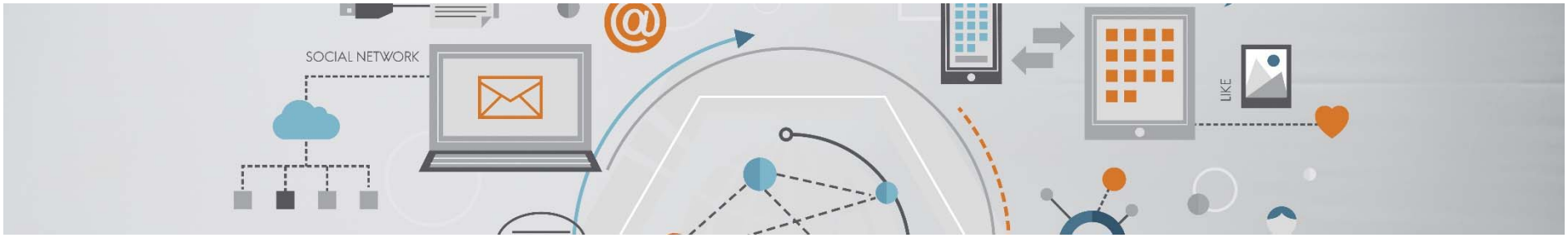
Estimation and Earned Value Management for ICT Projects

Agenda



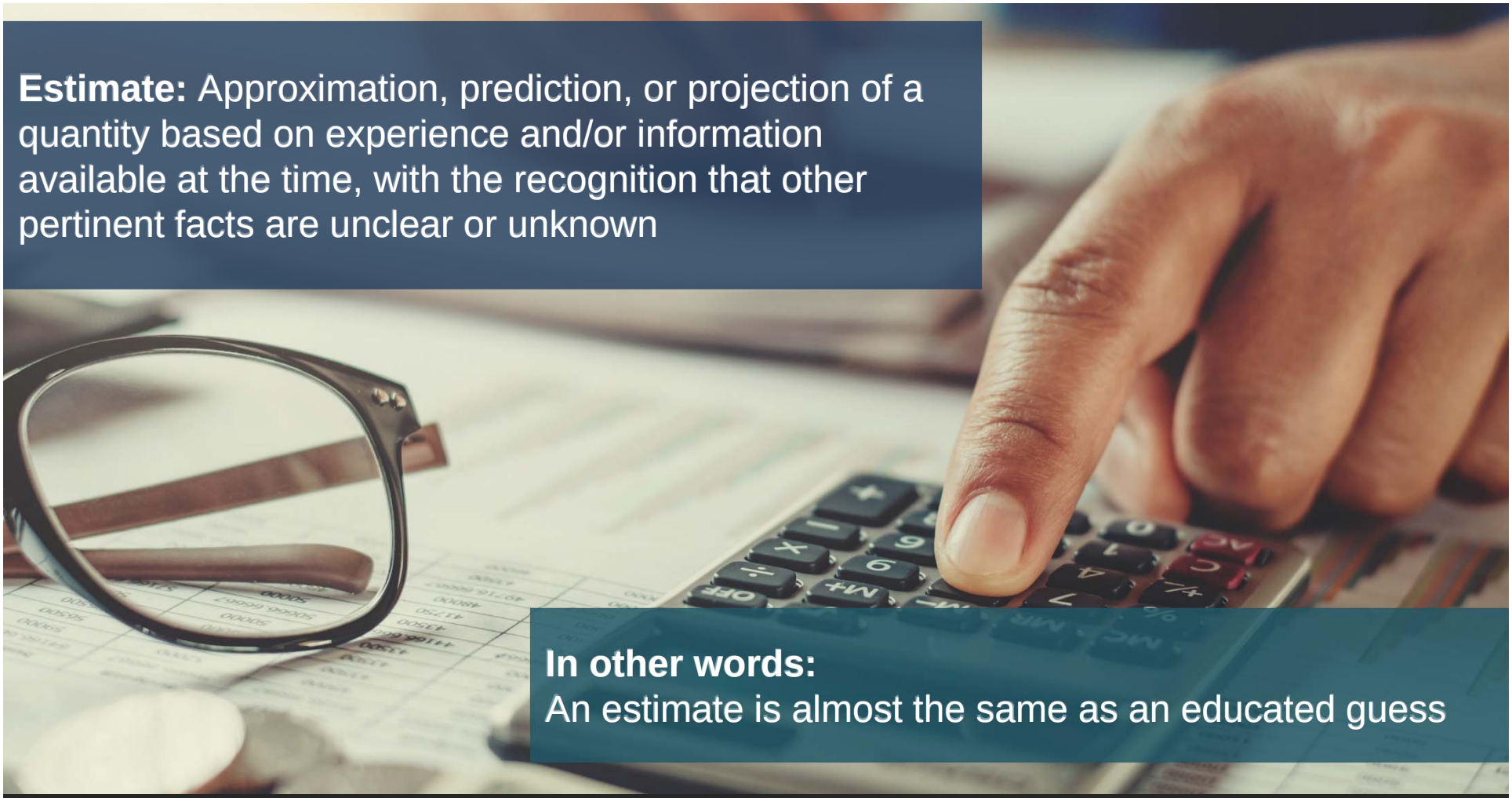
01 Estimation Best Practices

02 Overview of the Work Breakdown Structure (WBS)

03 Earned Value Management

Estimation Best Practices

What is the difference between an estimate and a guess?


Estimate: Approximation, prediction, or projection of a quantity based on experience and/or information available at the time, with the recognition that other pertinent facts are unclear or unknown
In other words:
An estimate is almost the same as an educated guess

Which estimation techniques have you used?

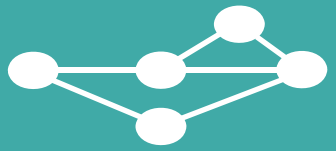
- Top-Down
- Parametric
- Bottom-Up
- PERT
- Analogous
- What-If

Common Estimating Practices

Top-Down

Analogous

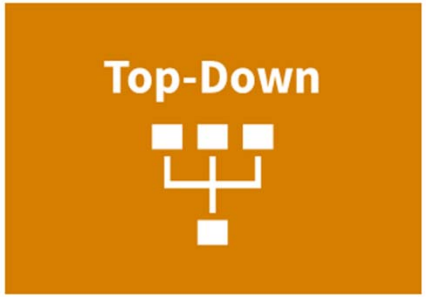
PERT



Bottom-Up

Parametric

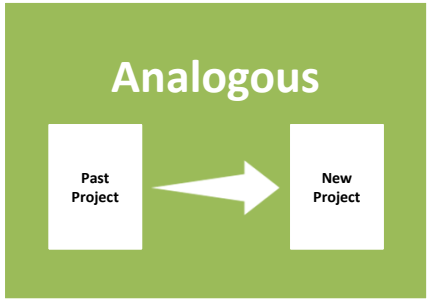
What-If



Pros	Cons
Quickly Develop Estimate	Accuracy
Lower Cost to Implement	Overlooks Lower Levels of Input
Small Tasks Can Be Aggregated	Potential to Mislead

Bottom-Up

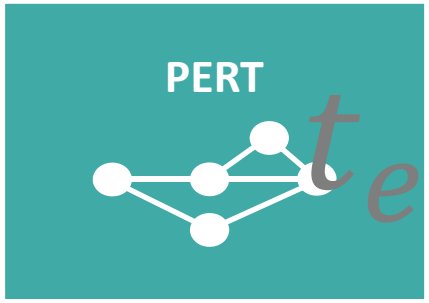
Pros	Cons
Extremely Accurate	Estimate Inflation Is Aggregated
Controls Cost	Scope of Work Must Be Complete
Risks Can Be Identified	Time Consuming to Develop



Pros	Cons
Extremely Fast	Requires Identical Projects
Easy to Implement	Adjustments Can Be Subjective
Great for Initial Estimates	Accuracy Can Suffer

Parametric

Pros	Cons
Versatility	Database Requirements
Sensitivity	Currency
Statistical Output	Relevancy



Pros	Cons
Easily Plan Large Projects	Can Be Complicated
Can Show Critical Path	Time Consuming
Accounts for Poor Outcomes	Estimation Inaccuracies

PERT Practice

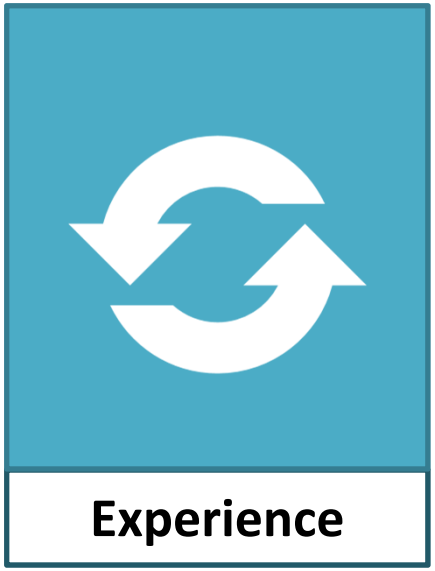
Task	Optimistic	Most Likely	Pessimistic	Answer
Trench Pathway	$15,000	$18,000	$22,000	$18,166.67
Install Conduit	$2,000	$3,400	$4,600	$3,366.67
Install Fiber	$8,000	$8,500	$8,750	$8,458.33
Test/Term Fiber	$1,000	$1,250	$2,000	$1,333.33

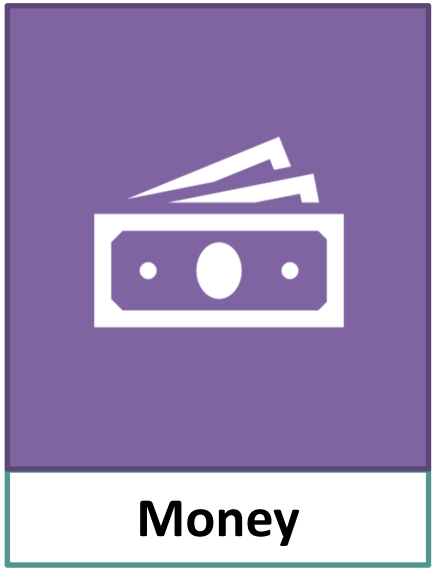
$$t_e = \frac{o + 4m + p}{6}$$

What-If

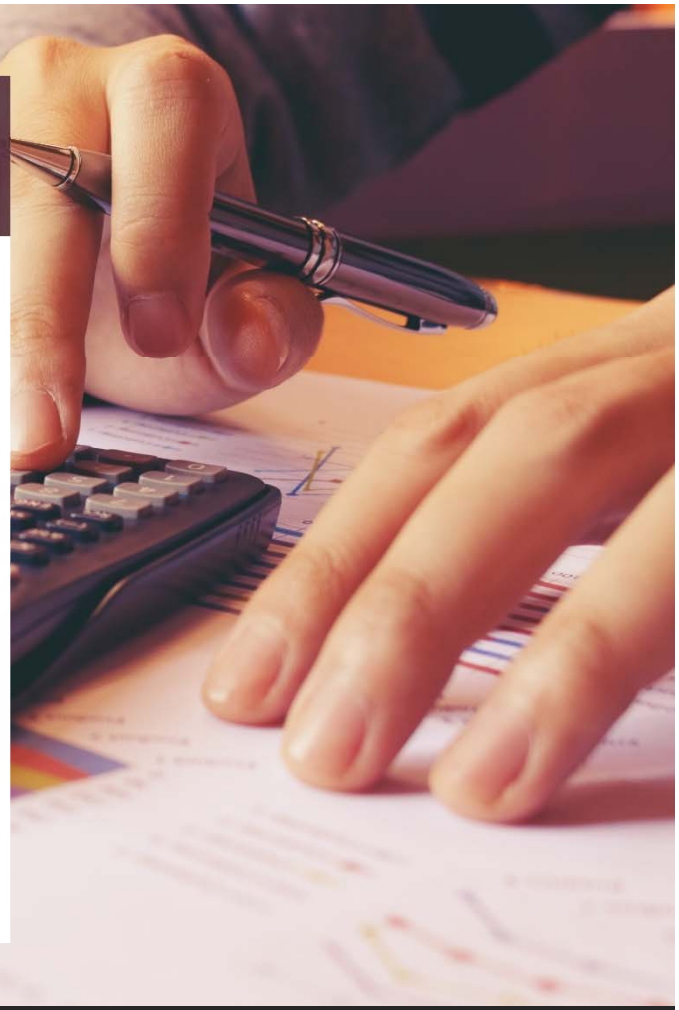
Pros	Cons
Evaluate Different Outcomes	Garbage In/Garbage Out
More Informed Decisions/Outcomes	Information Overload
Improved Project Predictability	Decision Paralysis

Which should you use?



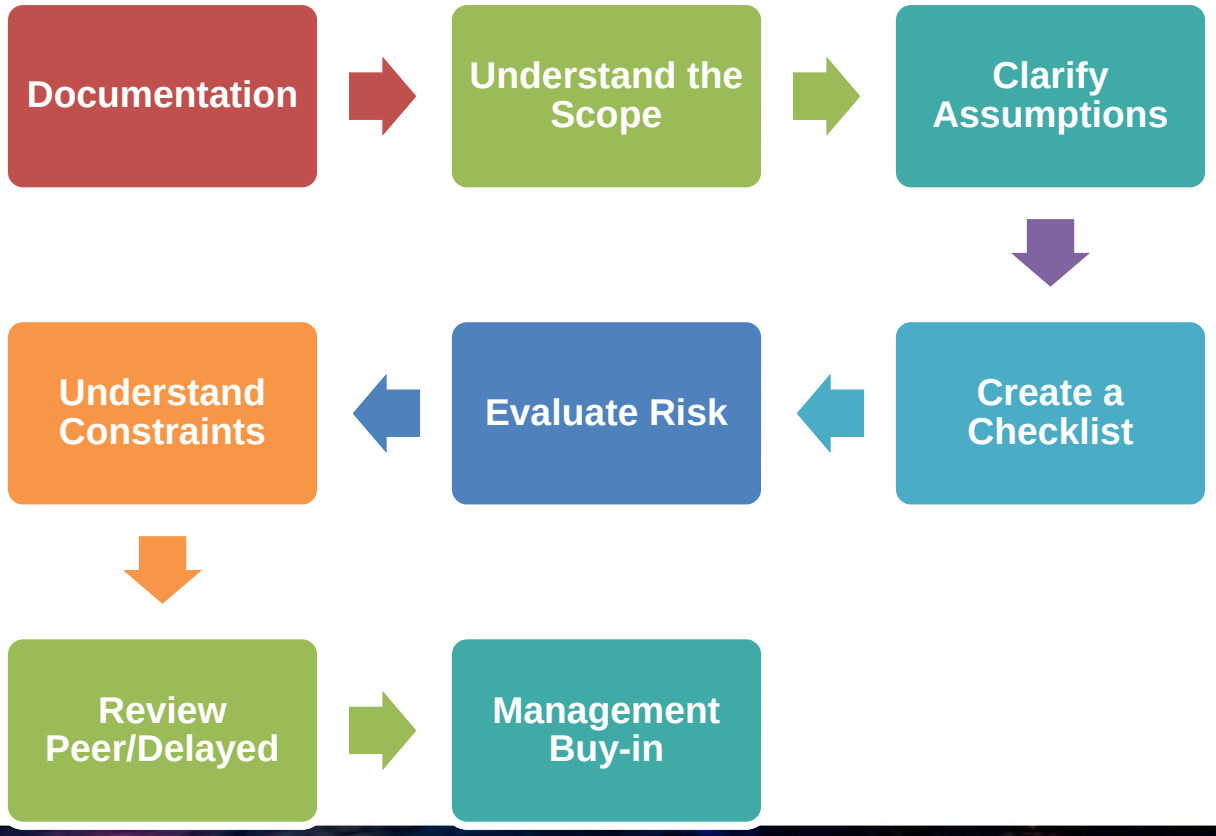


Exercise: Quick Estimate

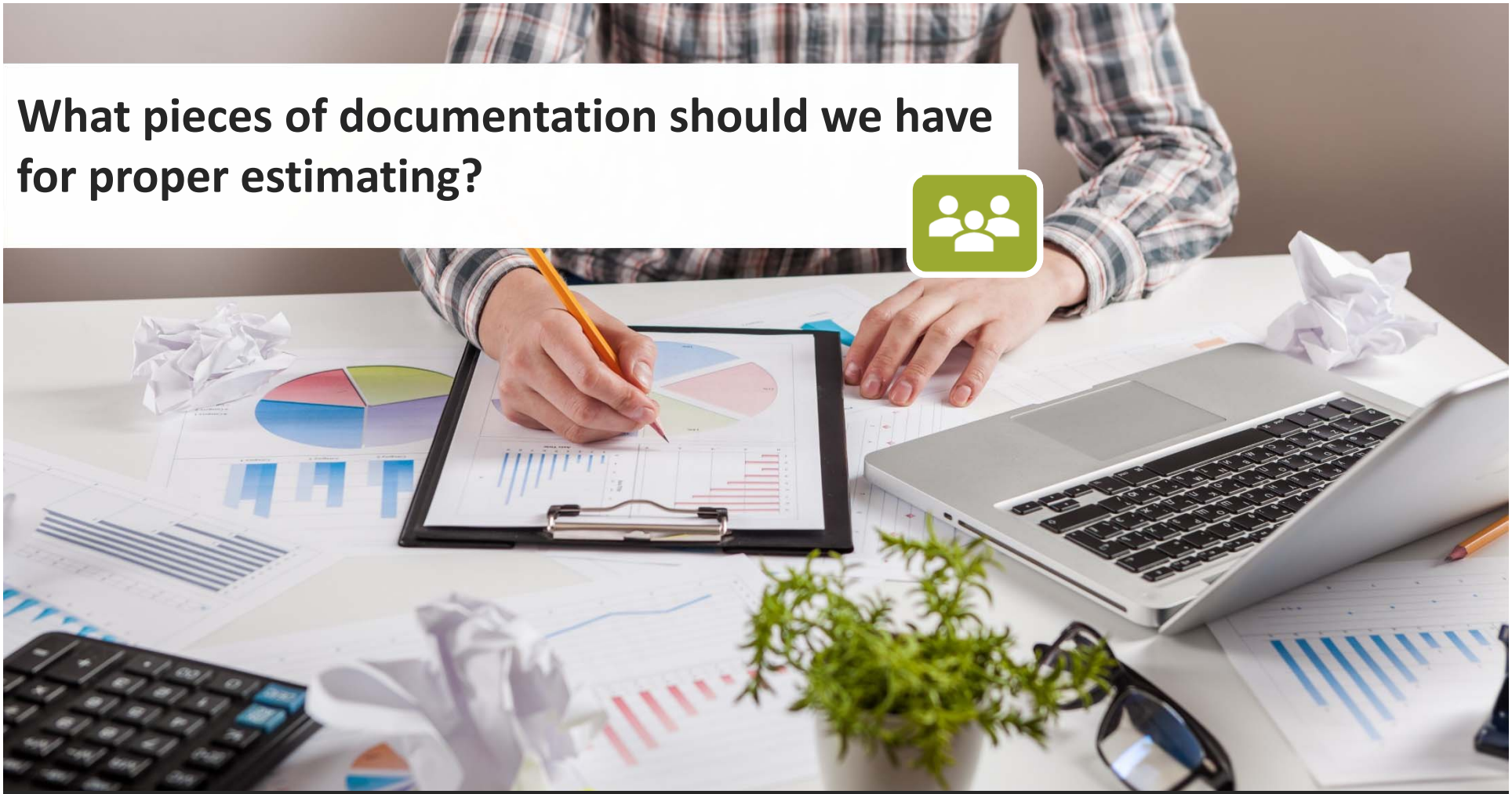


- You have been asked to estimate a small project.
- You will have 48 Category 6A cables running from one patch panel to another.
- The total distance between panels, include slack up and down, is 280 ft.
- **How many 1000-ft boxes of cable will be needed?**

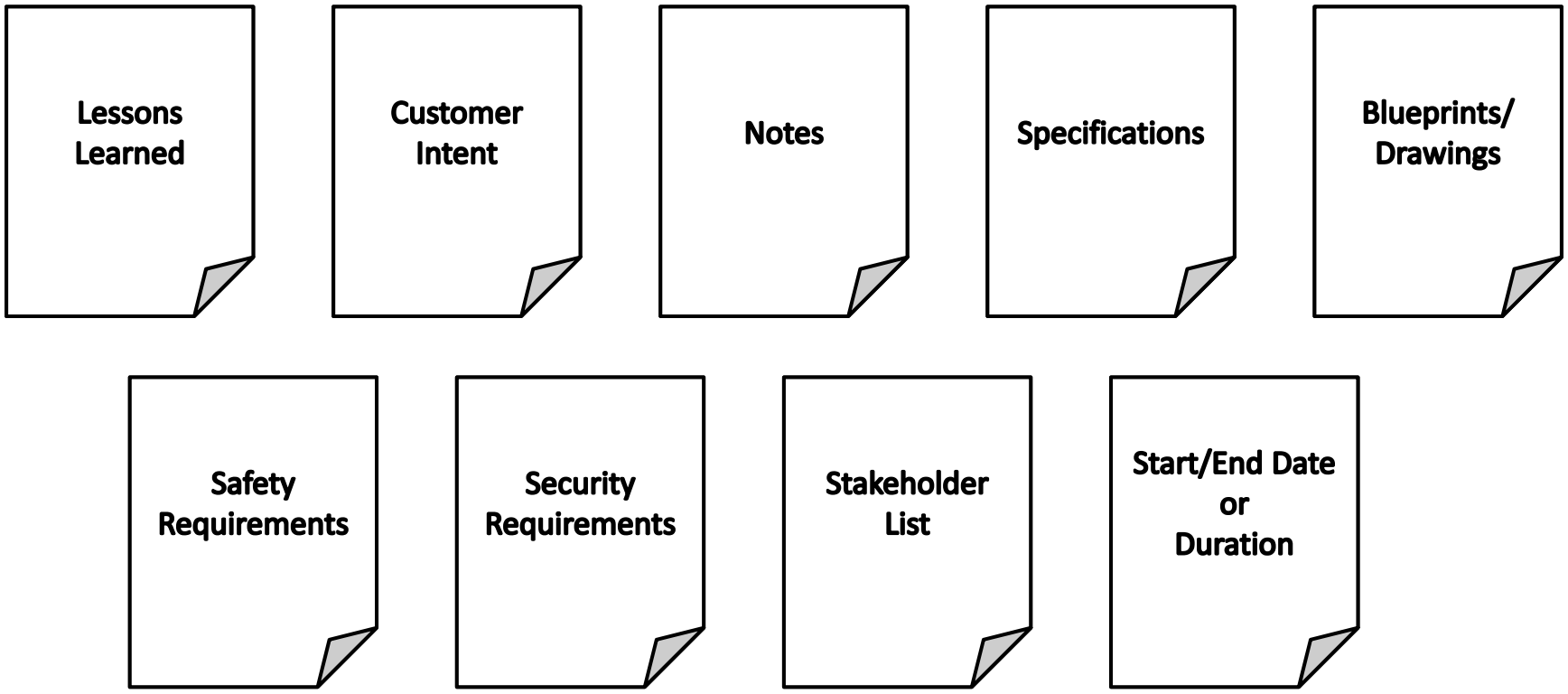
Steps to Better Estimates



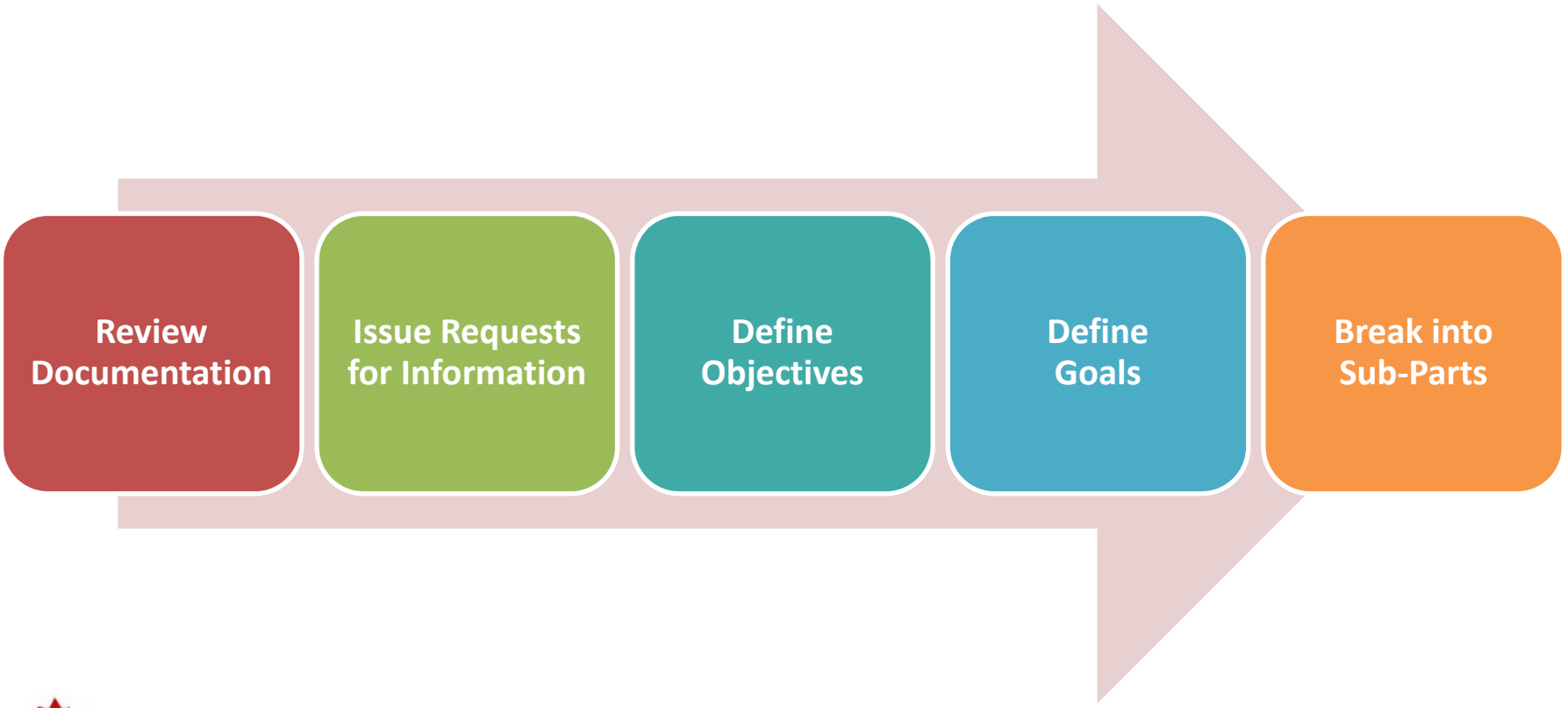
What pieces of documentation should we have for proper estimating?



Documentation



Understand the Scope



Clarify Assumptions

Create Checklist

- [x] Organization
- [x] Motivation
- [x] Productivity
- [x] Creativity
- [x] Delegation
- [x] Excellence

Evaluate Risk

When do you evaluate risk?

- At project estimation
- During project initiation
- I don’t currently evaluate risk

Understand Constraints

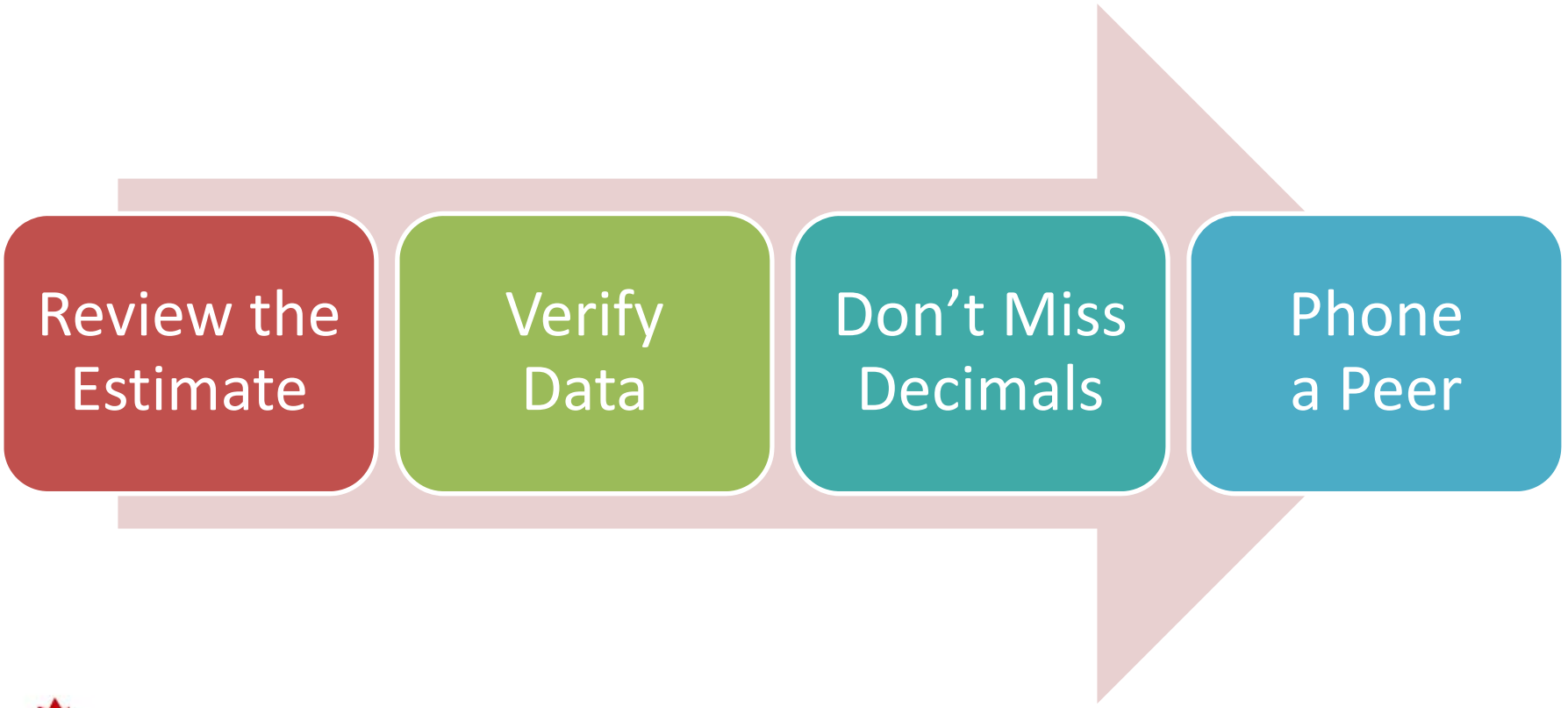
“

No one but a fool is always right

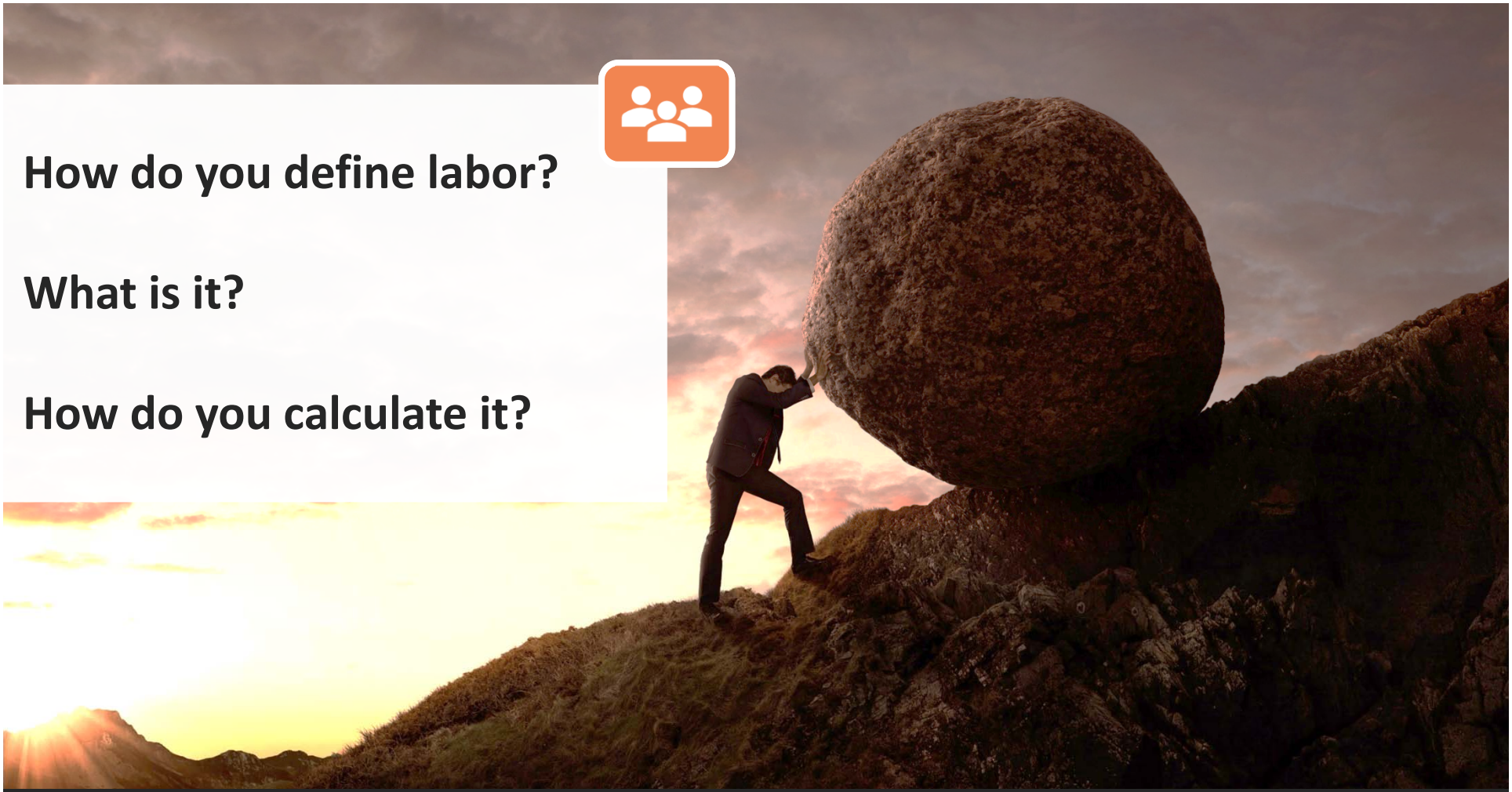
”

- David Hare

Review Peer/Delayed



Management Buy-in



How do you define labor?

What is it?

How do you calculate it?

Labor Cost

Direct vs Indirect Costs

Direct

Wage paid to the employee

Indirect

Examples?

Determine Base Compensation

1

Determine **Base Compensation** by multiplying the **Hourly Base Pay** by **Hours Worked Per Week** by **Weeks Per Year**.

STEP ONE	
Hourly Base Pay	$25.00
Hours Worked per Week	40
Weeks per Year	52
Base Compensation	**$52,000.00**

Determine the Hours of Total Paid Time Off

2 Determine the hours of **Total Paid Time Off** for which the employee is paid but does not work.

STEP TWO	
Total Paid Time Off	88
Holidays	
Days	6
Hours	8
Total	48
Vacation Time	
Days	5
Hours	8
Total	40
Sick Time	
Days	0
Hours	8
Total	0
Training Time	
Days	0
Hours	8
Total	0

Determine Admin Time

3 Determine the hours of **Admin Time** spent per year on tasks that are non-production related.

STEP THREE	
Admin Time Per Year	
Hours	2
Total Available Weeks	49
Total Yearly Admin	**98**

Calculate Available Working Hours

4 Calculate **Available Working Hours** by subtracting **Total Paid Time Off** from the **Total Hours per Year** (usually 2080).

STEP FOUR	
Total Hours Per Year	2080
Total Paid Time Off	88
Available Working Hours	**1992**

Determine the Total Production Hours

5 Determine the **Total Production Hours** the employee can work by subtracting the **Admin Time** from the **Available Working Hours**.

STEP FIVE	
Available Working Hours	1992
Admin Time	98
Total Production Hours	**1894**

Calculate the Indirect Costs

6 Calculate the **Indirect Costs** for the employee.

STEP SIX		
Indirect Costs	**%**	**$**
Payroll Tax Rate	10%	$5,200.00
Workers Compensation Rate	10%	$5,200.00
Uniforms	1%	$520.00
Tool Allowance	0%	$0.00
Company Events	0%	$0.00
Bonus	1%	$520.00
Cost Of Living Increase	1%	$520.00
Raises	1%	$520.00
Health Insurance	3%	$1,560.00
	Total Indirect Costs	**$14,040.00**

Determine the Total Burden Labor

7

Total Burden Labor is equal to the **Base Compensation** plus the **Total Indirect Costs**.

STEP SEVEN	
Base Compensation	$52,000.00
Total Indirect Costs	$14,040.00
Total Burden Labor	**$66,040.00**

Find the Actual Cost per Hour

8 To find the **Actual Cost Per Hour**, divide the **Total Burden Labor** by the **Total Production Hours**.

STEP EIGHT	
Total Burdened Labor	$66,040.00
Total Production Hours	1894
Actual Cost Per Hour	**$34.87**

Determine Labor Burden

9

Labor Burden can be determined taking **Actual Cost Per Hour** and dividing by **Hourly Base Pay**.

STEP NINE	
Actual Cost Per Hour	$34.87
Hourly Base Pay	$25.00
Labor Burden	**1.40**

Determine the Labor Sale Price

10 Multiply the determined **Markup on Labor** by the **Actual Cost per Hour** to determine the **Labor Sale Price**.

STEP TEN	
Markup on labor	25%
Actual Cost Per Hour	$34.87
Labor Sale Price	**$43.59**

Labor Calculator Workbook

LABOR CALCULATOR

STEP ONE	
Hourly Base Pay	$25.00
Hours Worked Per Week	40
Weeks Per Year	52
Base Compensation	**$52,000.00**

STEP TWO	
Total Paid Time Off	88
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STEP THREE	
Admin Time Per Year	
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STEP FOUR	
Total Hours Per Year	2080
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Available Working Hours	**1992**

STEP FIVE	
Available Working Hours	1992
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Total Production Hours	**1894**

STEP SEVEN	
Base Compensation	$52,000.00
Total Indirect Costs	$14,040.00
Total Burdened Labor	**$66,040.00**

STEP SIX		
Indirect Costs	**%**	**$**
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Total Burdened Labor	$66,040.00
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STEP NINE	
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Labor Burden	**1.40**

STEP TEN	
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Weighted Man-Hour Cost

$$W = \frac{Ac_1 + Bc_2 + Cc_3}{t}$$

W = Weighted Cost per Man-Hour

A, B, C = Number of Personnel per Cost Center

c_1, c_2, c_3 = Labor Cost Center per Man-Hour

t = Total Number Labor Cost Centers

Weighted Man-Hour Cost Scenario

Labor Cost Center	Quantity	Cost/Man Hour	Total Man Hour Cost
Apprentice	6	$25.00	$150.00
Journeyman	3	$35.00	$105.00
Foreman	1	$45.00	$ 45.00

“Lots of Math”

$$W = \frac{Ac_1 + Bc_2 + Cc_3}{t}$$

$$W = \frac{6*\$25 + 3*\$35 + 1*\$45}{3}$$

$$W = \frac{\$150 + \$105 + \$45}{3} = \frac{\$300}{3}$$

$$W = \$100$$

Scenario Check

Labor Cost Center	Cost/Man Hour	Quantity	Total Per Man Hour	Man Hours	Cost
Apprentice	$25.00	6	$150.00	40	$6,000.00
Journeyman	$35.00	3	$105.00	40	$4,200.00
Foreman	$45.00	1	$45.00	40	$1,800.00
			Totals:	120	$12,000.00

$$W * Total\ Man\ Hours = Total\ Cost$$

$$\$100 * 120 = \$12{,}000$$

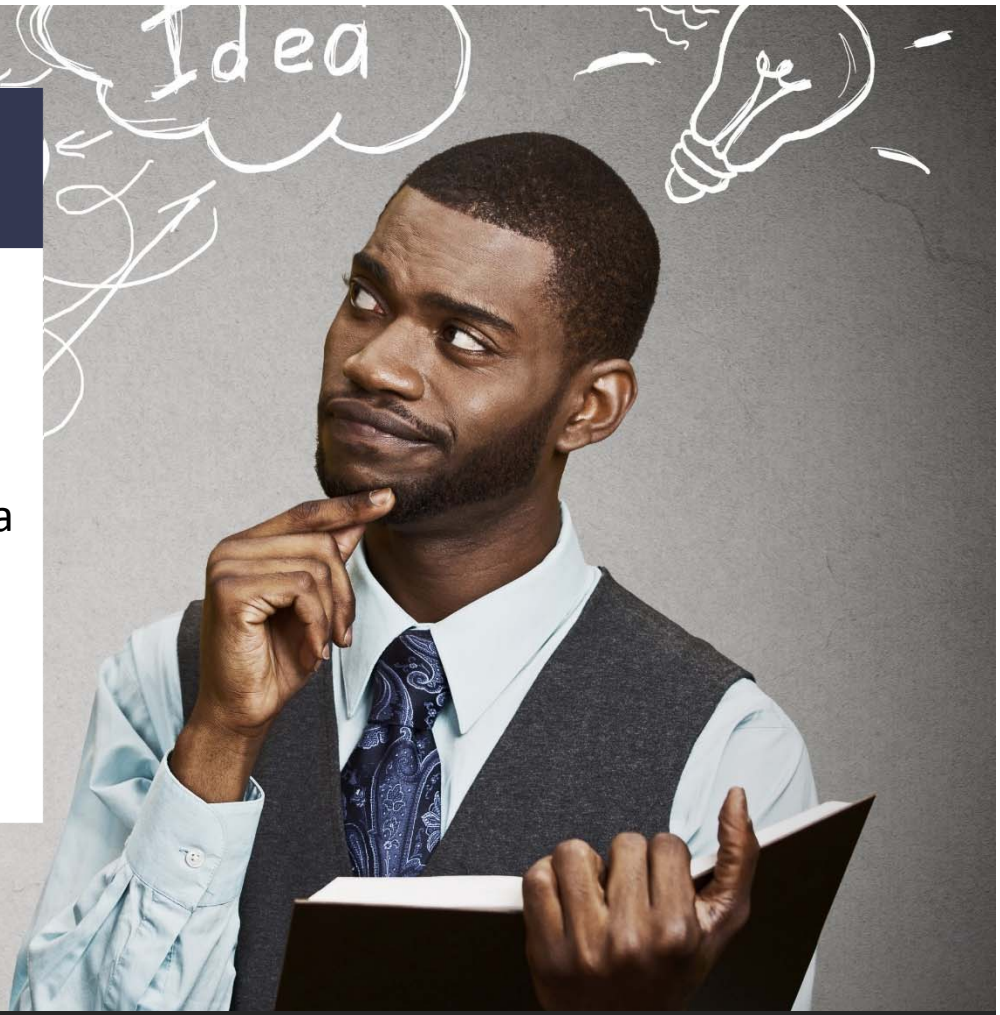
Overtime

Week of Extended OT	50 hrs/wk	60 hrs/wk	70-72 hrs/wk	84 hrs/wk
1	0.95	0.91	0.86	0.75
2	0.93	0.88	0.80	0.70
3	0.92	0.85	0.73	0.65
4	0.91	0.81	0.68	0.60
5	0.85	0.76	0.63	0.55
6	0.86	0.72	0.58	0.50
7	0.76	0.67	0.54	0.47
8	0.77	0.64	0.51	0.44
9	0.74	0.62	0.50	0.43
10	0.72	0.61	0.49	0.42
11	0.72	0.60	0.48	0.41
12	0.71	0.59	0.47	0.40
13	0.69	0.56	0.46	0.39
14	0.68	0.55	0.45	0.38
15	0.67	0.54	0.44	0.37
16	0.66	0.53	0.43	0.36

Exercise

Create labor rates for your sample project using the template provided (Materials):

- Assign at least four labor categories with a different number of personnel for each category.
- Compute the Weighted Man-Hour Cost.



Recap and Review

Weighted Labor Calculator

Weighted Labor Rate $ 67.16

Labor Cost Center	Number of Personnel	Cost/Man Hour	Total Cost
Apprentice	4	$ 31.38	$ 125.52
Journeyman	2	$ 43.59	$ 87.18
Foreman	1	$ 61.02	$ 61.02
Site Safety	1	$ 39.05	$ 39.05
Project Coordinator	1	$ 23.01	$ 23.01

The Work Breakdown Structure (WBS)

Which project would you choose?

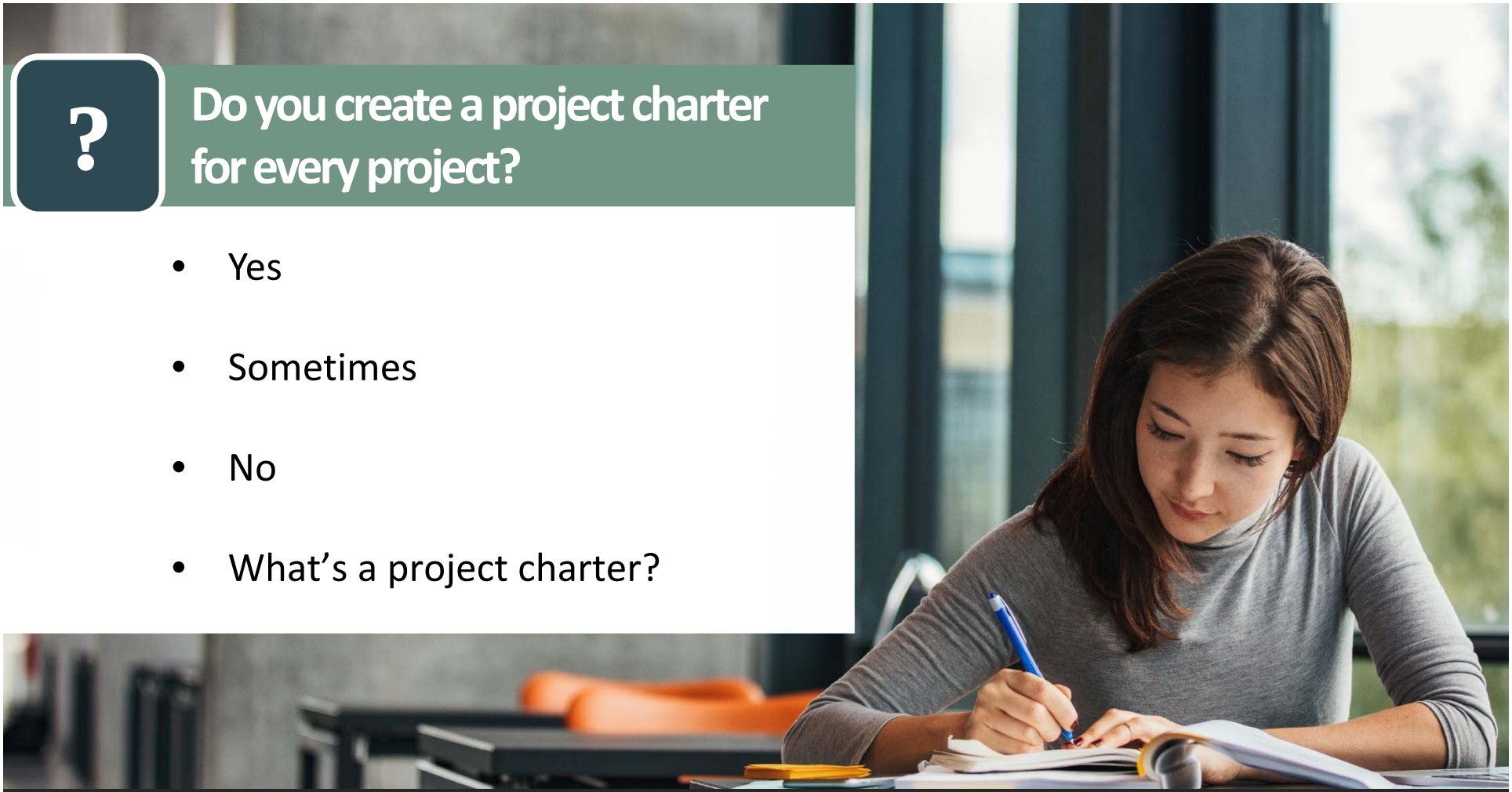
Photoshoot for Great White Sharks

Study of Polar Bear Migration Patterns

Study of Anacondas in Captivity

Do you create a project charter for every project?

- Yes
- Sometimes
- No
- What's a project charter?



“

First, have a definite, clear practical ideal; a goal, an objective. Second, have the necessary means to achieve your ends; wisdom, money, materials, and methods. Third, adjust all your means to that end.

”

- Aristotle

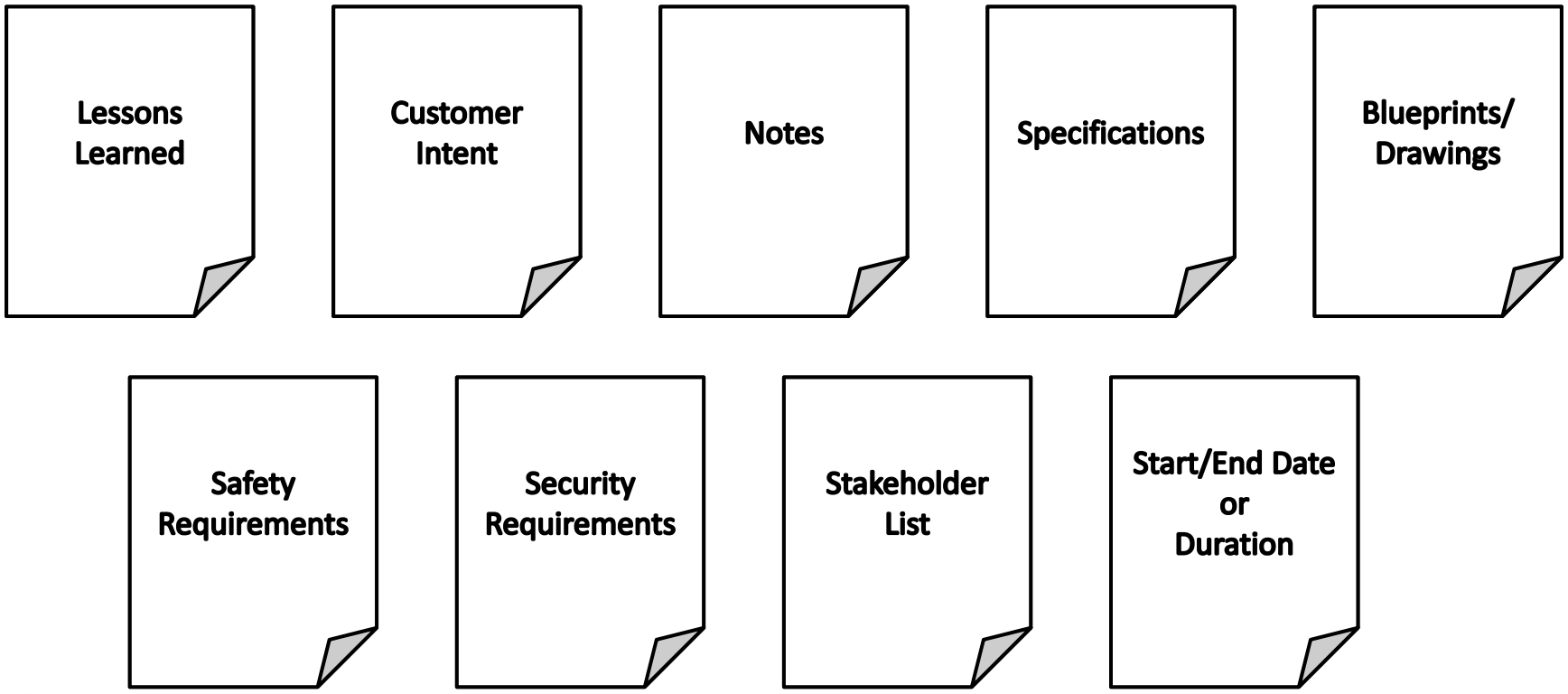
Project Charter

Defines	Critical Element	Single Point of Reference	Contract
• Scope • Objectives • Overall Approach	• Initiating • Planning • Executing • Controlling • Assessing	• Project goals • Scope • Organization • Estimates • Work Breakdown Structure • Budget	• Budget • Time • Risks • Resources • Standards

Scope of Work

- Goals and Objectives
- Statements of Work (SOW)
- Organizational Impacts
- Project Deliverables
- Project Estimated Costs & Duration

Recall: Documentation



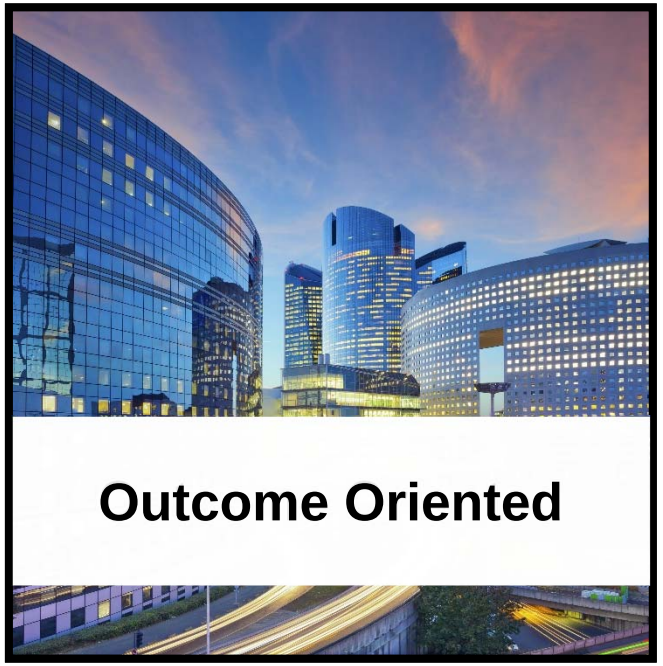
Recall: Evaluate Risk

Recall: Understand Constraints

What is a Work Breakdown Structure?

Work Breakdown Structure

Project Scope Defined

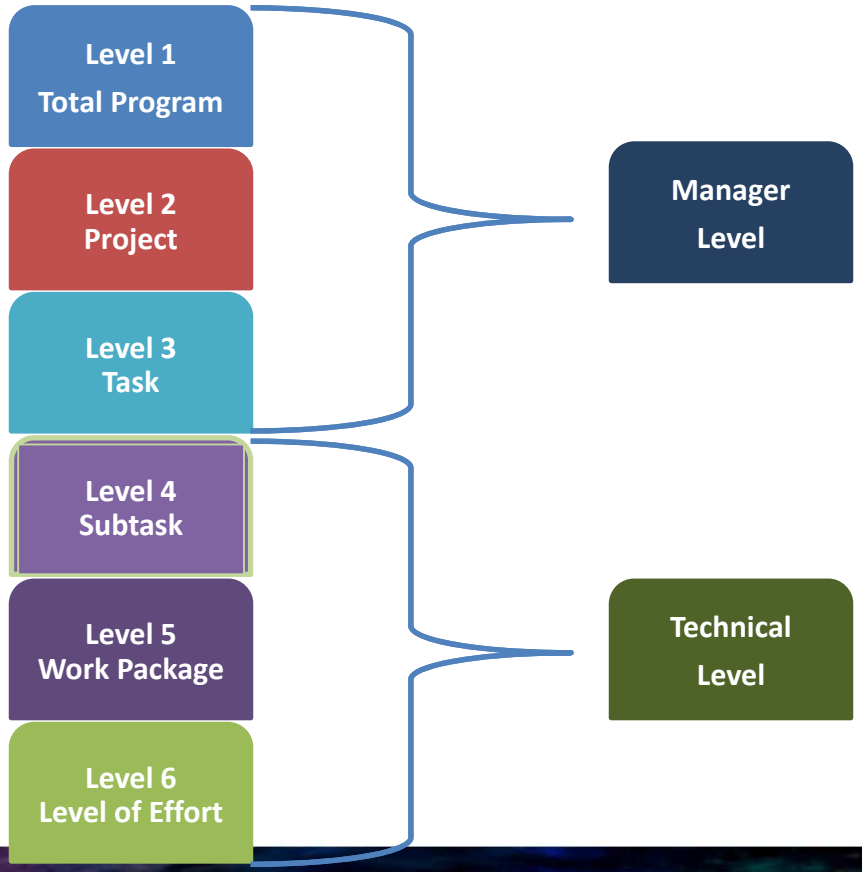


Outcome Oriented

Why Is It Important?

- The total program can be described as a summation of subdivided elements
- Planning can be performed
- Costs and budgets can be established
- Time, cost, and performance can be tracked
- Objectives can be linked to company resources in a logical manner
- Schedules and status-reporting procedures can be established
- Network construction and control planning can be initiated
- The responsibility assignments for each element can be established

Six-Level Structure



Two Basic Types of Work Breakdown Structure Design

Outline

1. University ICT Upgrade

1.1. Business Building

1.1.1. First Floor TR

1.1.1.1. Ladder Rack Construction

1.1.1.1.1. Install Supports

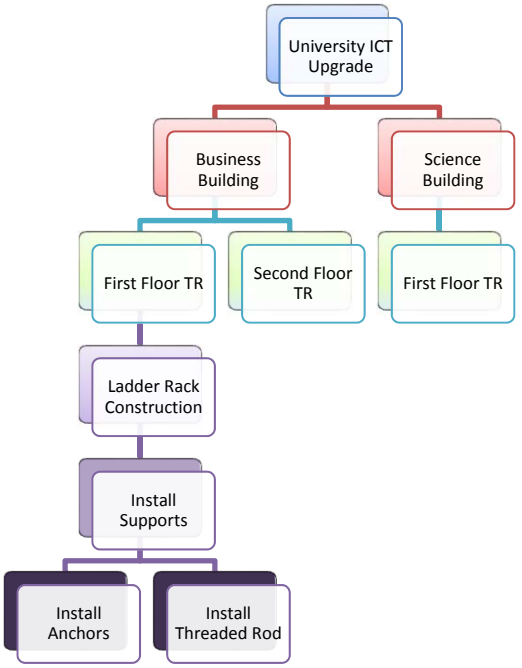
1.1.1.1.1.1. Install Anchors

1.1.1.1.1.2. Install Threaded Rod

1.2. Science Building

1.2.1. First Floor TR

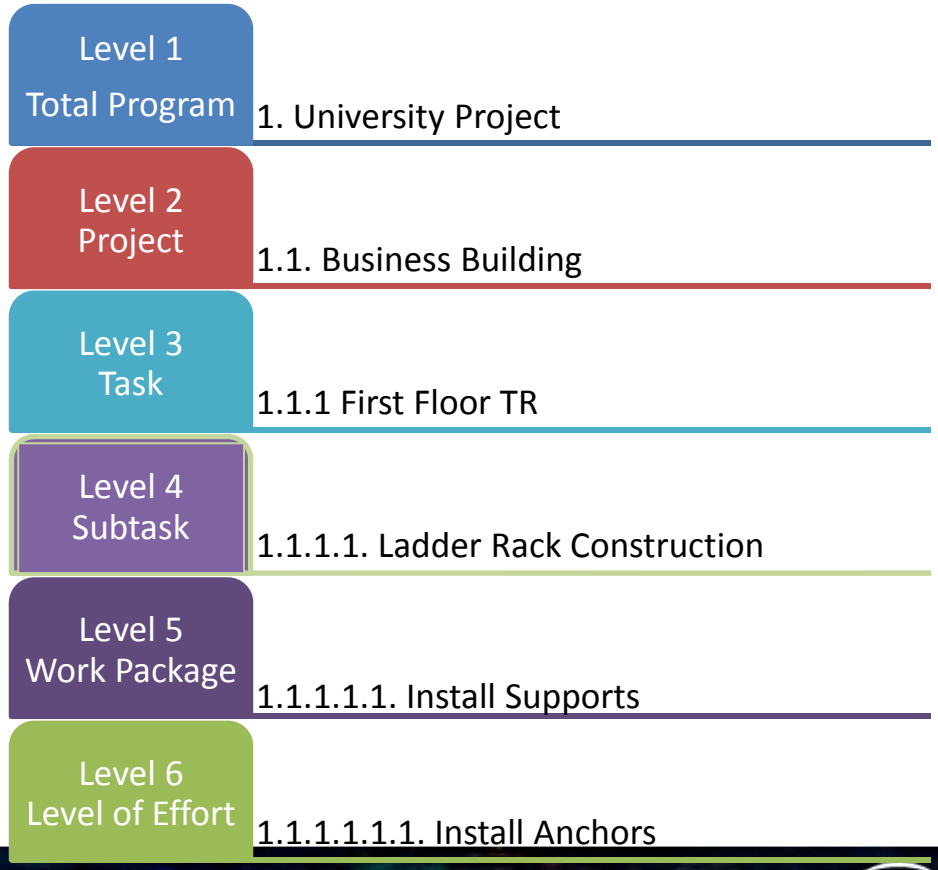
Tree



How Detailed Does It Need to Be?

Do not attempt to subdivide work to the lowest possible level.

DO WHAT MAKES SENSE!



HS11

Rules for Work Breakdown Structures

1. The WBS and work description should be easy to understand.

Slide 65

HS11 What do you think about having the list build over the slides? If it is too much, I can rethink

Heather Stadelhofer, 5/7/2018

Rules for Work Breakdown Structures

1. The WBS and work description should be easy to understand.

2. Since scope of effort can change during a program, every effort should be made to maintain flexibility in the WBS.

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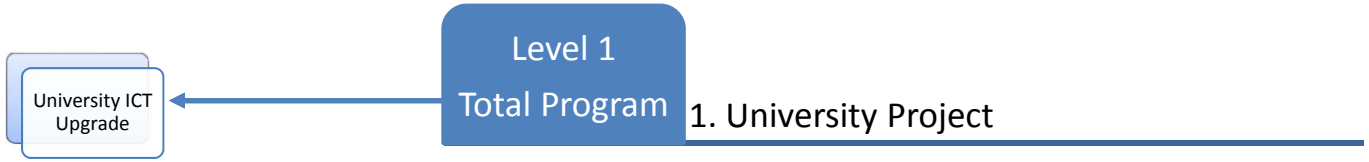
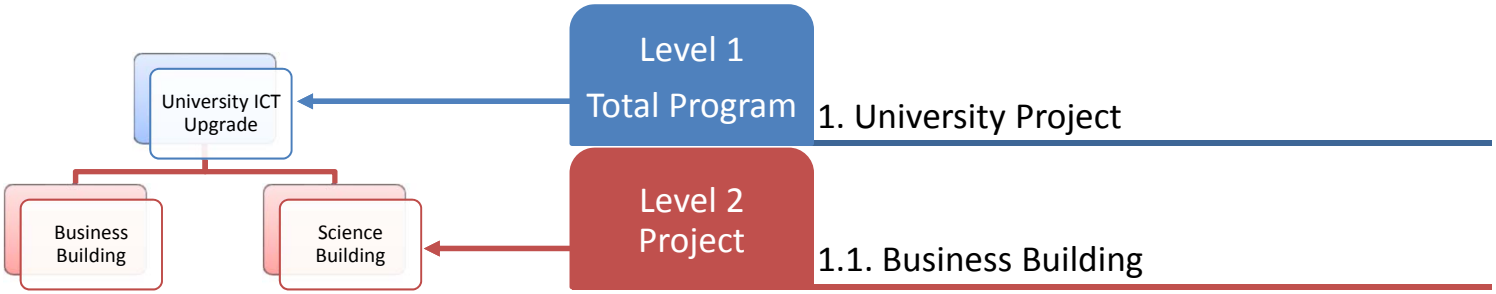
4. The WBS can act as a list of discrete and tangible milestones so that everyone will know when the milestones were achieved.
5. All schedules should follow the WBS.

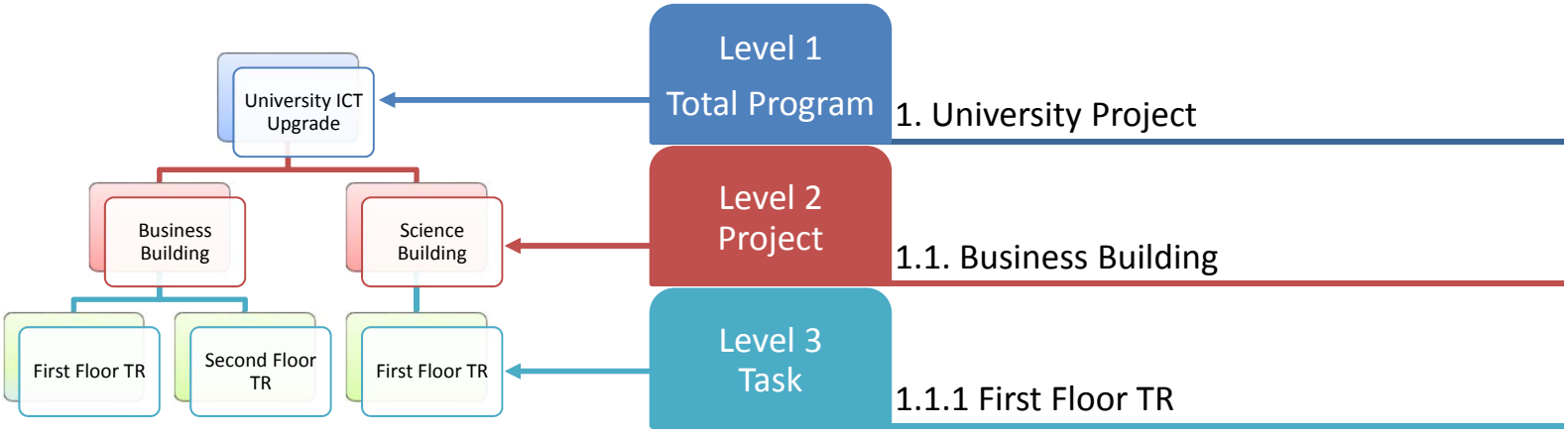
Level One—Define the Major Deliverables



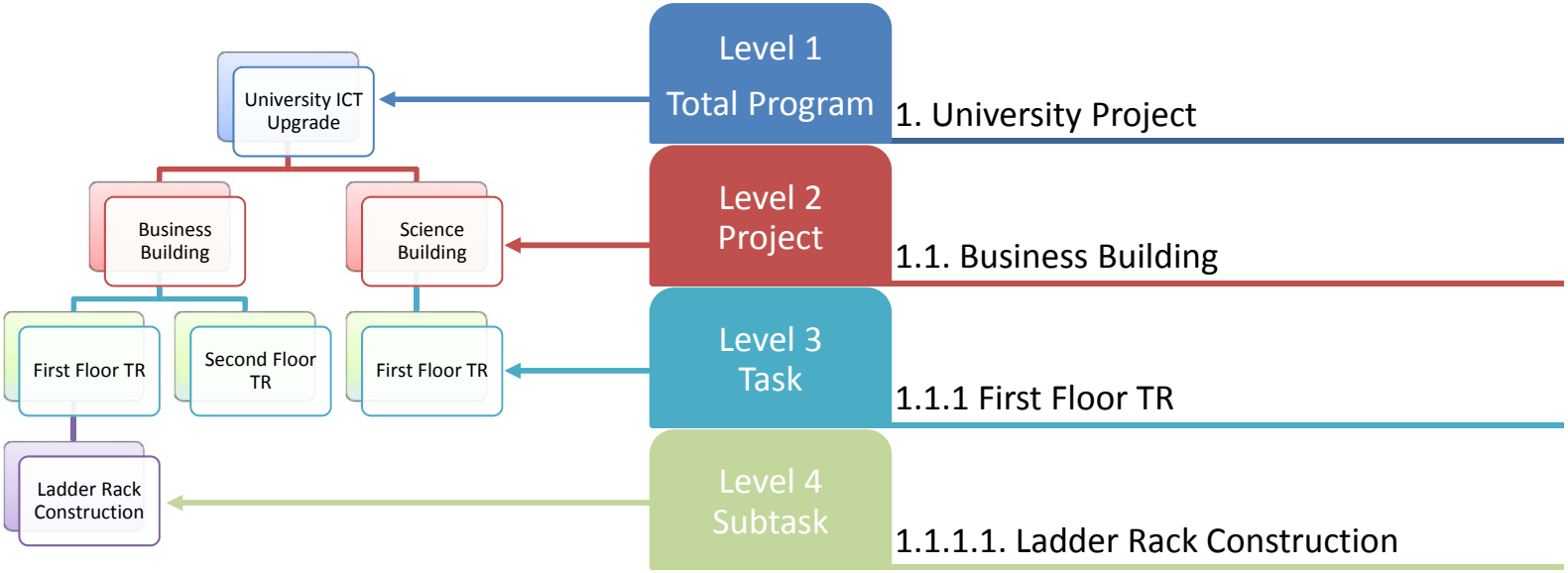
Level Two — Sub Deliverables / Project Level



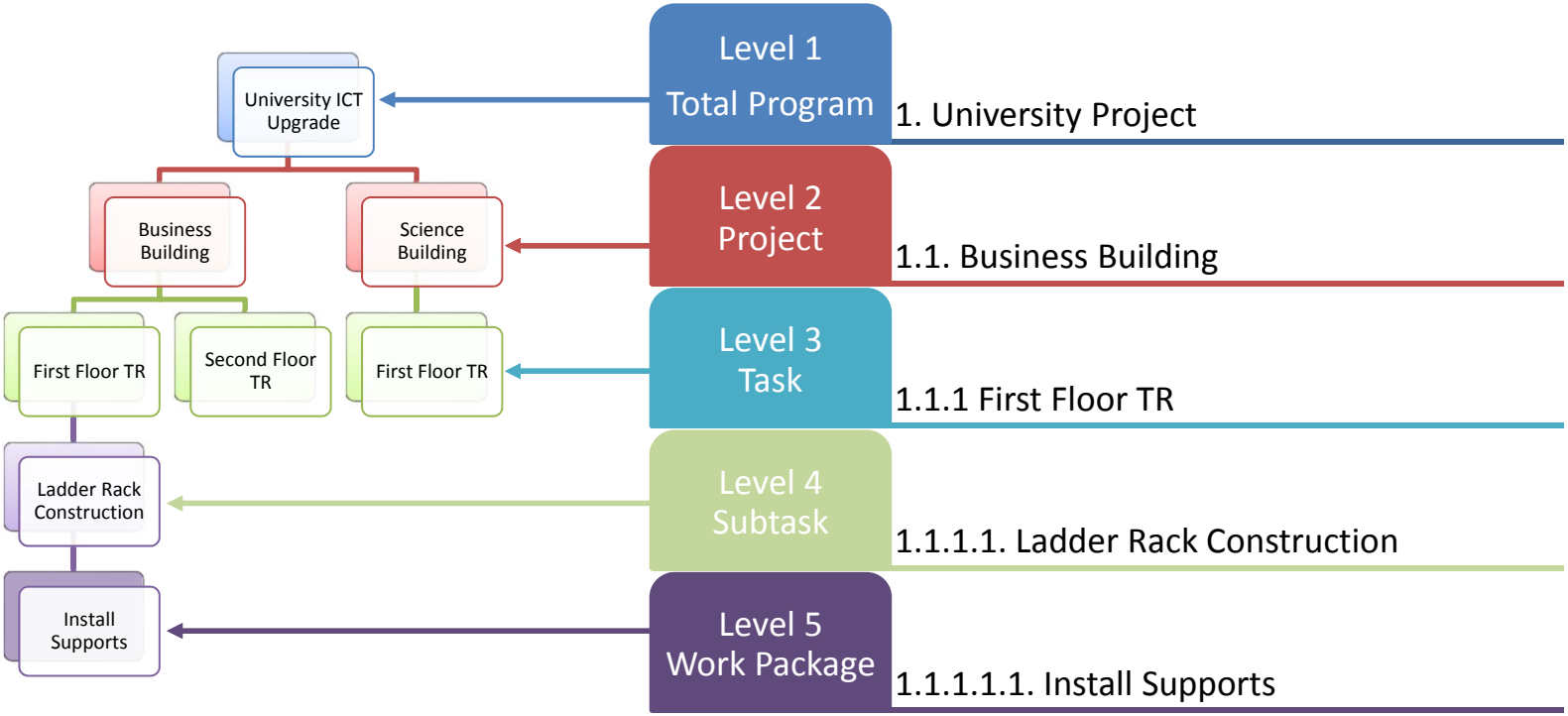
Level Three — Task



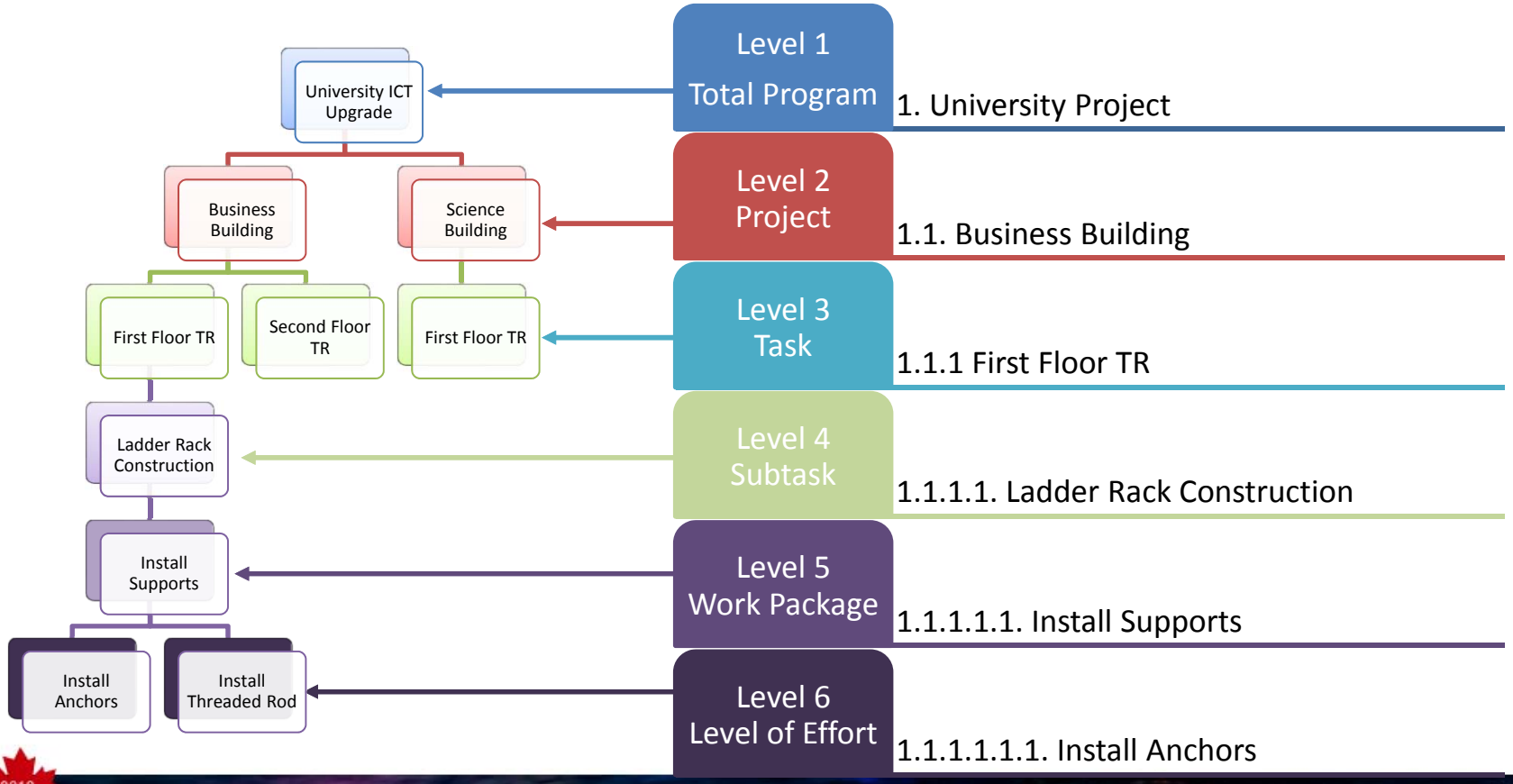
Level Four—Subtask



Level Five — Work Package

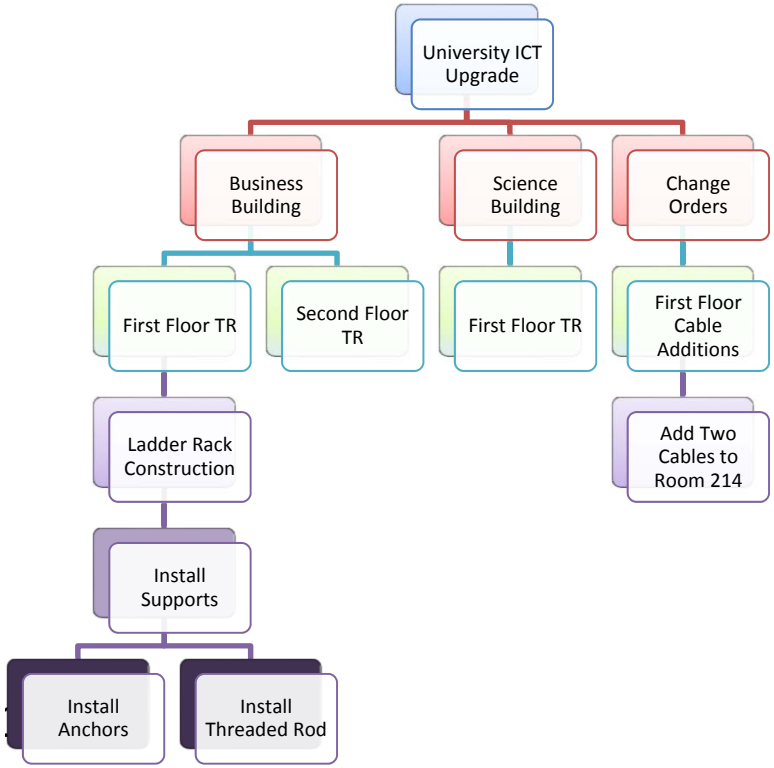


Level Six — Level of Effort



Change Orders

1. University ICT Upgrade
1.1. Business Building
1.1.1. First Floor TR
1.1.1.1. Ladder Rack Construction
1.1.1.1.1. Install Supports
1.1.1.1.1.1. Install Anchors
1.1.1.1.1.2. Install Threaded Rod
1.2. Science Building
1.2.1. First Floor TR
1.3 Change Orders
1.3.1. First Floor Cable Additions
1.3.1.1. Add Two Cables to Room 1



Work Breakdown Structure Checklist

BICSI Example — Work Breakdown Structure

	WBS	Task Name	Duration	Start	Finish	Predecess	Successor	%
106	**9**	**Sales**	**1 day**	**Wed 2/1/17**	**Wed 2/1/17**			**100%**
107	9.1	Course Pricing determined	2 days	Thu 2/1/18	Mon 2/5/18	136SF-60 da		100%
108	**10**	**Publications**	**1 day**	**Wed 1/24/18**	**Wed 1/24/18**			**100%**
109	10.1	OSPDRM Release	1 day	Wed 1/24/18	Wed 1/24/18			100%
110	**11**	**TD&O**		**Wed 2/1/17**				**25%**
111	**11.1**	**Pre-Release**		**Wed 2/1/17**				**25%**
112	11.1.1	Set Requirements for Certified Trainers	3 days	Mon 12/25/17	Wed 12/27/17	115	117FS+60 d	100%
113	11.1.2	Add event codes to CV for Pilot classes	1 day	Fri 2/9/18	Fri 2/9/18	39		100%
114	11.1.3	Add Event Codes to CV for all Webinars & CTU Sessions	1 day	Fri 2/9/18	Fri 2/9/18	39		100%
115	11.1.4	Certified Trainer (CT) Announcement of new Program Requirements (CTU/Pilot)	1 day	Fri 12/22/17	Mon 12/25/17	136SF-90 days	112	100%
116	11.1.5	Notify ATF/ADTP of new Program Requirements	1 day	Fri 12/22/17	Mon 12/25/17	136SF-90 da		100%
117	11.1.6	Announce Webinars & CTU Session to CTs	1 day	Thu 3/22/18	Thu 3/22/18	112FS+60 d		100%
118	11.1.7	Prepare for Pilot Class	2 days	Mon 3/26/18	Tue 3/27/18	44SS	120	100%
119	11.1.8	Create CT Comp Product Codes	3 days	Fri 3/23/18	Wed 3/28/18	120SF	74	100%
120	11.1.9	CTU/Webinars	5 days	Wed 3/28/18	Tue 4/3/18	118	119SF	100%

Simple Scope of Work

Project Scope and Notes

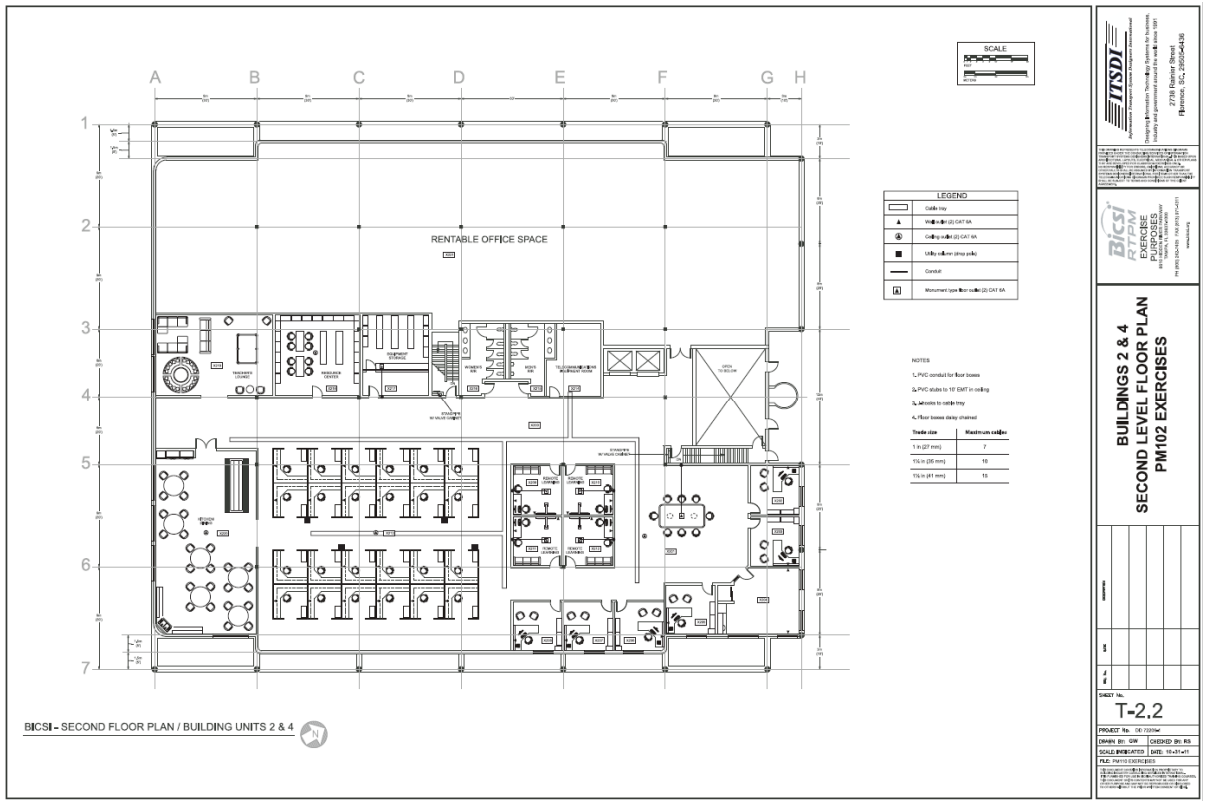
The following notes are based on information about the BICSI University ICT Upgrade Project gathered during the pre-bid phase and while developing the estimate. This information should be incorporated into your creation of your work breakdown structure.

The BICSI University is upgrading existing Category 6 cable plant to Category 6A cable plant to support 10Gig to the desktop. All existing horizontal cable infrastructure will be removed and replaced with Category 6A components. Outside Plant and intra-building backbone infrastructures are not part of this scope of work.

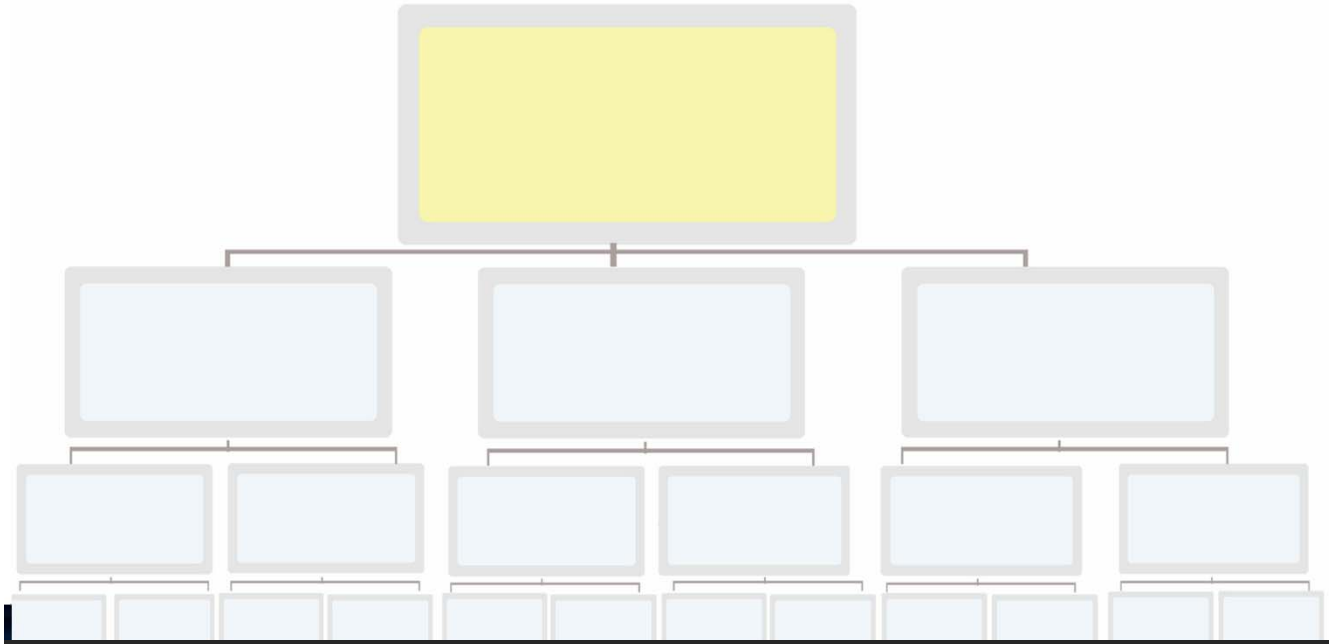
The ICT contractor (your team) will provide and install the new jacks and faceplates for the floor monuments. Horizontal cabling will be placed in existing cable tray through common areas and supported by non-continuous open-top supports within spaces (e.g., open offices, offices, classrooms, labs, and so on) after old infrastructure has been removed. Average horizontal cable runs for the second floor are 165ft (50m). All existing Category 6 cable plant is to be recycled with proof to be shown as part of the final documentation. Firestopping will be restored by the ICT contractor as required. All cable certification testing will be performed to ensure both TIA and ISO standards are met for the Category 6A installation.

The existing racks in the Telecommunications room (TR) will remain in place and be reutilized with the new Category 6 cable distribution equipment. An Operations & Maintenance Manual shall be included with Recycling Documentation, As-Built Documentation, As-built Drawings, Test results, including all required manufacturer submissions to assure execution of extended warranties.

Simple Prints



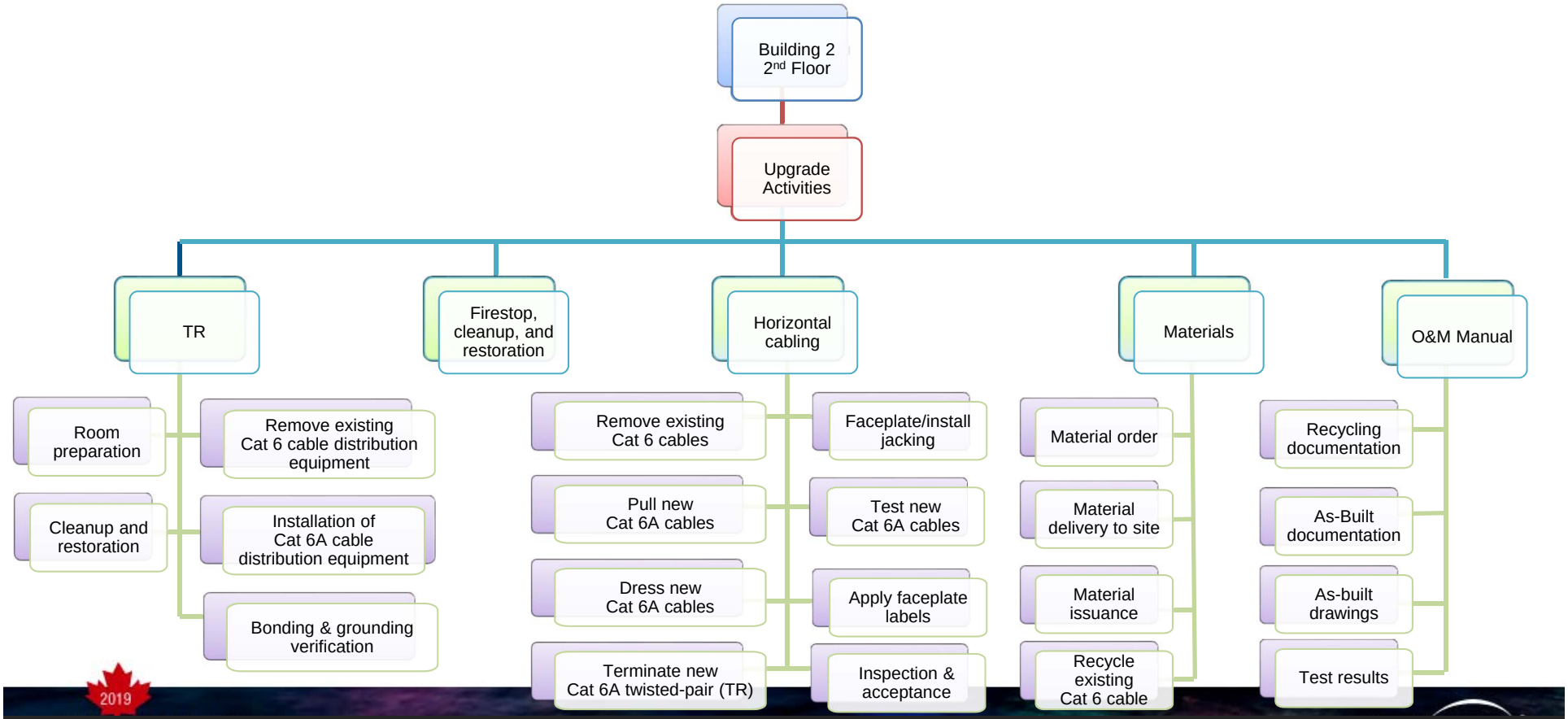
Create a Work Breakdown Structure



Work Breakdown Structure — Outline

1. Building Two Second Floor
   - 1.1. Upgrade Activities
     - 1.1.1. Telecommunications room (TR)
       - 1.1.1.1. Room preparation
       - 1.1.1.2. Remove existing Category 6 cable distribution equipment
       - 1.1.1.3. Installation of Category 6A cable distribution equipment
       - 1.1.1.4. Bonding and Grounding verification
       - 1.1.1.5. Cleanup and restoration
     - 1.1.2. Firestop, cleanup, and restoration
     - 1.1.3. Horizontal cabling (including)
       - 1.1.3.1. Remove Existing Category 6 cable
       - 1.1.3.2. Pull new Category 6A cables
       - 1.1.3.3. Dress new Category 6A cables
       - 1.1.3.4. Terminate new Category 6A twisted-pair (TRs)
       - 1.1.3.5. Faceplate install/jacking
       - 1.1.3.6. Test new Category 6A cable
       - 1.1.3.7. Apply faceplate labels
       - 1.1.3.8. Inspection and acceptance
     - 1.1.4. Materials
       - 1.1.4.1. Material order
       - 1.1.4.2. Material delivery to site
       - 1.1.4.3. Material issuance
       - 1.1.4.4. Recycle existing Category 6 cable
     - 1.1.5. Operations & Maintenance Manual
       - 1.1.5.1. Recycling Documentation
       - 1.1.5.2. As-Built Documentation
       - 1.1.5.3. As-built Drawings
       - 1.1.5.4. Test results

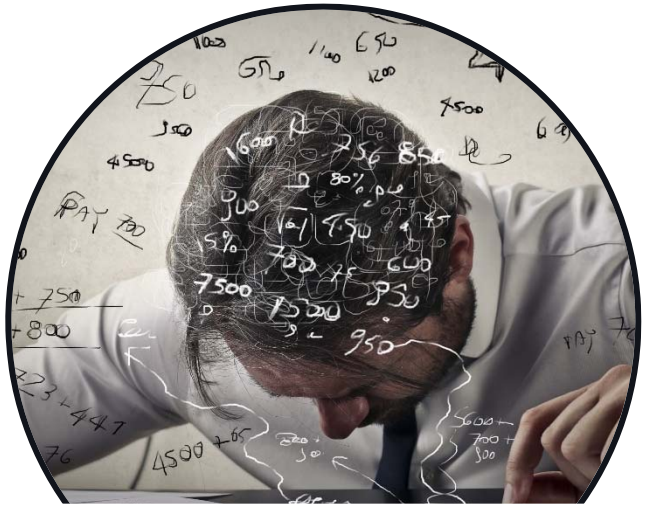
Work Breakdown Structure — Tree



Earned Value Management (EVM)

How do you feel about math?

I love it!
It was my favorite class!



Math? There's a reason I majored in history…

Elements of EVM

PV Planned Value

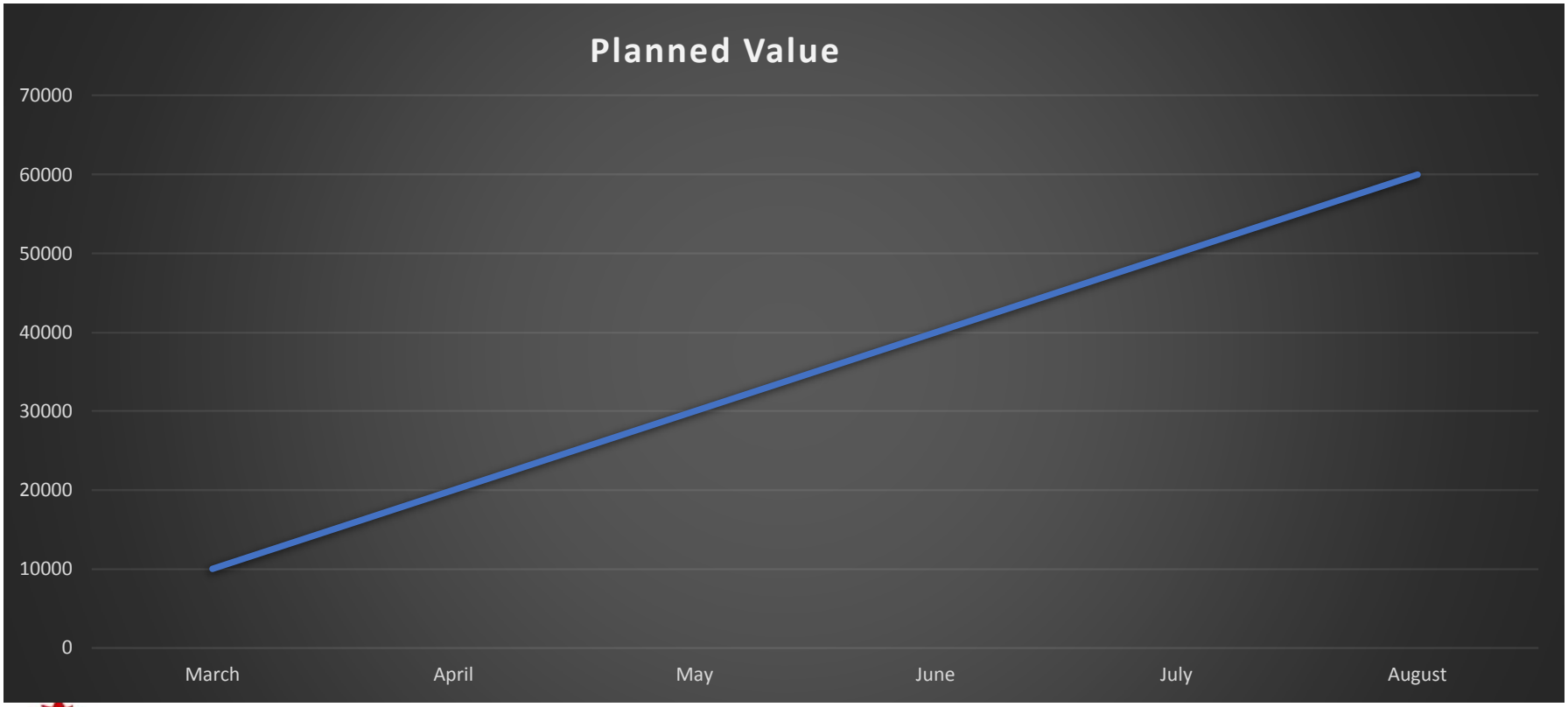
BAC Budget at Completion

AC Actual Cost

EV Earned Value

LOM Lots O' Math

Planned Value (PV)



Work Breakdown Structure Planned Values

Outline

1. University ICT Upgrade

1.1. Business Building

1.1.1. First Floor TR

1.1.1.1. Ladder Rack Construction

1.1.1.1.1. Install Supports - $1,200

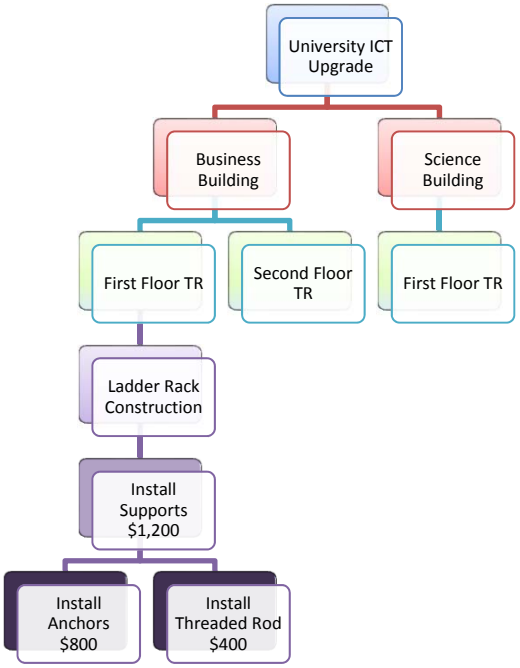
1.1.1.1.1.1. Install Anchors - $800

1.1.1.1.1.2. Install Threaded Rod - $400

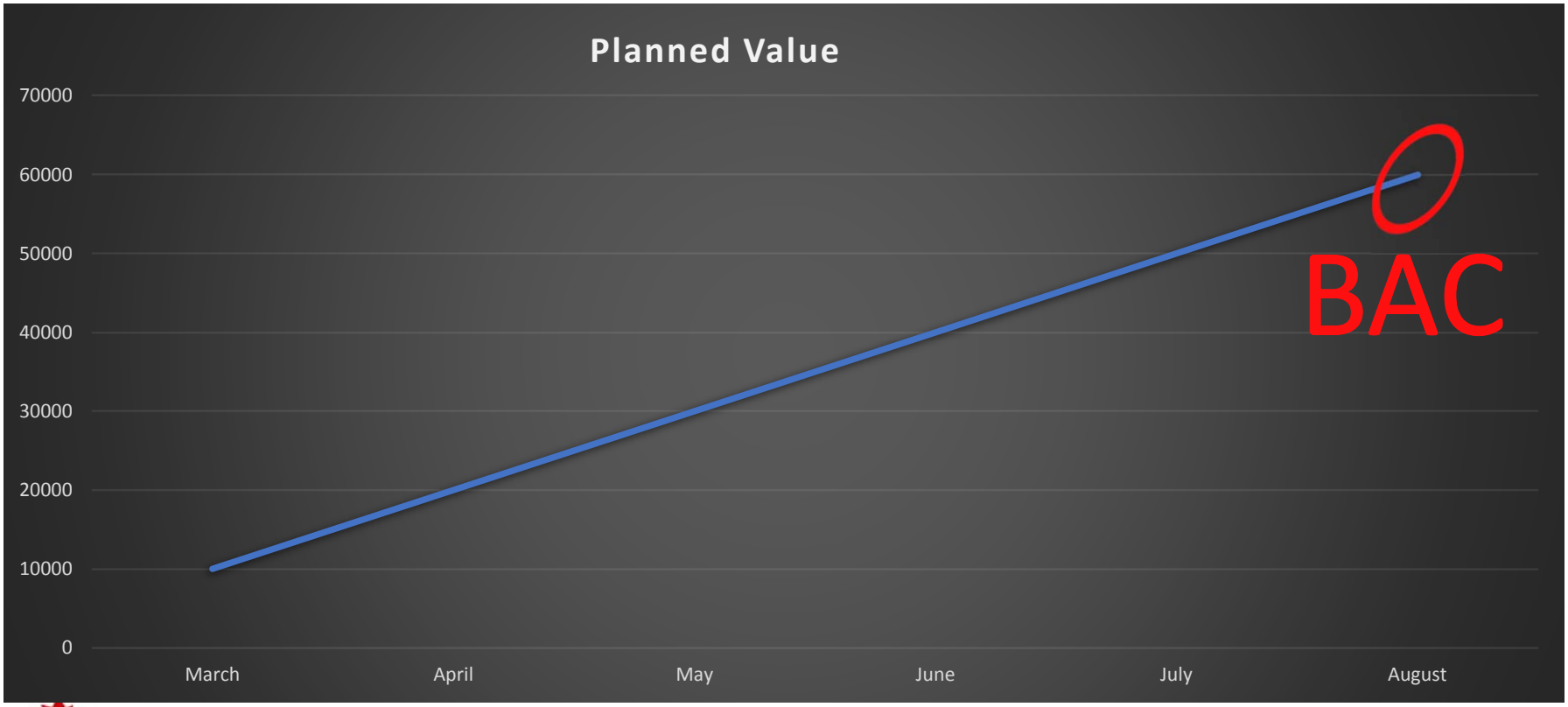
1.2. Science Building

1.2.1. First Floor TR

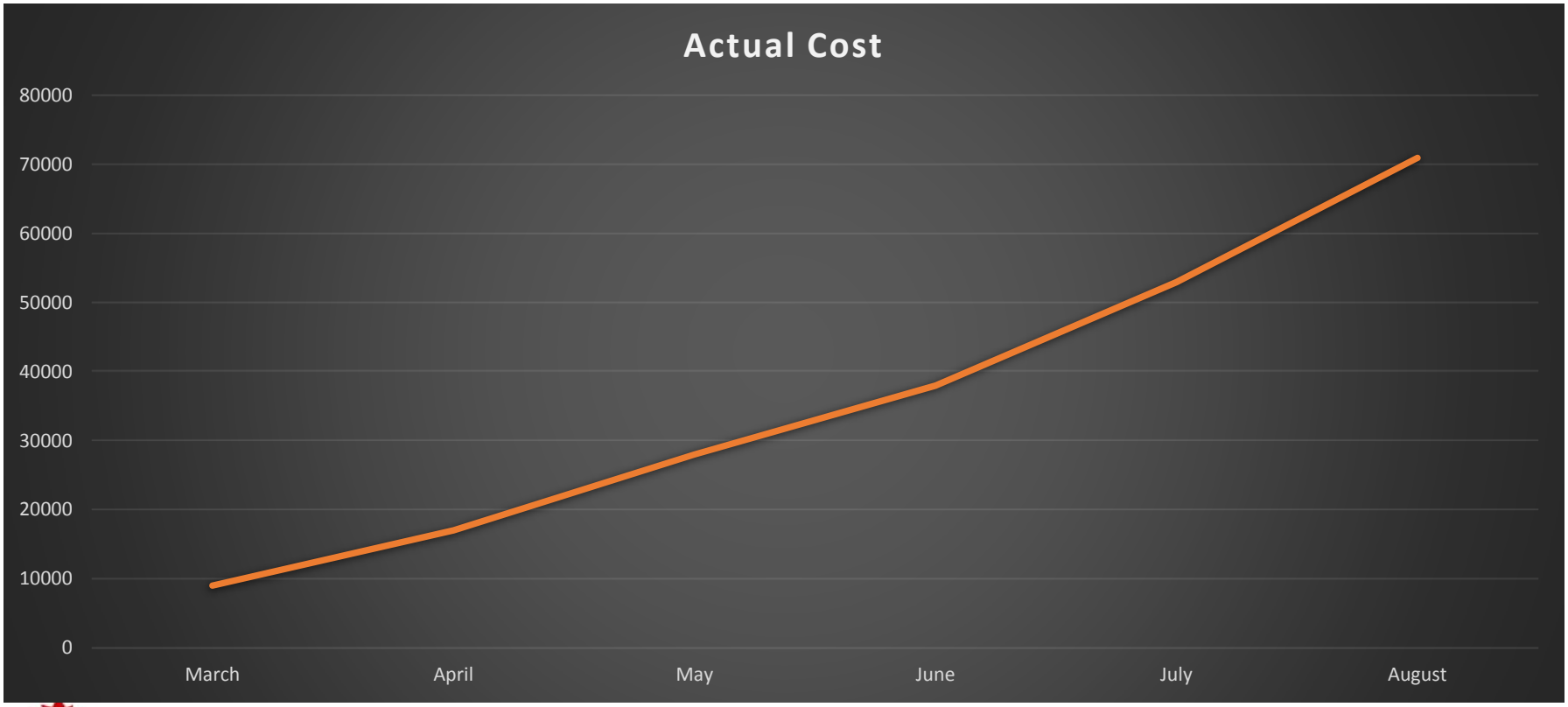
Tree



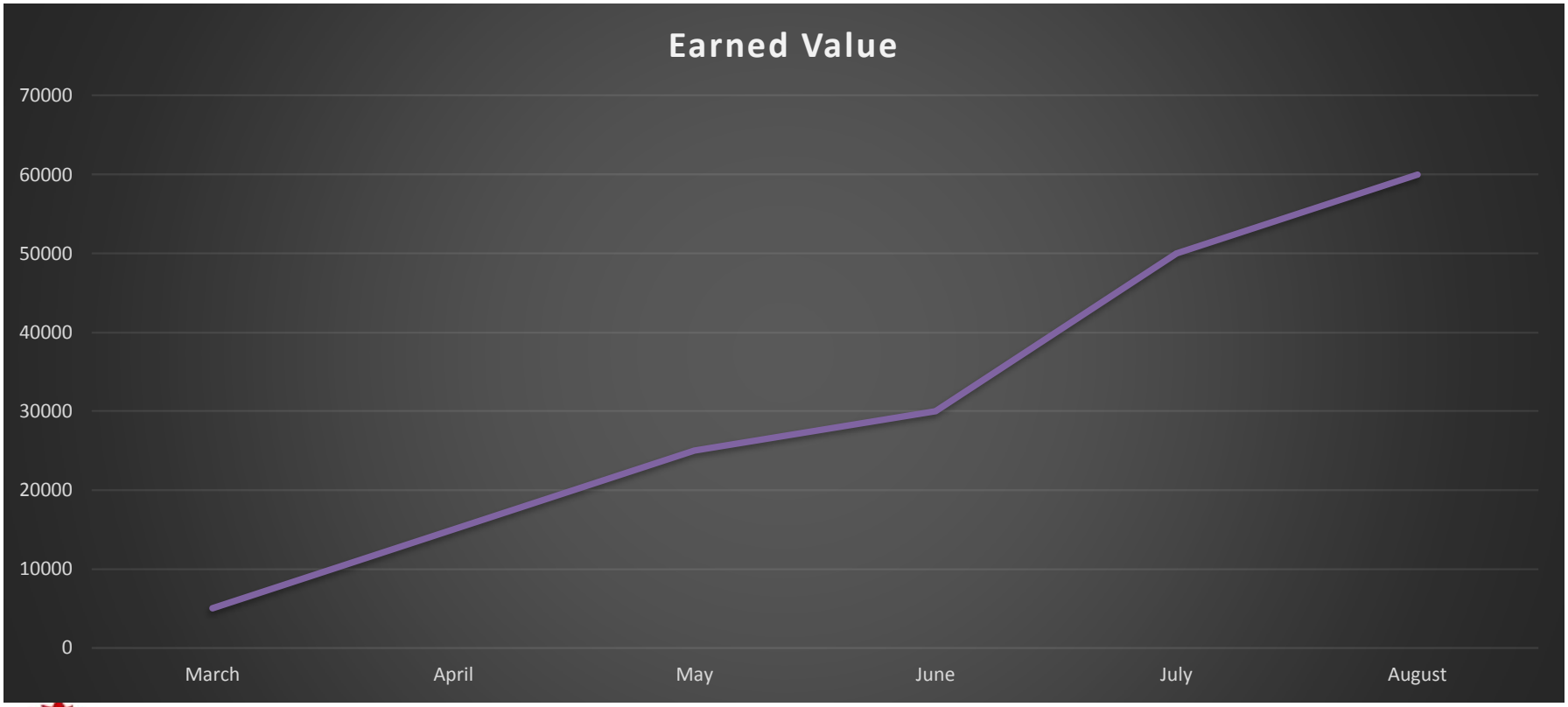
Budget at Completion (BAC)



Actual Cost (AC)



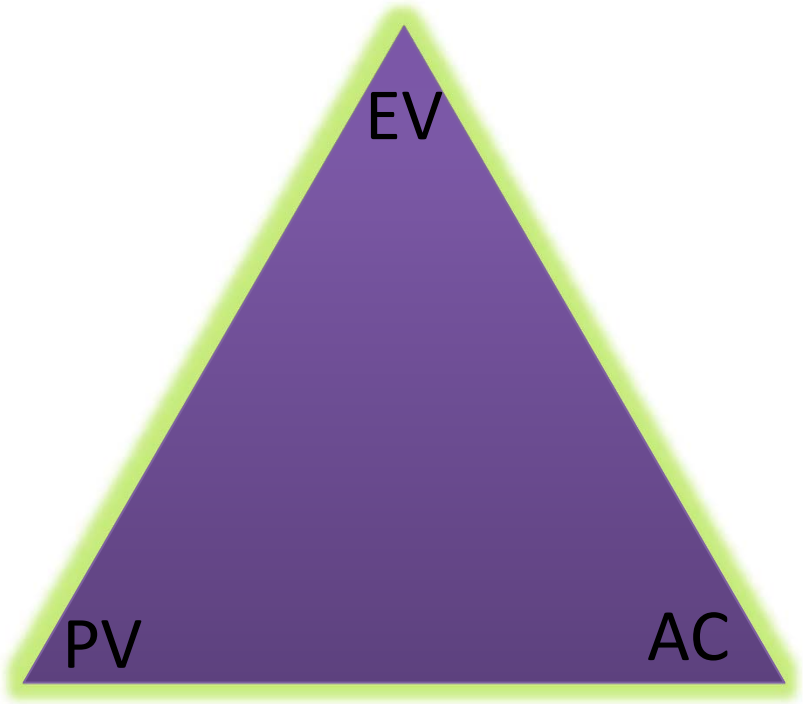
Earned Value (EV)



Earned Value Defined

WBS	ITEM	QUANTITY
1.1.1.1.1	Install Supports	
1.1.1.1.1.1	Install Anchors	120
1.1.1.1.1.2	Install Threaded Rod	120

Earned Value Management Relationships



“

Pure mathematics is, in its way, the poetry of logical ideas.

”

- Albert Einstein

Lots O' Math

NAME	ACRONYM	FORMULA	USE
Cost Variance	CV	EV-AC	Cost baseline comparison
Schedule Variance	SV	EV-PV	Schedule baseline comparison
Cost Performance Index	CPI	EV/AC	Project budget efficiency
Schedule Performance Index	SPI	EV/PV	Project schedule efficiency
Cost Schedule Index	CSI	CPI x SPI	Likelihood of project recover
Work in Progress	WIP	(CPI x SPI)/2	Cash flow and billing
Estimate At Completion	EAC	BAC/CPI	Project cost at completion
Estimate To Completion	ETC	EAC-AC	Budget to spend to complete project
Variance At Completion	VAC	BAC-EAC	Amount over/under original budget
To Complete Performance Index – BAC	$TCPI_{BAC}$	(BAC-EV)/(BAC-AC)	CPI needed to meet original budget
To Complete Performance Index – EAC	$TCPI_{EAC}$	(BAC-EV)/(EAC-AC)	CPI needed to meet Estimate at Completion

Cost Variance (CV)

- Cost Performance
- Budget Status
- Positive = Below Budget
- Negative = Over Budget

Example Problem

PV = $68,000
AC = $67,000
EV = $69,000
BAC = $134,000

$$CV = EV - AC$$

$$CV = \$69{,}000 - \$67{,}000$$

$$CV = \$2{,}000$$

Cost Variance (CV) – Student Problem One

$$CV = EV - AC$$

$$CV = \$33{,}000 - \$41{,}000$$

$$CV = \$ - 8{,}000$$

Student Problem

PV = $35,000
AC = $41,000
EV = $33,000
BAC = $94,000

Schedule Variance (SV)

- Schedule Performance
- Schedule Status
- Positive = Ahead of Schedule
- Negative = Behind Schedule

Example Problem

PV = $68,000
AC = $67,000
EV = $69,000
BAC = $134,000

$$SV = EV - PV$$

$$SV = \$69{,}000 - \$68{,}000$$

$$SV = \$1{,}000$$

Schedule Variance (SV) – Man Hours

$$SV = EV - PV$$

$$SV = \$69{,}000 - \$68{,}000$$

$$SV = \$1{,}000$$

$$M_c = \$25.00$$

$$M_h = \frac{SV}{M_c}$$

$$M_h = \frac{\$1{,}000}{\$25.00}$$

$$M_h = 40\ man\ hours$$

Schedule Variance (SV) – Student Problem Two

$$SV = EV - PV$$

$$SV = \$33{,}000 - \$35{,}000$$

$$SV = \$ - 2{,}000$$

Student Problem

PV = $35,000
AC = $41,000
EV = $33,000
BAC = $94,000

Cost Performance Index (CPI)

- Cost Performance
- Investment Payback
- 1 = On Target
- > 1 = Positive Payback
- < 1 = Negative Payback

Example Problem

PV = $68,000
AC = $67,000
EV = $69,000
BAC = $134,000

$$CPI = \frac{EV}{AC}$$

$$CPI = \frac{\$69{,}000}{\$67{,}000}$$

$$CPI = 1.03$$

Cost Performance Index (CPI) – Student Problem Three

$$CPI = \frac{EV}{AC}$$

$$CPI = \frac{\$33,000}{\$41,000}$$

$$CPI = .81$$

Student Problem

PV = $35,000

AC = $41,000

EV = $33,000

BAC = $94,000

Schedule Performance Index (SPI)

- Schedule Performance
- 1 = On Target
- > 1 = Ahead of Schedule
- < 1 = Behind Schedule

Example Problem

PV = $68,000
AC = $67,000
EV = $69,000
BAC = $134,000

$$SPI = \frac{EV}{PV}$$

$$SPI = \frac{\$69{,}000}{\$68{,}000}$$

$$SPI = 1.02$$

Schedule Performance Index (SPI) – Student Problem Four

$$SPI = \frac{EV}{PV}$$

$$SPI = \frac{\$33{,}000}{\$35{,}000}$$

$$SPI = .94$$

Student Problem

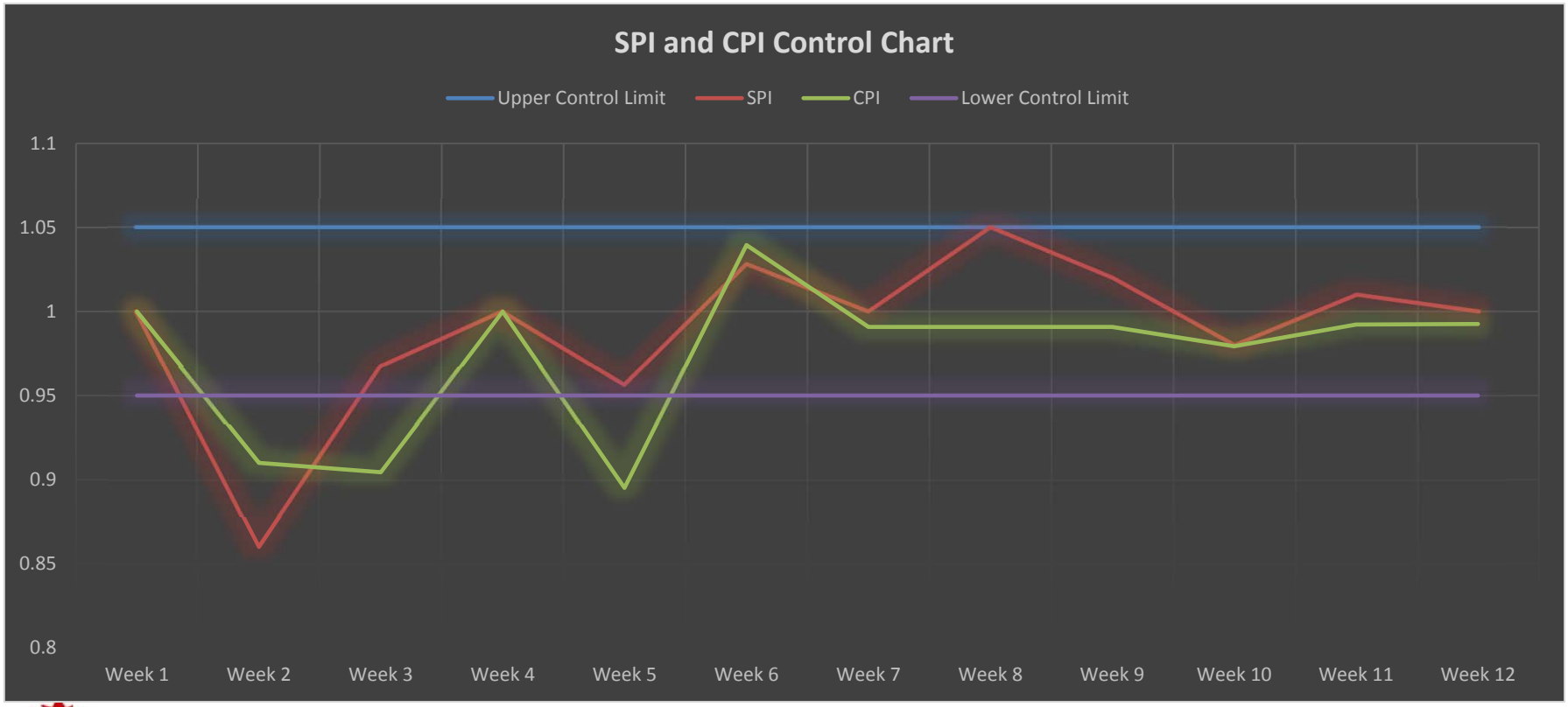
PV = $35,000

AC = $41,000

EV = $33,000

BAC = $94,000

Control Charts



Cost Schedule Index (CSI)

- *Shows likelihood of project recovery*
- *< 1 poor likelihood*
- *> 1 greater likelihood*

$$CSI = CPI\ X\ SPI$$

$$CSI = 1.03\ X\ 1.02$$

$$CSI = 1.05$$

Example Problem

PV = $68,000

AC = $67,000

EV = $69,000

BAC = $134,000

CPI = 1.03

SPI = 1.02

Cost Schedule Index (CSI) – Student Problem Five

$$CSI = CPI\ X\ SPI$$

$$CSI = .81\ X\ .94$$

$$CSI = .76$$

Student Problem

PV = $35,000
AC = $41,000
EV = $33,000
BAC = $94,000
CPI = .81
SPI = .94

Work in Progress (WIP)

$$WIP = \frac{CPI + SPI}{2}$$

$$WIP = \frac{1.03 + 1.02}{2}$$

$$WIP = 1.03$$

Example Problem

PV = $68,000
AC = $67,000
EV = $69,000
BAC = $134,000
CPI = 1.03
SPI = 1.02

Work in Progress (WIP) – Student Problem Six

$$WIP = \frac{CPI + SPI}{2}$$

$$WIP = \frac{.81 + .94}{2}$$

$$WIP = 0.88$$

Student Problem

PV = $35,000
AC = $41,000
EV = $33,000
BAC = $94,000
CPI = .81
SPI = .94

Estimate at Completion (EAC)

- Estimated total cost of project if CPI remains constant

$$EAC = \frac{BAC}{CPI}$$

$$EAC = \frac{\$134{,}000}{1.03}$$

$$EAC = 130{,}097$$

Example Problem

PV = $68,000

AC = $67,000

EV = $69,000

BAC = $134,000

CPI = 1.03

SPI = 1.02

Estimate at Completion (EAC) – Student Problem Seven

$$EAC = \frac{BAC}{CPI}$$

$$EAC = \frac{\$94{,}000}{.81}$$

$$EAC = 116{,}049$$

Student Problem

PV = $35,000
AC = $41,000
EV = $33,000
BAC = $94,000
CPI = .81
SPI = .94

Independent Estimate at Completion Calculation - One

- Cost will be performed at original budgeted rate

$$EAC = AC + (BAC - EV)$$

$$EAC = \$67{,}000 + (\$134{,}000 - \$69{,}000)$$

$$EAC = \$67{,}000 + \$65{,}000$$

$$EAC = \$132{,}000$$

Example Problem

PV = $68,000
AC = $67,000
EV = $69,000
BAC = $134,000
CPI = 1.03
SPI = 1.02

Independent Estimate at Completion Calculation – Student Problem Eight

- Cost will be performed at original budgeted rate

$$EAC = AC + (BAC - EV)$$

$$EAC = \$41{,}000 + (\$94{,}000 - \$33{,}000)$$

$$EAC = \$41{,}000 + \$61{,}000$$

$$EAC = \$102{,}000$$

Student Problem

PV = $35,000
AC = $41,000
EV = $33,000
BAC = $94,000
CPI = .81
SPI = .94

Independent Estimate at Completion Calculation - Two

- Future cost will be the same as the last three reporting periods.

$$EAC = AC + \frac{(BAC - EV)/(EV_a + EV_b + EV_c)}{(AC_a + AC_b + AC_c)}$$

Independent Estimate at Completion Calculation - Three

- Future performance will be affected by past schedule performance

$$EAC = AC + \frac{BAC\ - EV}{CPI\ x\ SPI}$$

$$EAC = \$67{,}000 + \frac{\$134{,}000\ - \$69{,}000}{1.03\ x\ 1.02}$$

$$EAC = \$67{,}000 + \frac{\$65{,}000}{1.05}$$

Example Problem

PV = $68,000

AC = $67,000

EV = $69,000

BAC = $134,000

CPI = 1.03

SPI = 1.02

Independent Estimate at Completion Calculation - Three

$$EAC = \$67{,}000 + \$61{,}905$$

$$EAC = \$128{,}905$$

Independent Estimate at Completion Calculation – Student Problem Nine

$$EAC = AC + \frac{BAC\ - EV}{CPI\ x\ SPI}$$

$$EAC = \$41{,}000 + \frac{\$94{,}000\ - \$33{,}000}{.81\ x\ .94}$$

$$EAC = \$41{,}000 + \frac{\$61{,}000}{.76}$$

$$EAC = \$41{,}000 + \$80{,}263$$

Student Problem

PV = $35,000
AC = $41,000
EV = $33,000
BAC = $94,000
CPI = .81
SPI = .94

$$EAC = \$121{,}263$$

Independent Estimate at Completion Calculation - Four

- Future performance will be affected by a proportion of the current cost and schedule performance

$$EAC = AC + \frac{BAC\ - EV}{0.8\ CPI + \ 0.2\ SPI}$$

$$EAC = \$67{,}000 + \frac{\$134{,}000\ - \$69{,}000}{0.8 * 1.03 + \ 0.2 * 1.02}$$

$$EAC = \$67{,}000 + \frac{\$65{,}000}{.824 + .204}$$

Example Problem

PV = $68,000

AC = $67,000

EV = $69,000

BAC = $134,000

CPI = 1.03

SPI = 1.02

Independent Estimate at Completion Calculation - Three

$$EAC = \$67{,}000 + \frac{\$65{,}000}{1.028}$$

$$EAC = \$67{,}000 + \$63{,}230$$

$$EAC = \$130{,}230$$

Independent EAC Calculation – Student Problem Ten

$$EAC = AC + \frac{BAC\ - EV}{0.8\ CPI + 0.2\ SPI}$$

$$EAC = \$41{,}000 + \frac{\$94{,}000\ - \$33{,}000}{0.8\ * .81 + 0.2 * .94}$$

$$EAC = \$41{,}000 + \frac{\$61{,}000}{.648 + .188}$$

$$EAC = \$41{,}000 + \frac{\$61{,}000}{.836}$$

Student Problem

PV = $35,000
AC = $41,000
EV = $33,000
BAC = $94,000
CPI = .81
SPI = .94

$$EAC = \$41{,}000 + \$\ 72{,}967$$

$$EAC = \$113{,}967$$

EAC Comparison

EAC Method	Example Value	Student Value
$EAC = \frac{BAC}{CPI}$	$130,097	$116,049
$EAC = AC + (BAC - EV)$	$132,000	$102,000
$EAC = AC + \frac{BAC - EV}{CPI \; x \; SPI}$	$128,905	$121,000
$EAC = AC + \frac{BAC - EV}{0.8\,CPI + 0.2\,SPI}$	$130,230	$113,967

	Example	Student
BAC	134,000	94,000

Estimate to Complete (ETC) – Statistical

- Remaining amount to be spent on project with no change to CPI

$$ETC = \frac{BAC - EV}{CPI}$$

$$ETC = \frac{\$134{,}000 - \$69{,}000}{1.03}$$

$$ETC = \frac{\$65{,}000}{1.03}$$

Example Problem

PV = $68,000
AC = $67,000
EV = $69,000
BAC = $134,000
CPI = 1.03
SPI = 1.02
EAC = $130,097

$$ETC = 63{,}107.00$$

Estimate to Complete (ETC) – Estimate at Completion

- Remaining amount to be spent on project using revised EAC

$$ETC = EAC - AC$$

$$ETC = \$130{,}097 - \$67{,}000$$

$$ETC = \$70{,}097$$

Example Problem

PV = $68,000
AC = $67,000
EV = $69,000
BAC = $134,000
CPI = 1.03
SPI = 1.02
EAC = $130,097

Estimate to Complete (ETC) – Student Problem Ten

$$ETC = EAC - AC$$

$$ETC = \$116{,}049 - \$41{,}000$$

$$ETC = \$75{,}049$$

Student Problem

PV = $35,000
AC = $41,000
EV = $33,000
BAC = $94,000
CPI = .81
SPI = .94
EAC = $116,049

Variance at Completion (VAC)

- How much more or less than was budgeted
- Positive value is under the original budget
- Negative value is over the original budget

$$VAC = BAC - EAC$$

$$VAC = \$134{,}000 - \$130{,}097$$

$$VAC = \$3{,}903$$

Example Problem

PV = $68,000
AC = $67,000
EV = $69,000
BAC = $134,000
CPI = 1.03
SPI = 1.02
EAC = $130,097

Variance at Completion (VAC) – Student Problem Eleven

$$VAC = BAC - EAC$$

$$VAC = \$94{,}000 - \$116{,}049$$

$$VAC = \$ - 22{,}049$$

Student Problem

PV = $35,000
AC = $41,000
EV = $33,000
BAC = $94,000
CPI = .81
SPI = .94
EAC = $116,049

To Complete Performance Index ($TCPI_{BAC}$) - Baseline

- Target CPI to Complete project at original budget
- TPCI < 1 = Project likely to be at or under budget
- TCPI > 1 = Project NOT likely to be at or under budget

Example Problem

PV = $68,000
AC = $67,000
EV = $69,000
BAC = $134,000
EAC = $130,097

$$TCPI_{BAC} = \frac{BAC - EV}{BAC - AC}$$

$$TCPI_{BAC} = \frac{\$134{,}000 - \$69{,}000}{\$134{,}000 - \$67{,}000}$$

$$TCPI_{BAC} = \frac{\$65{,}000}{\$67{,}000}$$

$$TCPI_{BAC} = .97$$

To Complete Performance Index ($TCPI_{BAC}$) – Student Problem 12

$$TCPI_{BAC} = \frac{BAC\ - EV}{BAC\ - AC}$$

$$TCPI_{BAC} = \frac{\$94{,}000\ - \$33{,}000}{\$94{,}000\ - \$41{,}000}$$

$$TCPI_{BAC} = \frac{\$61{,}000}{\$53{,}000}$$

$$TCPI_{BAC} = 1.15$$

Student Problem

PV = $35,000
AC = $41,000
EV = $33,000
BAC = $94,000
CPI = .81
SPI = .94
EAC = $116,049

To Complete Performance Index ($TCPI_{EAC}$) - Estimate

- Target CPI to Complete project at revised budget
- TPCI < 1 = Project likely to be at or under budget
- TCPI > 1 = Project NOT likely to be at or under budget

Example Problem

PV = $68,000
AC = $67,000
EV = $69,000
BAC = $134,000
EAC* = $132,000

$$TCPI_{EAC} = \frac{BAC - EV}{EAC - AC}$$

$$TCPI_{EAC} = \frac{\$134,000 - \$69,000}{\$132,000 - \$67,000}$$

$$TCPI_{EAC} = \frac{\$65,000}{\$63,097}$$

$$TCPI_{EAC} = 1.03$$

To Complete Performance Index ($TCPI_{EAC}$) – Student Problem 13

$$TCPI_{EAC} = \frac{BAC\ - EV}{EAC\ - AC}$$

$$TCPI_{EAC} = \frac{\$94{,}000\ - \$33{,}000}{\$102{,}000\ - \$41{,}000}$$

$$TCPI_{EAC} = \frac{\$61{,}000}{\$61{,}000}$$

$$TCPI_{EAC} = 1.00$$

Student Problem

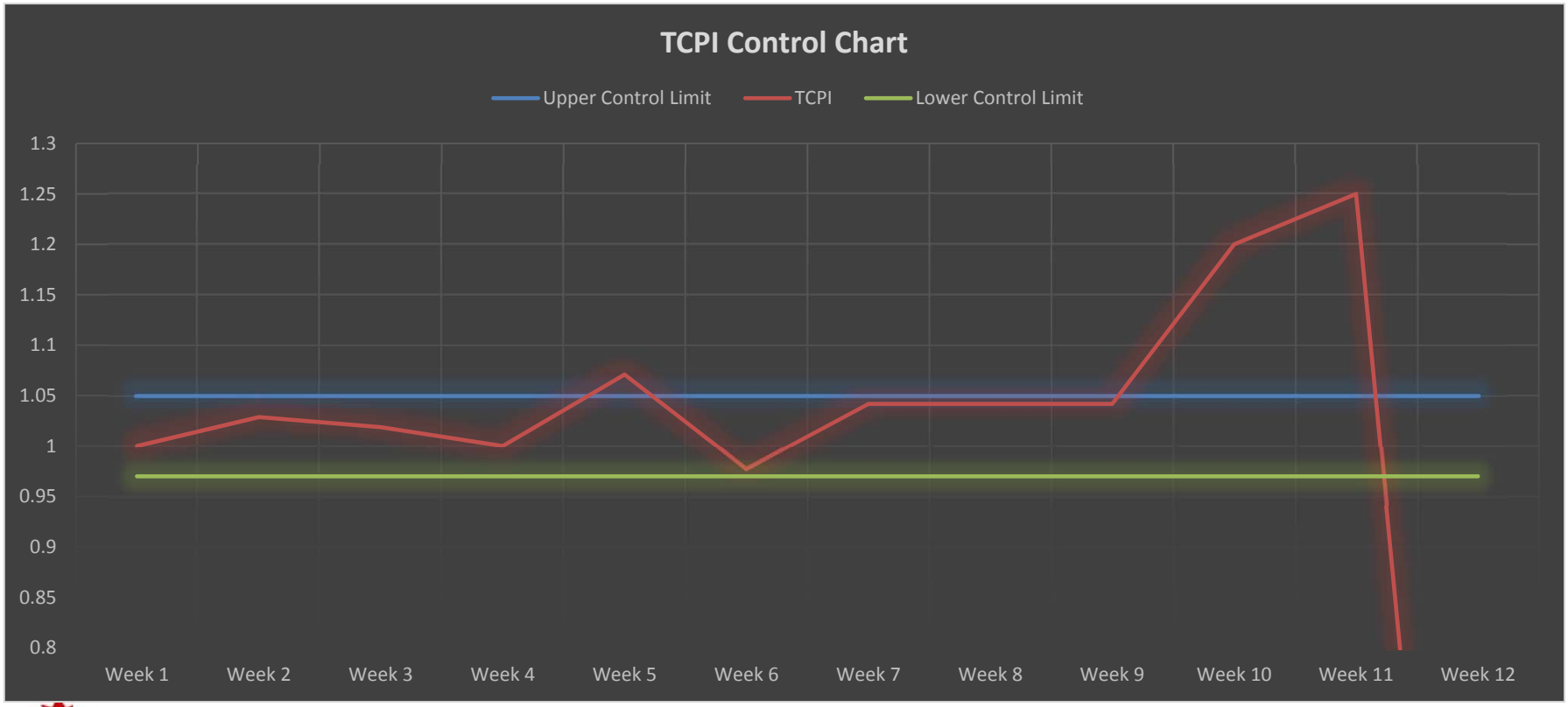
PV = $35,000
AC = $41,000
EV = $33,000
BAC = $94,000
CPI = .81
SPI = .94
EAC* = $102,000

TCPI Comparison

TCPI Method	Example Value	Student Value
$TCPI_{BAC} = \frac{BAC\ - EV}{BAC\ - AC}$	.97	1.15
$TCPI_{EAC} = \frac{BAC\ - EV}{EAC^*\ - AC}$	1.03	1.00

	Example	Student
Calculated CPI	1.03	.81
Difference $TCPI_{BAC}$	-0.6	.34
Difference $TCPI_{EAC}$	0.00	.19

TCPI Control Chart



Earned Value Management Benefits

- **Utilizing EVM allows us to manage by exception.**
- **Numbers don't lie—usually.**
- **Creates data-based decision-making.**
- **Acts as tactical and strategic planning for projects and programs.**

EVM Workbook

[Project Name] [Company Name]

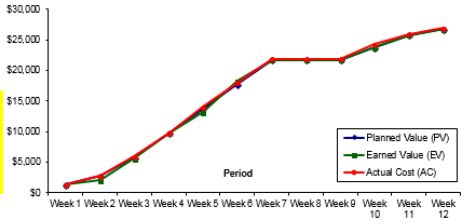
Earned Value Analysis Report

Prepared By: _____
Date: _____

For Reporting Period: _____

Summary:

[place any notes in here about this reporting period. Reasons why project is ahead or behind, project issues, change orders, and stakeholder communications]



Planned Value (PV)

WBS	Task Name	TBC	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
1.1	1st Floor TR Buildout	1375	$ 1,375											
1.2	2nd Floor TR Buildout	1375		$ 1,375										
1.3	1st Floor rough in	4000			$ 3,000	$ 1,000								
1.4	2nd floor rough in	4000				$ 3,000	$ 1,000							
1.5	backbone rough in	3000					$ 3,000							
1.6	1st floor trim out	4000						$ 4,000						
1.7	2nd floor trim out	4000							$ 4,000					
1.8	1st floor testing	2000										$ 2,000		
1.9	2nd floor testing	2000											$ 2,000	
2	project closeout	1000												$ 1,000
2.1		0												
2.2		0												
2.3		0												
2.4		0												
2.5		0												
2.6		0												
2.7		0												
2.8		0												
2.9		0												
3		0												
		0												

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Budget At Completion (BAC)	**26750**	1375	1375	3000	4000	4000	4000	4000	0	0	2000	2000	1000
Cumulative Planned Value (PV)		1375	2750	5750	9750	13750	17750	21750	21750	21750	23750	25750	26750

Actual Cost and Earned Value

Cumulative Actual Cost (AC)	1375	2750	5950	9750	14050	18050	21950	21950	21950	24250	25950	26950
Cumulative Earned Value (EV)	1375	2062.5	5562.5	9750	13150	18250	21750	21750	21750	23750	25750	26750

Project Performance Metrics

Cost Variance (CV = EV - AC)	0	-687.5	-387.5	0	-900	200	-200	-200	-200	-500	-200	-200
Schedule Variance (SV = EV - PV)	0	-687.5	-187.5	0	-600	500	0	0	0	0	0	0
Cost Performance Index (CPI = EV/AC)	1.00	0.75	0.93	1.00	0.94	1.01	0.99	0.99	0.99	0.96	0.99	0.99
Schedule Performance Index (SPI = EV/PV)	1.00	0.75	0.97	1.00	0.96	1.03	1.00	1.00	1.00	1.00	1.00	1.00
Cost Schedule Index (CSI = CPI X SPI)	1.00	0.56	0.90	1.00	0.90	1.04	0.99	0.99	0.99	0.98	0.99	0.99
Work In Progress (WIP = (CPI + SPI)/2)	1.00	0.75	0.95	1.00	0.95	1.02	1.00	1.00	1.00	0.99	1.00	1.00
Estimated Cost at Completion (EAC = BAC / CPI)	26750	35667	28613	26750	28581	26457	26996	26996	26996	27313	26958	26950
Esimtate to Complete (ETC = EAC - AC)	25375	32917	22663	17000	14531	8407	5046	5046	5046	3063	1008	0
erformance Index (TCPI = (BAC - EV) / (BAC - AC))	1.00	1.03	1.02	1.00	1.07	0.98	1.04	1.04	1.04	1.20	1.25	0.00


What is one thing you learned from the course?

Any Questions?

PM102:
Applied Telecommunications
Project Management

35 CECs

PM103:
Advanced Tools for
ICT Project Management

6 CECs

Resource
Management

2 CECs


THANK
YOU