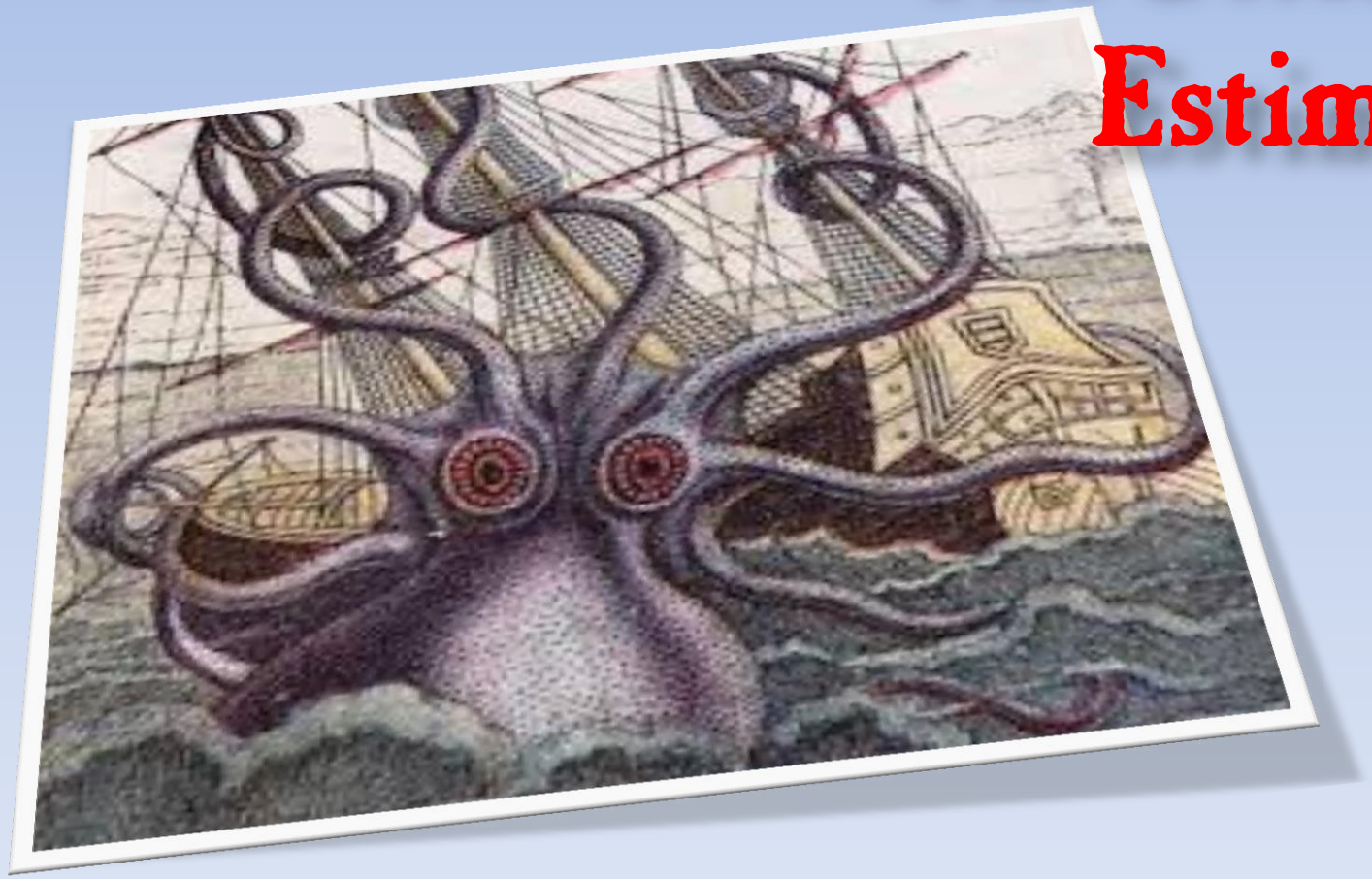
Unmythology and The Science of Estimation



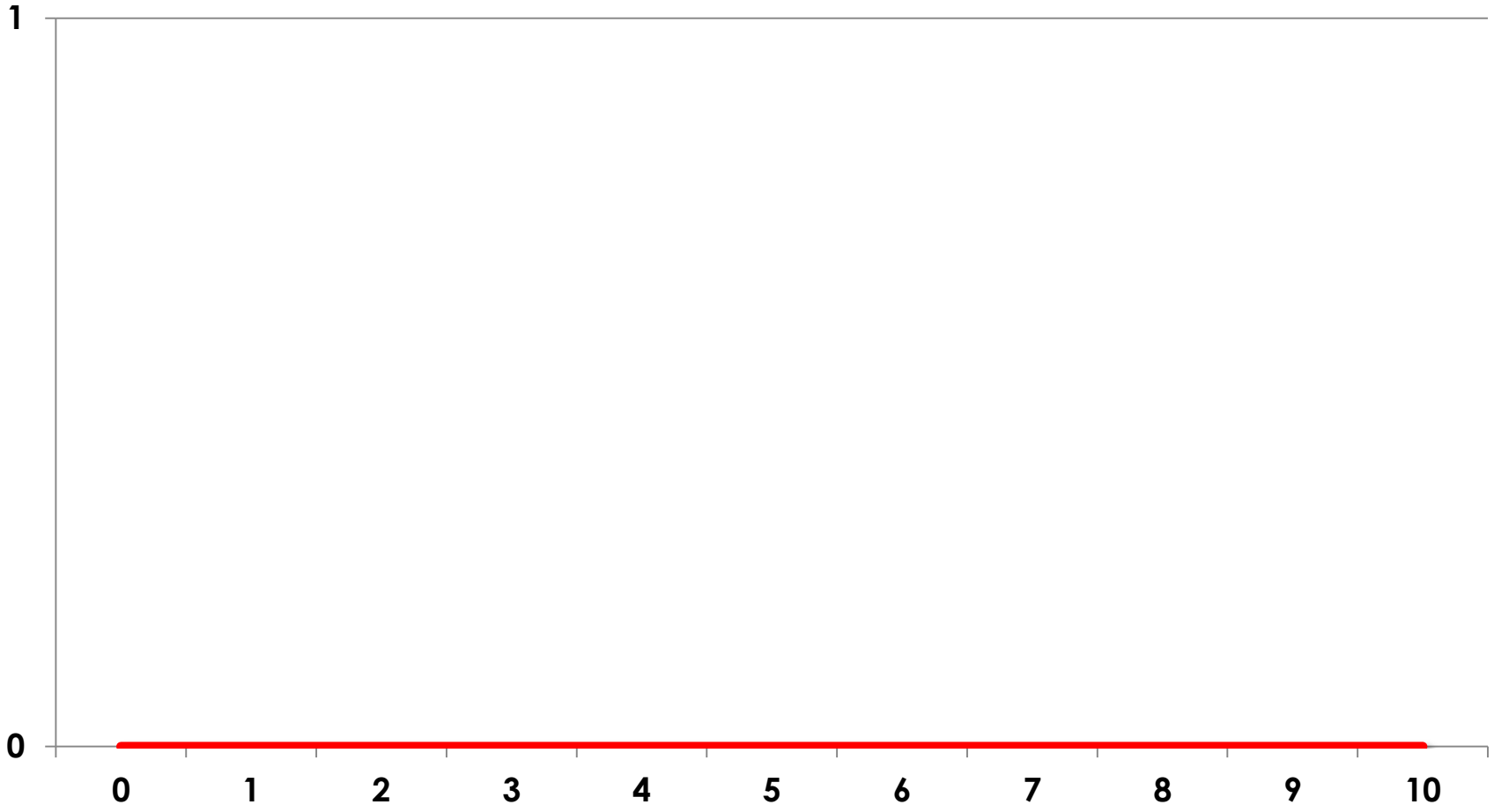
Corvus International Inc
Systems, Psychology and Software

But First… a test…

1. How old was comedian George Burns when he died?. . . . . **100 Years**
2. In what year was Noah Webster's ***An American Dictionary*** . . . . **1828** first published?
3. At what temperature does steel melt (in °C)?. . . . . **1,480°C (varies 1,400-1,538°C)**
4. What was $1 in 1945 equivalent to in the year 2005?. **$10.85**
5. In what year was Alexander the Great born?. . . . . **356 BCE**
6. What were the worldwide box office receipts for the . . . . . **$1.835bn** movie ***Titanic***?
7. What is the surface temperature of the Sun (°C)?. . . . . **6,000°C**
8. What was the population of Auckland, New Zealand in 2001?. . **1,089,891**
9. What is the total volume of water in the Great Lakes (in cu ft)?. **2.4 x 10^{22} cu ft**
10. What is the mass of Earth's Moon (in kg)? . . . . . **6.37 x 10^{22} kg**

Source: Inspired by a similar quiz in
McConnell, Steve
Software Estimation, Demystifying the Black Art
Microsoft Press 2006

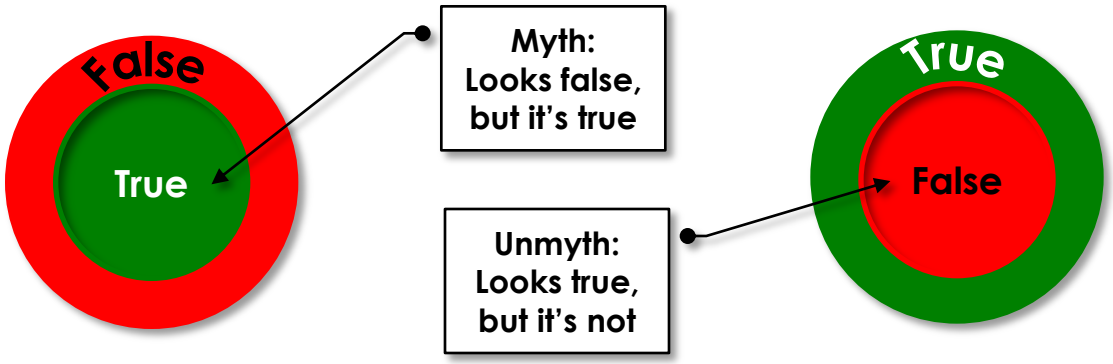
How Many Correct?



Myths and Unmyths

- Myths are not "untrue"
- A myth is an essential truth, but it's wrapped up in a fanciful story that is not *literally* true.
- If a myth is a truth that seems to be untrue,…
  …then an "unmyth" is something that seems to be true but is actually false.

"Mythology is not a lie,…
…it is metaphorical. It has been well said that mythology is the penultimate truth.
Joseph Campbell
The Power of Myth



Unmyths of Estimation

There are a number of unmyths in project estimation:

- **The Accuracy Unmyth:** we can get an accurate estimate if only we just use the right: process, technique, tool, calibration, data, or estimator (pick one or more)
- **The End-Date Unmyth:** the job of an estimate is to tell us when the project will finish (related to **The Budget Unmyth**, the **Headcount Unmyth**, etc.)
- **The Commitment Unmyth:** the estimate is what the project is committed to achieving

Source: Armour, Phillip, G.
"Ten Unmyths of Project Estimation"
Communications of the ACM
Vol 45 No 11. Nov 2003

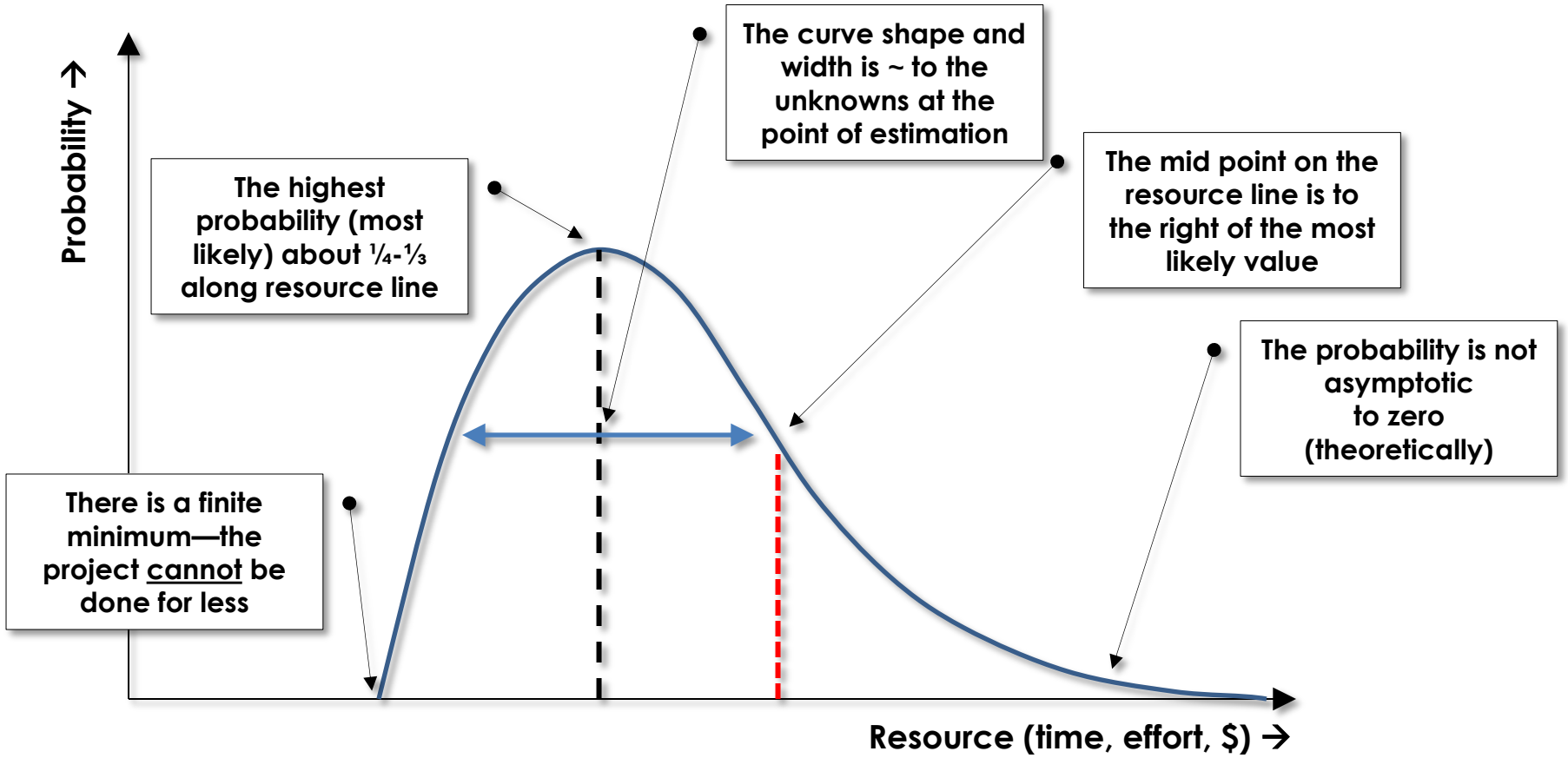
THE ACCURACY UNMYTH

It is possible to get an accurate estimate

The Accuracy Unmyth

It is possible to get an "accurate" estimate

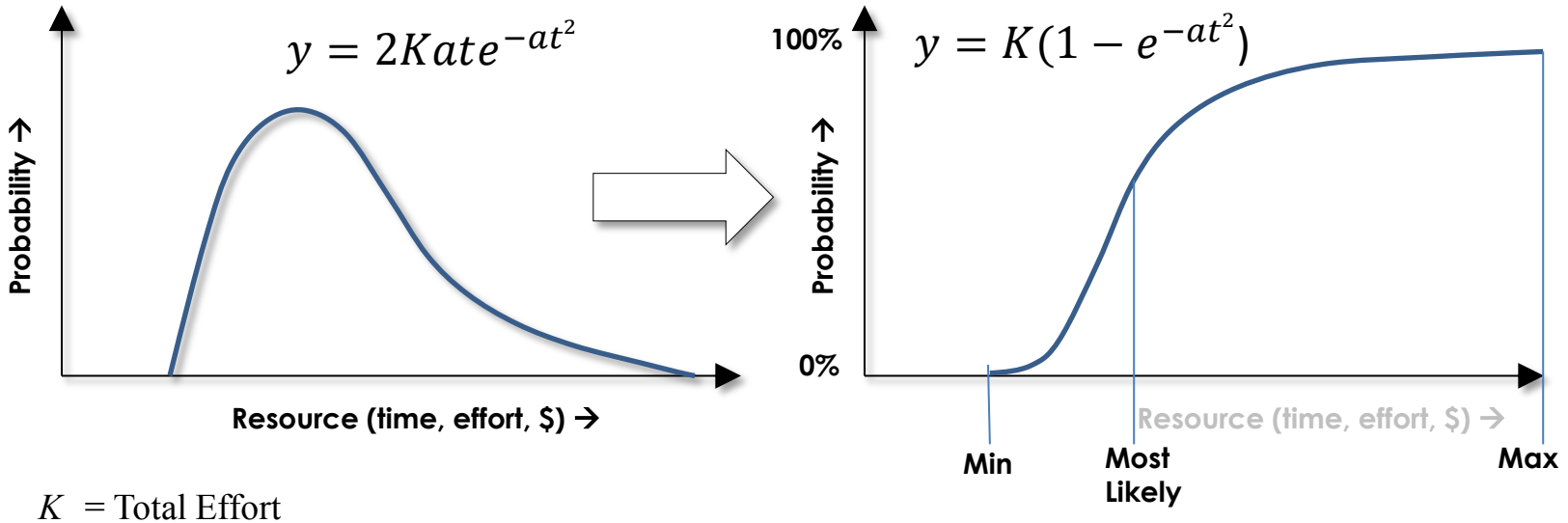
- Estimates are not values, they are ***probability distributions***



The Accuracy Unmyth

It is possible to get an "accurate" estimate

- Integrating this function gives the following distribution:

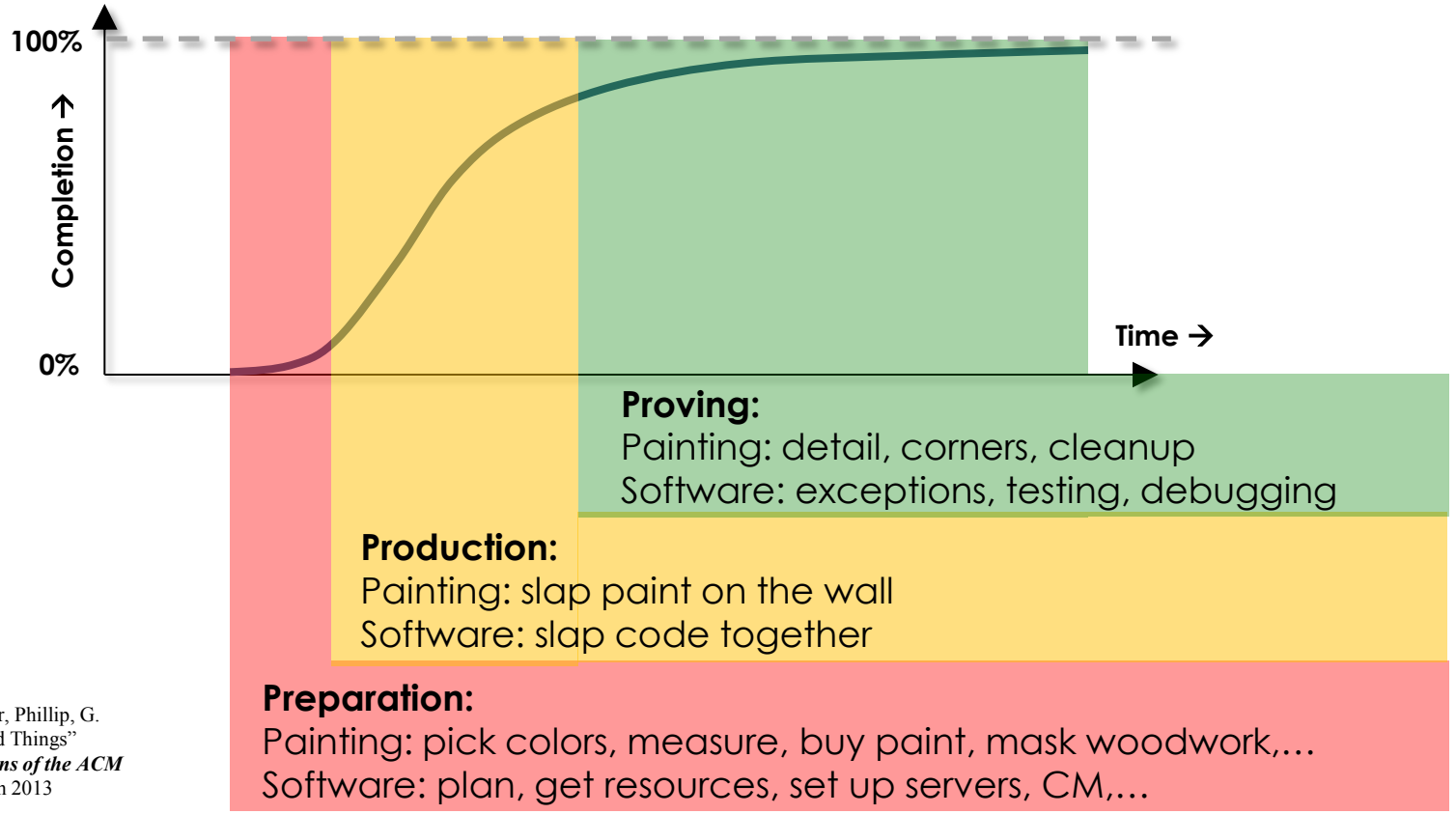


K = Total Effort
a = acceleration factor (~productivity)
t = time

Sources: Londeix, Bernard,
Cost Estimation for Software Development
Addison-Wesley 1987 pp..76-78
and Armour, Phillip, G.
"How We Build Things"
Communications of the ACM
Vol.56 No.1 Jan 2013

How We Build Things

The probability curve to build things is quite intuitive and applies as much to painting a room as it does to building software

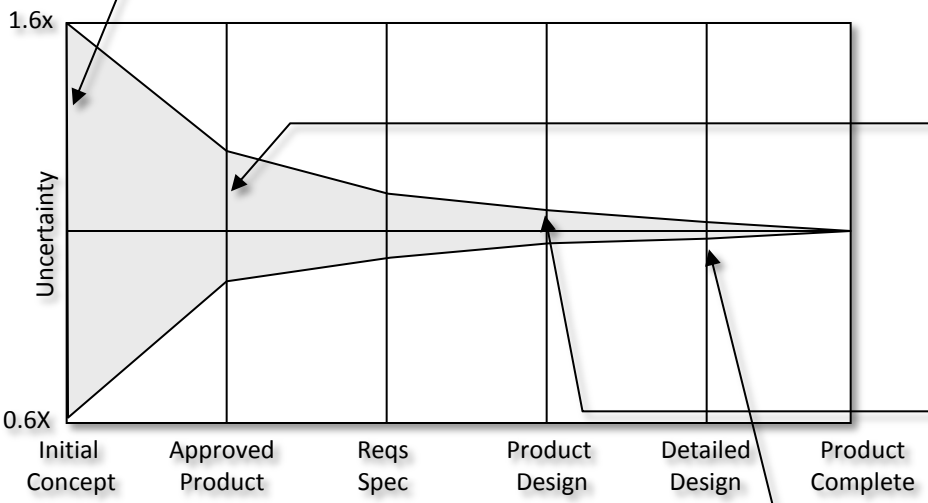


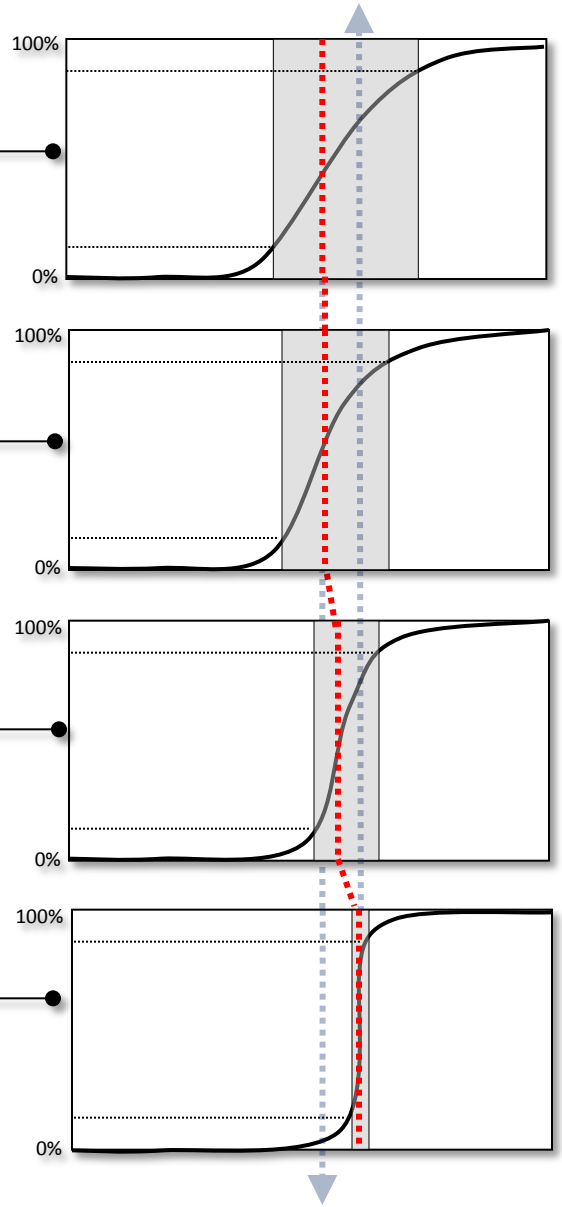
Source: Armour, Phillip, G.
"How We Build Things"
Communications of the ACM
Vol.56 No.1 Jan 2013

“Accuracy” and The Cone of Uncertainty

Source: adapted from McConnell, Steve. ***Software Estimation*** Microsoft Press 2006 & Cohn, Mike. ***Agile Estimating and Planning*** Prentice Hall PTR 2006

- **The “accuracy” of an estimate is a function of how much is unknown at the time of estimating—this varies through the lifecycle.**

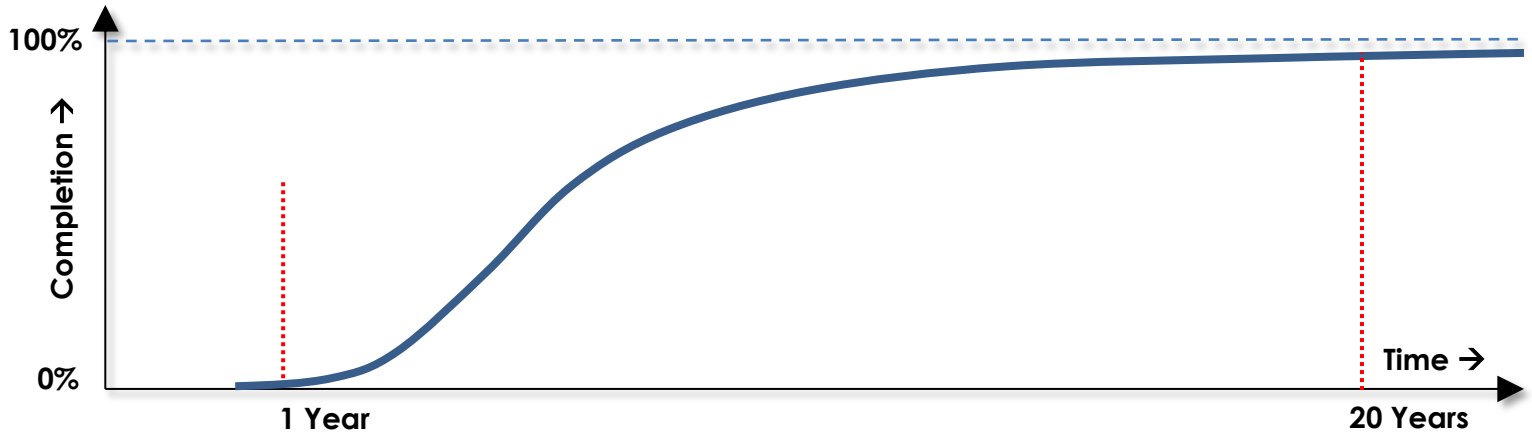




- **The “width” of the estimate band is a measure of the intrinsic uncertainty at that point in time.**
- **An estimate mathematically <u>cannot</u> be more precise than this**

Risky Projects

- Given enough variables and enough variation the probability distribution could be very flat



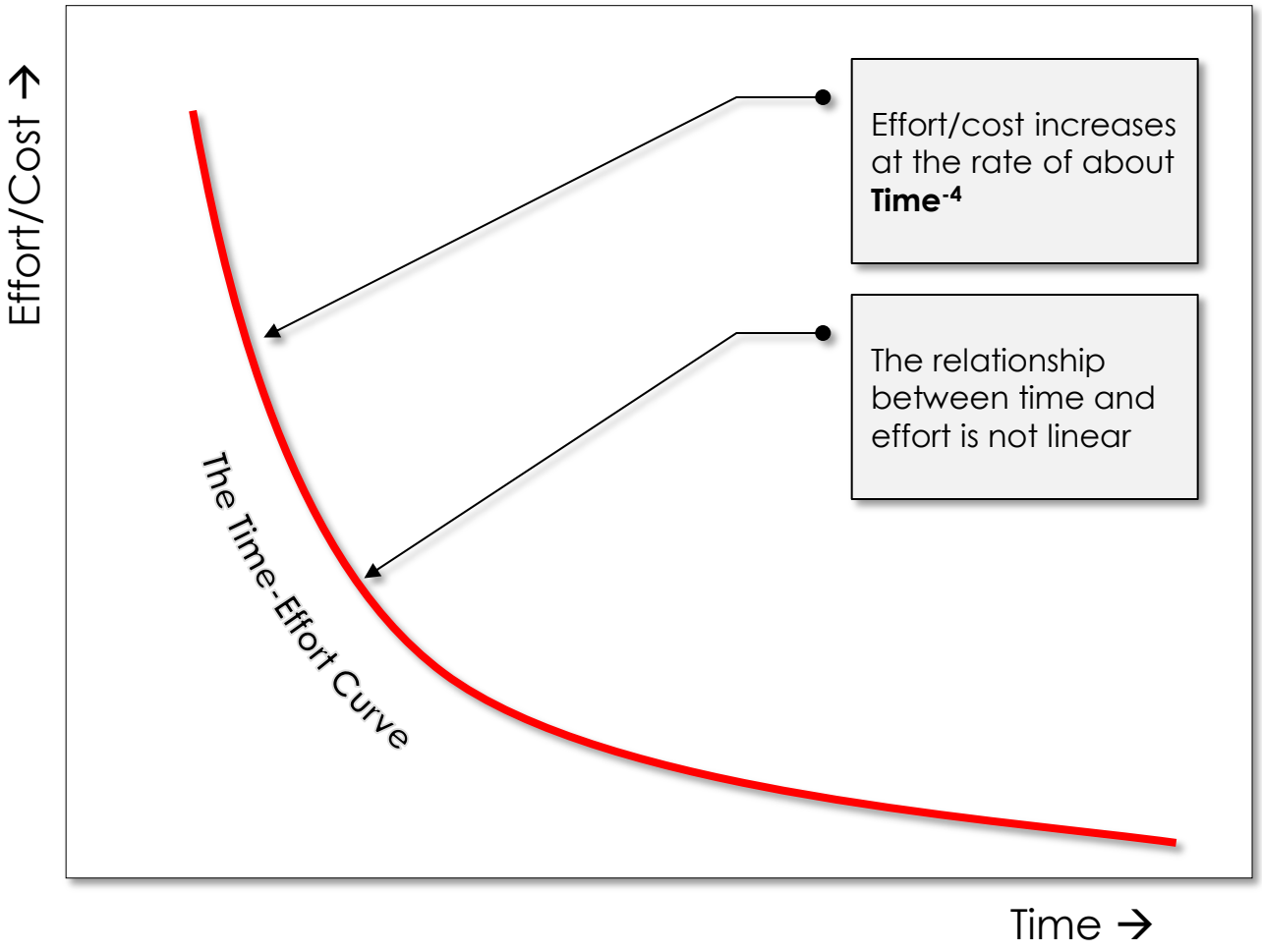
- For such projects, estimation might only be able to assert that the project should be finished sometime between one year and 20 years(!)

  [Note, this might actually be an ***"accurate"*** estimate!]

The Time-Effort Curve

The relationship between effort and time is a high-order reciprocal exponent.

As we try to compress a project's schedule, the effort doesn't just go up—it goes up ***a lot*** and it goes up ***really quickly***



The Time-Effort Relationship

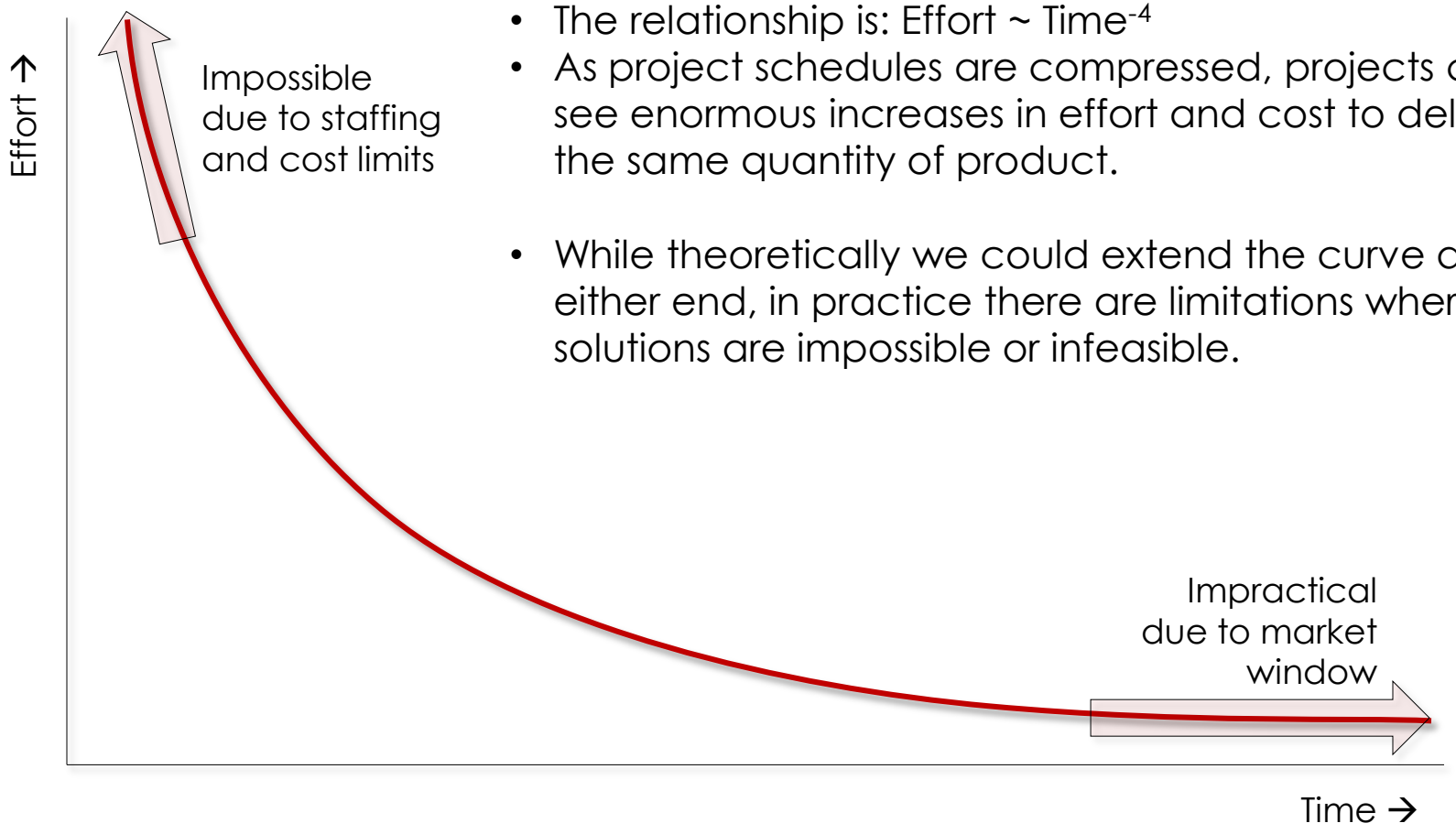
This curve is derived from the ***Software Production Equation*** which is obtained by factoring in the delivered system size into the Rayleigh function and integrating it.

$$\text{Size} \sim \text{Effort}^{1/3} \cdot \text{Delivery Time}^{4/3} \cdot \text{“Productivity”}$$

- Size: A proxy for the value delivered to the Customer
- Effort: Number of staff over time
- Delivery Time: Project duration
- “Productivity”: Capability + “difficulty”

Adapted from:
Putnam, Lawrence H. and Myers, Ware
Measures for Excellence
Prentice Hall 1992 p.28
and Londeix, Bernard,
Cost Estimation for Software Development
Addison-Wesley 1987 pp.78-88

The Time/Effort Relationship



- Effort increases as schedule is shortened.
- The relationship is: Effort ~ Time^{-4}
- As project schedules are compressed, projects can see enormous increases in effort and cost to deliver the same quantity of product.

- While theoretically we could extend the curve at either end, in practice there are limitations where solutions are impossible or infeasible.

Source: Armour, Phillip G.
"Real Work, Necessary Friction, Optional Chaos"
Communications of the ACM Vol 47 No 6 June 2004

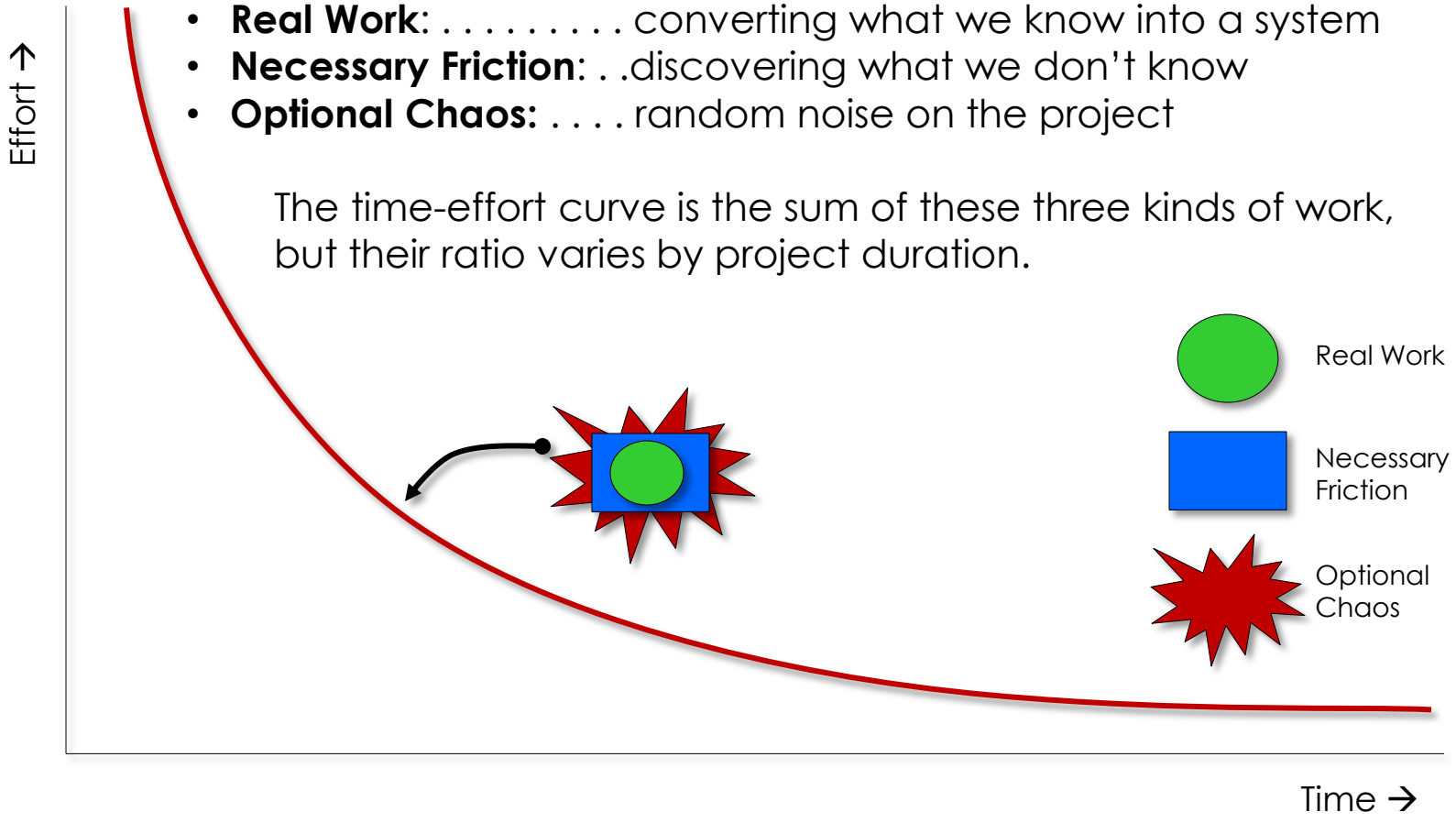
Real Work, Necessary Friction, Optional Chaos

The mathematics explains ***how*** projects function, but it doesn't explain ***why…***

There are three kinds of work on projects:

- **Real Work**: . . . . . converting what we know into a system
- **Necessary Friction**: . .discovering what we don't know
- **Optional Chaos:** . . . . random noise on the project

The time-effort curve is the sum of these three kinds of work, but their ratio varies by project duration.



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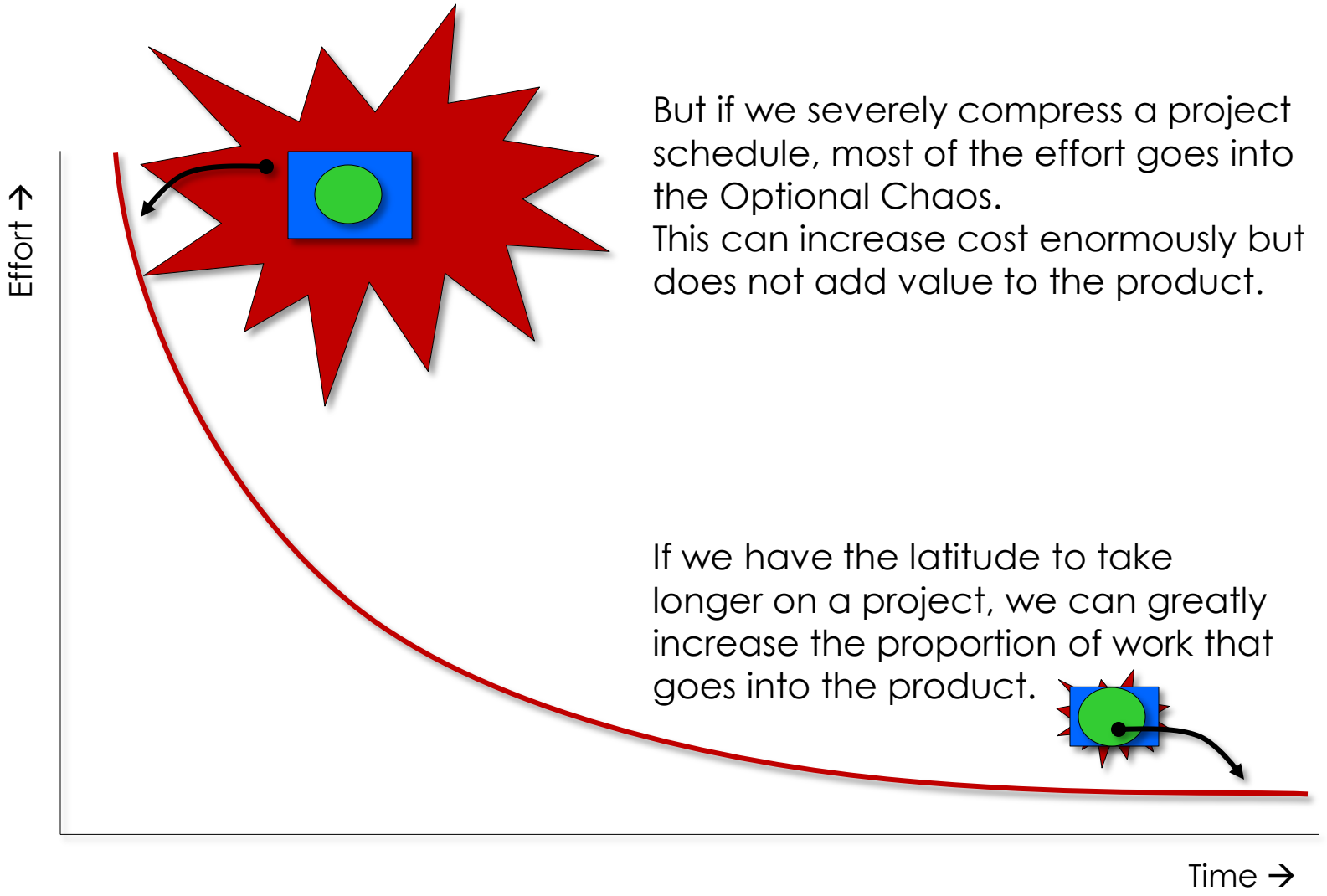
Real Work, Necessary Friction, Optional Chaos



But if we severely compress a project schedule, most of the effort goes into the Optional Chaos.
This can increase cost enormously but does not add value to the product.

If we have the latitude to take longer on a project, we can greatly increase the proportion of work that goes into the product.

Source: Armour, Phillip G.
"Real Work, Necessary Friction, Optional Chaos"
Communications of the ACM Vol 47 No 6 June 2004

The Accurate Estimate

- There are exactly ***two*** situations where an estimate value will precisely equal the actual number when the project finishes.
- Neither of these situations occur in the real world.
- We need a different criterion by which to judge estimates.

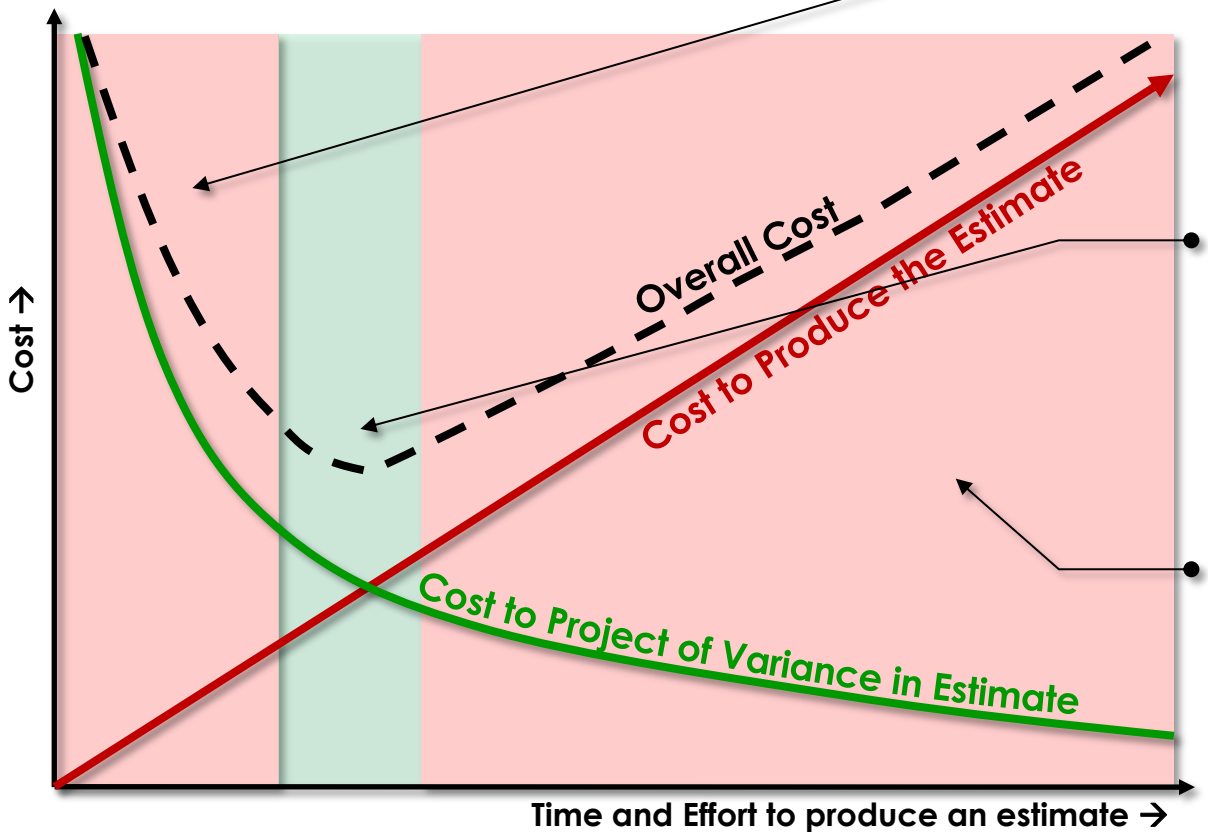
The ~~Accurate~~ *Useful* Estimate

The value of an estimate is given only by:
the degree it helps us make a more optimal business decision

- Producing an estimate is ***buying information***.
- Value is determined by:
  - How much the estimate costs to create
  - The cost difference between a business decision made using the estimate information and the same business decision made using whatever other process (such as guessing and wishing) you care to use.

Cost of Estimation

So how much should we spend to produce an estimate?



The Drive-By Estimate
Spending too ***little*** time or effort on an estimate results in a high risk of variance—the estimate is not "accurate"

The Optimal Estimate
Ideally, we would spend just enough time and effort to produce the **most valuable** estimate in the **time available**

The Never-Ending Estimate
Spending too ***much*** time and effort may "over-engineer" the estimate...
…and the clock is running!

A useful formula:

Cost_of_Estimate = *a* * Target_Cost_of_Project $^{0.35}$

Where ***a*** = **24**. . .Order of Magnitude Estimate
60. . .Budgetary Estimate
115. .Planning Estimate

Source: Remer, D.S. and Buchanan, H.R,
"A Model for the Cost of Doing a Cost Estimate,"
The Telecommunications and Data Acquisition Progress Report
JPL April/June 1992, pp. 278-283

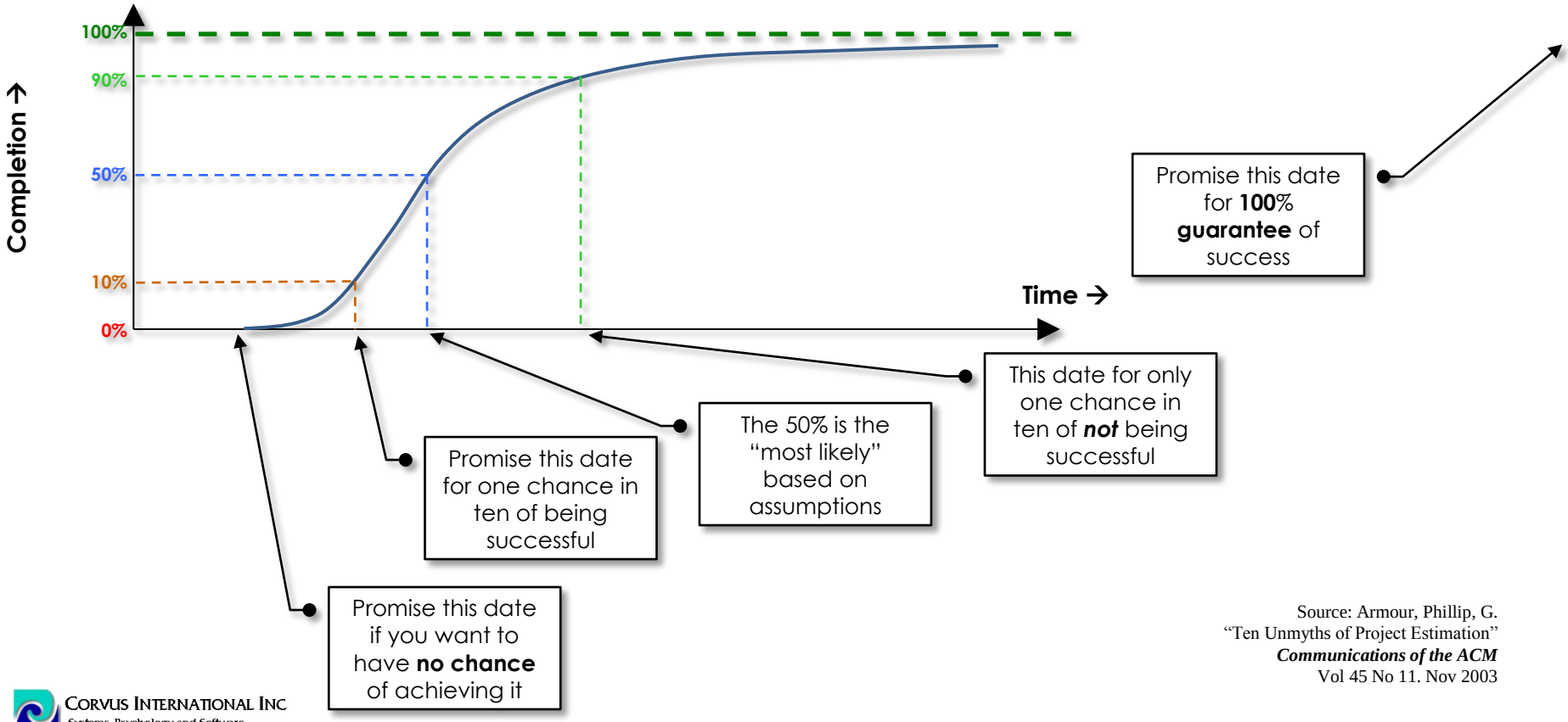
THE END-DATE UNMYTH

The job of an estimate is to tell us when the project will finish

The End-Date Unmyth

We can have any end-date we want—provided we are willing to live with the associated risk.

Risk can be expressed as the probability of ***not*** achieving the date.

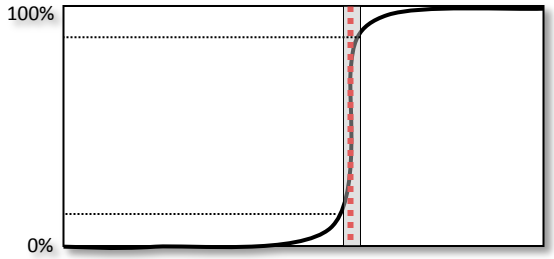


Source: Armour, Phillip, G.
"Ten Unmyths of Project Estimation"
Communications of the ACM
Vol 45 No 11. Nov 2003

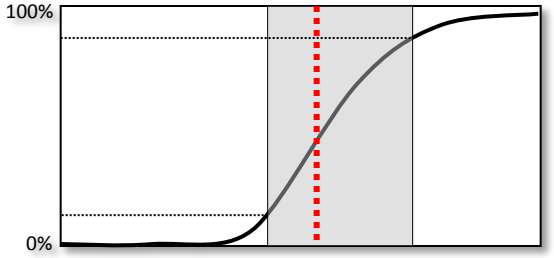
The End-Date Unmyth

The shape of the probability distribution determines the difference between the choices of dates and the risk they carry.

This shape is driven by the ***number of unknowns*** at the time of estimating.



- This project has few unknowns—the probability distribution is almost vertical.
- There is almost no difference in resources between the 10%, 50%, 90% and 100% solutions.
- This does not happen very often.



- This project has many unknowns.
- There is significant difference in required resources between low and high probability solutions.
- This is what happens in the real world.

Source: Armour, Phillip, G.
"Ten Unmyths of Project Estimation"
Communications of the ACM
Vol 45 No 11. Nov 2003

THE COMMITMENT UNMYTH

The project will commit to the estimate

Estimation is Technical [Commitment is Business]

Estimation is a ***technical*** activity of assembling technical information about a specific situation to create hypothetical scenarios that (we hope) support a business decision. Making a commitment based on these scenarios is a **business** function.

Technical "Estimation" decisions:

- When does our flight leave?
- How do we get there? Car? Bus?
- What route do we take?
- What time of day and traffic conditions?
- How busy is the airport, how long are the lines?
- What is the weather like? Are there flight delays?

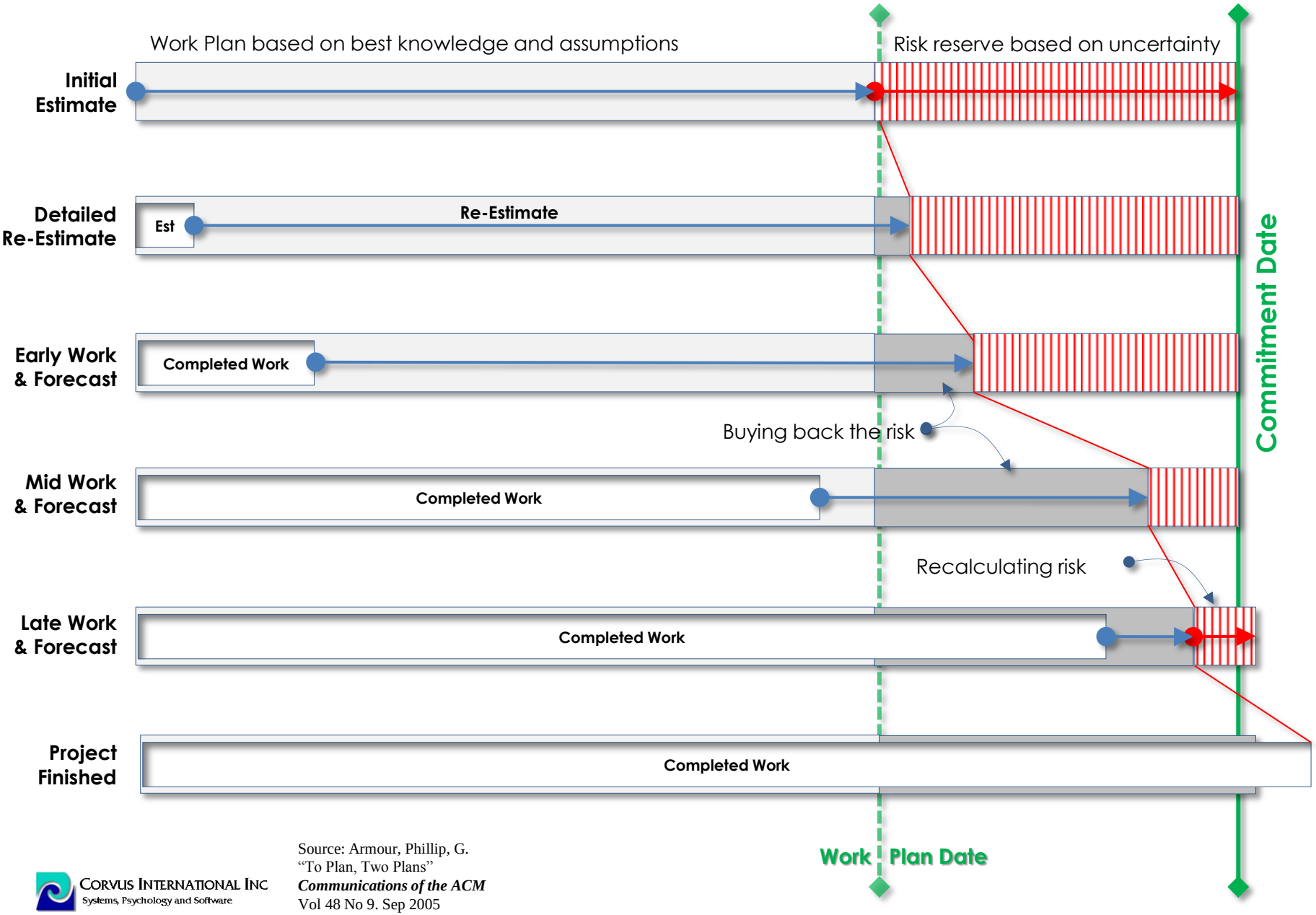
This kind of information allows us to calculate the amount of time we should allow to get there.

Business "Commitment" and Risk decisions:

- What are the benefits in catching the flight on time?
- What are the consequences of missing the plane?
- What is the cost of leaving early?

These are the *business consequences* that determine how much risk we can afford to take.

The Commitment Unmyth



Source: Armour, Phillip, G.
"To Plan, Two Plans"
Communications of the ACM
Vol 48 No 9. Sep 2005

The Commitment Unmyth

- We should not promise the results of the **estimate**—it does not cover the **cost of risk**.
- We need two plans:
  - The **work plan**—the best assumptions without assigned risk.
  - The **commitment plan**—including the calculated cost of risk. This is what we should tell the customer
- We work to the work plan, not the commitment plan.
- As the project runs, we should:
  - Measure artifact creation and milestone progress against plan.
  - Only use risk reserve for work that conflicts with assumptions, measure the burndown of risk reserve separately from regular work.
  - Dynamically adjust productivity based upon progress (artifact, milestone…).
  - Re-assess the remaining work plan based on actual productivity.
  - Re-assess the current risk level—track if: (a) risk is increasing or decreasing (b) if the risk reserve needs to be adjusted.

Sources: Armour, Phillip, G. "Ten Unmyths of Project Estimation" ***Communications of the ACM*** Vol 45 No 11. Nov 2003 & "To Plan, Two Plans" ***Communications of the ACM*** Vol 48 No 9 Sep 2005

Unmyths of Estimation

They ***look*** true, but they're not:

- **The Accuracy Unmyth:** we can get an accurate estimate if only we just use the right: process, technique, tool, calibration, data, or estimator (pick one or more)
- **The End-Date Unmyth:** the job of an estimate is to tell us when the project will finish (related to **The Budget Unmyth**, the **Headcount Unmyth**, etc.)
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Source: Armour, Phillip, G.
"Ten Unmyths of Project Estimation"
Communications of the ACM
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Myth-treating the Unmyths

- Don't treat estimates as point values—they aren't, they're probability ranges.
- A wide range means you're carrying a lot of risk—deal with it.
- Don't look for "accuracy" in an estimate—it's a contradiction and we can't measure it anyway—look for ***value***: how does it help us make a decision?
- There are formulae that address how projects typically behave—use them.
- Don't confuse an estimate with a commitment—estimation is a ***technical*** activity, commitment is a ***business*** activity.
- Estimators should not decide how much risk to take. The people who sign the checks should; they are the ones who should decide what to commit to.
- Track legitimate progress (construction, not consumption) of the project.
- Track usage of risk reserve separately from regular work.
- Recalibrate and re-forecast based upon performance. While you're doing that, don't forget to recalculate the risk.
- Track risk to see if it's growing or declining and if you will run out of risk reserve before you run out of risk.

Unmythology and The Science of Estimation

The Kraken

The Vasa

Phillip Glen Armour
Corvus International Inc.

armour@corvusintl.com
847-438-1609

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