

Psychology of Cost Estimating

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Human Judgement Thought Exercise

“Think of how stupid the average person is and realize half of them are stupider than that.”

-George Carlin

Takeaway: Consider how much we rely on human judgement throughout the lengthy process of cost estimating development, presentation, and utilization through the PPBE process

Data vs. Human Judgement

- ▶ Source: Kahneman, Daniel. *Thinking, Fast and Slow*. Farrar, Straus and Giroux, New York, 2011
- ▶ Psychology, sociology, economics, and anthropology have all studied various aspects of humans and their behavior
- ▶ Subjective predictions (human) vs. statistical predictions (data)
- ▶ 200 studies over the last 50 years – score has not changed
 - ▶ 60% of studies prove data > humans at making predictions
 - ▶ Other 40% prove data = humans at making predictions
 - ▶ Data is less expensive than expert judgement typically
- ▶ Humans are inconsistent in making summary judgements of complex information (i.e. Acquisition is complex!)
- ▶ Example: Experienced radiologists contradict themselves 20% of the time when reviewing the exact same x-Ray

Takeaway: Regardless of data availability, we still need to rely on human judgement in Cost Estimating. Our brains have limitations that can impact our judgement.

System 1 vs System 2

- ▶ Daniel Kahneman – Leading voice in psychology, Nobel Prize winner in Economics
 - ▶ Decades of research with Amos Tversky = same basis for our Unconscious Bias training we all take
 - ▶ Defines the human brain as having two separate systems of thought
- ▶ **System 1:** Operates automatically and quickly, with little or no effort and sense of voluntary control.
- ▶ **System 2:** Allocates attention to the effortful mental activities that demand it, including complex computations. The operations of System 2 are often associated with the subjective experience of agency, choice, and concentration.
- ▶ Cost Estimating Impact Area:
 - ▶ SME Interviews and data gathering
 - ▶ Building a cost model

For consideration: Will you get a better input from a SME if you ask them for a quick answer in a crowded meeting, or if you send them an email and give them time to utilize System 2 before discussing? How quickly are you considering Risk assessments in your cost model?

Illusion of Understanding

- ▶ **Narrative Fallacy:** Flawed stories of the past shape our expectations for the future
 - ▶ Every single New England Patriots fan understands this deeply
 - ▶ Belichick is the best coach of all-time, we don't need Brady to win a SB
- ▶ **Halo Effect:** Tendency to like or dislike everything about a person (or program!)
 - ▶ Michael Jackson was the greatest showman of all time, he's beyond reproach
 - ▶ Woody Allen is a despicable human being, his movies are garbage
- ▶ Cost Estimating Impact Area:
 - ▶ Data Gathering
 - ▶ SME Interview
 - ▶ Analogies to other programs

For consideration: Rather than disregard data from an unsuccessful program, is it worth looking into how it went poorly? Do we truly understand the data from the past so we can make an accurate forecast of the future? Do you just like the SME personally, or did they provide valid/relevant inputs?

Anchoring

- ▶ Definition: occurs when people consider a particular value for an unknown quantity before estimating that quantity
- ▶ Effects of anchoring can impact the human brain in a variety of ways
- ▶ Can be used as a negotiation tactic
 - ▶ Shark Tank – Entrepreneurs anchor discussions with potential investors
 - ▶ “We’re asking for \$200,000 for 5% of the company” – not usually where it ends up
- ▶ Anchoring can be used as a priming effect
 - ▶ We NEED to have this radar fielded within 5 years
 - ▶ Henceforth our program schedule will be 5 years, ignoring any and all data that says otherwise
- ▶ Cost Estimating Impact Area:
 - ▶ Cost vs Funding Discussions
 - ▶ Presenting Updated Cost Estimates to PM/Stakeholders

For consideration: Just because ACC wants your POE, is it a good idea to start anchoring your program cost before your team has even had Industry Day? Just because your program was budgeted for \$10M, is the PM correct in saying that “your \$15M estimate is too high?”

Compounding

- ▶ Source: Housel, Morgan. *The Psychology of Money*. Harriman House LTD, Great Britain, 2020.
- ▶ Concept: a little growth serves as the fuel for future growth
- ▶ Most often associated with money, investing, & portfolio growth – Warren Buffett example
- ▶ In 2020, Warren Buffett's net worth was \$84.5B
 - ▶ \$84.2B accumulated after his 50th bday; \$81.5B accumulated after his 65th bday
 - ▶ Not just a great investor; started at age 10, accumulated \$1M by 30th bday (\$9.3M with inflation)
 - ▶ His 75 years of investing are a huge part of his success, not just his acumen – TIME is a huge factor
- ▶ Human brain has trouble understanding this concept of accumulation of small growth over long periods of time

- ▶ Cost Estimating Impact Area:
 - ▶ Inflation & Escalation
 - ▶ Presenting Updated Cost Estimates to PM/Stakeholders

For consideration: Does the PM/Stakeholder understand what the life cycle cost estimate is communicating in terms of inflation & escalation impacts when O&S costs run all the way to FY50?

Interpersonal Communication

- ▶ Source: Carnegie, Dale. *How to Win Friends and Influence People*, Dale Carnegie, 1936
- ▶ Fundamental challenge of cost estimating – getting data and information from people
- ▶ How you talk to people impacts the way they respond to your requests
 - ▶ Carnegie's Nine principles for influencing people
 - ▶ Principle 1: begin with praise and honest appreciation
 - ▶ Principle 3: talk about your own mistakes before criticizing the other person
 - ▶ Principle 4: ask questions instead of giving direct orders
 - ▶ Principle 7: give the other person a fine reputation to live up to
 - ▶ Principle 9: make the other person happy about doing the thing you suggest
- ▶ Cost Estimating Impact Area:
 - ▶ All areas where you interact with other people!

For consideration: Did I properly explain to the person WHY I'm asking for something, rather than point blank demand it? Do I find that people are more responsive to me in my life when I compliment them or when I criticize them?

Kahneman Project Example

- ▶ Assembled team of experts to write high school curriculum on science of decision-making
- ▶ Asked team of experts how long this would take:
 - ▶ Low: 1.5 Years
 - ▶ High: 2.5 Years
- ▶ One of experts predicted 2 Years; Ignored actual data at hand from prior experience
 - ▶ When pressed, admitted 40% of similar projects never finish
 - ▶ Most take close to 7 Years!
- ▶ Decided to tackle the project, with expected length of 2 Years due to expertise
- ▶ ***Result: took 8 Years, Kahneman no longer on the team, company didn't want the obsolete product anymore***

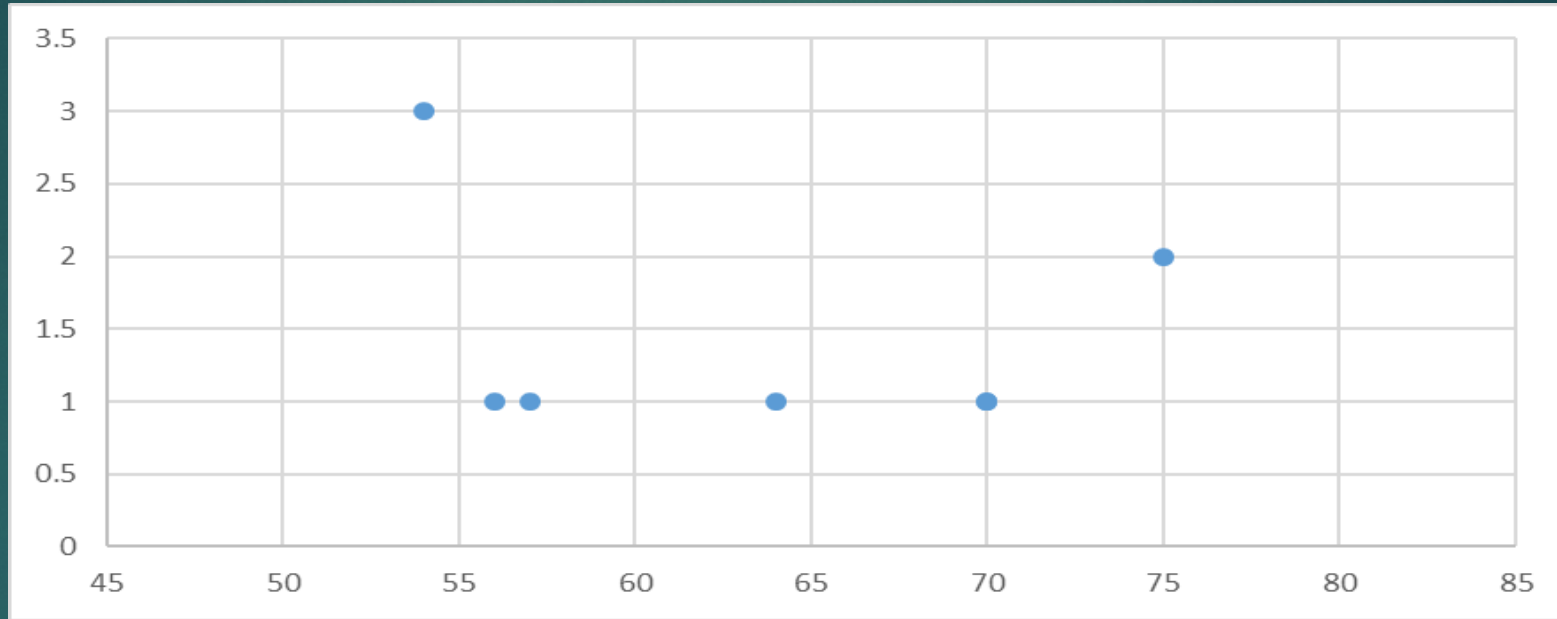
Takeaway: Even experts are usually incapable of making accurate predictions—they're human after all. Humans are quick to forget about actual experiences if the data isn't what they want to hear.

Harvard Business School Example

- ▶ Source: Epstein, David. *Range*. Riverhead Books, New York, 2019
- ▶ Professor gives group of 7 students a case study
- ▶ Premise: decide whether the Carter Racing Team should race given the data?
- ▶ One hour from race time; expected to be 40 degrees Fahrenheit at race time; can ask for more data
- ▶ Argument for Racing:
 - ▶ Been successful, placed top five in 12 of 24 races
 - ▶ Sponsorships gained, and will get better with win in this race
 - ▶ Race is on national tv
 - ▶ If they don't race, money lost—season ends at \$80K loss; If they win, huge financial success
- ▶ Argument Against Racing:
 - ▶ Engine failure in 7 of 24 races (see data on next slide)
 - ▶ Last two races, pit crew made adjustment, had no trouble—but have not identified root cause
 - ▶ If they have engine failure on national tv, sponsorships lost

Data on Engine Failures

Number of Breaks
in Head Gasket



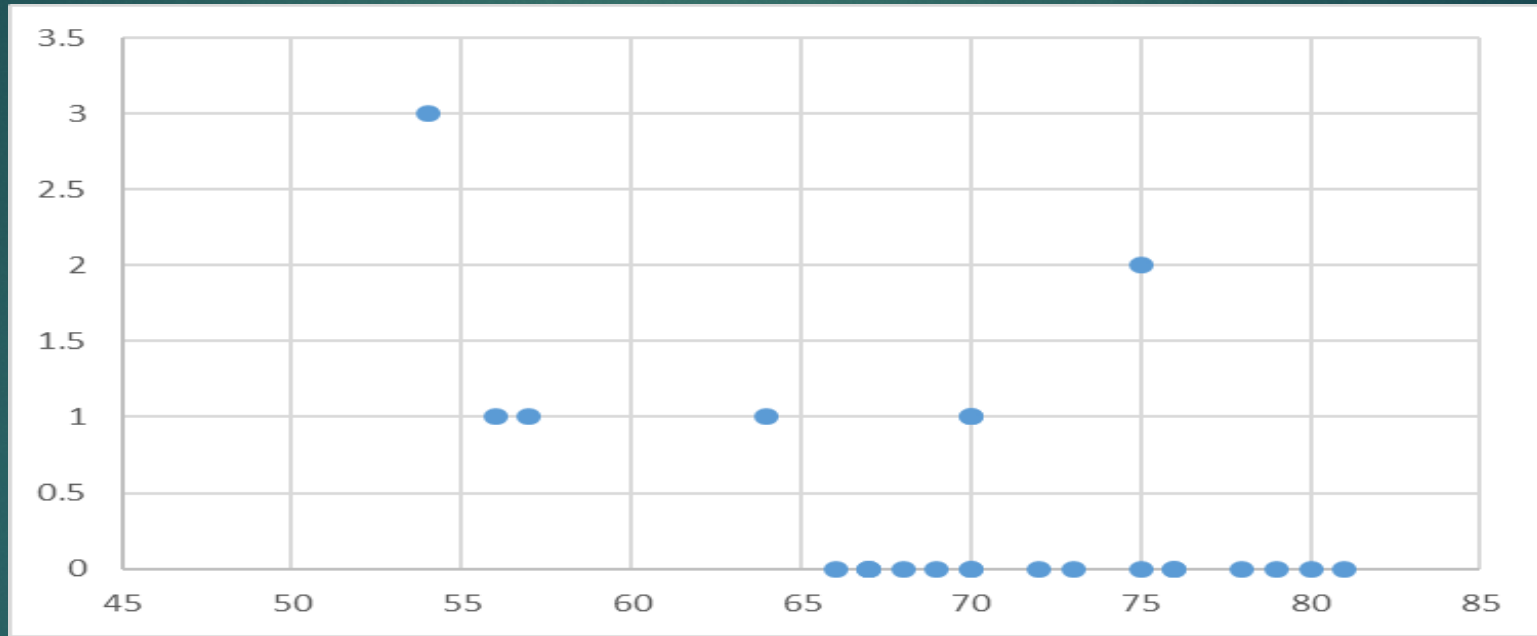
Temperature (F°)

Provided by Engine Mechanic

- High school dropout with no engineering experience but decades of racing experience
- Thought it had something to do with temperature, but no time left to explore root cause

Data on All Races

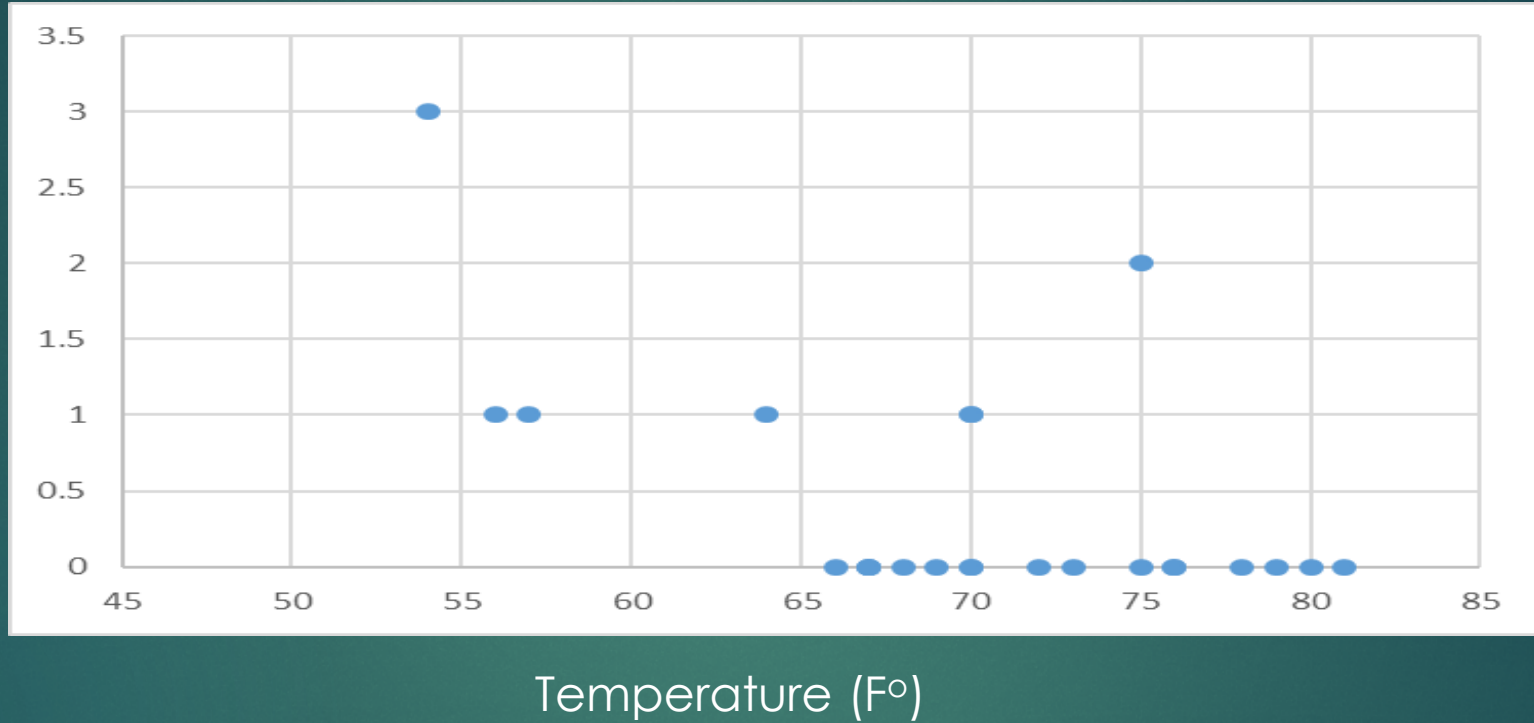
Number of Breaks
in Head Gasket



Temperature (F°)

Actual O-Ring Data for Challenger

Number of O-Ring Failures



- NASA never asked for the complete set of O-Ring data from contractor, only the failures
- Contractor offered non-quantitative reasons for wanting to postpone launch
- Subjective data was ignored because it couldn't be quantified, or so they thought

Takeaway: Human error led many brilliant people to ask for the wrong data; Halo effect based on NASA reputation obscured the source of the problem; Data was ignored that wasn't convenient.

Wide Area Surveillance Ex - Anchoring

- ▶ Asked to complete Block II development estimate for UFR – by 2pm tomorrow
- ▶ Background Facts:
 - ▶ Block I unit cost ~10M
 - ▶ Contractor marketing Block II as cheaper option/smaller prototype already built
 - ▶ Cost estimator was given one day to complete UFR
- ▶ Submitted an official UFR for \$25M based on available data
- ▶ UFR funded / On contract / Monitoring costs & funding
- ▶ Cost trending higher than baseline right from the start; scope larger than UFR POE
- ▶ SML, User Command view – focus on why initial POE was low, not contractor performance
- ▶ Every time costs continued to increase, finger pointed at costers not contractor...for 4 years!

Takeaway: Even a simple UFR POE can result in unintended anchoring effect taking hold. The challenge is trying to manage this and communicate with stakeholders effectively.

3DELRR Ex – Narrative Fallacy

- ▶ TPS-75 radars are failing, Ao falling, spares have all been used, units being cannibalized
- ▶ Acquisition strategy guided by significant FMS market for similar US long range mobile radar
- ▶ Winner of EMD/LRIP contract setup for years of long-term FMS profits
- ▶ US will get a great business deal on EMD/LRIP contract
 - ▶ FMS sales
 - ▶ IRAD investment
 - ▶ Competition from major primes
- ▶ Focus on Price, rather than Technical & Schedule – drove protests, lawsuits, re-open SS
- ▶ Business deal sounded so terrific and amazing, completely ignored any warning signs from Service Cost Position
- ▶ 2 years into EMD contract, contractor was 3 years behind schedule

Takeaway: A story was crafted based on market research that sounded perfect, but the reality of the system in the field was forgotten. Ignored impacts of 3-year delay on tech requirements, changing operational environment, changing contractor motivation due to the great deal.

Conclusions

- ▶ As cost estimators, we rely on human judgement & interactions for a large part of our job
- ▶ Understanding some elements of psychology can help perform this part of the job
- ▶ Caution: it's not going to eliminate the issues, but can help guide the way we interact
- ▶ These are just a few examples of psychology concepts – research some more!
- ▶ Consider your own programs and cost estimates – any of these concepts hit home?
- ▶ Ultimately, we need other people to help us do our job – can't forget that critical piece