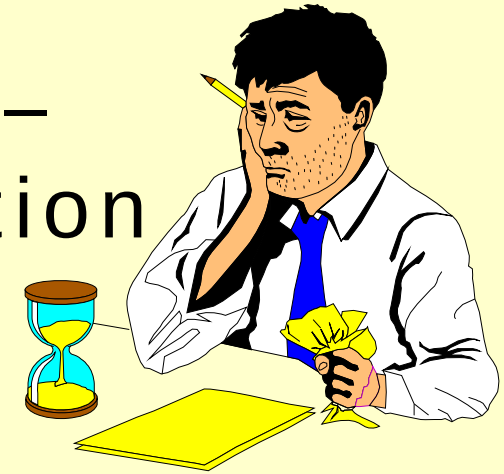
Realistic Time Estimating – A Critical Problem; & a Solution



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THE SITUATION

After developing key

ACTIVITIES & MILESTONES

to monitor

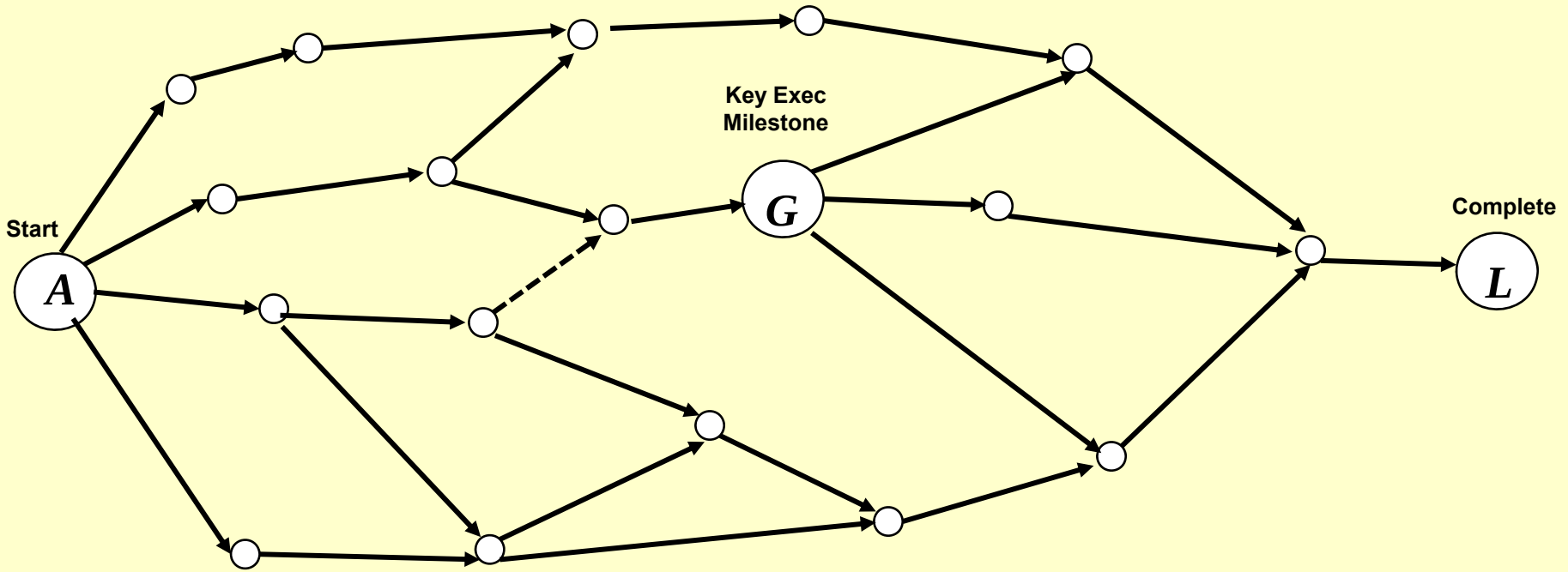
(based on the Project

WORK BREAKDOWN STRUCTURE)

& SEQUENCING THEM

in a Precedence Network

Project Activity (***Activity-on-Arrow***) & Milestone Precedence Network



1. Estimating *ACTIVITY DURATIONS*
as *Accurately as Possible*
and
2. Identifying the Project's
'CRITICAL PATH'

in terms of *Probability* **and** *Impact*

Are the next Steps
for *SCHEDULING & BUDGETING*

ESTIMATING ACTIVITY DURATIONS

TIME is fundamental to all Projects

- **Most Project Managers focus on managing TIME**
- Most **Project Management Software** focuses on **TIME**
- **Control of Time is often used to control costs**

Estimating Project Activities & Overall Duration, as well as Costs is not Easy

Estimating as Accurately as possible is important, but

- Time, Cost & Quality **affect each other**
- **How much detail do you need?**
  - **Top Down, or**
  - **Bottom up**
- **Estimating Methods affect accuracy**
- **In the Real World, Estimates and Actuals are usually different**

THE PROBLEM

Project Activity Duration Estimating & Scheduling

Time estimates are typically Over-optimistic **for one of three principal reasons:**

1. INTERNAL *MANAGEMENT-IMPOSED*

   "TOP-DOWN" DEADLINES

2. EXTERNAL *CLIENT-DRIVEN* DEADLINES

3. *INADEQUATE ESTIMATING TECHNIQUES*

   APPLIED BY PROJECT MANAGERS

   AND

   TECHNICAL SPECIALISTS

1. INTERNAL MANAGEMENT TOP-DOWN DEADLINES

2. CLIENT DRIVEN

1. **The Client establishes the project's completion deadline before technical analysis, consultation or project management feedback**
2. **In order to be "Fully Responsive" Contractors (Project Managers) accept the Client's deadline to hopefully win the contract**

3. **After technical analysis Contractors** either

- Arbitrarily "Cut and Paste" **activity time estimates to fit the Client's pre-determined schedule.**
- **Use various** estimating methods **to compute each Activity Time"**

However, IMPLEMENTATION **experience is that even these computed time estimates are usually over-optimistic** ***& unrealistic!***

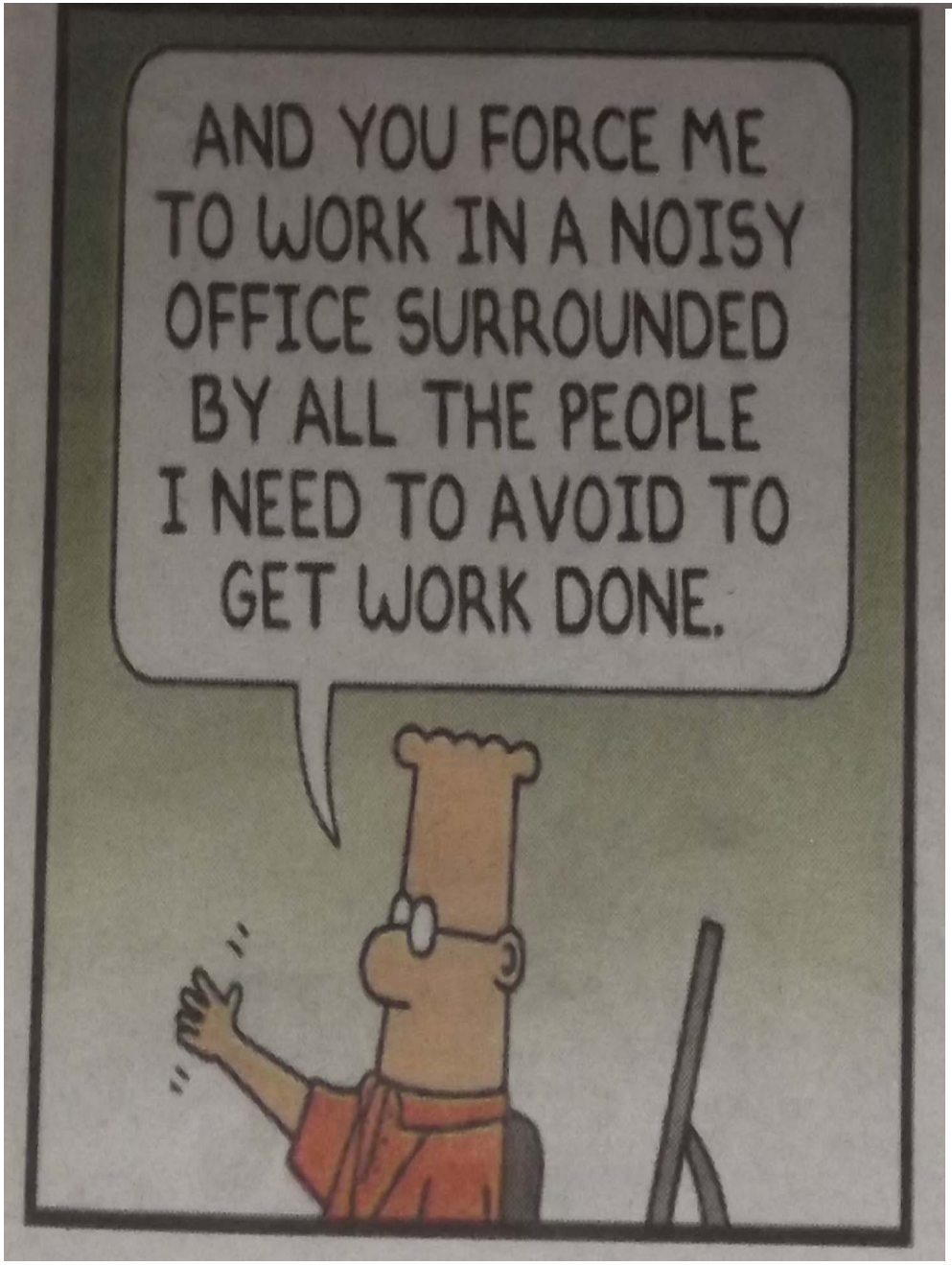
3. INADEQUATE ESTIMATING TECHNIQUES

- Analogous **(i.e. based on similar projects, or processes; usually** Top Down**)**
- Parametric Modeling **(i.e. *"Rule of Thumb"* formulas or ratios)** **Examples:**

  In software development, the number of lines of code may predict cost.

  In construction, using the per- square meter of living space to estimate cost.
- Various '*3-time*' Range **(i.e. *"Best Case, Worst Case, Most Likely")* and other 'Quick & Easy'** Risk Assessment Formulas

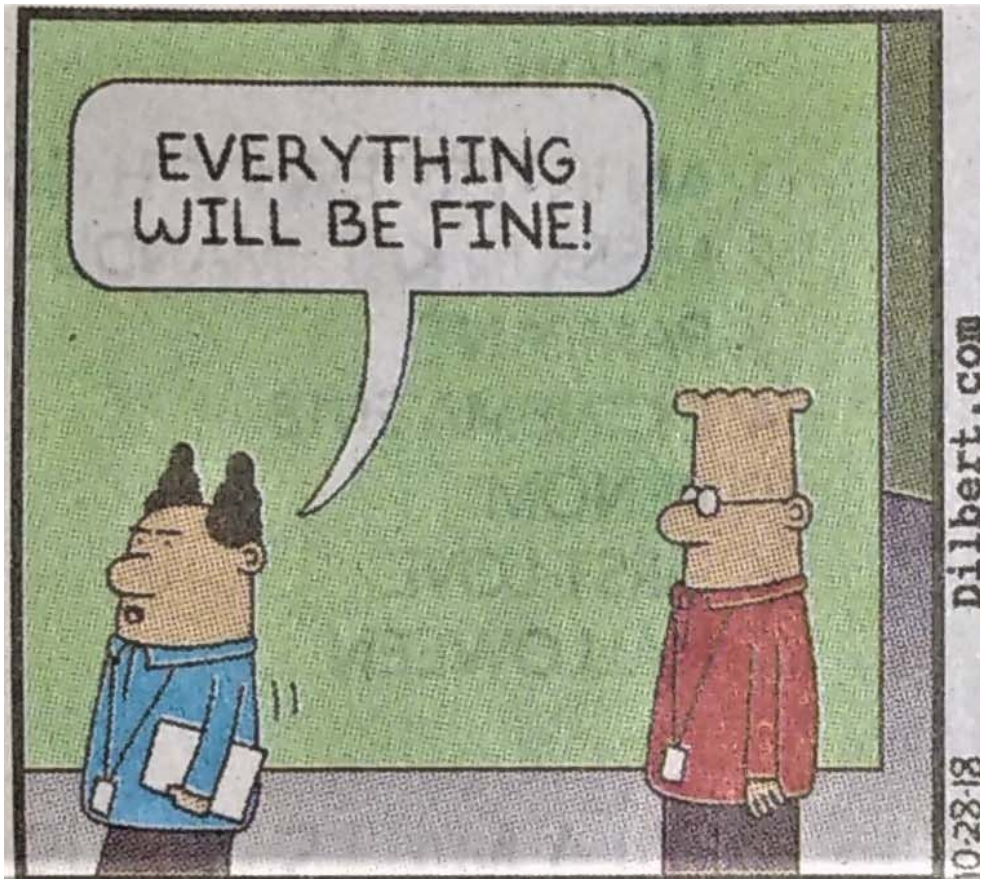
Best Case



Worst Case

Top Down Deadline!

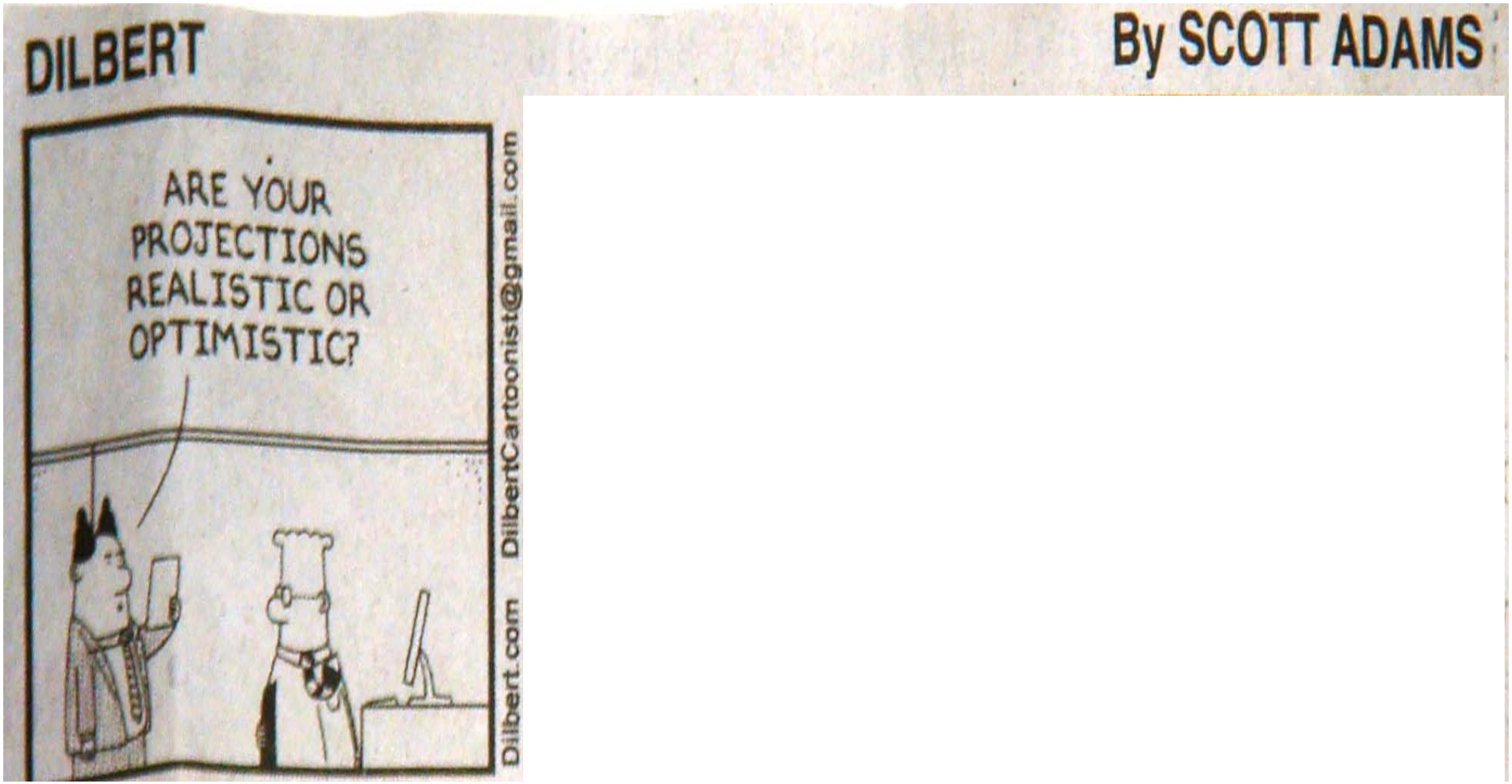
Micro-Management !

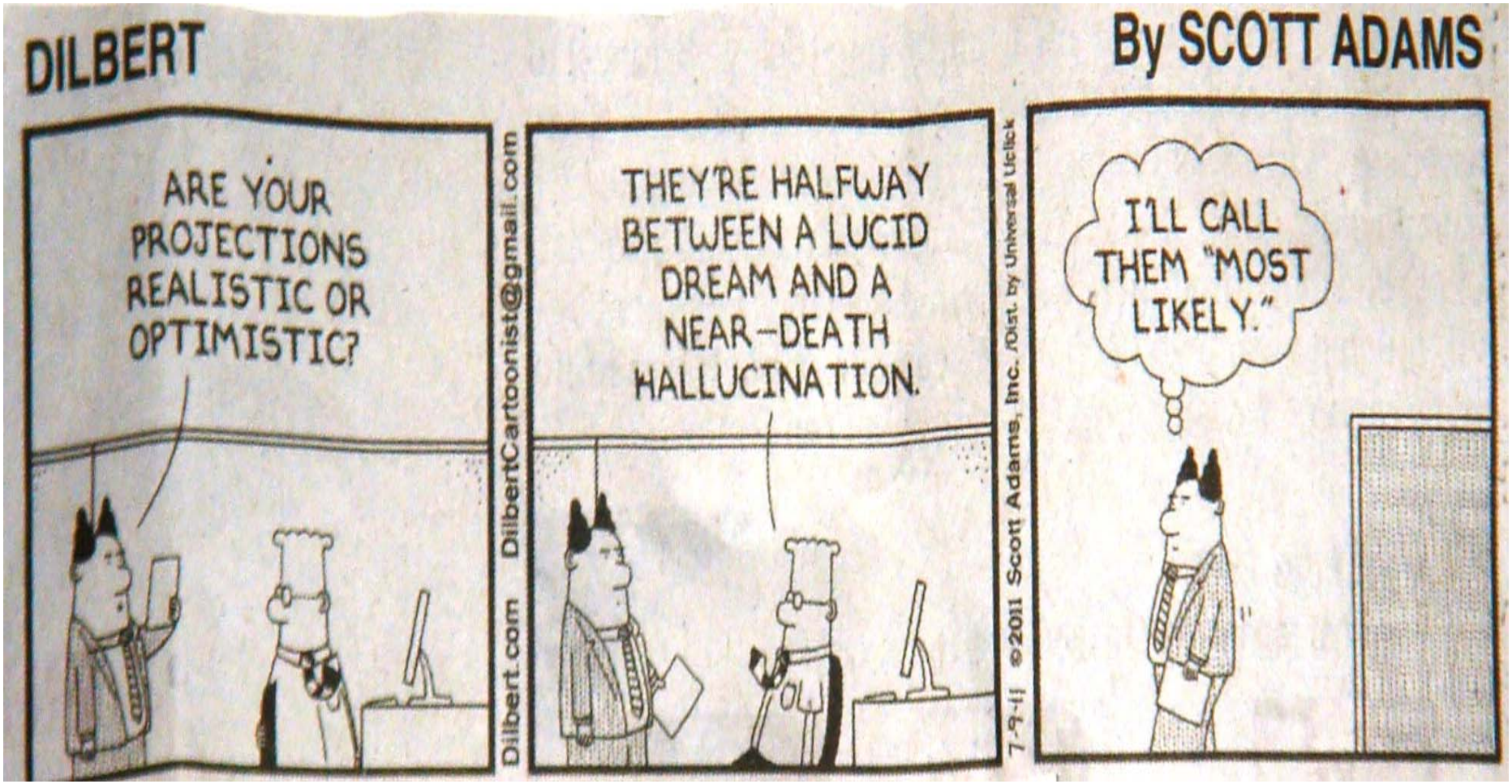


Moreover, usually, none of the above have any detailed knowledge or experience as to what is involved

or

how long it actually takes to do the work!





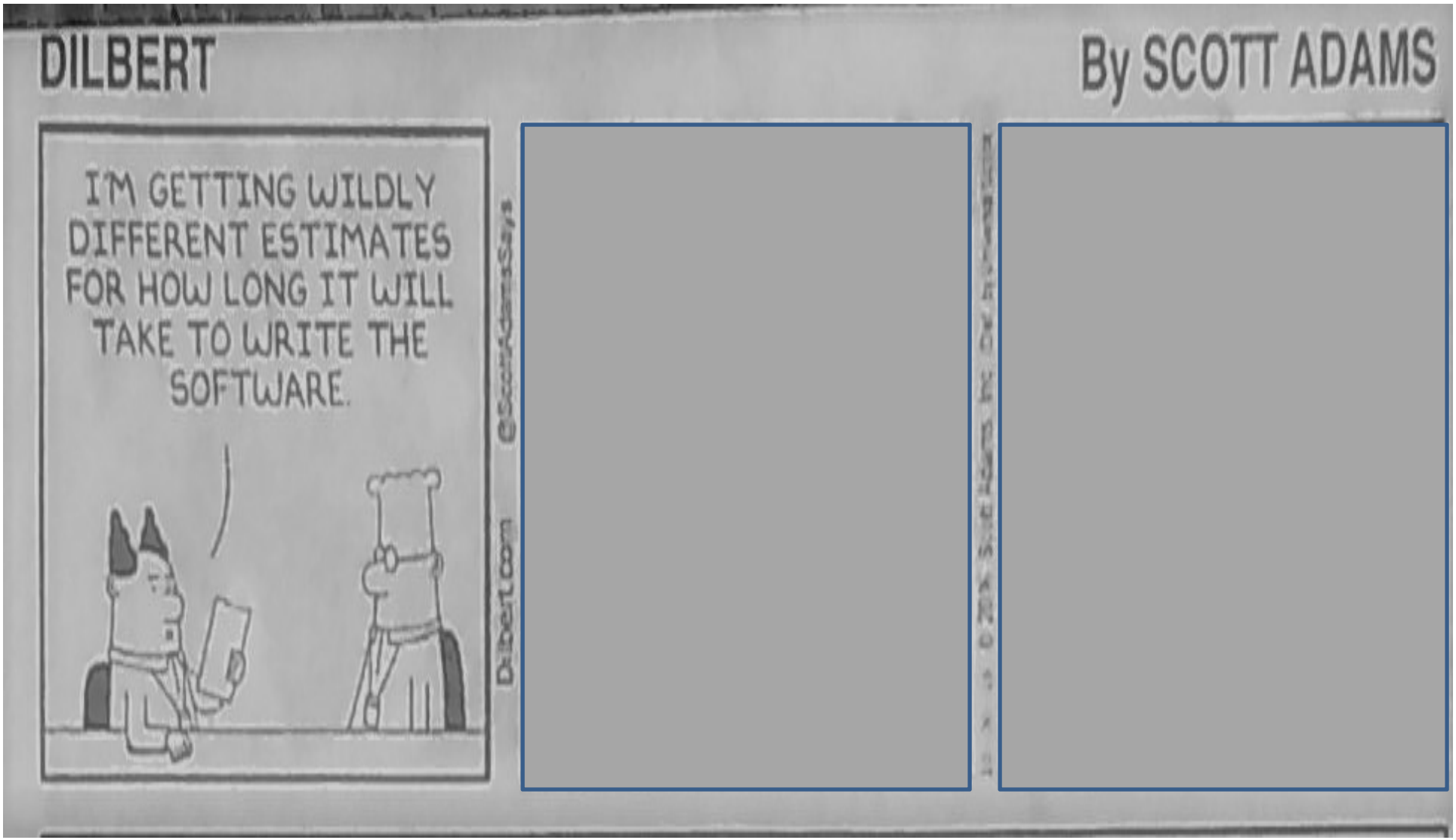
The Dilbert cartoons illustrate the problems faced by project managers & estimators,

as well as some of the terms, tools & techniques commonly used in planning:

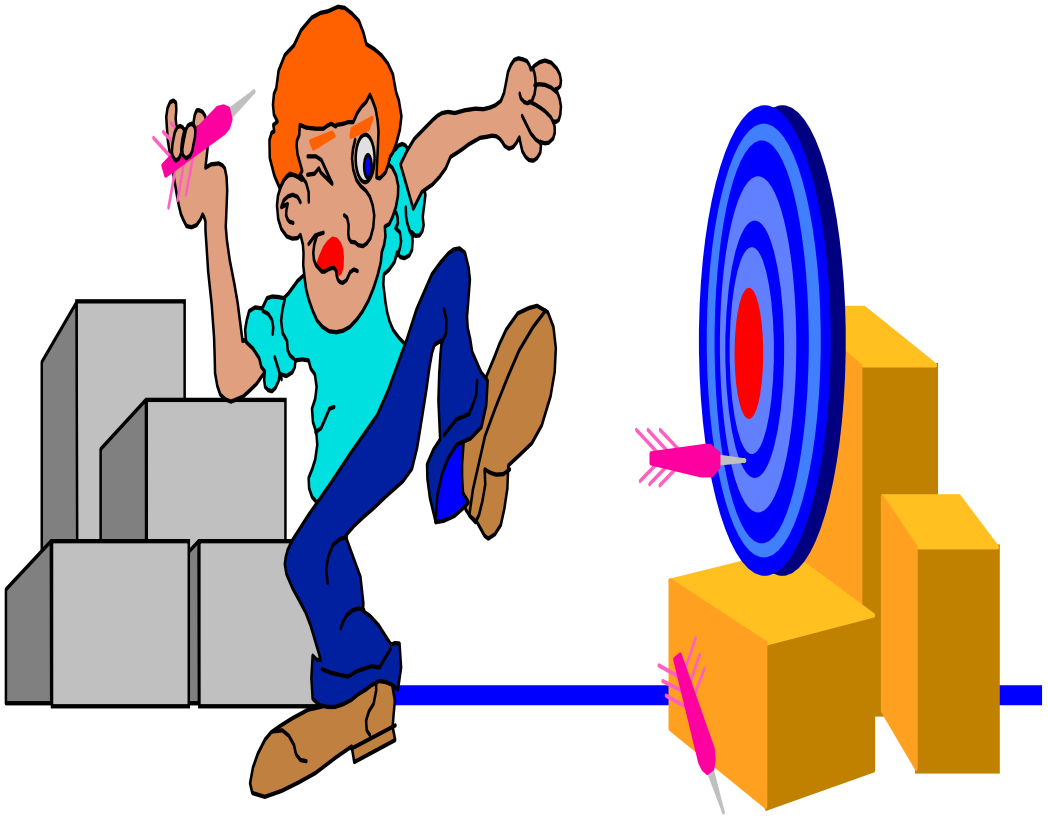
- Optimistic
- Most Likely
- Pessimistic,
- Earliest Expected, &
- Realistic

Times

RISK QUANTIFICATION APPROACHES



COMMON RISK QUANTIFICATION FORMULAE



t_e = 3 x Most Likely (ML)

$$t_e = \frac{O + ML + P}{3}$$

$$t_e = \frac{O + 4ML + P}{6}$$

t_e = 10 x ML

t_e = ?

Triangular Distribution Technique

$$t_e = \frac{O + ML + P}{3}$$

i.e. a Simple Average or "Mean"

of the range of possibilities

A 3-time *probability-based* time estimating technique *sometimes used* to estimate activity durations when there is uncertainty about their time durations

Triangular Distribution
Activity Duration Estimate

$$\frac{\text{Optimistic + Most Likely + Pessimistic}}{3}$$

Example:

Optimistic time is 10 weeks

Pessimistic time is 35 weeks

Most likely time is 15 weeks

$$\frac{10+ 15 + 35}{3} = \frac{60}{3}$$

t_e = ***20 weeks Earliest Expected Time***

The "Triangular Distribution" Formula: A Fundamental Flaw.

The Triangular Distribution formula to estimate Activity duration – i.e. the "Earliest Expected" time **-- is a** simple average, **so the *same weight is given to the two extremes* (i.e. best and worst cases) *as the "most likely"* estimate.**

However, since the Optimistic and Pessimistic estimates are extremes -- *by definition* they are less likely to occur. *Hence the formula and its resultant Earliest Expected Time computation at 50% probability is unrealistic!*

Program Evaluation & Review Technique (PERT)

"Beta Distribution"

$$t_e = \frac{O + 4ML + P}{6}$$

i.e. a Weighted Average or "Weighted Mean"

of the range of possibilities

The 'Classic' PERT/CPM 3-time *probability-based* time estimating technique *which is more often used* to estimate activity durations when there is uncertainty about their time durations

PERT Method – Activity Duration Estimate

$$\frac{\text{Optimistic} + (4 \times \text{Most Likely}) + \text{Pessimistic}}{6}$$

Example:

Optimistic time is 10 weeks

Pessimistic time is 35 weeks

Most likely time is 15 weeks

$$\frac{10+(4\times15)+35}{6} = \frac{10+60+35}{6} = \frac{105}{6}$$

t_e = ***17.5 weeks, or 18 weeks (rounded up)***

Earliest Expected Time

The "PERT" Formula (Beta Distribution) A Fundamental Flaw, & Caution

The PERT formula to estimate Activity duration – i.e. the "Earliest Expected" time **-- is a** weighted average that attempts to rectify the undue bias in the Triangular Distribution.

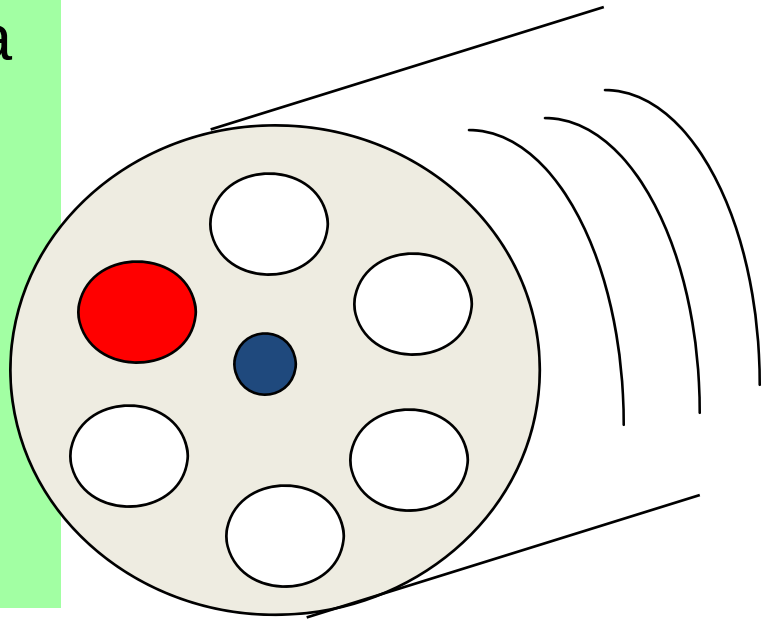
Nevertheless, *the probability of completing the Activity by the* "Earliest Expected" time ***is still*** *only 50%*

In other words, at the outset, the Activity duration is *under-estimated half of the time*, *so there is an equal likelihood the Earliest Expected time computed will not be met, but will be overrun.*

Russian Roulette *"RR"*

Therefore, Project Managers who use the Standard PERT 3-Time formula to estimate project Activity timing run a high risk of Failure . . .

Even <u>Worse</u> than Playing RUSSIAN ROULETTE !!!



Russian Roulette *"RR"*

What is the Probability of Surviving "RR" with One Round in a Six Cylinder Chamber Revolver?

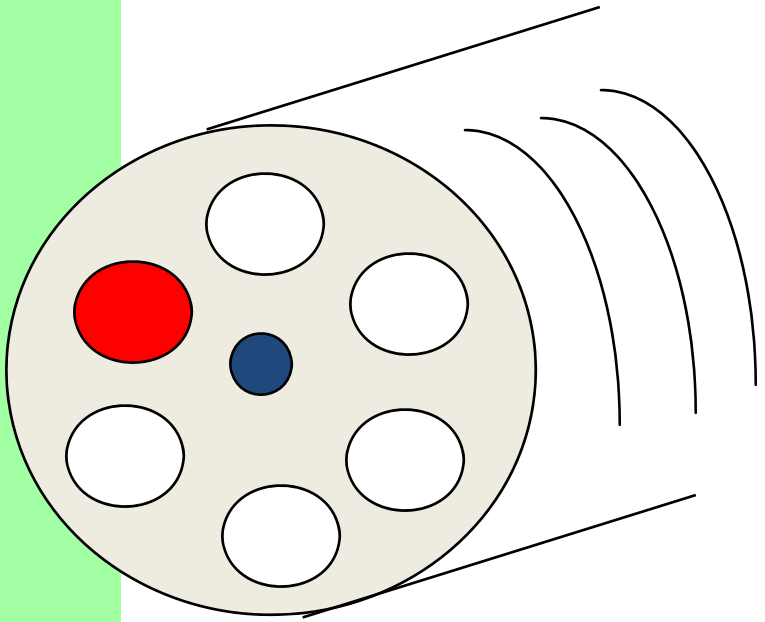
- ***Point the Gun at Your Head***
- ***Spin the Chamber***
- ***Pull the Trigger***
- ***Probability of being killed is***

1 / 6 = 17 %

& *Probability of Surviving*

= 100% - Probability of Dying

= 83%

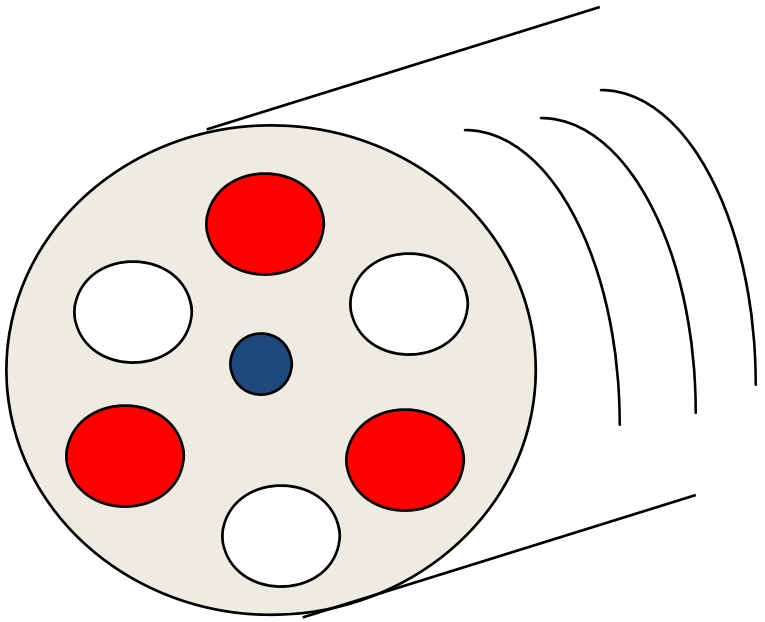


Russian Roulette *"RR"*

And the Probability of <u>Surviving</u> with:

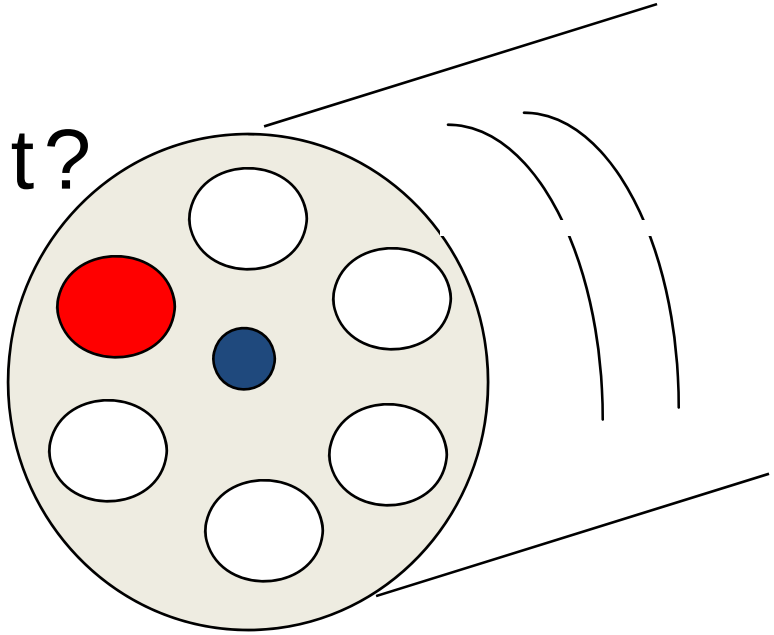
***Three Rounds* in the Chamber**

= 3 / 6 = 50 %



This is the same probability as the PERT "3 time" weighted-average estimating formula!!!

Would *You* play Russian Roulette with One bullet?



NO? **Then why expect** Project Managers **to Estimate & Schedule Project Activities with the** "PERT 3 Time Formula" *Which is the equivalent of Russian Roulette with Three bullets?*

Another Issue to consider when estimating Activity Durations is

“Touch Time”

Key 'Time' Concepts

"Touch-time" **= The amount of direct *on-the-job* working time needed to perform an Activity**

"Waiting (Idling) time" **= The time when an Activity is on-going *(i.e. started, but not yet finished)* but with nothing productive happening**

"ESTIMATED ACTIVITY TIME" **= *Should be the*** Touch time ***plus*** Waiting time

"Opportunity time" **= Waiting time when *– if given the resources* – productive work could be done on the activity; another task, or an activity on another project.)**

In many project working environments
considerable amounts of
"Waiting" & 'Opportunity time' exist

Particularly matrix organizations where equipment and personnel resources are shared, outsourced and/or team members are often concurrently assigned to support multiple projects,

but are *beyond the control of individual project managers***.**

Touch time **for an activity could be as little as 10% of the Actual** Elapsed time**!**

Since the Project Schedule **(time plan) is the basis for establishing the** Project Budget **(money over time)**

Effective Activity Time Management is the Key to curtailing Costs as well as accelerating Schedule performance

Recommended Project Management Strategy:

If it's Late, Don't Wait!

Follow up.

SINCE Touch time **for an activity could be as little as 10% of** Elapsed time

A 'Quick & Easy' Guide to Estimating your "Pessimistic Time" – i.e. your *Worst Case* -- is to:

Multiply your "Most Likely Time" by 10 !

BUT YOU PROBABLY WON'T BE ABLE TO JUSTIFY THAT!

THE SOLUTION

However, we <u>CAN</u> apply

PROBABILITY THEORY

to develop
a more

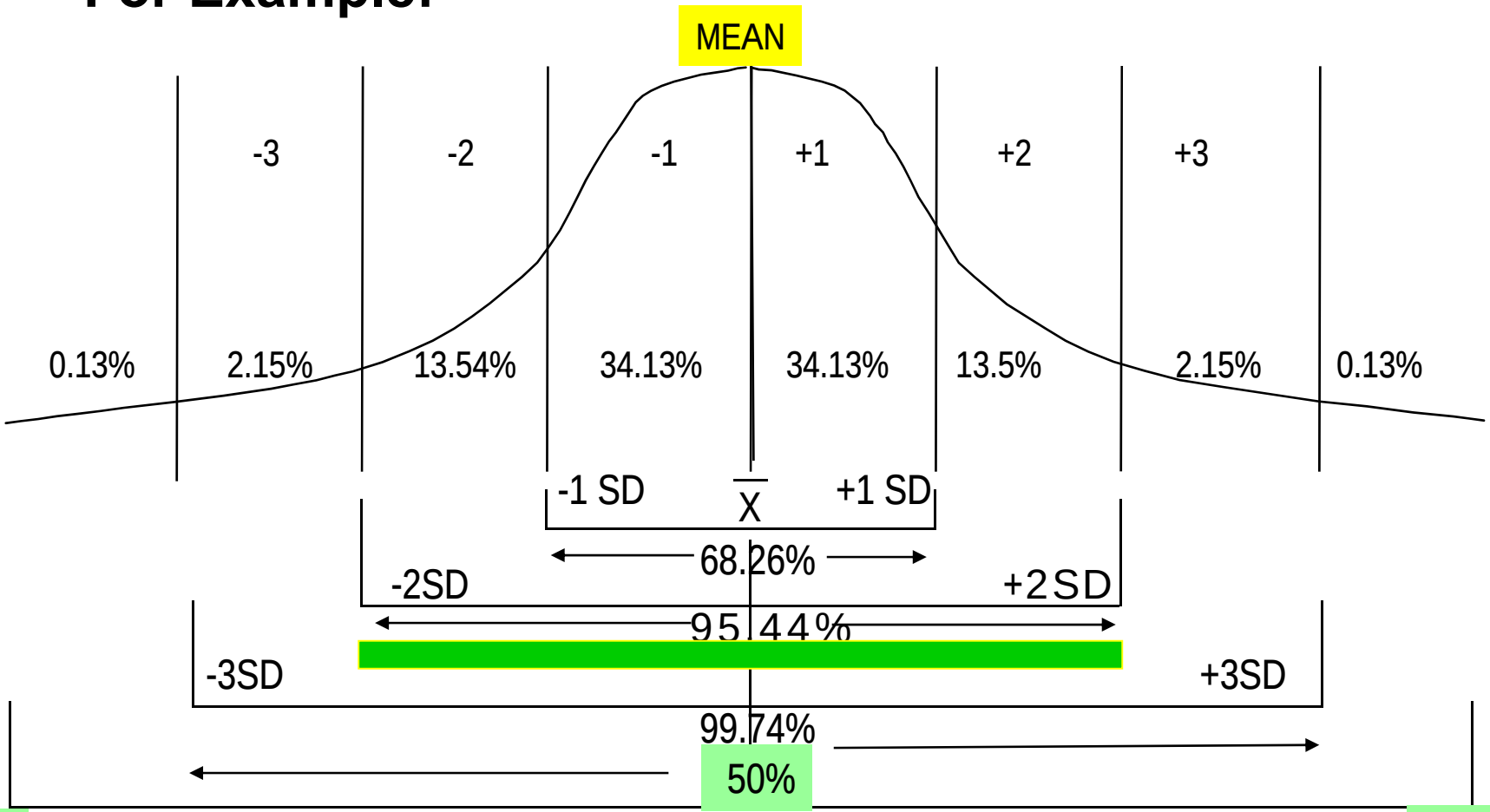
REALISTIC ESTIMATE

The Essential Elements of PROBABILITY Estimating are the MEAN & the STANDARD DEVIATION:

- The **Mean** (***Average)*** is a measure of **"Central Tendency"** – *i.e. the midpoint in a range of values*
- The **Standard Deviation** is *the Opposite of a Mean.* **The SD** measures the ***variation from the Mean"*** at fixed **percentage intervals,** of a set of data values -- *effectively the area under a 'normal distribution curve' between selected values in the range.*
- The **Probability of any value occurring** in a normal range is **then the size of its standard deviation –** *i.e. its distance from the mean* ***– as a percentage***

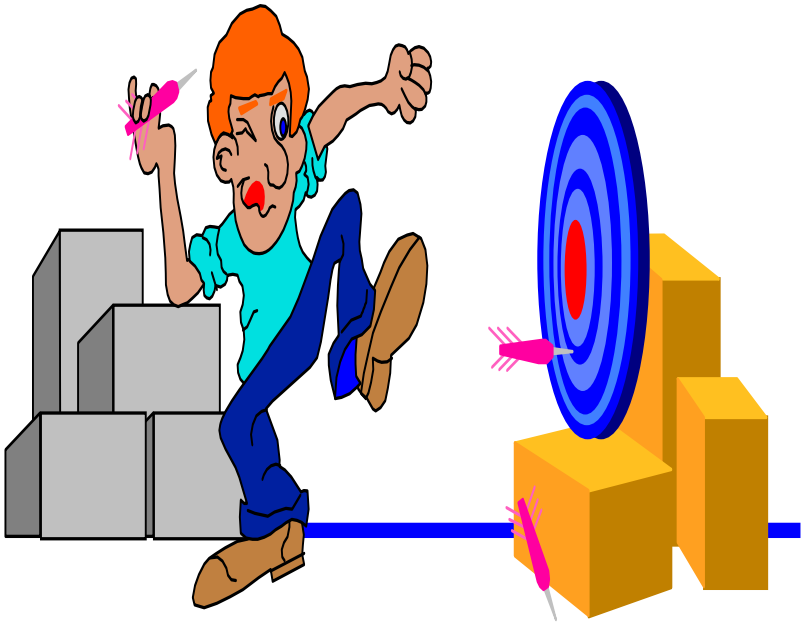
NORMAL CURVE, RANGE, STANDARD DEVIATION, and RELATED PROBABILITIES

For Example:



0 % *CUMULATIVE PROBABILITY,* from OPTIMISTIC to PESSIMISTIC ESTIMATES 100%

Who Provides the Best Estimates?



- **Those Accountable for the work (i.e. First Line Supervisors)**
- **Those who know the work (Senior Technical Specialists)**
- **Those who Actually do the work (Journeymen)**

PERT Formula — A Work-Around Solution

Ken Smith's "Realistic Time" Strategy

Given the range of Optimistic, Most Likely & Pessimistic estimates available,

1. **Use the 3-time PERT beta distribution formula *as the first step* to estimate the Mean for each activity during the planning stage.**
2. **Then *add two standard deviations* to the PERT Mean.**

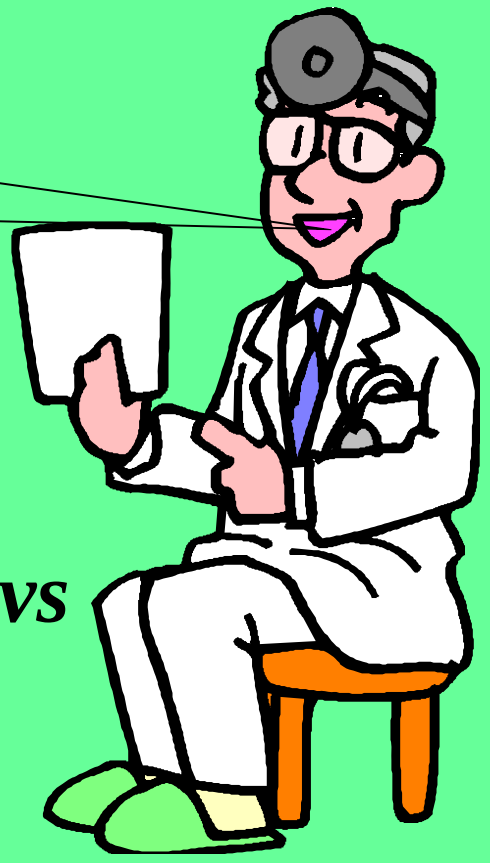
Using this new duration will increase the probability for completing the activity from 50% to 95%

"It is better to be approximately right Than Precisely Wrong!"
Warren Buffet

Realistic Activity Time

***Dr. Ken's* prescription for improving activity duration estimating**

Take 1 PERT + 2 ESD's



$$te_r = \frac{opt + 4\ ML + pess}{6} + 2\ Std.\ Devs$$

NOTE: Very Practical, but Not in PMBOK or PMP Exam

Basic PERT/CPM Formula

$$\textit{Earliest Expected Time} = \frac{\textit{opt} + 4\,\textit{ML} + \textit{pess}}{6}$$

$$\textit{Activity Estimated Standard Deviation} = \frac{\textit{pess} - \textit{opt}}{6}$$

$$\textit{Two Estimated Standard Deviations} = \frac{\textit{pess} - \textit{opt}}{3}$$

Ken's "Realistic Time" Method:

$$\frac{\text{Optimistic} + (4 \times \text{Most Likely}) + \text{Pessimistic}}{6} + 2\ \text{SDs}$$

Example:

Optimistic time is 10 weeks

Pessimistic time is 35 weeks

Most likely time is 15 weeks

$$\frac{10+(4\times15)+35}{6} = \frac{10+60+35}{6} = \frac{105}{6} = 17.5 \text{ weeks}$$

1 SD = (35 – 10)/6 = 25/6 = 4.16 & 2 SDs = 8.33

So Realistic Time = 25.83, or 26 weeks (rounded up)

For a 95% probability of Success in attainment.

Project Activity Duration Estimating & Scheduling

MY SUGGESTED REMEDY

CONTRACTOR RESPONSE: Contractors *(Project Managers)*

- ***Conduct aTechnical Analysis*** *using* ***my supplement*** ***to the PERT 3-time estimating approach*** *to improve the probability of developing a more realistic time estimate*
- ***Provide feedback to the Client ASAP*** *-- Brief the Client to demonstrate why their deadline is unrealistic, and appeal for duration extension, or reduction in Scope of Work before submitting a bid*
- ***If Client insists on the Original Project Completion Deadline &/or Scope,*** *Either*
  - ***Get a change order ASAP*** *if you are the successful bidder*
  - ***Don't Bid,*** *and consider yourself lucky you won't have to deal with the time, cost & quality problems that will inevitably arise!*

XPERT
Crispin Piney's Formula

The '*pessimistic time*' attempts to capture the "*Known-Unknowns*"

The following formula by Piney is another systematic approach to take "*Unknown-Unknowns*" into account

XPERT = PERT + 2(Pess – PERT)/3

= 17.5 + 2(35 – 17.5)/3

= 17.5 + 2(17.5)/3

= 17.5 + 35/3

= 17.5 + 11.7 = 29.2 weeks

A NOTE ON PROBABILITY

Remember . . .

- **A Risk Event *could still occur* Despite a Low Probability**

and

- **A Risk Event *might not occur* Despite a High Probability**

There are No Guarantees !!!

I developed an Excel Template that takes these -- *and other* -- probabilities into account

TOOLKIT TEMPLATE 2-10a

ESTIMATING ACTIVITY DURATIONS FOR PLANNING & SCHEDULING *UNDER CONDITIONS OF UNCERTAINTY*

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NOTE: The Probability of SURVIVING Russian Roulette is 83% !

Activity #	PERT FORMULA (O + 4 ML + P) / 6		Ursula Kuehn's* Worksheet to Estimate "P" in PERT Pessimistic Time Formula **"What Could Go Wrong?"**			PERT FORMULA	Dr. Ken's REALISTIC FORMULA*	Enter DESIRED Probability % for "Known Unknowns"	Crispin Piney's Formula (Includes Buffer for "Unknown Unknowns")
	Enter O, ML & P Time Data in cells Below		*Integrated Cost & Schedule Control in Project Management. 2nd Edition. Management Concepts *Identify* Top Three Risks			*P = MURPHY's Law: What if ALL THREE Risks Occur!*	50% PROBABILITY	PERT + 2ESDs 95.44% PROBABILITY	99.00	PERT + 2((P-PERT)/3)
	OPTIMISTIC TIME	**MOST LIKELY TIME**	Risk 1	Risk 2	Risk 3		EXPECTED TIME DURATION	REALISTIC TIME	Your Time	XPERT Time
1	**10**	**30**	150	90	40	200	55.00	118.33	136.38	151.67

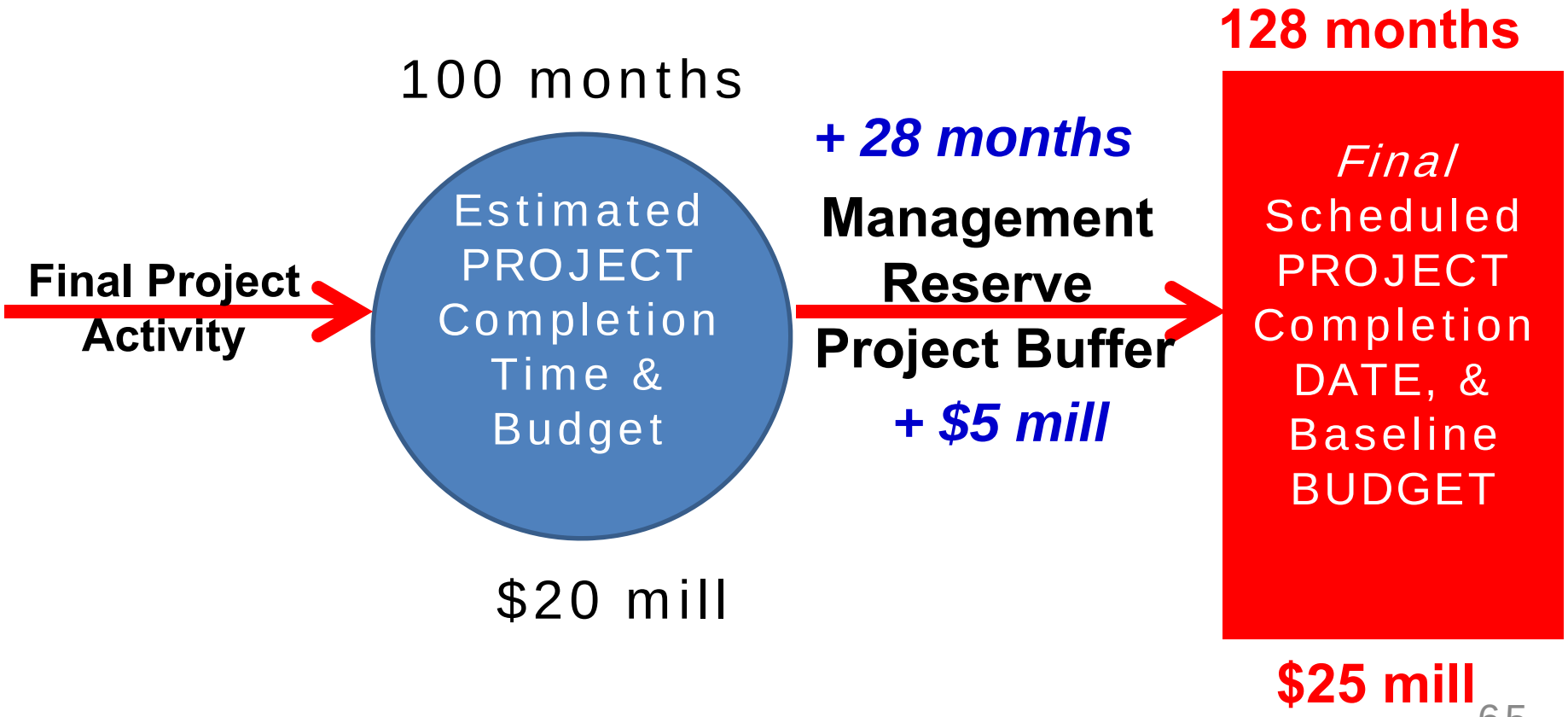
ANALYSIS OF *PROJECT-SPECIFIC* RISKS TO IMPLEMENTATION

After estimating individual activity durations and determining the Project's Critical Path

it is also important to Establish a TIME & COST MANAGEMENT RESERVE BUFFER in the event that pre-identified Project-specific risks* occur

***i.e. "Known-Unknowns in PMI's PMBOK language**

Then insert a final *pseudo-activity* Project Buffer on the Project's Critical Path, with *Estimated Values* for Time & Cost.



ISSUE

How much Time & Money should you set aside in this *Management Reserve Buffer?*

5%, 10%, 15% . . .

??%

AGAIN . . .

Estimating Risk Exposure
through
Probability & Impact Analysis

Provides a Solution!

Decision Tree Analysis

is a good technique for looking at generic Overall Risk Exposure

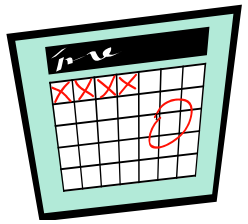
confronting the Project

And estimating the Time & Budget Management Reserve

Decision Tree / Risk Breakdown Structure

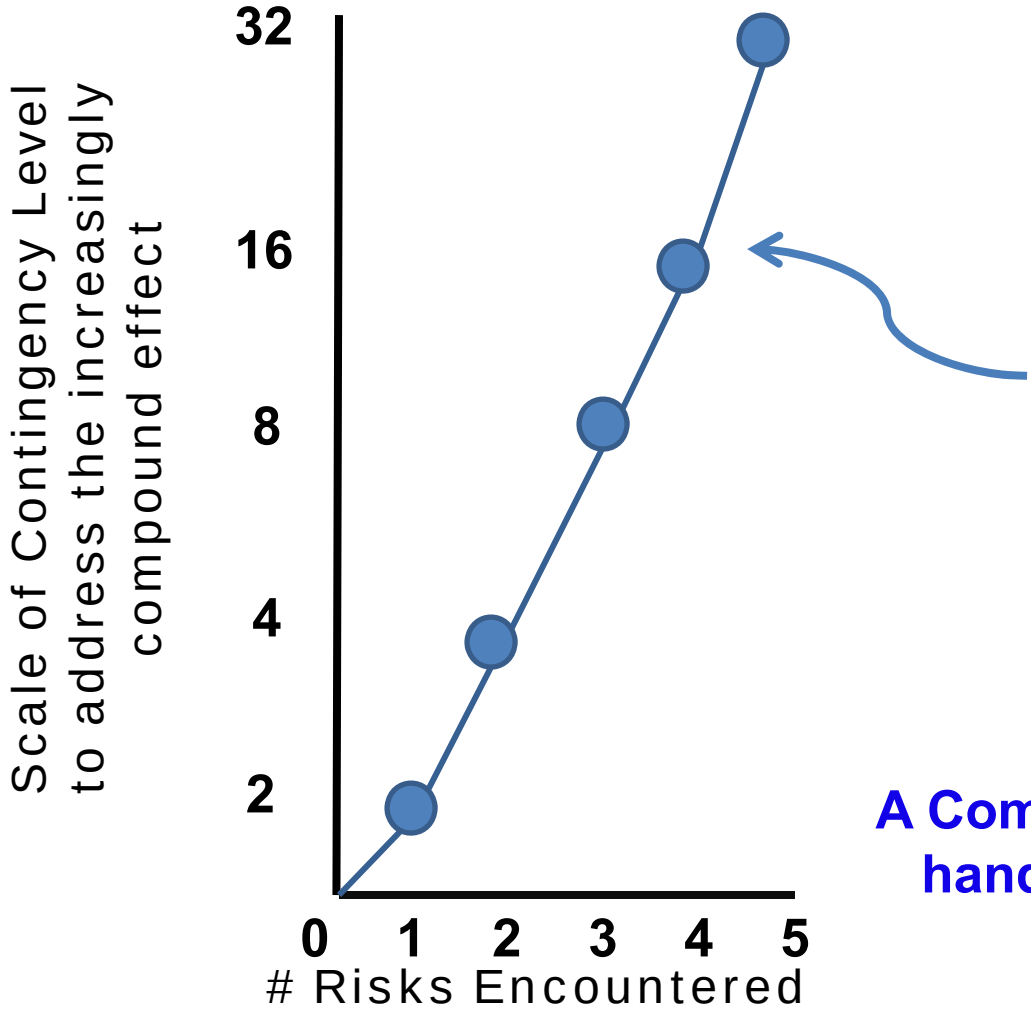
to Analyze the Probability of up to Five Sequential Risk Tiers

Etc., etc., resulting in 32 separate different possible outcomes for Five Sequential Risks



Each of which affect the schedule and budget in different ways!

Exponential Contingency / Management Reserve Needed to address the Cascading Effect of Additional Risks Likely to be Encountered



The Cumulative Impact of "Murphy's Law"

"If anything can go wrong, it will, and at the worst possible time"

A Computer Program is needed to handle all the possibilities and outcomes

2. Applying the Decision Tree / Risk Breakdown Structure (DT/RBS) Technique

I developed another Excel Template
to Estimate PROJECT
Schedule Buffer & Budget
Management Reserves

DECISION TREE ANALYSIS [5 Tier Scenario]

TOOLKIT TEMPLATE 1-8

Project ID: FOR ESTIMATING A SCHEDULE BUFFER & MANAGEMENT RESERVE BUDGET

An "*A Priori Analysis*" of Possible Outcomes for [*Up to Five*] Mutually Independent Risks

Enter Risks and data in the Yellow Cells Below

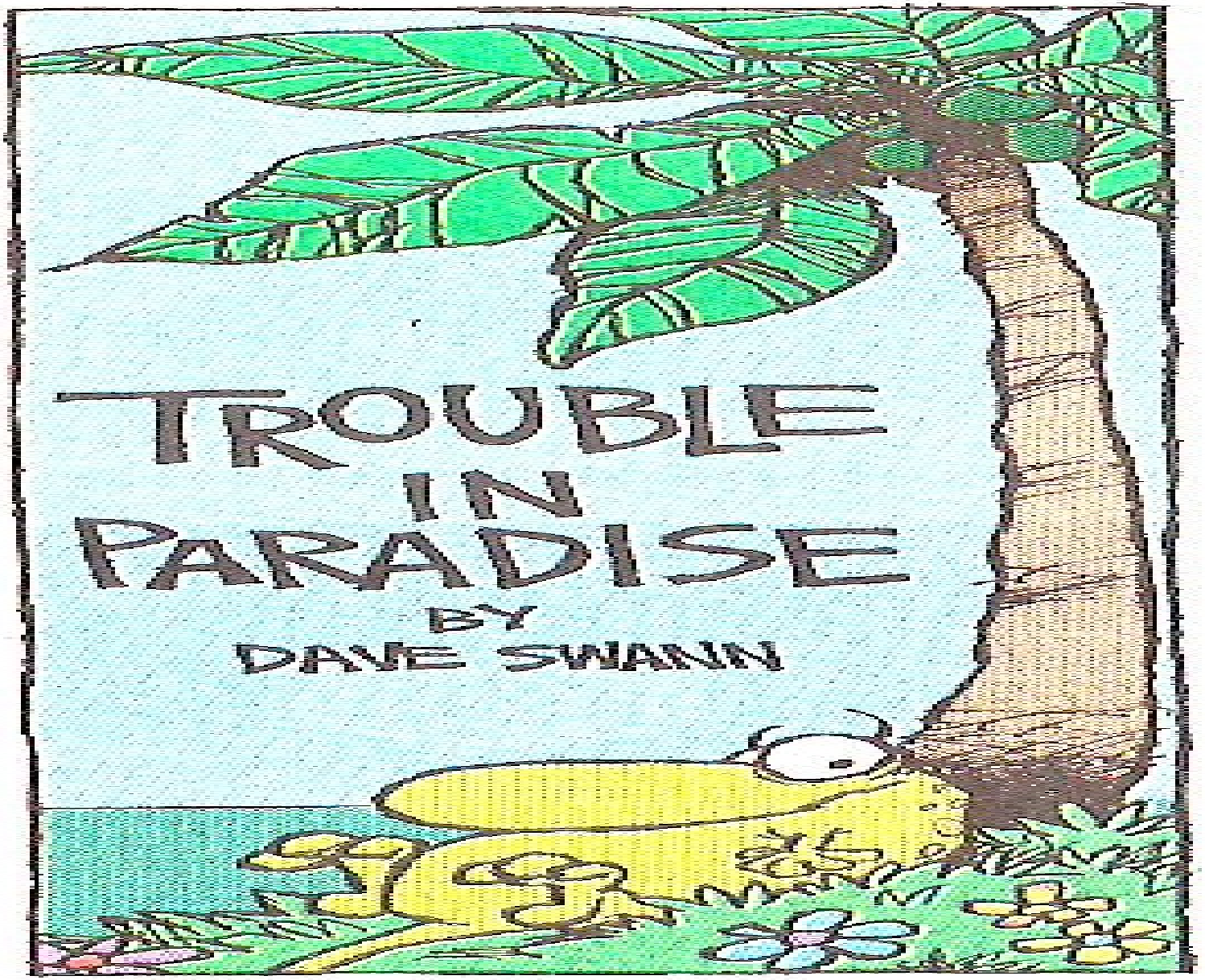
"Murphy Cascade" i.e. YOUR Estimated IMPACT if ALL KNOWN RISKS Occur

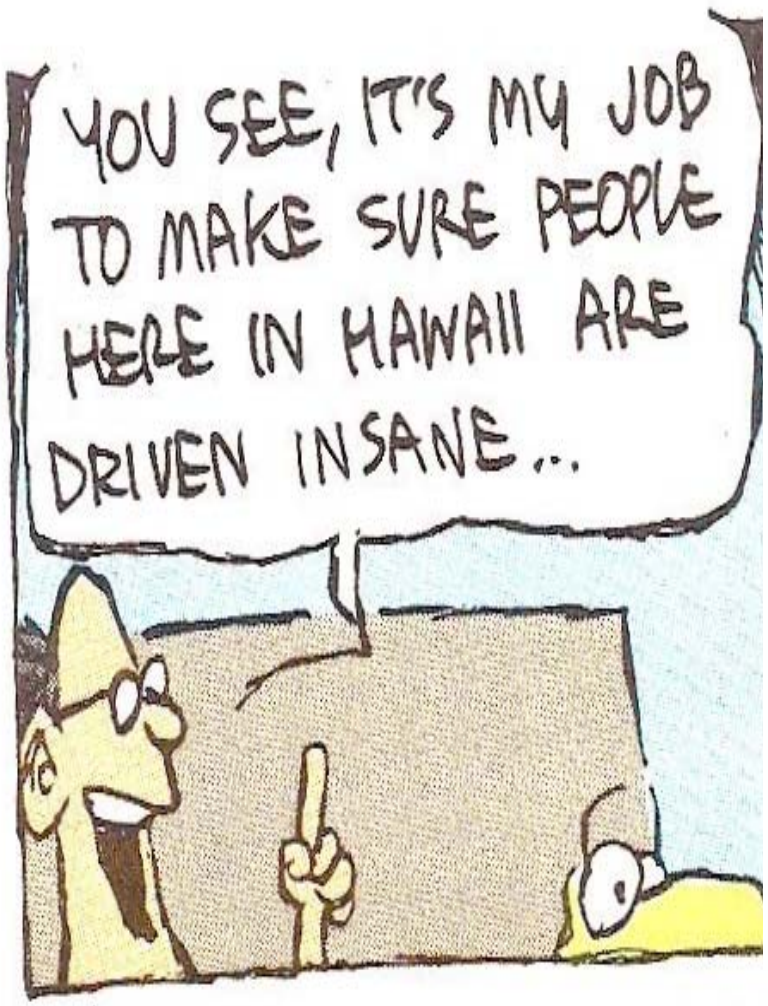
Murphy Cascade = All Risks Occur

3.06% = Cascade Rate

Computation Basis

		OBJECTIVE	RISK 1		RISK 2		RISK 3		RISK 4		RISK 5								
			Probability	Impact	Probability	Impact	Probability	Impact	Probability	Impact	Probability	Impact	EXPECTED IMPACT	TOTAL "As is" IMPACT	"Murphy Cascade" i.e. YOUR Estimated IMPACT if ALL KNOWN RISKS Occur	Added Cumulative Cascade Effect	SUGGESTED CONTINGENCY SCHEDULE & BUDGET	SUGGESTED REVISED SCHEDULE & BUDGET	Actual Number of Risks in Each Scenario	Effect in Each Scenario
		PLANNED SCHEDULE	Poor Design	Ceiling Estimate	Unavailable Skills	Ceiling Estimate	Equipment Breakdown	Ceiling Estimate	Bad Weather	Ceiling Estimate	Civil Disorder	Ceiling Estimate	for CONTINGENCY	SCENARIO OVERUN						
	Time Unit =	days		days		days		days		days		days		days	days	days	days	days		
Alt	Input Drivers:	124	15%	5	10%	10	13%	3	30%	15	10%	10	7.64%	43	50	8.01	51	175		
	Money Unit	$m		$m		$m		$m		$m		$m		$m	$m	$m	$m	$m		
	Input Drivers:	$244	15%	$20	10%	$3	13%	$5	30%	$6	10%	55	7.62%	$89	$95	$8	$100	$344		





Mahalo!

Questions?