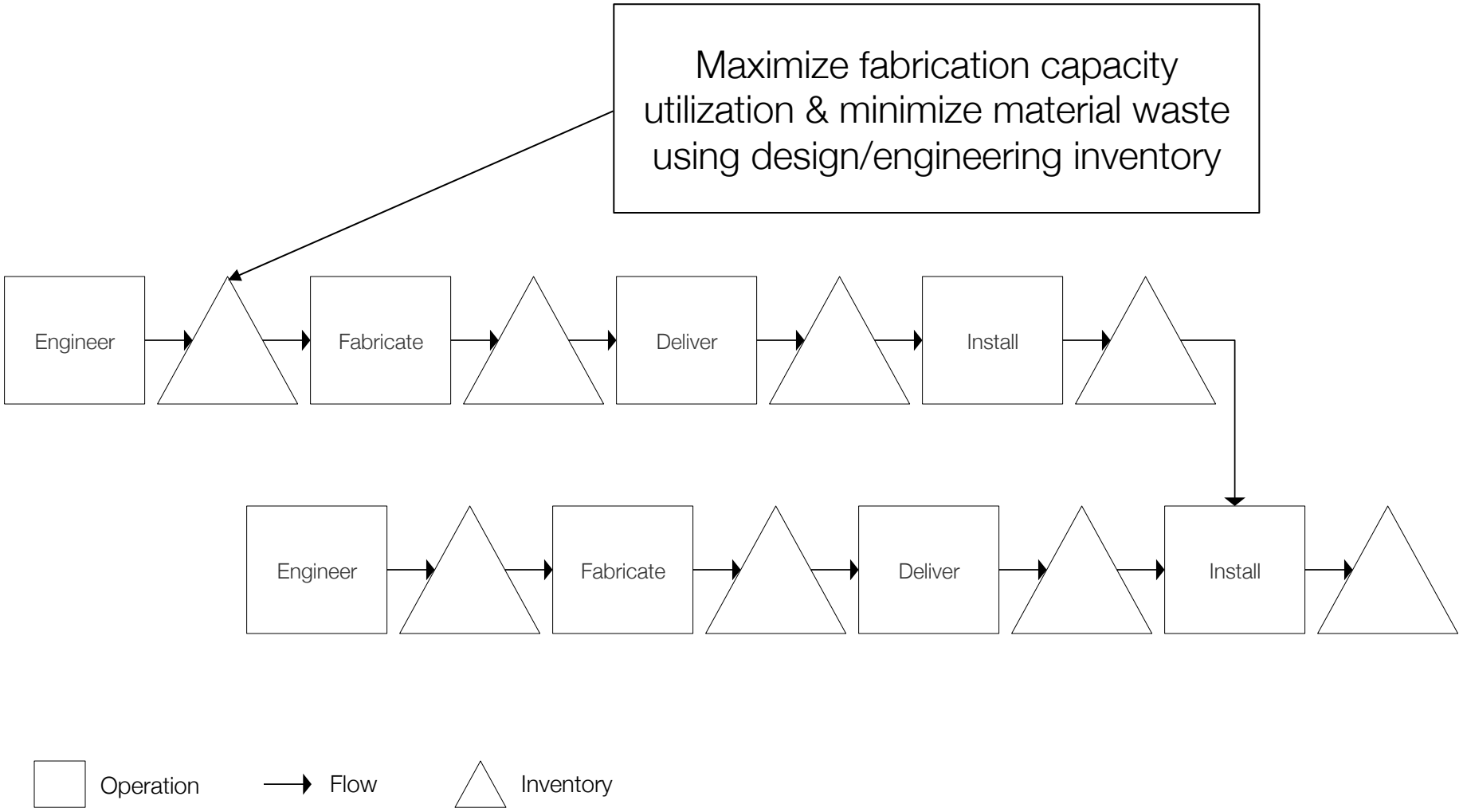
Mark Spearman & James Choo

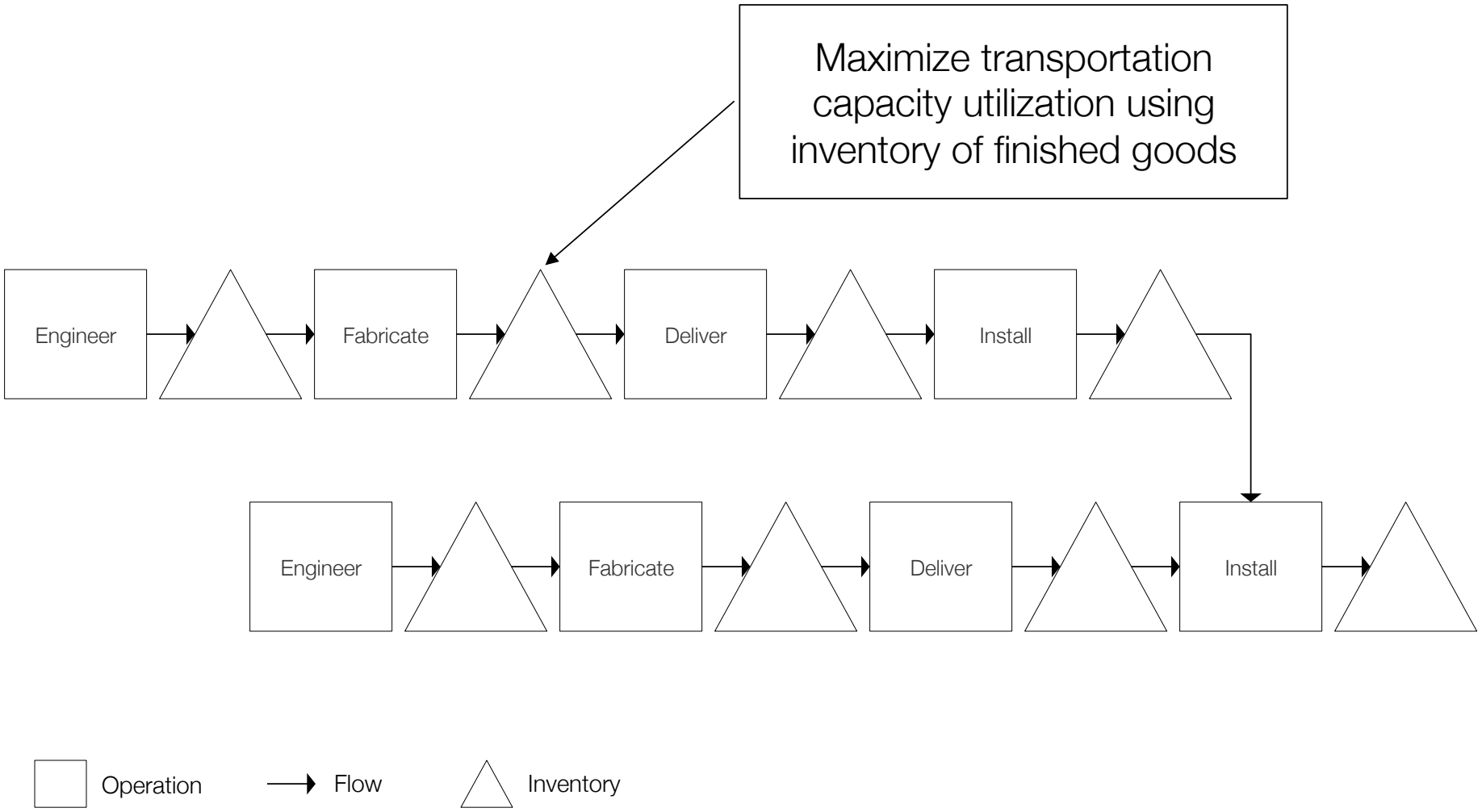
2015 Symposium
San Francisco | 9 December 2015

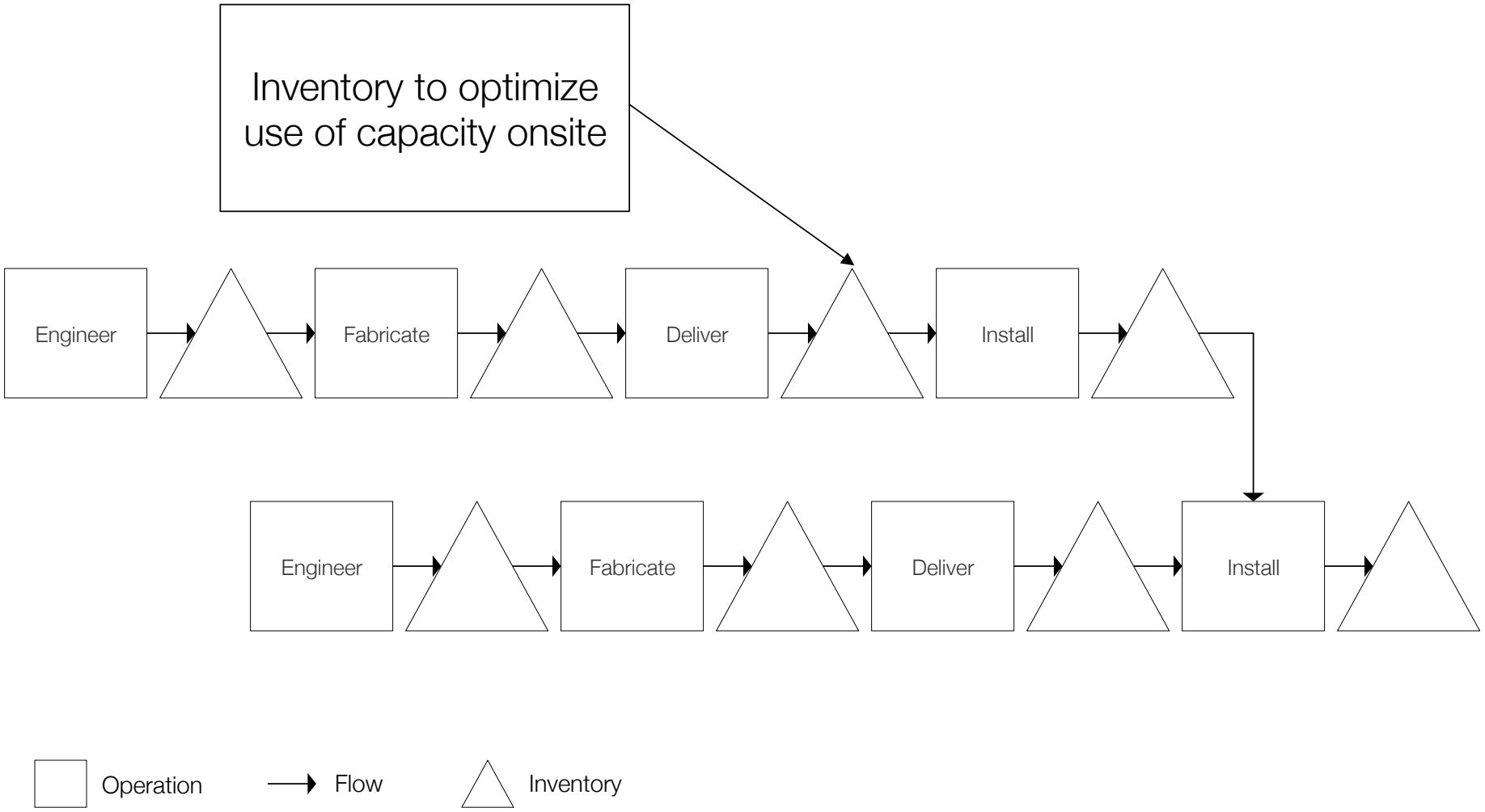


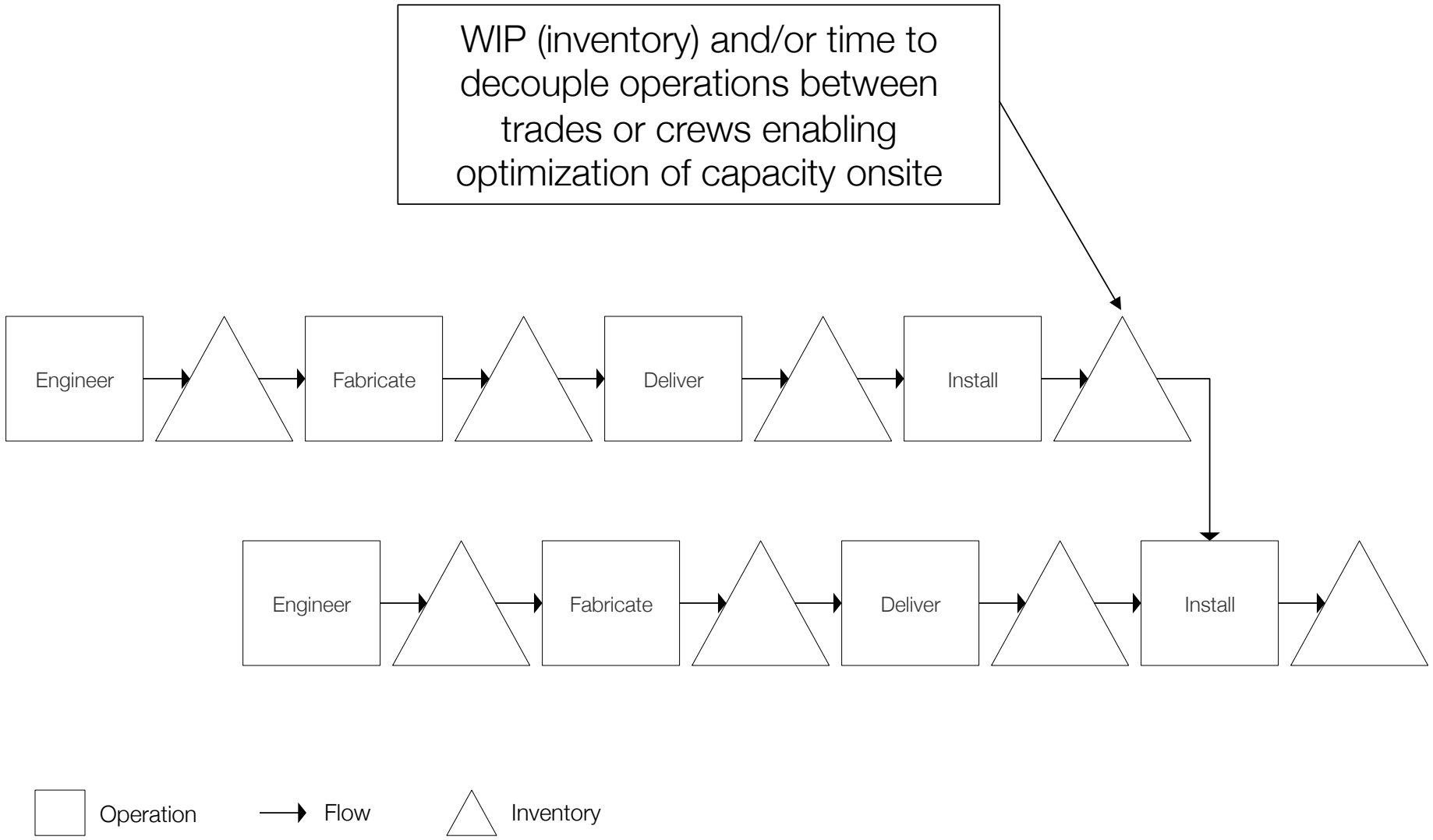
Project as a Flow

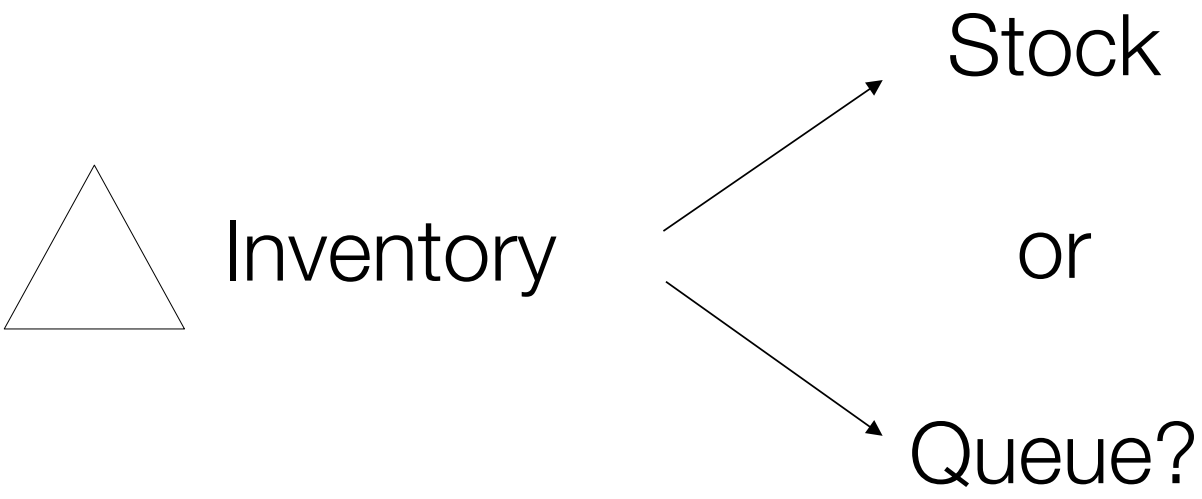












STOCK is where supply and demand meet

QUEUE is where a part waits for a resource

Faster = More $

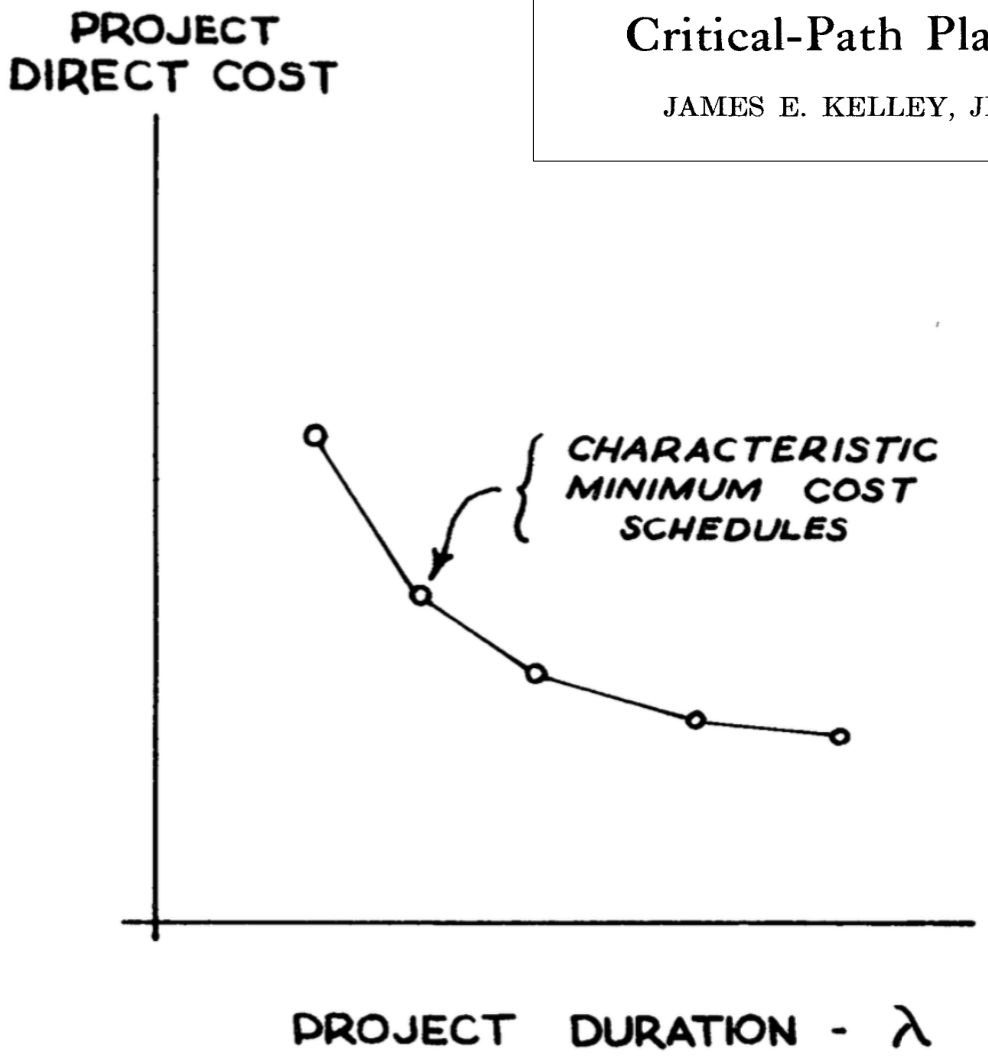
Lower $ = Slower

Any other solution?

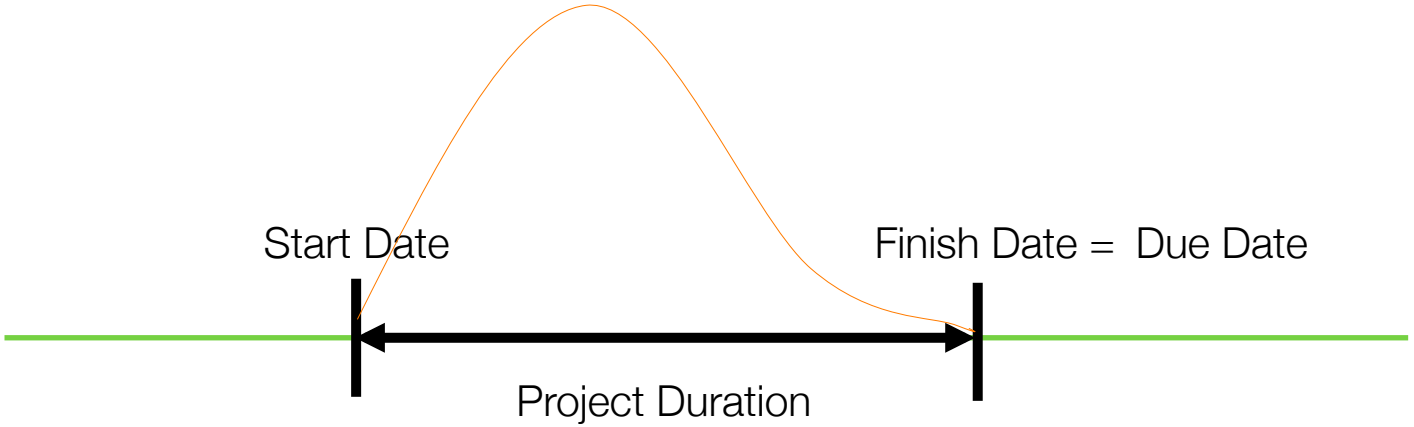
1959 PROCEEDINGS OF THE EASTERN JOINT COMPUTER CONFERENCE

Critical-Path Planning and Scheduling

JAMES E. KELLEY, JR.† AND MORGAN R. WALKER†

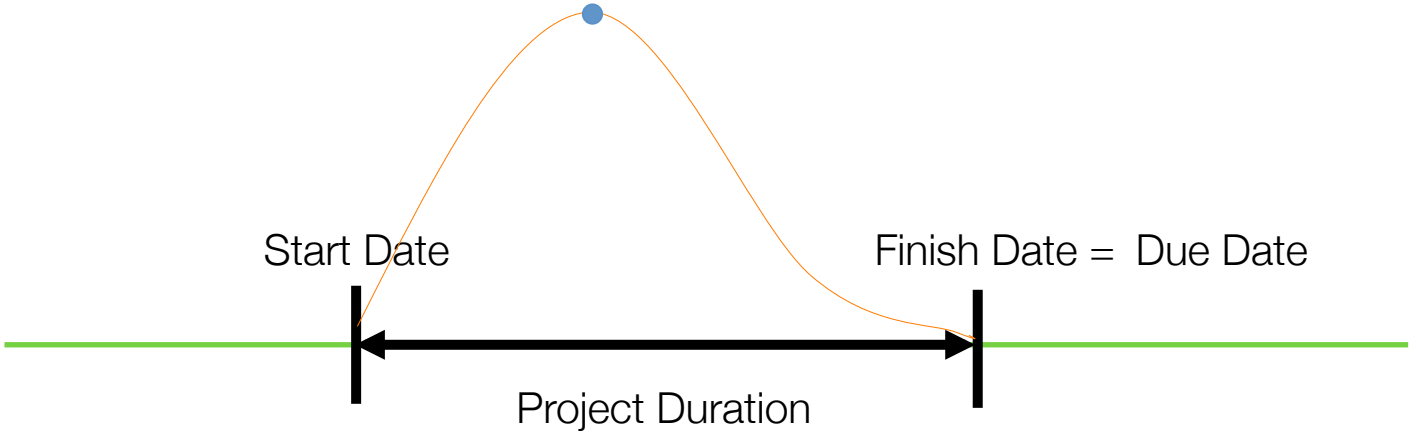


No variability

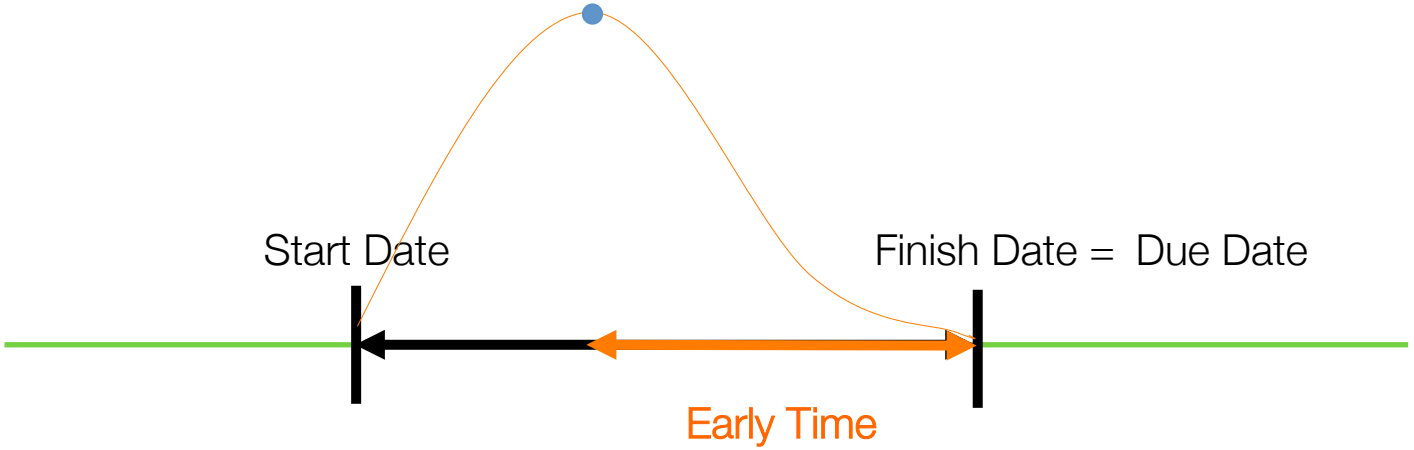


When will it finish?

Most likely finish time



Most likely finish time



What does Early Time cost?

Work in process (WIP)
Little's Law

- $\mathbf{WIP = Early\ Time \times Throughput}$
- *Throughput* is rate of construction

So what?

- WIP is money (reduces cash flow)
- WIP can be lost, damaged, or stolen
- WIP can become obsolete when design changes are made

What does Early Time cost?

Example: Build 1 assembly per day at $100,000 each

Deliver 2 weeks early

$1.4 million in WIP!

Not counting loss, damage, or obsolete costs

Where does the Variability come from?

Re-sequencing

New technology

Material defects

New techniques

Material delays

Equipment failures

Longer completion times

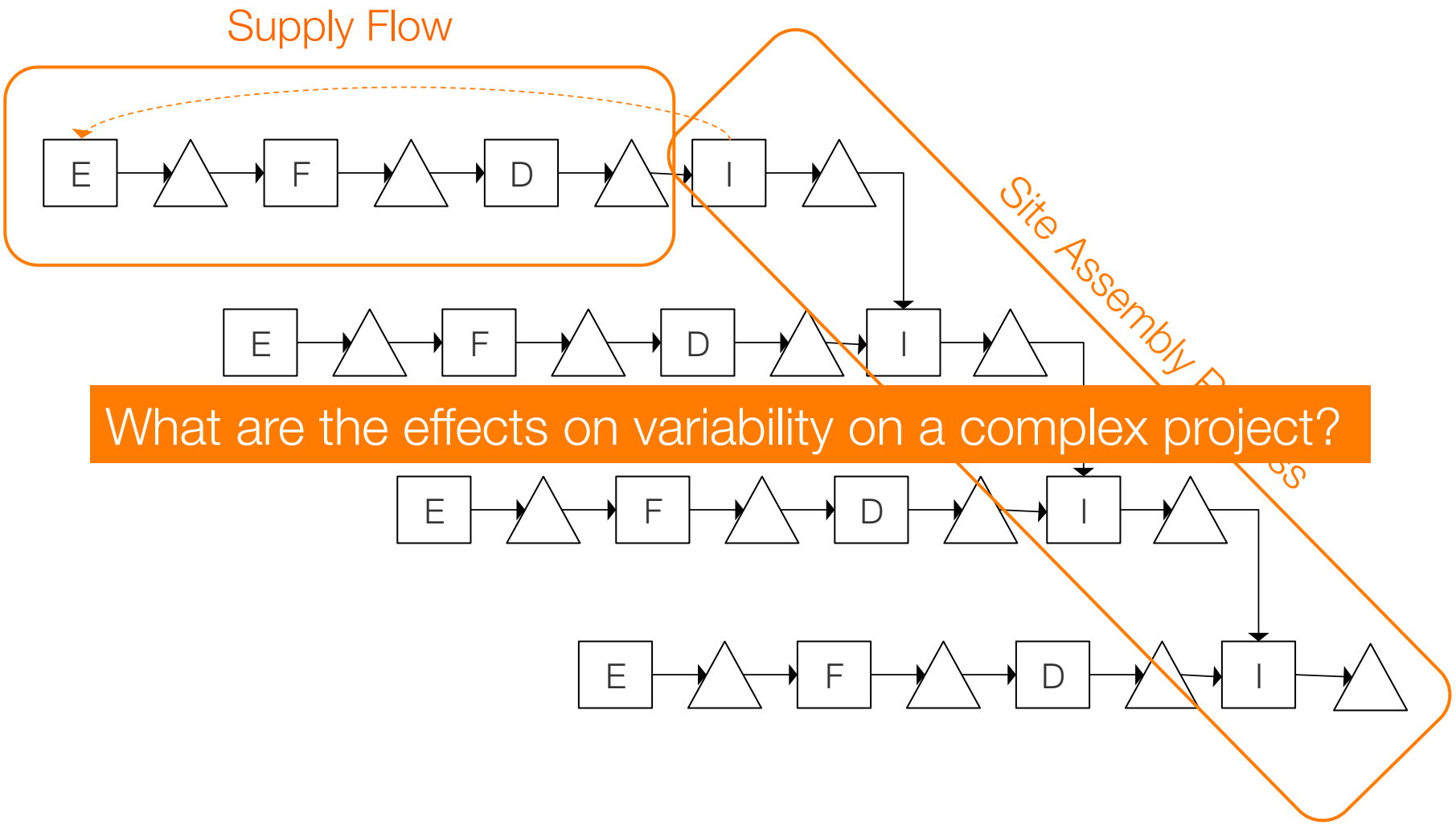
Weather delays

Ground conditions

Expedited permits

More favorable locations

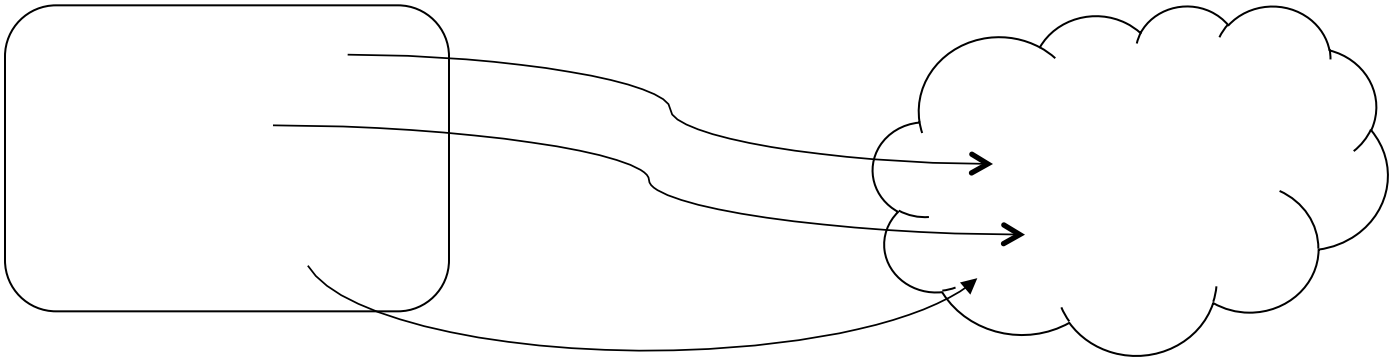
Rework



How does Variability effect Wait Time?

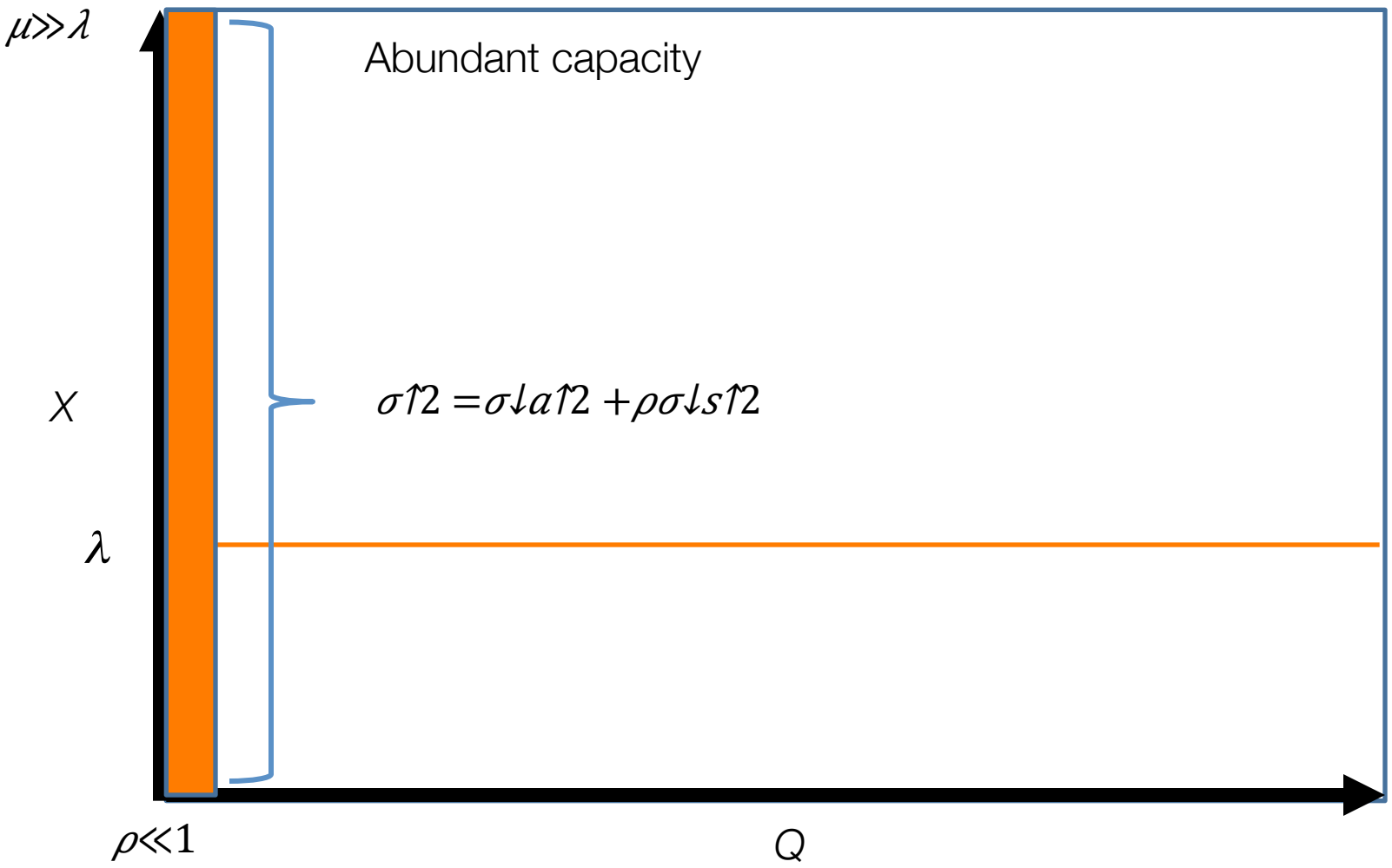
Variability behaves like an “incompressible fluid”

It must go somewhere!



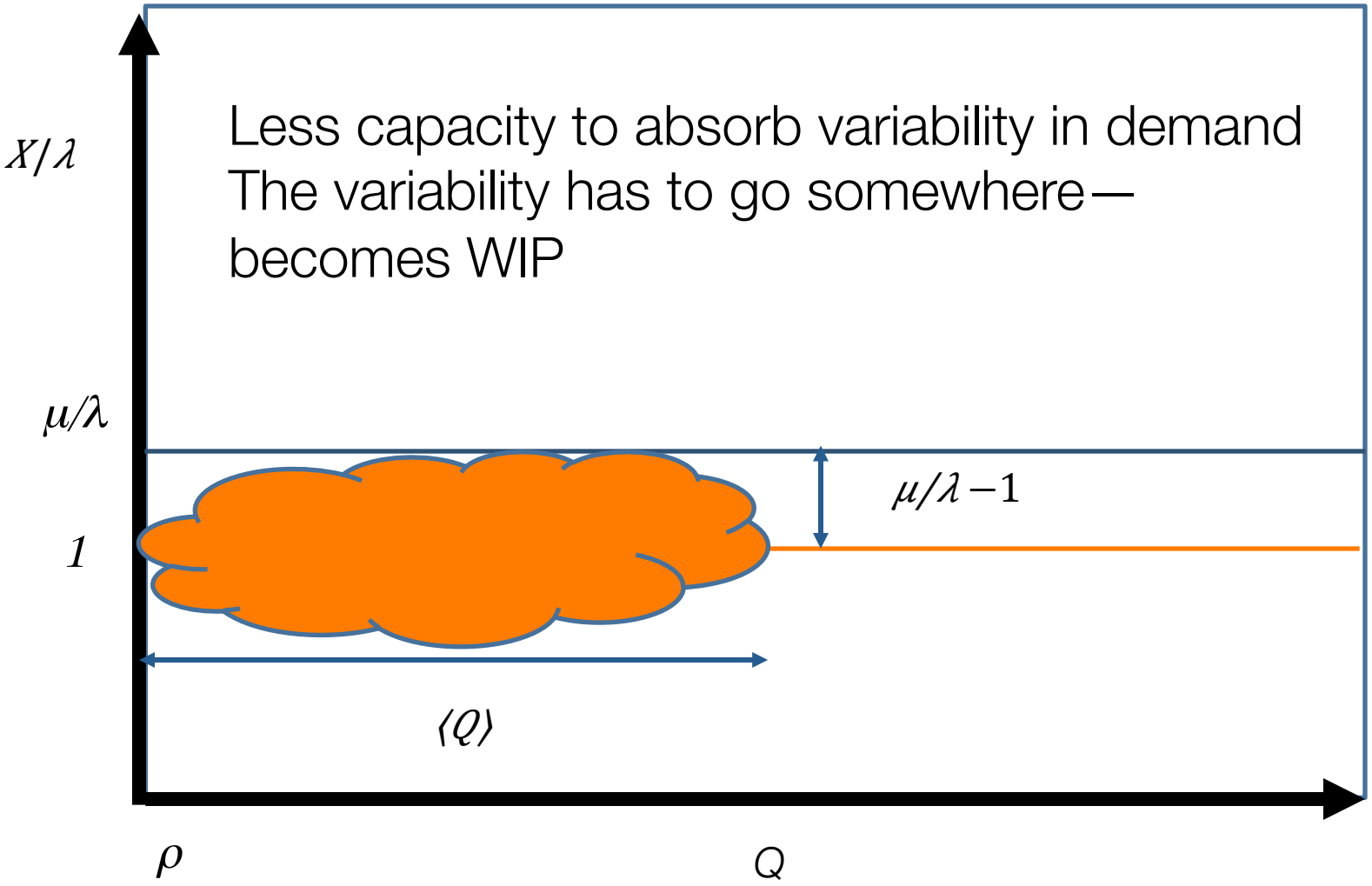
$D(0)$ $t>0$ $D(t)$

Variability and Waiting



Number "waiting" is the % of time the resource is busy

Variability and Waiting

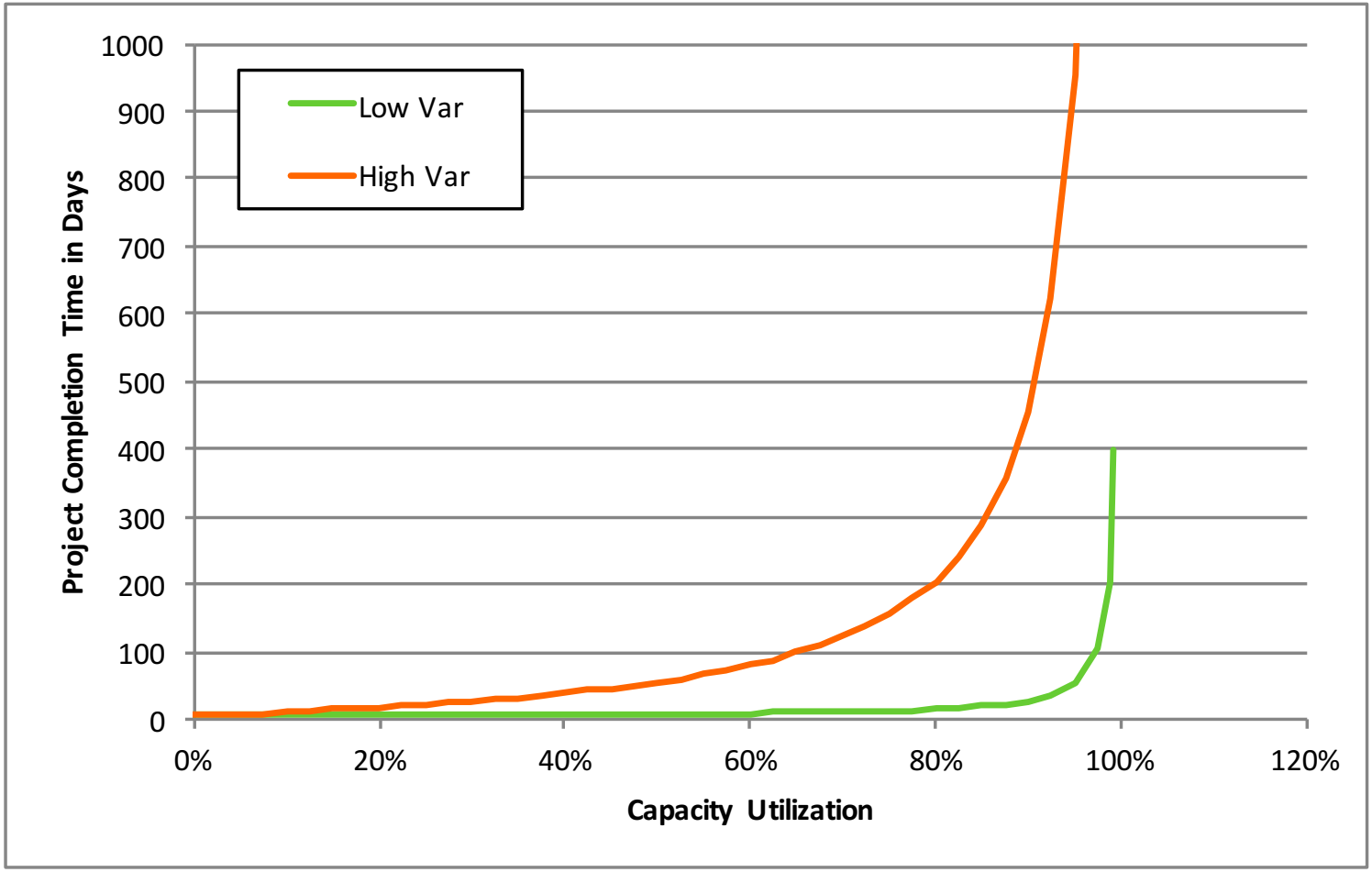


From these two graphs and a little algebra we get the VUT equation

$$CT_q \approx V \times U \times t$$

$$\approx \left(\frac{c_a^2 + c_e^2}{2} \right) \left(\frac{u}{1-u} \right) t_e$$

Time vs Utilization



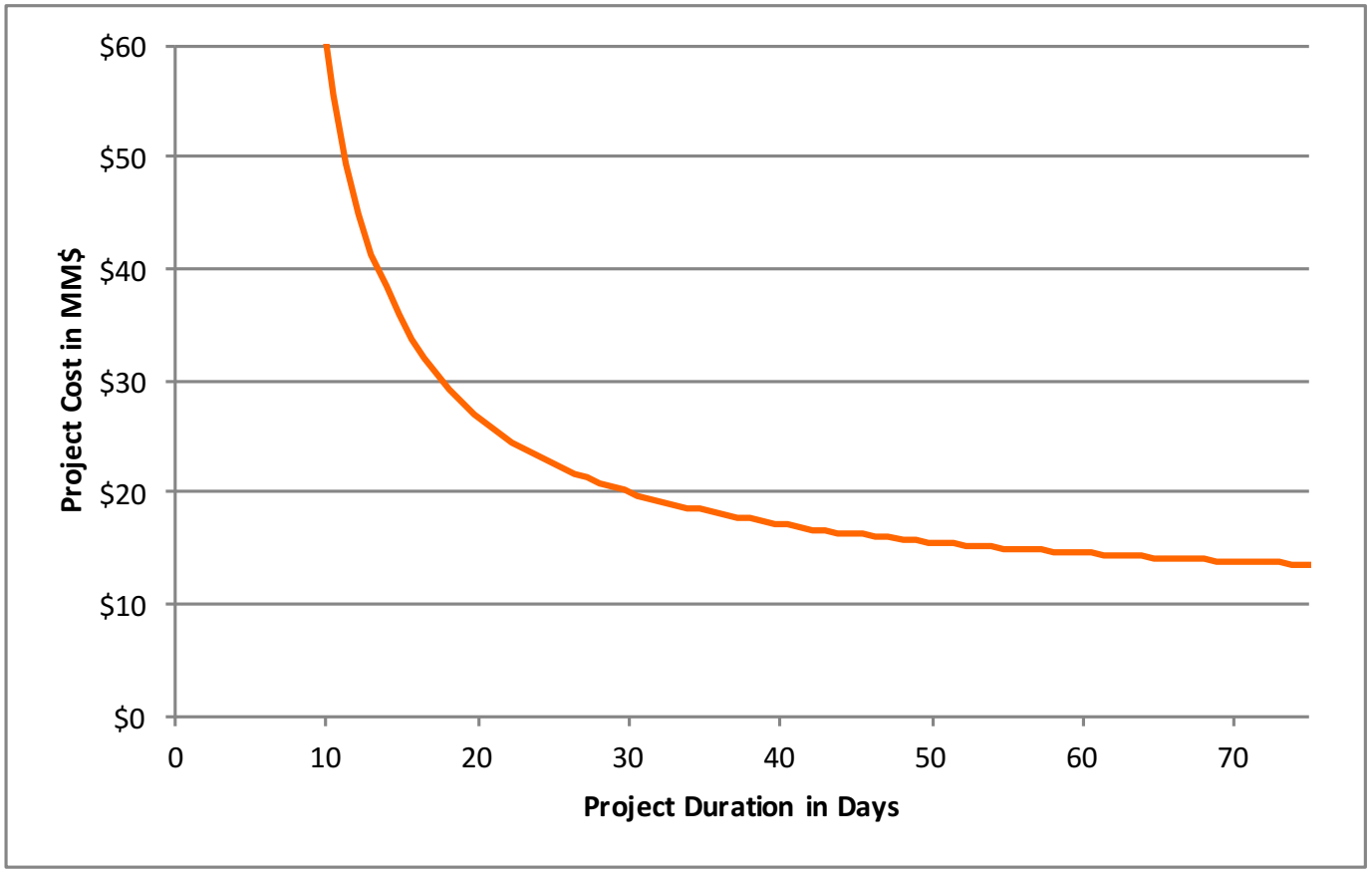
Utilization is related to Cost

Scope: 200,000 Man-Hours
Duration: 1000 Days at 10 hr/day
Rate: $50 / hr

<u>Utilization</u>
100%: 200 people required → $10M
80%: 250 people required → $12.5M

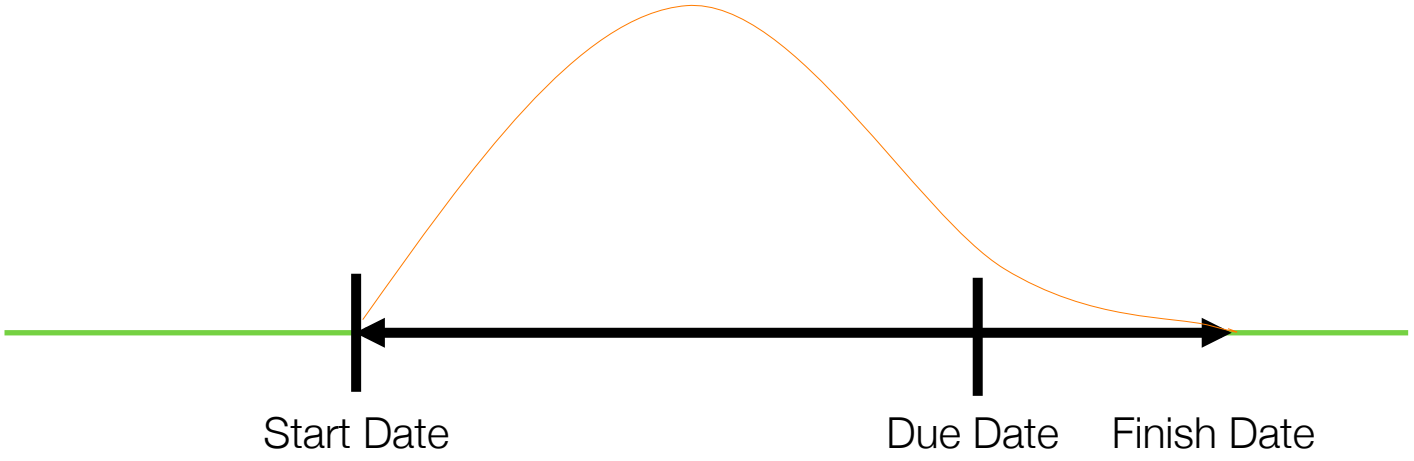
Cost is 25% more!

Is there an implicit amount of variability in our time-cost trade-off curve that we take for granted?

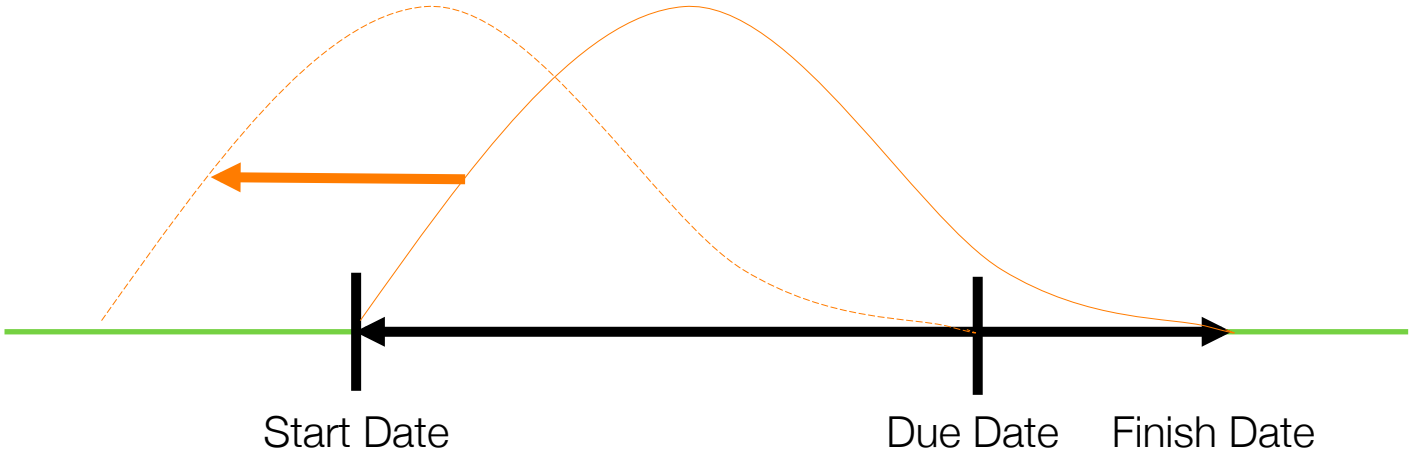


At 100% utilization, with high variability, you never hit 50 days!

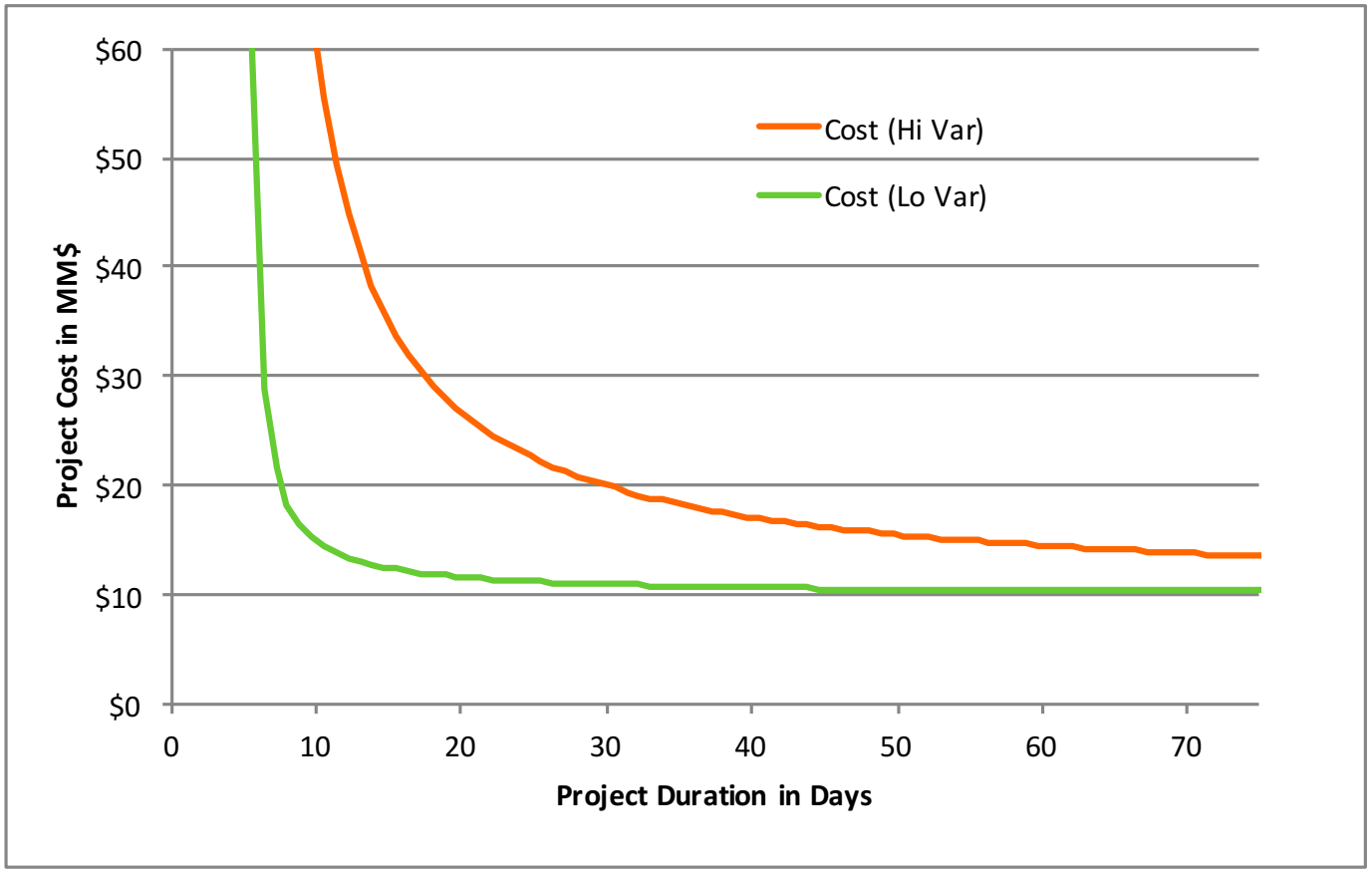
What Typically Happens?



How Do We Avoid It?



Start even earlier!



With low variability, you are able to achieve 50 days!

Is inventory root of all evil?

Variability is root of evil

Inventory is its flower

How do we make optimal cost – inventory/time, variability/complexity trade-off decision in a complex project production system?

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