

NetPoint+GPM CONFERENCE

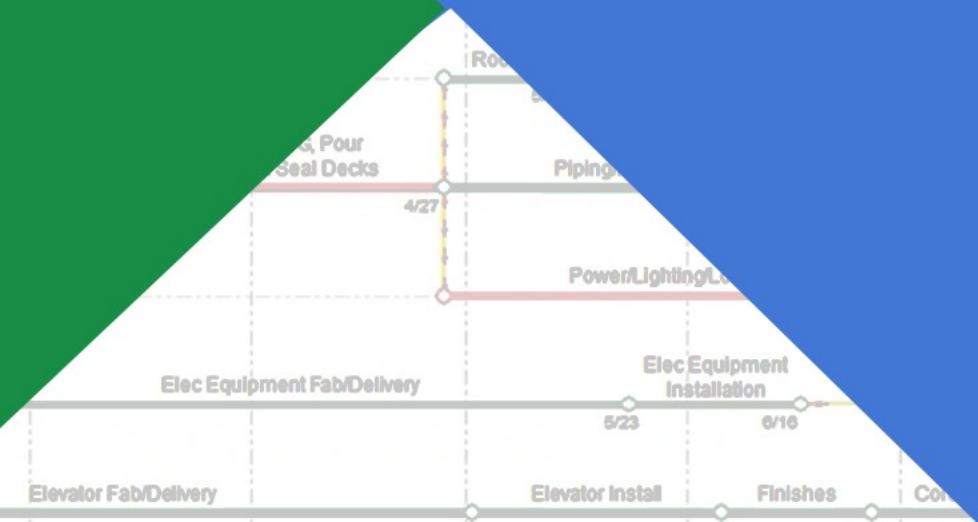
May 12 & 13, 2022

Bringing GPM and NetRisk™ into Graduate Classroom

Presented by:
Gerald (Jerry) Klanac

Consultant Emeritus, PMA Consultants LLC

Faculty of Practice, Director of Construction Engineering & Management Graduate Program, University of Dayton



PMA Consultants Est. 1971

University of Dayton School of Engineering



Presentation Overview

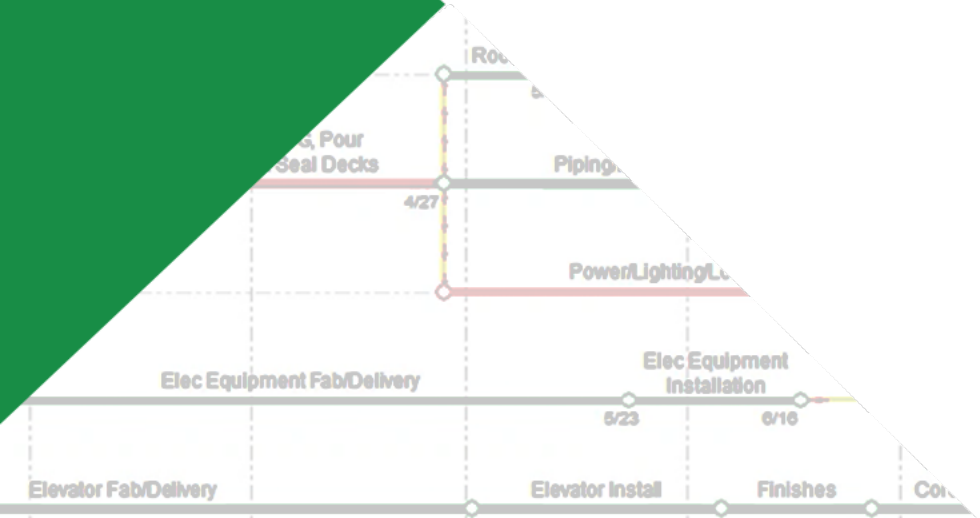
Course Instructor + Course Background

Schedule Risk Analysis Teaching Approach

Case Study Assignment

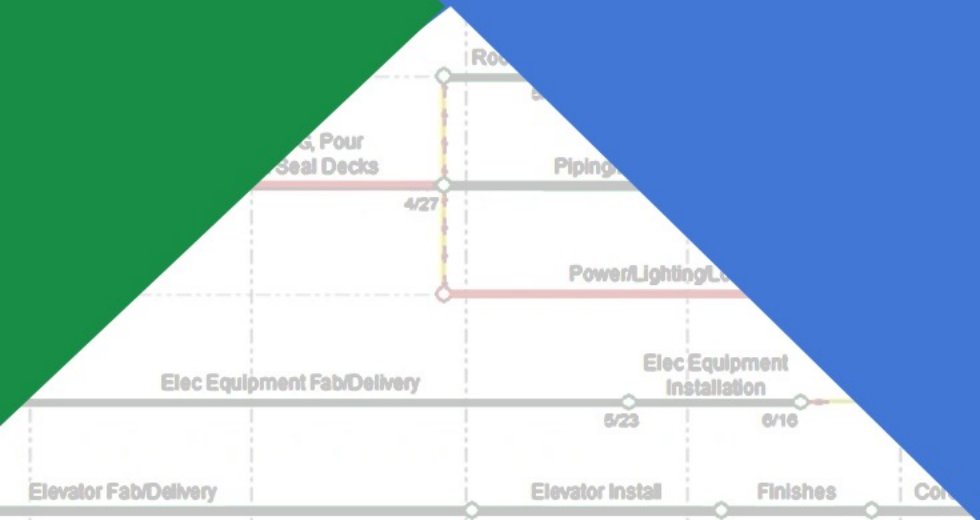
Set-Up
Student Performance
Lessons Learned

Calibration Exercise





Course Instructor + Course Background



Instructor:

Gerald (Jerry) Klanac

Faculty of Practice, Director of Upcoming Construction Engineering & Management Graduate Program

- CEE graduate from University of Dayton (UD) (1978)
- MBA graduate from University of Chicago Graduate School of Business (1989)
- 40 years of experience in project management of design and construction projects worldwide.
- Now Consultant Emeritus with PMA Consultants LLC (was Managing Director)
- Consulted or participated in over 100 projects worldwide.
- Has been teaching part-time at UD since January 2003.
- Now full-time faculty at UD and launching director for the upcoming Construction Engineering and Management master's program.
- Significant expertise in construction planning & scheduling, construction estimates, project risk management, claims and dispute analysis and resolution, project organizations



Instructor's Risk Consulting:

Types of Construction Projects



Oil & Gas

- Refinery Expansions
- Chemical Plant Units
- Facility Turnarounds
- Offshore Platforms
- Offshore Pipelines
- Cross-Country Pipelines
- Oil Terminals
- Gas Terminals
- LNG Regas Terminals
- LNG Liquefaction Terminals
- Lubricants Facilities
- Tar Sands Facilities



Alternative Energy

- Windfarms
- Solar Panel Manufacturing
- Hydrogen Energy
- Biofuel Facilities



Pharma/Life Sciences

- Pharma Manufacturing Facilities
- Pharma Packaging Facilities
- Laboratories
- Health Product Manufacturing



Other

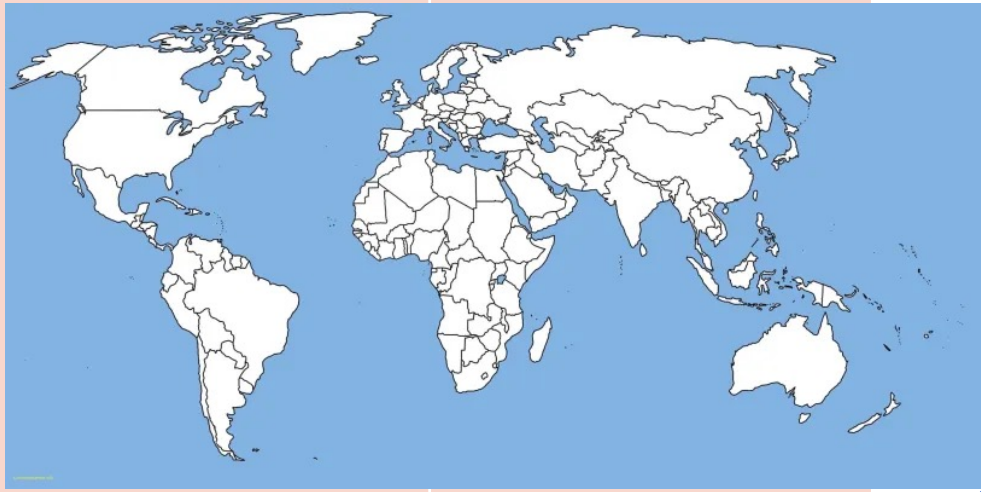
- Office Renovations
- Daycare Center
- On-Campus Urgent Care Center
- Luxury Hotel
- Metals Processing Plant
- Electric Power Plants
- Food Manufacturing Facility
- Airport Parking Garage Expansion
- Data Center

Location of Construction Projects:

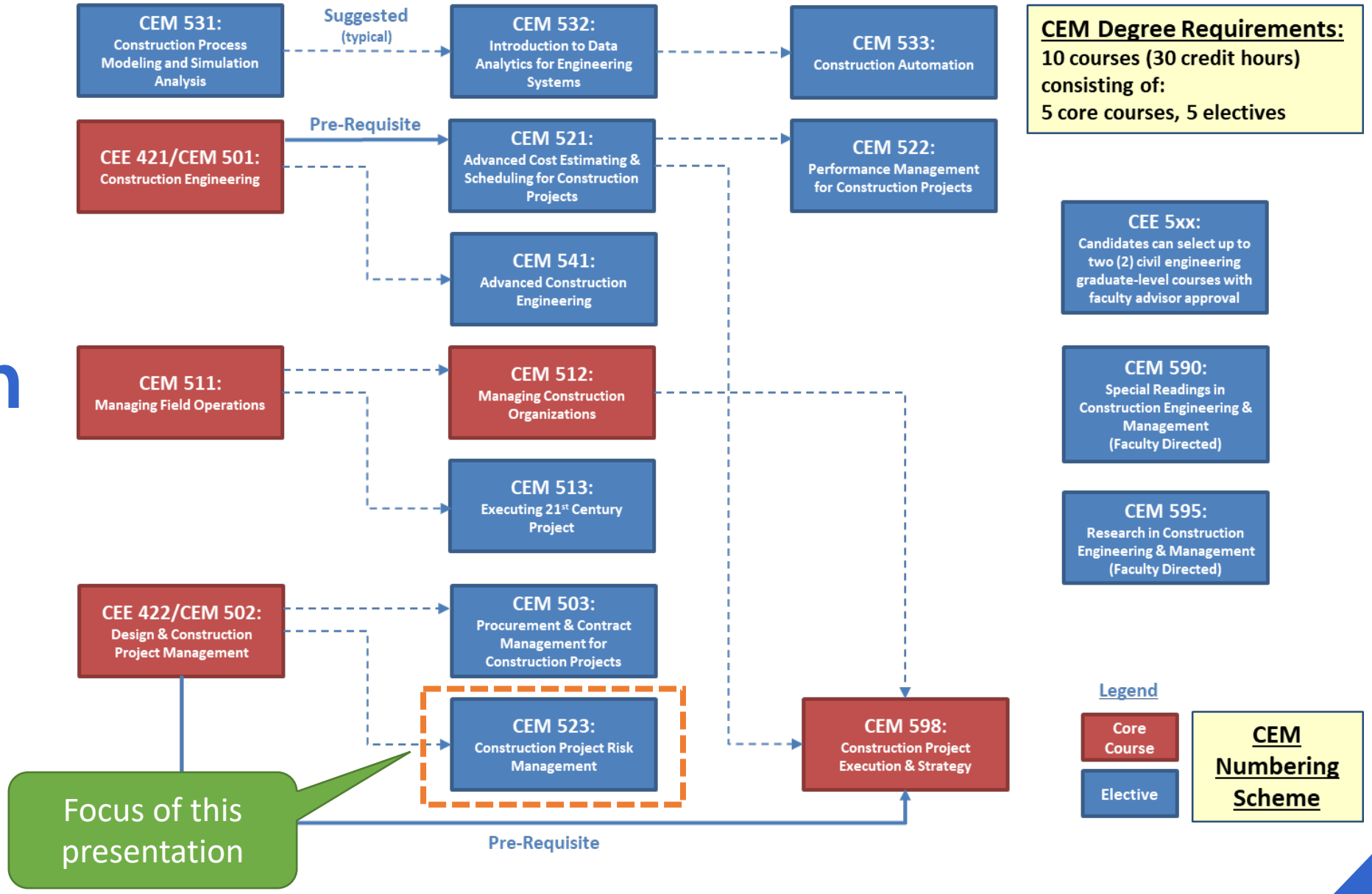
Instructor's Risk Consulting Experience

North America	Europe	Asia	Other

USA:
• Texas
• Louisiana
• Washington
• California
• Pennsylvania
• Michigan
• Ohio
• Illinois
• Indiana
• Wisconsin
• Maryland
• Kansas
• Georgia
• Minnesota
• Colorado
• Gulf of Mexico
• South Carolina
• Florida
• Alaska
Canada:
• Newfoundland
• Alberta
	• Netherlands
	  • Leiden
	  • Rotterdam
	• Germany
	  • Gelsenkirchen
	  • Neustadt
	• France
	  • Dunkerque
	• Austria
	  • Vienna
	• Romania
	• Spain
	  • Bilbao
	  • Madrid
	  • Castellon
	• Russia
	  • Korotchaevo, Valengin
	• United Kingdom
	  • Coryton
	  • Hull
		• China
		  • Guangdong
		  • Zhuhai
		  • Tianjin
		  • South China Sea
		  • Chongqing
		• India
		  • Rajasthan Desert (Barmer)
		• Indonesia
			• Australia
			• Trinidad & Tobago
			• Puerto Rico
			• Algeria
			• Oman
			• Brazil



UD's CEM Curriculum Proposal



Spring 2022 CEM 523 Class

- 1st delivery of class
  - Early Jan to End April 2022
- “Just in time” development of lectures, assignments, quizzes & exams
- 23 students in class
  - Roughly 50%/50% split between graduate students & undergraduate CEE students
  - Most were “Repeat Customers”



Course Objectives



Risk Management Process

Understand and be able to apply a risk management process to any construction project.



Qualitative Risk Analysis

Develop competencies related to qualitative risk analysis to be able to:

- Identify risks to any construction project
- Prioritize these risks, and
- Create a risk register to manage these risks from beginning to end of the project.



Quantitative Risk Analysis

Develop competencies related to:

- Assembly of cost and schedule risk assessment models
- Conducting a Monte Carlo simulation of the risks, and
- Interpreting the results from the simulation for the benefit of the project.

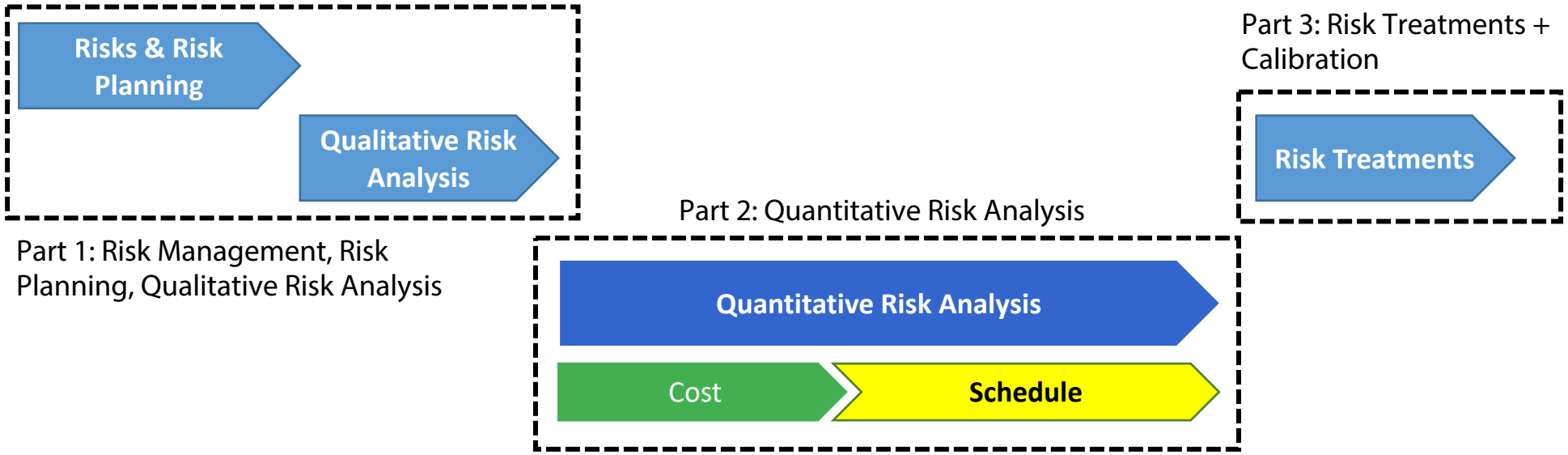


Risk Treatments

Develop strategies and tactics for treatment of risks, which would include development of risk mitigation strategies and risk response plans.

Course Timetable

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
10-Jan	17-Jan	24-Jan	31-Jan	7-Feb	14-Feb	21-Feb	28-Feb	7-Mar	14-Mar	21-Mar	28-Mar	4-Apr	11-Apr	18-Apr	25-Apr	2-May





Schedule Risk Analysis Teaching Approach



Major Considerations



Software availability + latest thinking led to:

Building schedule model in NetPoint™

Using NetRisk™ as simulation tool

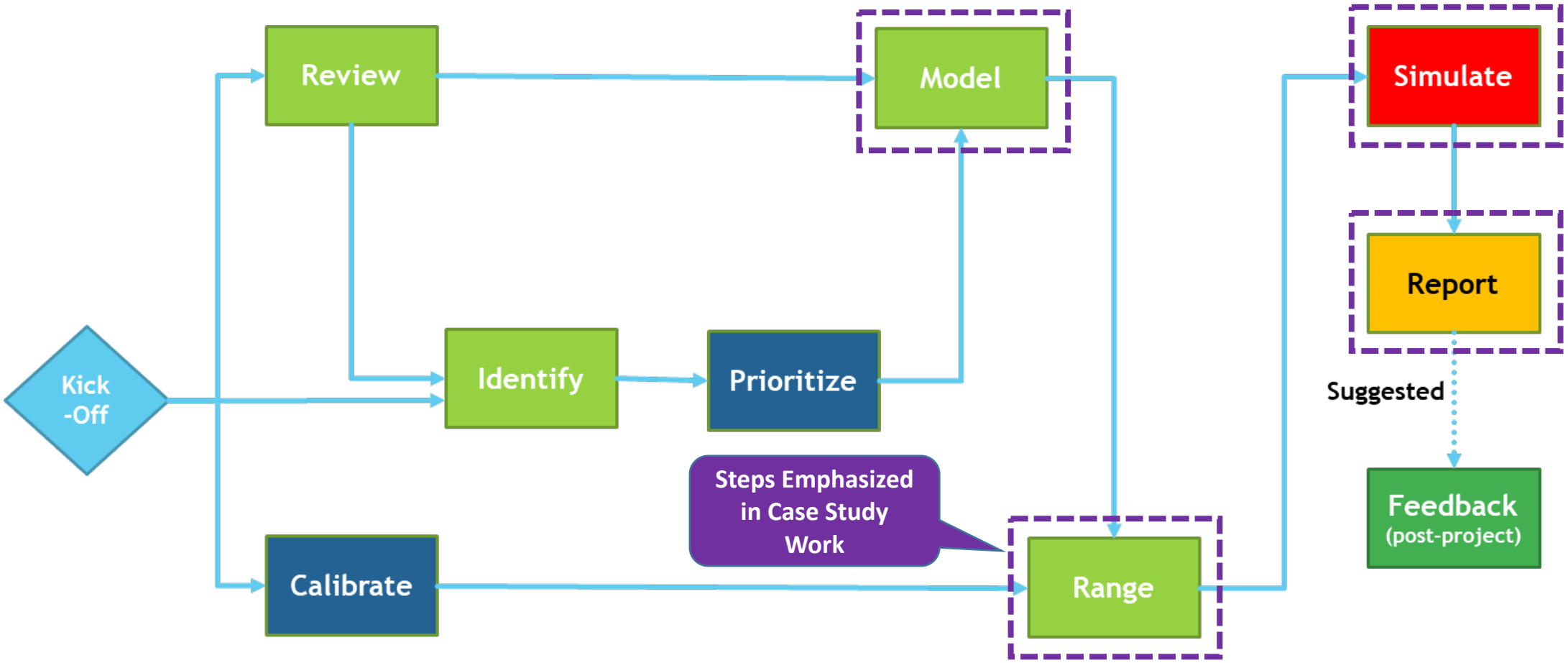


Selection of topic for case study work

Desired model to be less than 50 activities

Schedule Risk Analysis Approach

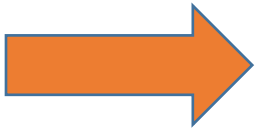
Leveraged PMA's Protocol



Copyright 2022 PMA Consultants LLC

Schedule Modelling Options

Full Schedule "As Is"	Can be used when schedule is somewhat small. A model consisting of 10,000 activities is very cumbersome – although most simulation tools can handle that size.
Full Schedule: Level II Depiction	Level II is seen to be a good level to avoid being overly detailed for the entire project
Sensible Subset	Consists of extraction of key sequences in the overall schedule – this is where the "art of the effort" comes into play



Basis of Case Study



Case Study Assignment



Case Study Topic:

BP's High Performance Computing Center

- 3-story, 110,000 SF building located at BP's Westlake campus in NW Houston, Texas.
- Designed to be equipped with 67,000+ CPUs and have ability to process data of up to two (2) petaflops.
- Building was completed in 2013
- PMA conducted risk reviews of project in 2011 and 2012
- Actual project performance data was modified in the cases study to protect confidentiality agreements



Petaflop = a unit of computing speed equal to one thousand million million (10^{15}) floating-point operations per second.

Case Study Information

- Project Background
- Current Project Schedule in 2 formats
  - Barchart by WBS
  - Barchart by TF, ES, EF

- Summary of Interviews with Project Team:
  - Ranges for Activity Duration Uncertainty
  - Two (2) Discrete Risk Events

CEE 595 01 (CEM 523) Case Study Number 4: Quantitative Risk Analysis (Schedule Risk Analysis)
BP Center for High Performance Computing (CHPC) Project, Part 2

This case study is derived from an actual BP project. Due to the proprietary nature of the project, cost details have been altered from the actual conceptual cost estimate values to maintain confidentiality of the project. All other information provided in the case study is either from public domain sources or fiction for use of this project as an academic case study.

Project Background

Westlake Campus

BP, the international oil & gas company, has a campus in the western reaches of Houston, Texas that is locally termed the Energy Corridor due to abundance offices for many oil & gas industry companies as well as suppliers and contractors that serve that industry.

BP's campus is known as the Westlake campus, and it provides a home to its various business and engineering functions. In their website, BP indicates that this campus also serves as its North American Headquarters. A current aerial view of the campus is provided in Figure 1.[1]

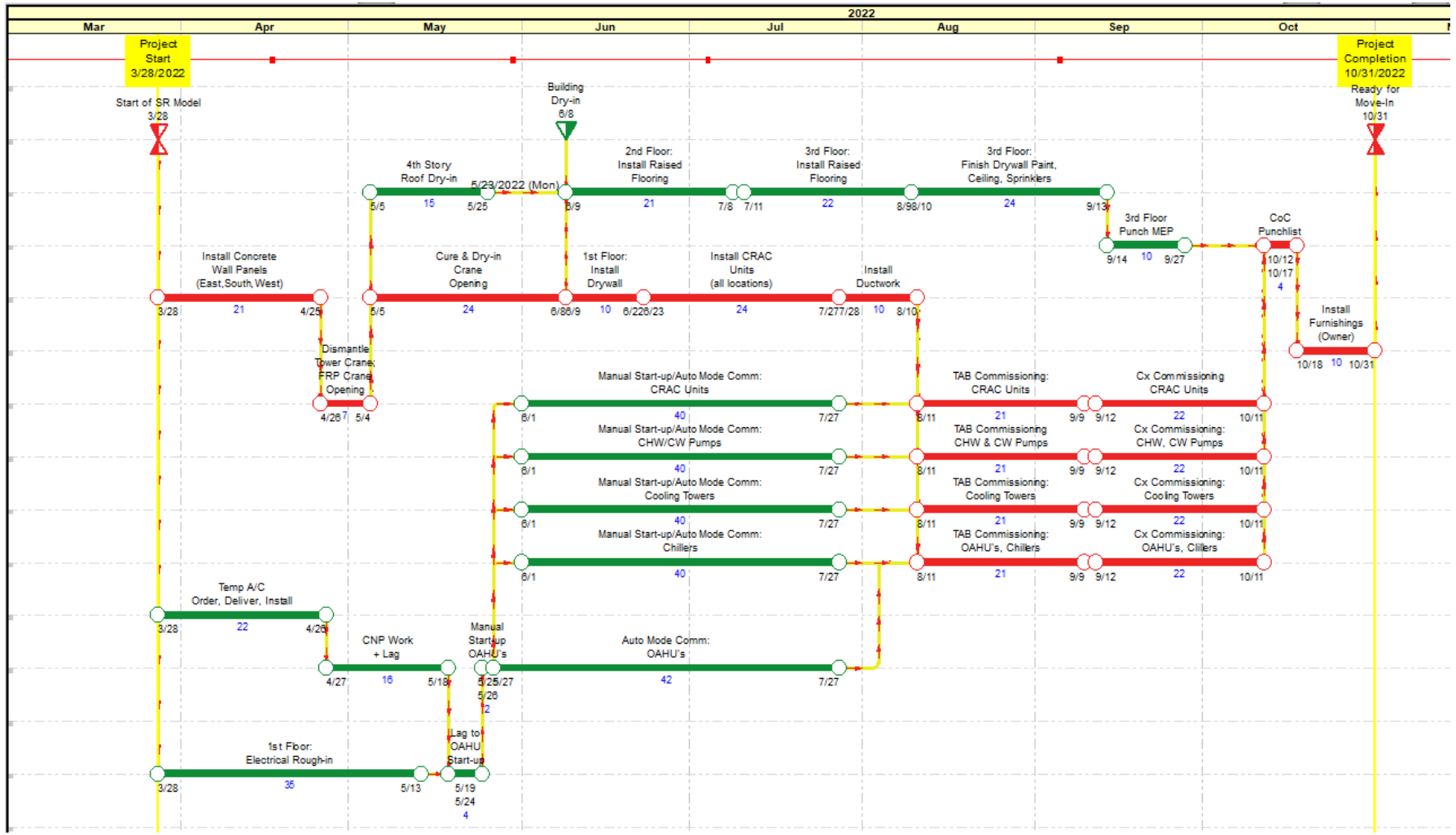


Figure 1: Current Aerial View of BP's Westlake Campus

Student Work for Case Study

1. PREPARE SCHEDULE MODEL IN NETPOINT™
2. UPLOAD SCHEDULE MODEL INTO NETRISK™
3. ENTER RANGES & RISKS INTO MODEL
4. RUN SIMULATIONS: BASE RUN + “FLOAT USE” SENSITIVITY
5. INTERPRET RESULTS

NetPoint™ Schedule Model



Schedule Modelling Considerations

1. Wanted students to interpret schedule information from a contractor
2. Use of "Built-Environment" project
3. Application of the "Sensible Subset" approach of composing a schedule risk model by extracting critical, near-critical and risk sensitive sequences
4. Keep model 50 activities.

SRA Model Features in Case Study



Activity Duration Range Inputs



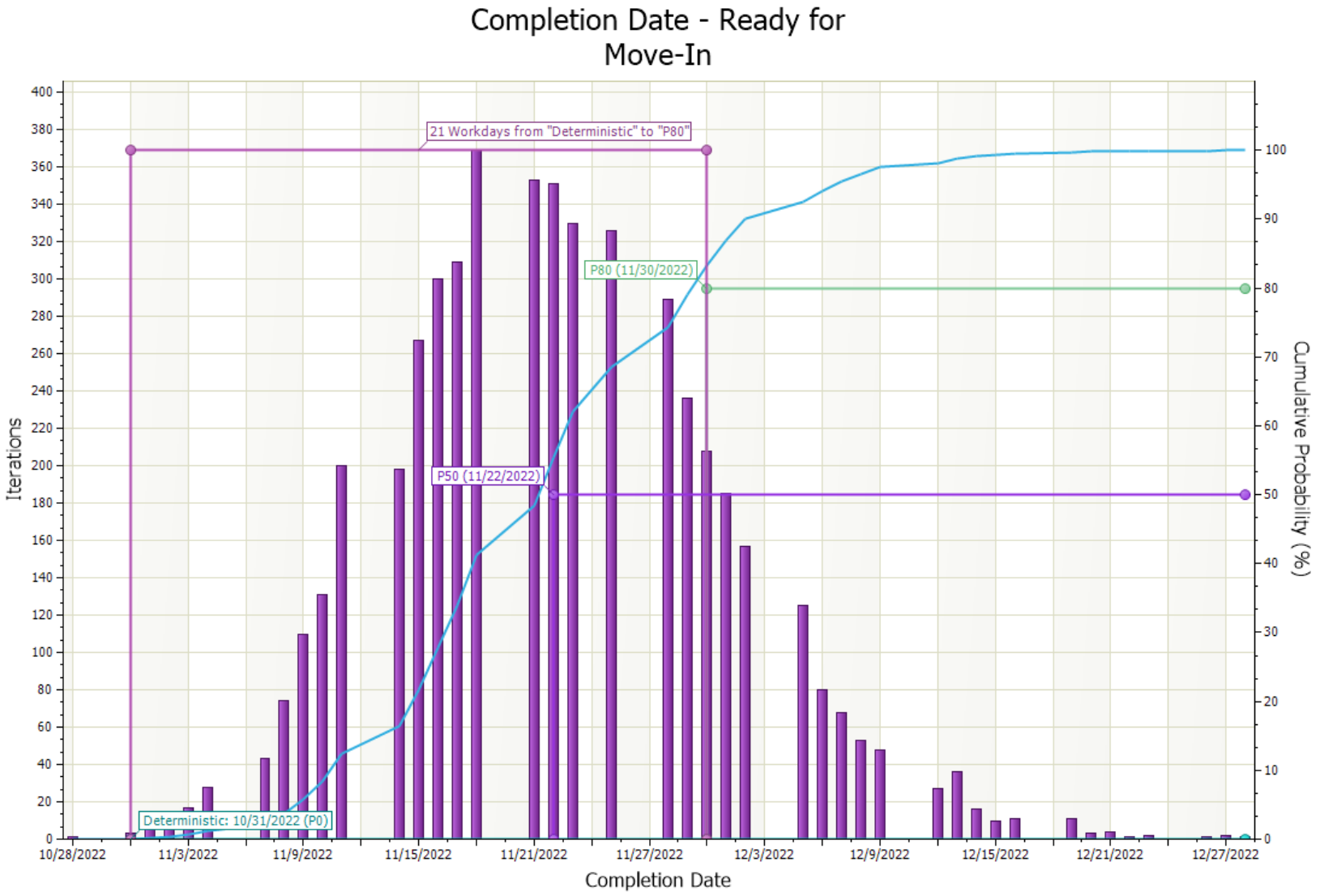
Discrete Risk Events



Consideration of Float Use for “Late Curve”

Run 1: Simulation Result

Probability Distribution of Ready for Move-In

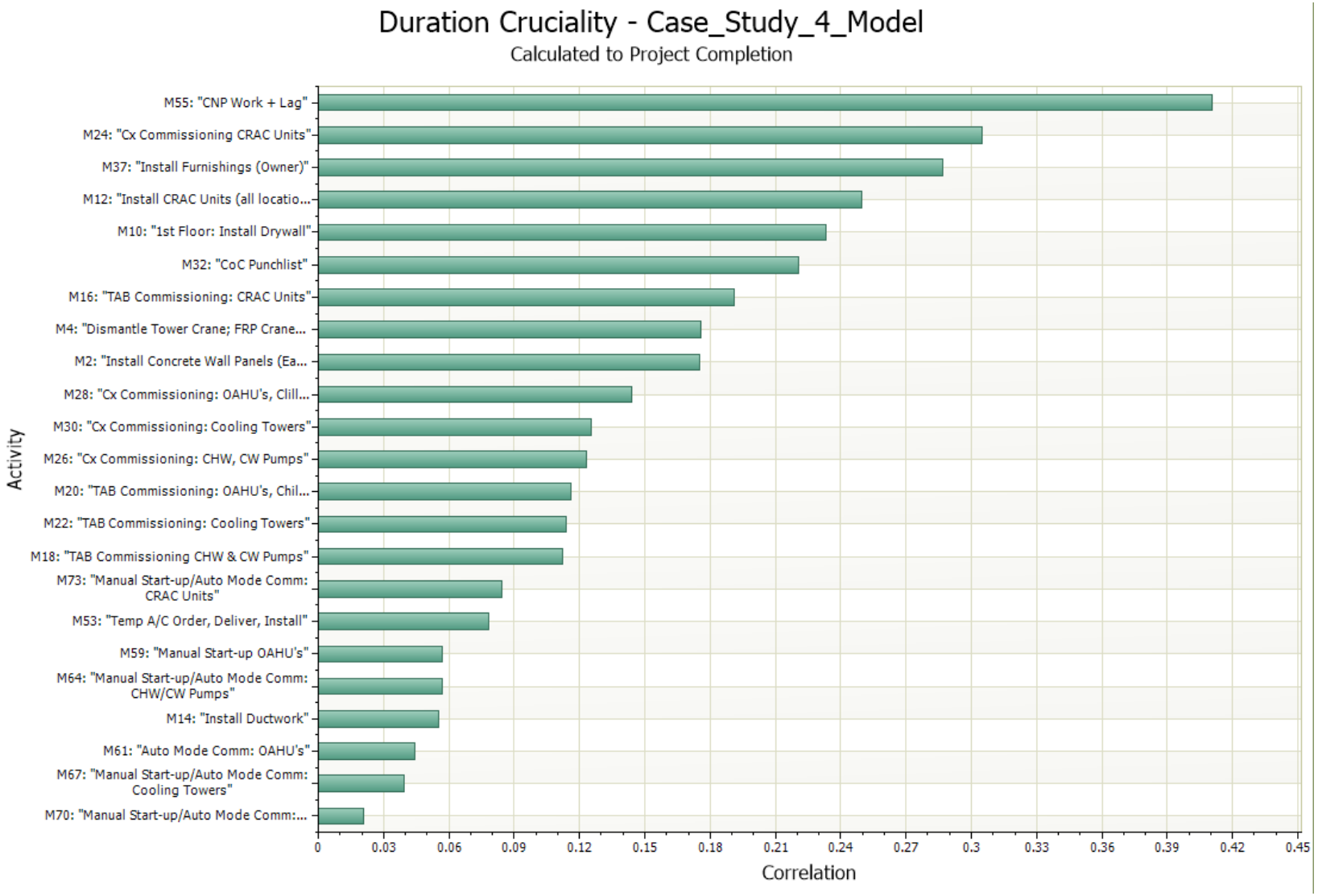


Simulation Results:

- P80 Date = 30 November 2022, 21 workdays from deterministic finish date of 31 Oct 22
- P50 Date = 22 November 2022
- Probability of completing project by 31 Oct 22 is less than 1%

Run 1: Simulation Result

Tornado Diagram: Duration Cruciality



Simulation Results:

- Most influential activity in the simulation was M55, “CNP Work + Lag”

Case Study Questions:

1. *Schedule Model Development*: Prepare a schedule model for the completion of the project in NetPoint, using the attached schedule as the basis. Seek to include all work that has total float of 15 workdays or less.

2. *Simulation Effort*: Once the schedule model is complete, transfer the schedule information into NetRisk and execute the following:

    a. Add inputs into NetRisk for underlying uncertainty in the estimates of activity durations;

    b. Add the two risk events

    c. *Early Curve Basis*: Run a simulation consisting of at least 5,000 iterations of the schedule model with the risk inputs included. Provide the following:

        i. Cumulative probability distribution for the end project node (Ready for Move-In)

        ii. Cumulative probability distribution for Building Dry-In

        iii. Tornado diagram for Duration Cruciality

    d. *Late Curve Basis*: Run a simulation consisting of at least 5,000 iterations of the schedule model with 50% of the float being used for 100% of the activities. Provide the following information from the simulation:

        i. Cumulative probability distribution for the project end node (Ready for Move-In)

        ii. Cumulative probability distribution for Building Dry-In

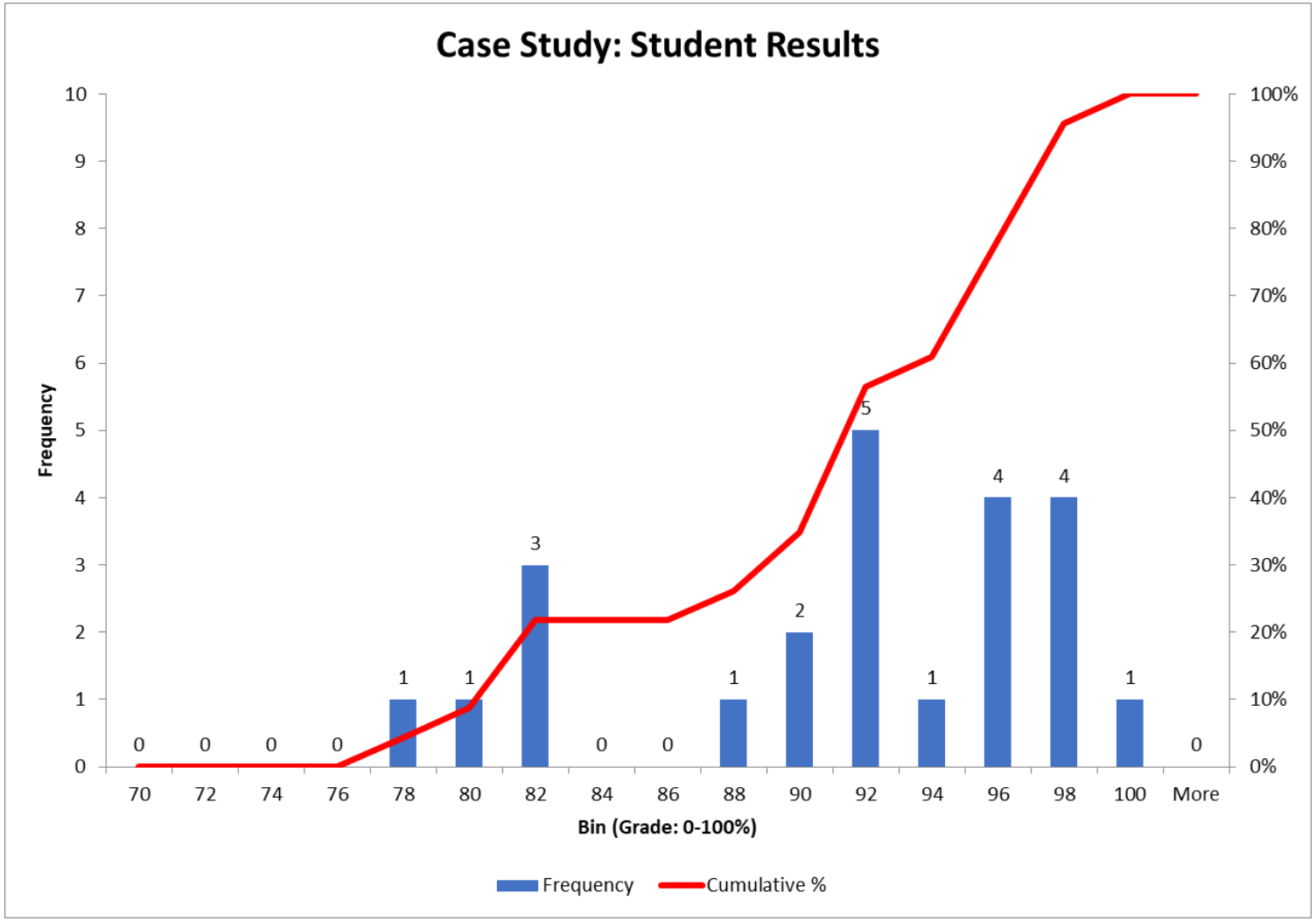
        iii. Comparison of the early curve and late curve for the project end node (Ready for Move-In).

    e. If you were the project manager for the project, what date would you commit to your boss as being the date for Move-in? Explain your answer.

Rubric (Scorecard) Used

Question	Area of Grading	Grading Comment	Score	
			Possible	Graded
1	Schedule Model (Content)	Model looks to contain all of the important work.	15.0	15.0
	Schedule Model (Logic)	Logic looks good	15.0	15.0
	Schedule Model (Timing)	Completion dates are correct	5.0	5.0
2	Simulation Tool (Range Inputs)	Risk model was not submitted but NetRisk graphics were, which is an indication that you had a workable model. Your results are close to the instructor's solution. I cannot provide any detailed feedback without seeing the NetRisk model.	15.0	15.0
	Simulation Tool (Risk Inputs)		10.0	10.0
	Simulation Tool (Base Run Results)		20.0	20.0
	Simulation Tool (Float Use Inputs)	Risk model was not submitted but NetRisk graphics were, which is an indication that you had a workable model. The results should show some differences when floating is added (just a couple of days) and your results do not show that (-1 point)	5.0	5.0
	Simulation Tool (Floating Run Results)		10.0	9.0
	Recommendation	It would be good to cite what is the probability related to your recommendation target completion date.	5.0	4.0
		Total	100.0	98.0

Student Performance on Case Study



Common Errors by Students - compounded by students working together on the assignment, which was allowed:

- Failure to enter ranges for all activities
- Incorrect impact ranges for discrete risk events
- Failure to complete inputs for assigning parameters for "float use"
- Failing to use results to make a recommendation

Was This a Valuable Exercise?

The Verdict (Instructor's View)

The Positives:

- Students adapted very well in using something new: NetPoint and NetRisk
- Students had few questions on how to use NetPoint and NetRisk, more questions on whether their results were sensible
- 74% of the students score 90% or higher on the assignment
- 18 out of 18 students got the GPM/NetPoint question on the final exam correct (questions are randomly assigned)

The Negatives:

- Students struggled with "sensible subset" approach to build a model – mostly due to level of experience in scheduling
- Base schedule for exercise flawed – needed to cover more construction work
- Assignment took longer for the students to prepare than normal, many extensions granted:
  - 3-4 weeks needed versus 2 weeks planned

The Verdict: Yes – exercise was valuable. Would continue to use NetPoint and NetRisk for this assignment. Plan to upgrade base deterministic schedule in case study for next delivery.

Late-Breaking News: Student Feedback

What was MOST EFFECTIVE in helping me to learn? "NetPoint and NetRisk"

"The case studies really applied to what we were learning and introduced us to many stimulating projects."

"Classes devoted to going through the software and the explanation of the outputs were very helpful in understanding the material."

"Awesome class. I really did not know much about risk analysis, but I am interested in my future career to explore it"



Q: I would recommend this course to other students:

4.8

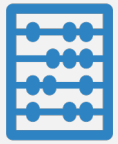
Perfection = 5.0



Calibration Exercise



Exercise Overview



Conduct Quiz #1, which asks students to develop a 90% confidence interval for a trivia-related question



Conduct Quiz #2, which asks students to determine whether statement is true or false and declare their level of confidence in their response



Grade Quizzes and use data to show:

- Level of Calibration in setting ranges
- Level of Confidence in providing responses

Quiz #1 (ranges)

Example Question

In “developed countries”, what is the average daily calorie intake per person?



Quiz #1 (ranges)

Example Question

In “developed countries”, what is the average daily calorie intake per person?

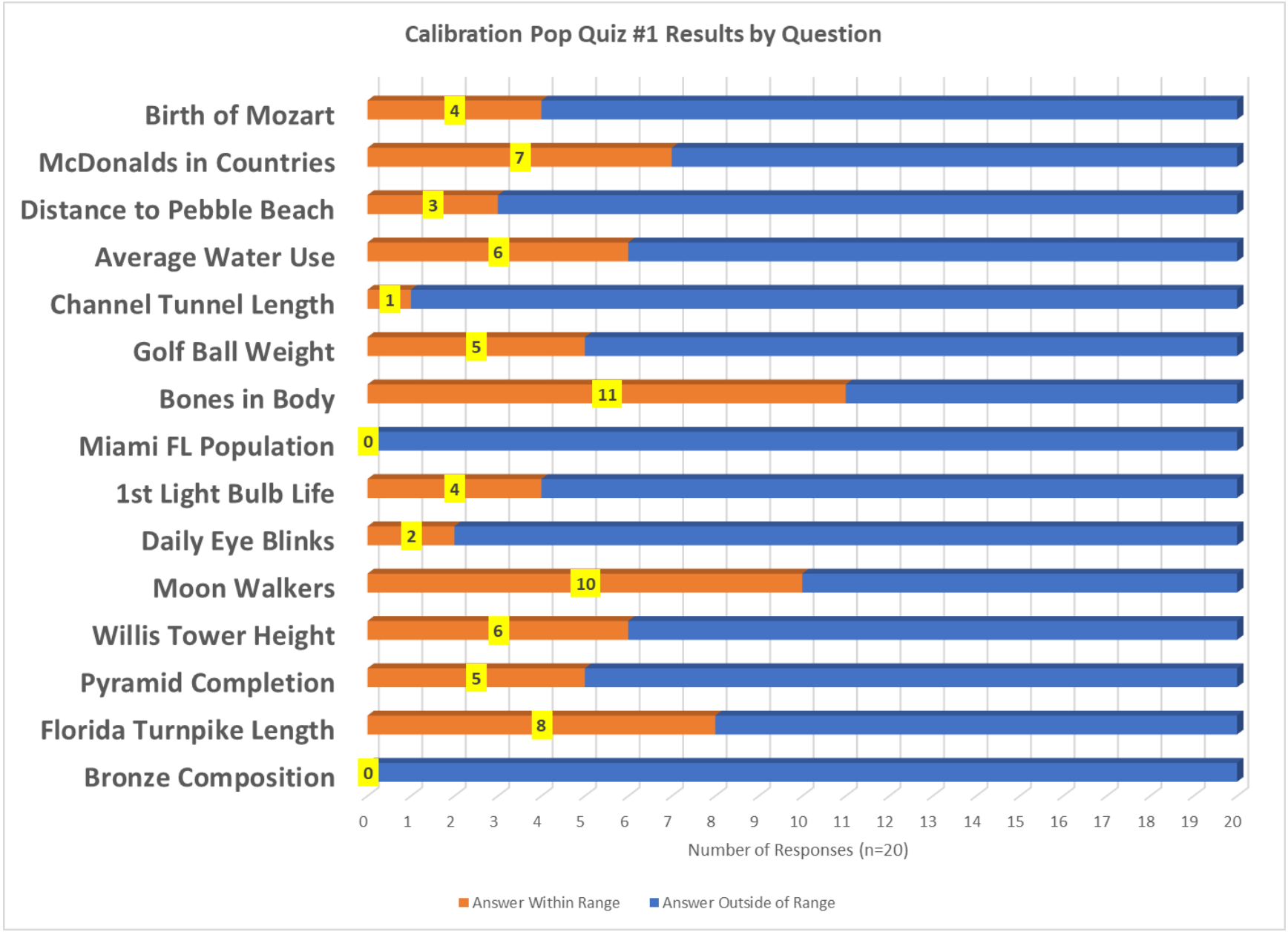


Possible Response

Optimistic	Most Likely	Pessimistic
1,800 calories	2,700 calories	4,000 calories

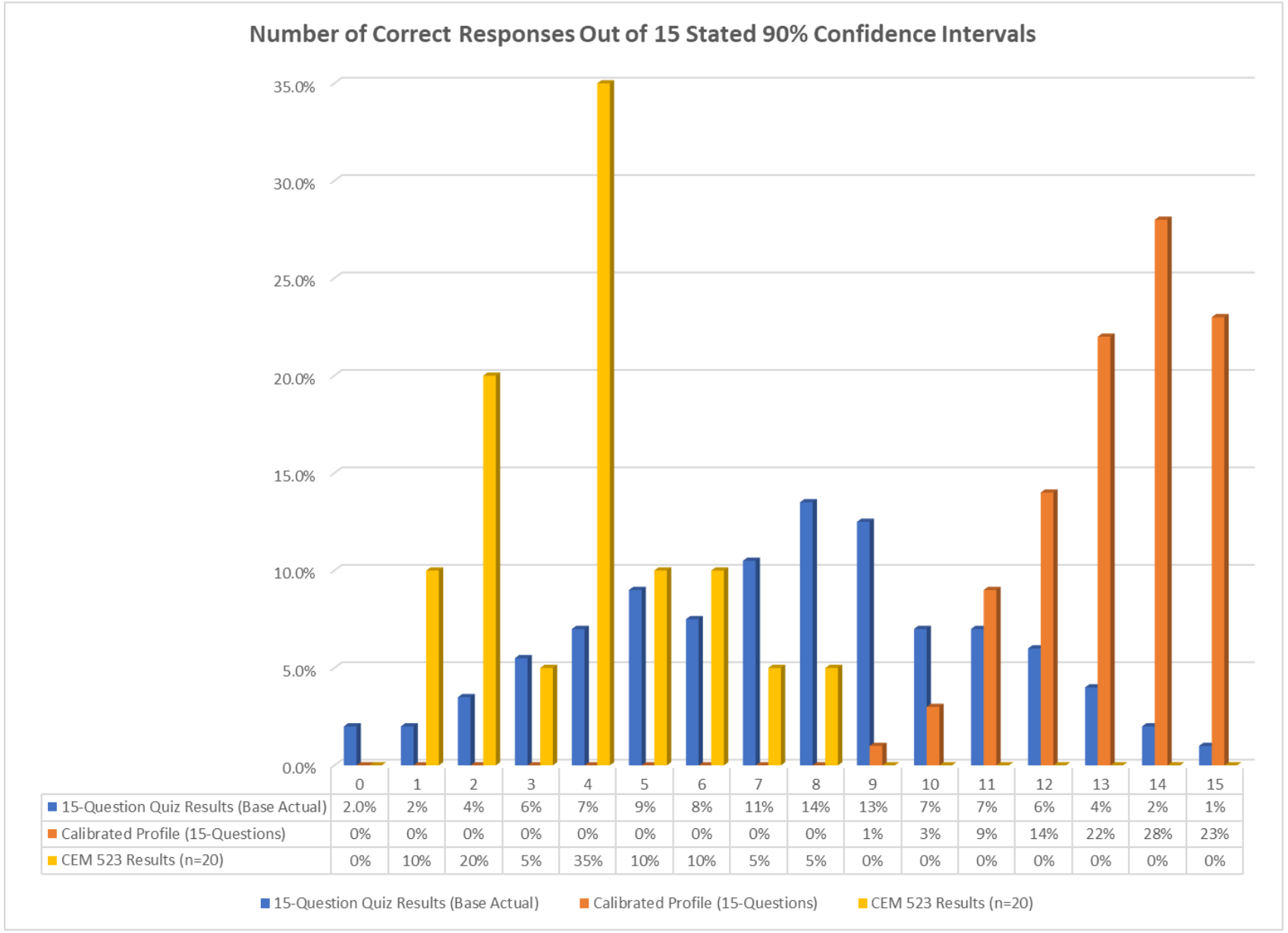
Range Quiz Results:

Comparison of Outcomes by Question



Range Quiz Results:

CEM 523 Class v. Norm v. Perfectly Calibrated



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15-Question Quiz Results (Base Actual)	2.0%	2%	4%	6%	7%	9%	8%	11%	14%	13%	7%	7%	6%	4%	2%	1%
Calibrated Profile (15-Questions)	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	3%	9%	14%	22%	28%	23%
CEM 523 Results (n=20)	0%	10%	20%	5%	35%	10%	10%	5%	5%	0%	0%	0%	0%	0%	0%	0%

CEM 523 results are skewed to the left. Likely due to experience level of audience.

Example Question (Quiz #2: True or false)

Francis Scott Key wrote the lyrics, but not the music, for the American National Anthem.



Your Answer

True
False

Your Confidence that You are Correct (circle one)

50%	**60%**	**70%**	**80%**	**90%**	**100%**

Example Question (Quiz #2: True or false)

Francis Scott Key wrote the lyrics, but not the music, for the American National Anthem.



Your Answer

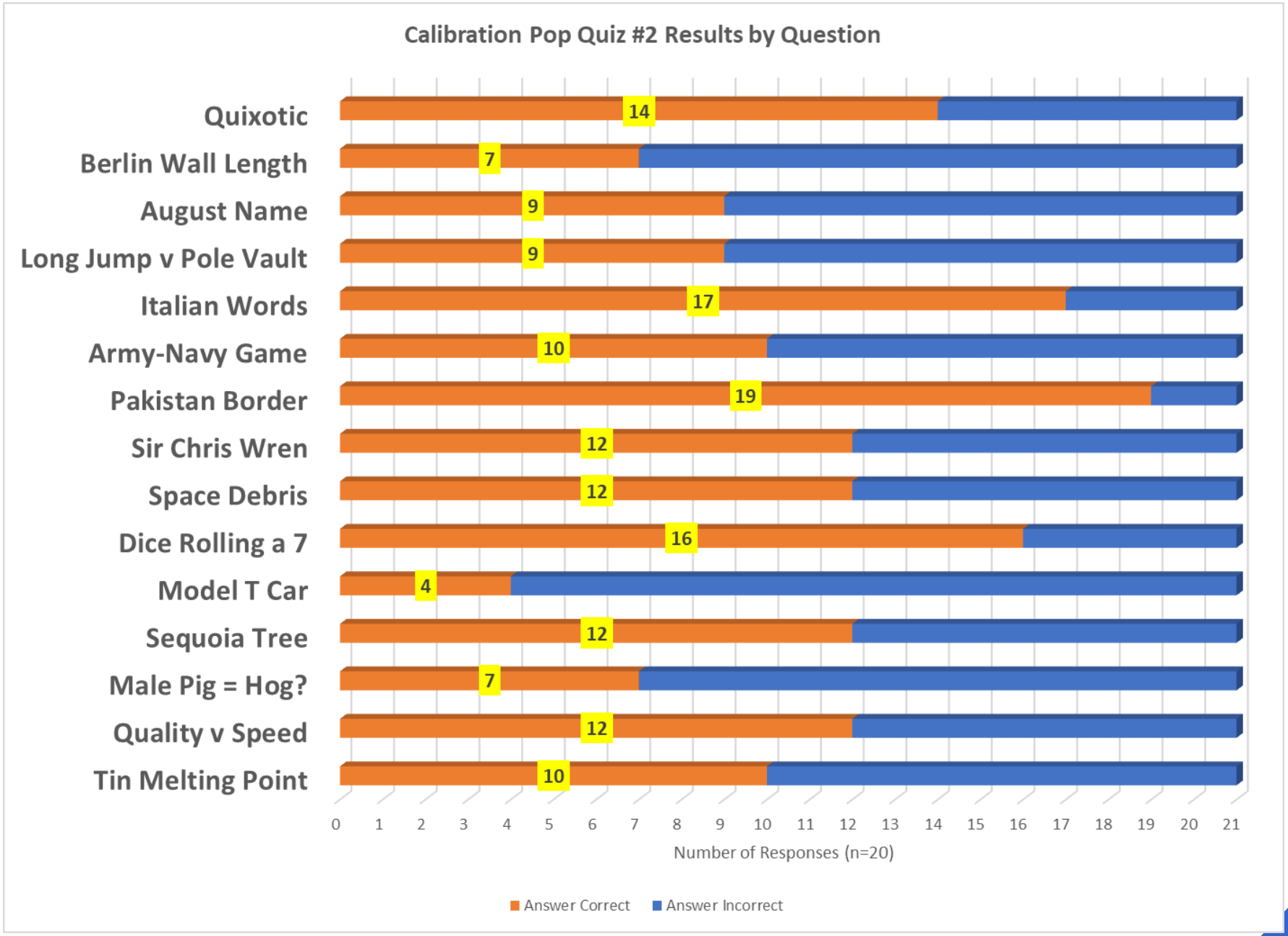
True
False

Your Confidence that You are Correct (circle one)

50%	60%	70%	80%	90%	100%

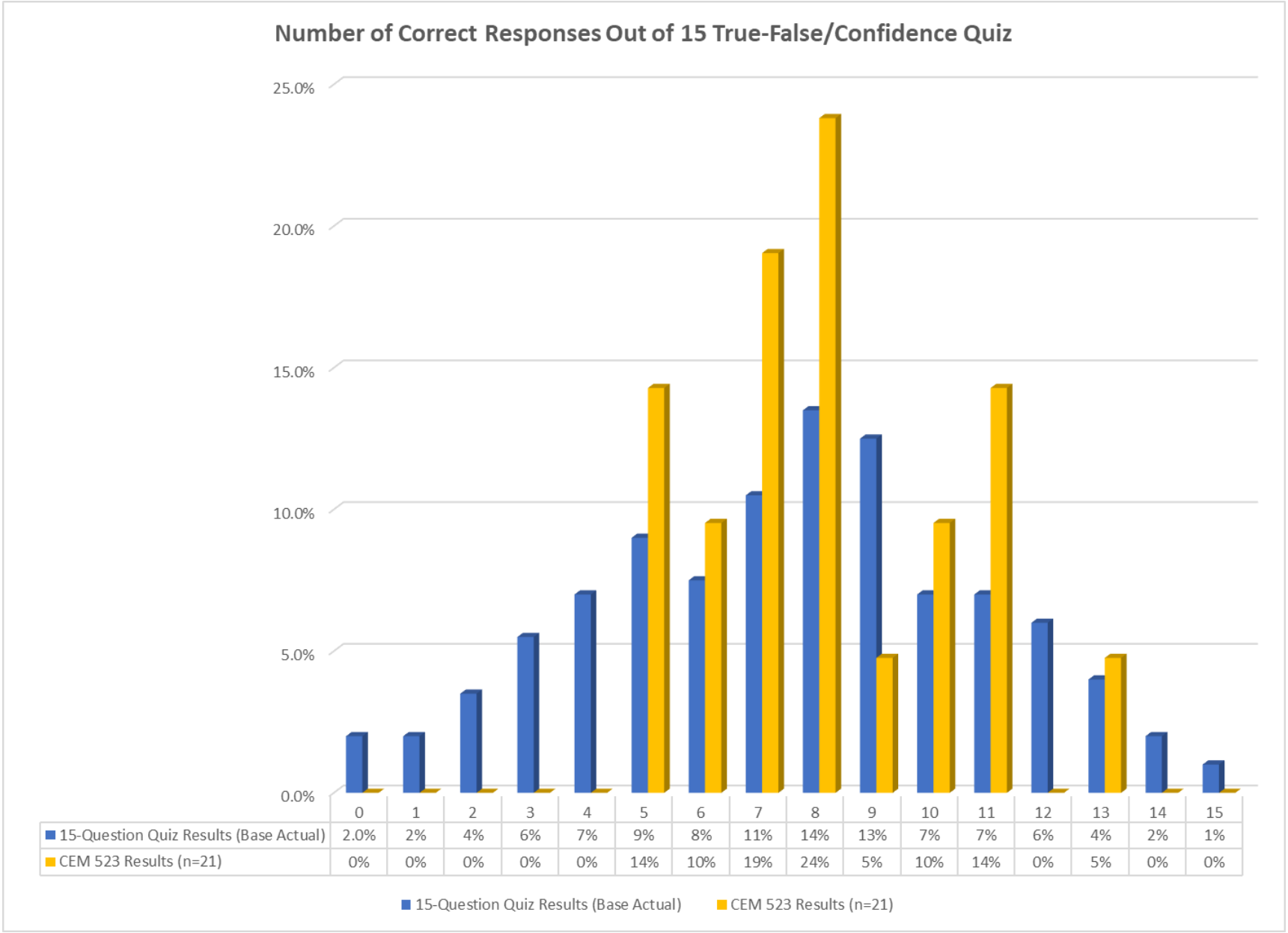
True-False Quiz Results:

Comparison of Outcomes by Question



True-False Quiz Results:

CEM 523 Class Results



Student	Range Quiz		True/False + Confidence Quiz					
	%. of Correct Ranges	Interpretation	% of Correct Answers	Interpretation	No. of Correct Answers - Sum of Confidence Entries	Interpretation	100% Confidence "Batting Average"	Interpretation
1	13.3%	Not Well-Calibrated	53.3%	Close to Calibrated	2	Calibrated	1.000	Calibrated
2	13.3%	Not Well-Calibrated	60.0%	Close to Calibrated	3.3	Over-Confident	0.714	Over-Confident
3	33.3%	Not Well-Calibrated	33.3%	Not Well-Calibrated	5.1	Over-Confident	0.333	Very Over-Confident
4	26.7%	Not Well-Calibrated	73.3%	Well-Calibrated	-2.3	Calibrated	n/a	none
5	33.3%	Not Well-Calibrated	86.7%	Well-Calibrated	-3.2	Under-Confident	1.000	Calibrated
6	13.3%	Not Well-Calibrated	46.7%	Not Well-Calibrated	3.9	Over-Confident	0.500	Over-Confident
7	20.0%	Not Well-Calibrated	73.3%	Well-Calibrated	0.2	Calibrated	0.667	Over-Confident
8	26.7%	Not Well-Calibrated	46.7%	Not Well-Calibrated	5.5	Over-Confident	0.500	Over-Confident
9	46.7%	Not Well-Calibrated	73.3%	Well-Calibrated	-0.7	Calibrated	0.500	Over-Confident
10	53.3%	Close to Calibrated	53.3%	Close to Calibrated	2.4	Calibrated	1.000	Calibrated
11	6.7%	Not Well-Calibrated	33.3%	Not Well-Calibrated	7.6	Over-Confident	0.250	Very Over-Confident
12	40.0%	Not Well-Calibrated	53.3%	Close to Calibrated	2	Calibrated	1.000	Calibrated
13	26.7%	Not Well-Calibrated	46.7%	Not Well-Calibrated	2.9	Over-Confident	1.000	Calibrated
14	6.7%	Not Well-Calibrated	66.7%	Close to Calibrated	1.2	Calibrated	1.000	Calibrated
15	26.7%	Not Well-Calibrated	33.3%	Not Well-Calibrated	7.2	Over-Confident	0.500	Over-Confident
16	13.3%	Not Well-Calibrated	46.7%	Not Well-Calibrated	4.9	Over-Confident	0.000	Very Over-Confident
17	26.7%	Not Well-Calibrated	40.0%	Not Well-Calibrated	5.4	Over-Confident	1.000	Calibrated
18	26.7%	Not Well-Calibrated	40.0%	Not Well-Calibrated	4.3	Over-Confident	0.500	Over-Confident
19	26.7%	Not Well-Calibrated	66.7%	Close to Calibrated	3	Over-Confident	0.667	Over-Confident
20	40.0%	Not Well-Calibrated	53.3%	Close to Calibrated	5.1	Over-Confident	0.750	Over-Confident
21	n/a	none	53.3%	Close to Calibrated	2.5	Calibrated	1.000	Calibrated

Analysis of Results by Individual

Key Learnings (Calibration)



Simple tests help to determine who can provide most reasonable inputs to quantitative risk analysis models



There are additional techniques that can be used to elevate ratings



Exercise was nice change of pace at end of term.



Do individual and team evaluation in next delivery of class.

Overall Key Learnings



"Hands-On" use of NetPoint & NetRisk was very valuable to students. Trial versions of software was perfect for class.



Experience indicates this structure of class can be applied/used in academia as well as industry.



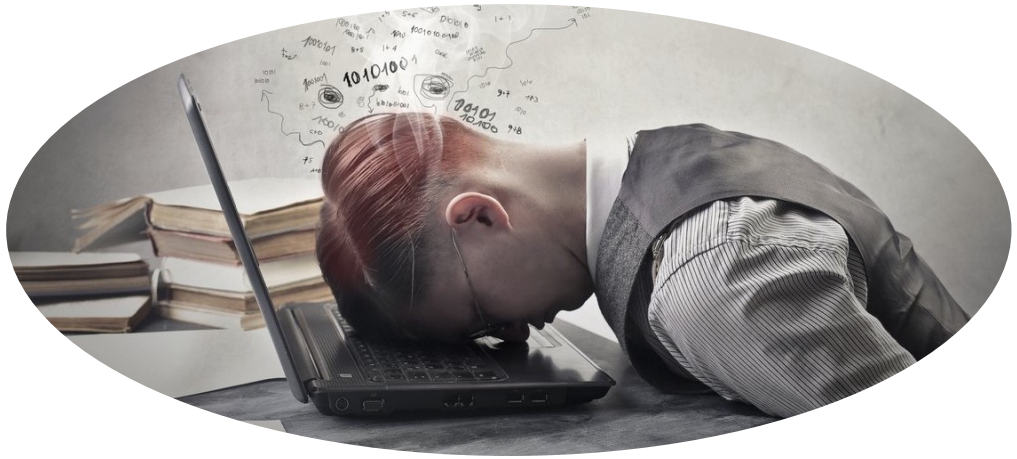
Case Study topic good; but can be improved. Look to upgrade base schedule for analysis.



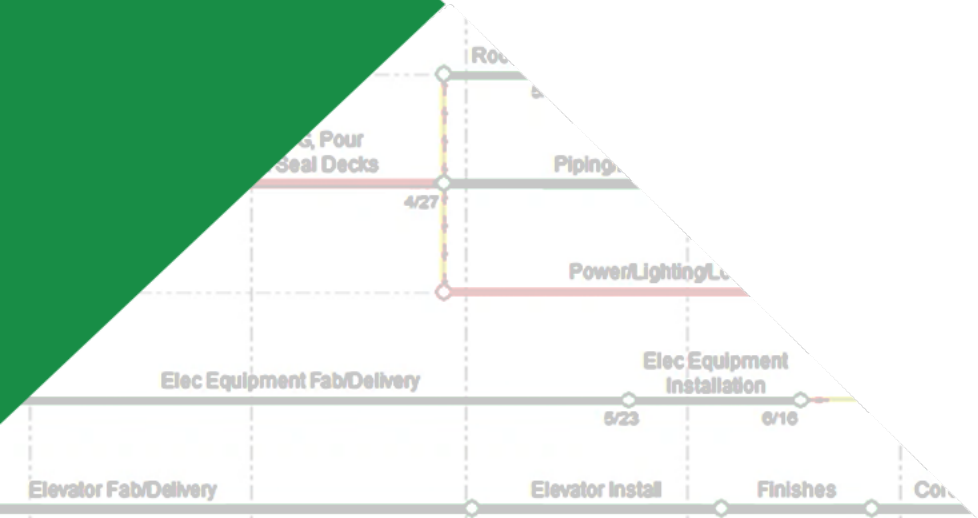
Introduction of calibration testing revealed (not-surprisingly) lack of calibration and over-confidence in students.



NetPoint+GPM
CONFERENCE
May 12 & 13, 2022



Any Questions?





Supplemental Slides



Key Skills Developed

Risk Identification Techniques
Risk Evaluation & Use of Risk Register
Cost Risk Modelling
Use of Monte Carlo Simulation for Cost (Palisades @Risk)
Schedule Risk Modelling, Use of NetPoint™
Use of Monte Carlo Simulation for Schedule (NetRisk™)
Interpretation of Simulation Results
Risk Response & Use of Risk Register
Calibration for Risk Inputs, Recognition of Cognitive Biases

Individual Response Analysis

Quiz	Analysis	Interpretation
Range	Number of Correct Ranges	• Less than 50% Correct: Not-Well Calibrated • 50%-70% Correct: Getting Close Calibrated • >70%: Well-Calibrated
True-False, Confidence	Number of Correct Answers	• Less than 50% Correct: Not-Well Calibrated • 50%-70% Correct: Getting Close Calibrated • >70%: Well-Calibrated
	Correct Answers v. Sum of Confidence Inputs	• > 2.5: Over-Confident • 2.5 to -2.5: Calibrated • <-2.5: Under-Confident
	Performance on 100% Confidence Questions (Batting Average)	• 1.000 – Calibrated • 1.000 – 0.800 – Somewhat Over-Confident • 0.800 – 0.500 – Over-Confident • <0.500 – Very Over-Confident