AFFORDABLE ROCKS (AND BATTERIES)

A LIGHTHEARTED DIALOGUE ABOUT VALUE

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ABSTRACT

Affordable rocks? Sometimes, it can seem like all the fuss about affordability has gotten out of hand. We all buy things so we all know what it means for something to be affordable, right? Explore what affordability is (and isn't) plus some of the tools in the systems engineer's toolbox. Join us for a lighthearted, interactive dialogue about affordability and value. Learn why affordability tells us nothing about what we get for our money and why we should focus on value instead.

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WHAT IS "AFFORDABILITY"?

- Afford
  - *to be able to meet the expense of; have or be able to spare the price of* (dictionary.com)

- Simple Affordability Definition #1
  - Able to bear the price of something

- Example
  - Say I have $5
  - Is a $4 item affordable?
    - Yes, $4 < $5, so I can bear the price of the item. The $4 item is affordable.
  - Is a $6 item affordable?
    - No, $6 > $5, so I am unable to bear the price of the item. The $6 item is unaffordable.

"A Ford"

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AFFORDABILITY CAN BE MEASURED

- Affordability
  - *the extent to which something is affordable, as measured by its cost relative to the amount that the purchaser is able to pay* (Wiktionary.com)

- Example
  - Say I have $5
  - We decided that a $4 item was affordable
  - Is a $2 item affordable?
    - Yes, $2 < $5
  - Which is more affordable, a $4 item or a $2 item?
    - $2 item is more affordable, $2 < $4
    - the $2 item has more headroom to the $5 budget than the $4 item does

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CONSTRAINTS ON AFFORDABILITY

- Afford
  - *to be able to do, manage, or bear without serious consequence or adverse effect* (dictionary.com)
  - *to incur, stand, or bear without serious detriment, as an act which might under other circumstances be injurious* (Wiktionary.com)
- Simple Affordability Definition #2
  - Able to bear the price of something
  - Without adverse effects

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EXAMPLE

- Say I have $10,000
- Is a $8000 European vacation affordable?
  - Yes ($8000 is less than $10,000)
- Is $9000 for college expenses affordable?
  - Yes ($9000 is less than $10,000)
- Which is more affordable, the vacation or the college expenses?
  - Vacation is more affordable, $8000 < $9000

- But wait. If I need to pay the college expenses, is the vacation really affordable?
  - No (adverse effect if I choose the vacation over college expenses)

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AFFORDABILITY IN CONTEXT

- Simple Affordability Definition #3
  - Able to bear the price of something
  - Without adverse effects
  - In the context of all other things needed

OBSERVATION:
AFFORDABILITY OF ONE ITEM DEPENDS ON OTHER ITEMS COMPETING FOR A (DYNAMIC) BUDGET

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AFFORDABLE ROCKS

- I still have my $5
- You have a rock
- Being an entrepreneur, you offer to sell it to me for $4
- Is the $4 rock affordable?
  - Yes, $4 < $5
- Any adverse effects?
  - No, probably not
- In the context of other things needed?
  - Probably ok

- But, would I be happy getting a rock for my $4?
  - Probably not
- Why not?
  - I expect more for my $4 than a rock

"An Affordable Rock"

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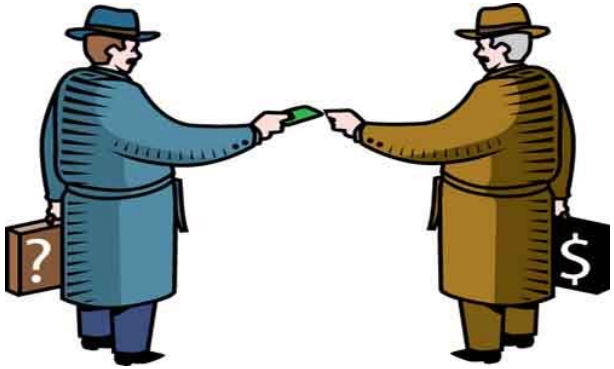
WHAT DO I GET FOR MY MONEY?

- What do I want to avoid?
  - Throwing money away
  - Not getting something for my money

- What do I want?
  - Capability
  - Performance
  - Some need fulfilled



COUNTERINTUITIVE OBSERVATION:

"AFFORDABILITY" DIDN'T TELL ME ANYTHING ABOUT WHAT I GOT FOR MY MONEY

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WHAT IS "VALUE"?

- Value
  - *relative worth, merit, or importance* (dictionary.com)
  - *the worth of something in terms of the amount of other things for which it can be exchanged or in terms of some medium of exchange* (dictionary.com)
    - Value quantifies the exchange (ratio)
    - Tells me what I get for my money
- Because Value is a ratio, we have 2 ways to drive it
  - Increase numerator:
    - Today's special: 2 rocks for the price of 1! Double the value!
  - Decrease denominator:
    - Today's special: half price! Double the value!

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SCENARIO: CUSTOMER NEEDS A BATTERY

- Actual battery price list from 1956
- 4 main categories
  - Economy
  - Extra-Duty
  - Original Equipment
  - Tractor
- Primary measure of performance is Amp Hours

GM GENERAL MOTORS PARTS SALES UNITED MOTORS SYSTEM

UNITED MOTORS SERVICE
DIVISION OF GENERAL MOTORS CORPORATION
CENTRAL OFFICE—DETROIT

BULLETIN 7 A-49
EFFECTIVE DATE 5-1-56
Supersedes Bulletin 7A-49 Dated 2-13-56

DELCO BATTERY SUGGESTED PRICE LIST

All Delco Batteries are in genuine hard rubber cases

Delco Group No.	Delco Type	Delco Service Classification	Suggested List Price	U.M.S. Code Numbers: Wet Charge	U.M.S. Code Numbers: Dry Charge	No. of Full-sized Plates Per Cell	20 Hour Rating in Amp. Hours	Separators	**MONTHS OF WARRANTY WHEN USED IN— Passenger Cars and Trucks Through One Ton	Farm and Industrial Tractors With Generators	All On-Highway Vehicles Over One Ton, Taxi-cabs, Police Cars and All Other Applications
RECOMMENDED FOR 6 VOLT PASSENGER CAR AND LIGHT COMMERCIAL USE. ALL IN GENUINE HARD RUBBER CASES.											
1	1MR65T	Tractor	$18.95	1MT1337	1MT1207D	11	65	Rubber	24	16	12
	1M70	Economy	14.45	1M1129	.....	13	70	Wood	18	12	9
	1M72	Economy	17.75	.....	1M1265D	13	72	Mfd.	24	16	12
	1MR85T	Tractor	20.95	1MT1477	1MT1357D	15	85	Rubber	30	20	15
	15AA-1MR105	Orig. Equip.	23.95	1M1651	1M1531D	15	105	Rubber	36	24	18
	1MR115T	Tractor	26.95	1MT1902	1MT1777D	17	115	Rubber	42	28	21
	1HR115	Extra-Duty	29.95	1H2067	1H1942D	17	115	Rubber	48	32	24
2L	2L70	Economy	14.45	2L1129	.....	13	70	Wood	18	12	9
	2L72	Economy	17.75	.....	2L1265D	13	72	Mfd.	24	16	12
	17P-2LR105	Orig. Equip.	24.95	2L1719	2L1599D	17	105	Rubber	36	24	18
	2LR115	Extra-Duty	29.95	2L2067	2L1942D	19	115	Rubber	48	32	24
2	2M90	Economy	17.75	2M1385	.....	15	90	Wood	18	12	9
	2M92	Economy	20.95	.....	2M1514D	15	92	Mfd.	24	16	12
	17K-2MR120	Orig. Equip.	26.95	2M1861	2M1726D	17	120	Rubber	36	24	18
	2HR130	Extra-Duty	32.95	2H2299	2H2164D	19	130	Rubber	48	32	24
2E	2E90	Economy	17.75	2E1385	.....	15	90	Wood	18	12	9
	2E92	Economy	20.95	.....	2E1514D	15	92	Mfd.	24	16	12
	15E	Orig. Equip.	19.95	2E1377	.....	15	100	Wood	21	21	11
	17E-2ER120	Orig. Equip.	27.95	2E1949	2E1814D	17	120	Rubber	36	24	18
	2ER130	Extra-Duty	34.75	2E2395	2E2260D	19	130	Rubber	48	32	24
2F	2FR105	Orig. Equip.	24.95	2F1719	2F1589D	15	105	Rubber	36	24	18
2N	2N70	Economy	16.95	2N1322	.....	15	70	Wood	18	12	9
	2N72	Economy	19.95	.....	2N1436D	15	72	Mfd.	24	16	12
	2NR100	Orig. Equip.	26.95	2N1861	2N1736D	19	100	Rubber	36	24	18
3N	3NR110A	Orig. Equip.	28.95	3N1998	3N1873D	21	110	Rubber	36	24	18
RECOMMENDED FOR 12 VOLT PASSENGER CAR AND LIGHT COMMERCIAL USE. ALL IN GENUINE HARD RUBBER CASES.											
4N	4NR55	Orig. Equip.	33.95	4N2356	4N2221D	11	55	Rubber	36	24	18
5N	5NR65	Orig. Equip.	39.95	5N2757	5N2617D	13	65	Rubber	36	24	18
3EM	3EM45	Economy	20.95	3EM1634	.....	9	45	Wood	18	12	9
	3EM46	Economy	23.95	.....	3EM1748D	9	46	Mfd.	24	16	12
	3EMR62	Orig. Equip.	32.95	3EM2272	3EM2137D	9	62	Rubber	36	24	18
	3EMR70	Orig. Equip.	36.95	3EM2551	3EM2411D	11	70	Rubber	36	24	18
	***3EMR72	Extra-Duty	38.95	3EM2707	3EM2667D	11	72	Rubber	48	32	24
3KM	3KM45	Economy	20.95	3KM1634	.....	9	45	Wood	18	12	9
	3KM46	Economy	23.95	.....	3KM1748D	9	46	Mfd.	24	16	12
	3KMR62	Orig. Equip.	32.95	3KM2272	3KM2137D	9	62	Rubber	36	24	18
	3KMR72	Extra-Duty	38.95	3KM2707	3KM2567D	11	72	Rubber	48	32	24
2SM	2SM40	Economy	20.95	2SM1634	.....	7	40	Wood	18	12	9
	2SM41	Economy	23.95	.....	2SM1748D	7	41	Mfd.	24	16	12
	2SMR53	Orig. Equip.	29.95	2SM2097	2SM1972D	9	53	Rubber	36	24	18
	2SMR60	Extra-Duty	34.95	2SM2409	2SM2284D	9	60	Rubber	48	32	24
3SM	3SM70	Orig. Equip.	34.50	3SM2242	.....	11	70	Wood	24	16	12
	3SMR72	Extra-Duty	38.95	3SM2707	3SM2667D	11	72	Rubber	48	32	24
RECOMMENDED FOR 6 VOLT TRACTOR USE. ALL IN GENUINE HARD RUBBER CASES											
1MT	6ST	Tractor	15.95	1MT1117	.....	11	65	Wood	18	12	9
	1MR65T	Tractor	18.95	1MT1337	1MT1207D	11	65	Rubber	24	16	12
	15T	Tractor	18.95	1MT1327	.....	15	85	Wood	27	18	14
	1MR85T	Tractor	20.95	1MT1477	1MT1357D	15	85	Rubber	30	20	15
	115T	Tractor	22.50	1MT1575	.....	17	115	Wood	30	20	15
	1MR115T	Tractor	26.95	1MT1902	1MT1777	17	115	Rubber	42	28	21

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NEED: "ORIGINAL EQUIPMENT" BATTERY

- How many batteries are affordable?
  - If I have $15
    - No batteries are affordable
  - If I have $20
    - Only 1 battery is affordable
  - If I have $25
    - 4 batteries are affordable
  - If I have $30
    - 9 batteries are affordable

Name	Application	Price
15E	Orig. Equip.	$ 19.95
15AA·IMRIOS	Orig. Equip.	$ 23.95
17P-2LR105	Orig. Equip.	$ 24.95
2FR105	Orig. Equip.	$ 24.95
2NR100	Orig. Equip.	$ 26.95
17K·2MRl20	Orig. Equip.	$ 26.95
17E·2ER120	Orig. Equip.	$ 27.95
3NR110A	Orig. Equip.	$ 28.95
2SMR53	Orig. Equip.	$ 29.95
3EMR62	Orig. Equip.	$ 32.95
3KMR62	Orig. Equip.	$ 32.95
4NR55	Orig. Equip.	$ 33.95
3SM70	Orig. Equip.	$ 34.50
3EMR70	Orig. Equip.	$ 36.95

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NEED: "ORIGINAL EQUIPMENT" BATTERY WITH 70 AMP HOURS

- How many batteries provide 70 Amp Hours?
  - 2
- Are they affordable?
  - Depends on Budget
- If I have $30?
  - No
- If I have $35?
  - Yes, 1 70AH battery is affordable
- If I have $40?
  - Yes, 2 70AH batteries are affordable

Name	Application	Price	AH
15E	Orig. Equip.	$19.95	100
15AA·IMRIOS	Orig. Equip.	$23.95	105
17P-2LR105	Orig. Equip.	$24.95	105
2FR105	Orig. Equip.	$24.95	105
2NR100	Orig. Equip.	$26.95	100
17K·2MRl20	Orig. Equip.	$26.95	120
17E·2ER120	Orig. Equip.	$27.95	120
3NR110A	Orig. Equip.	$28.95	110
2SMR53	Orig. Equip.	$29.95	53
3EMR62	Orig. Equip.	$32.95	62
3KMR62	Orig. Equip.	$32.95	62
4NR55	Orig. Equip.	$33.95	55
3SM70	Orig. Equip.	$34.50	70
3EMR70	Orig. Equip.	$36.95	70

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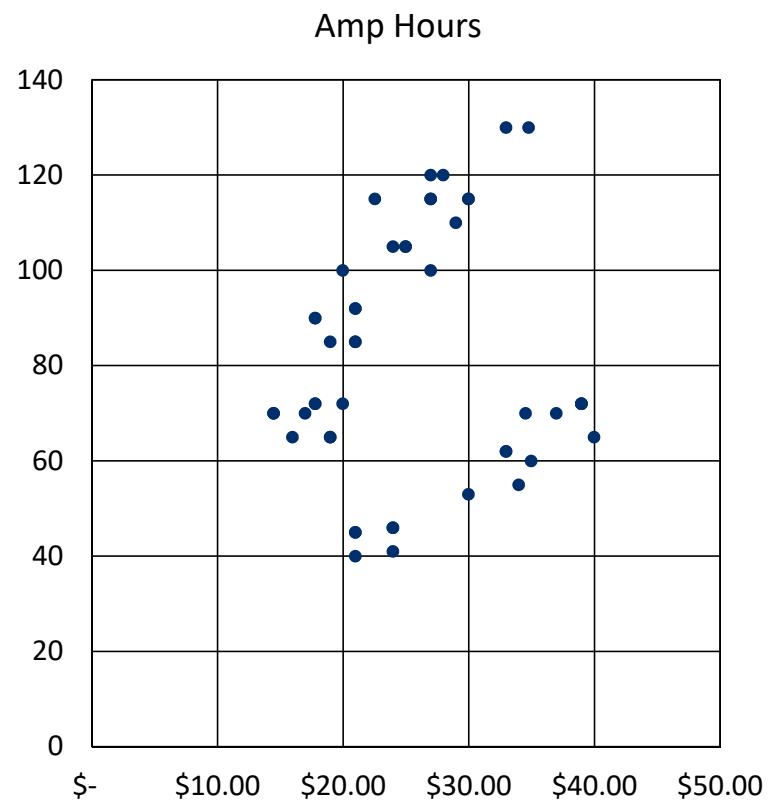
TRADE SPACE VIEW

- Plot performance vs cost
- Would the customer be interested in this perspective?
  - Yes!
- Why?
  - Helps to understand the trade space
  - Better informed about the available options
  - Depending on what the customer values, this approach can point the way to the “best value” solution



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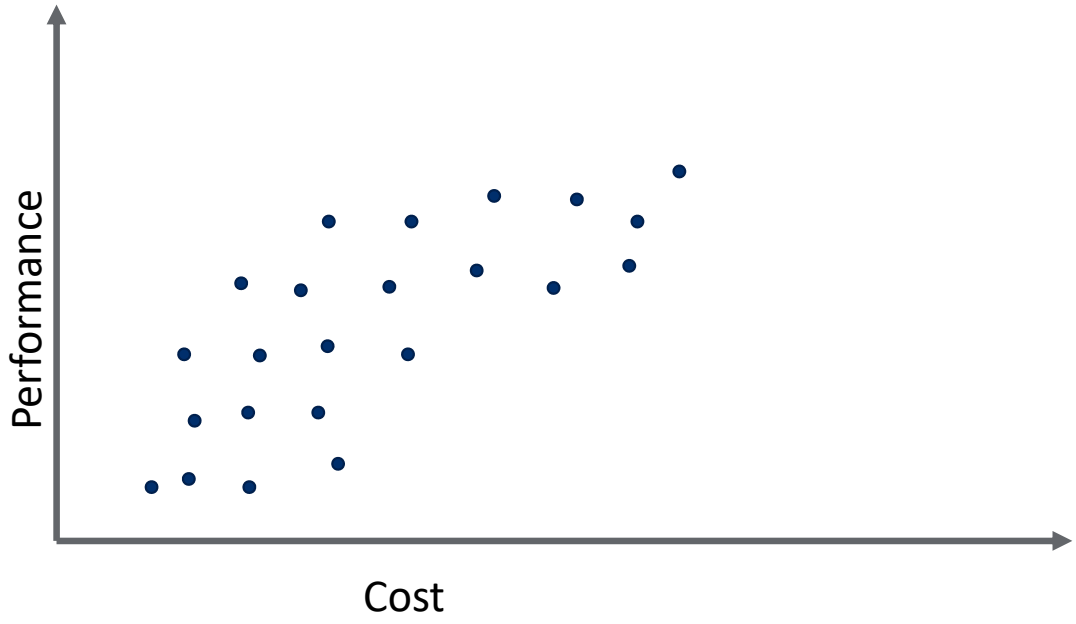
TRADE SPACE: PERFORMANCE AND COST



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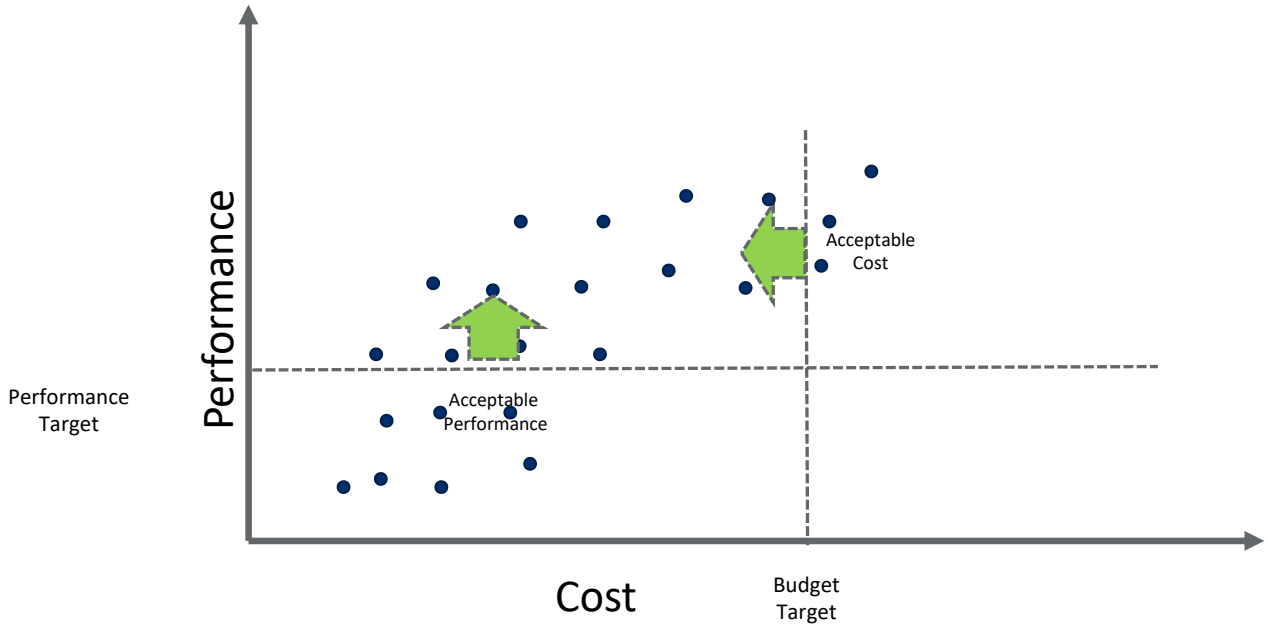
AFFORDABLE AND COMPLIANT



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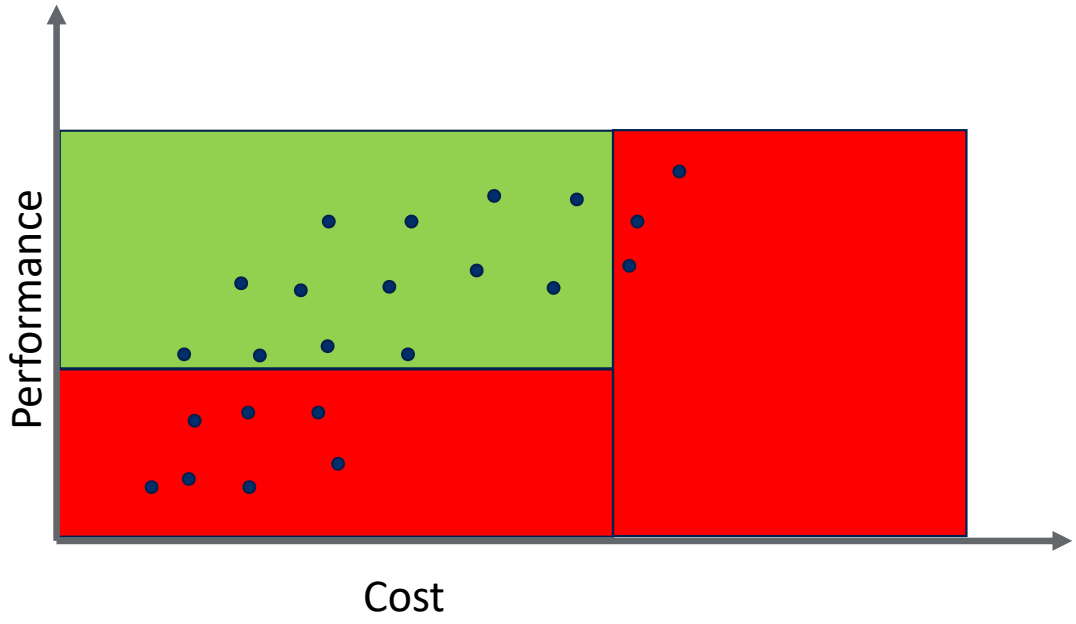
AFFORDABLE AND COMPLIANT



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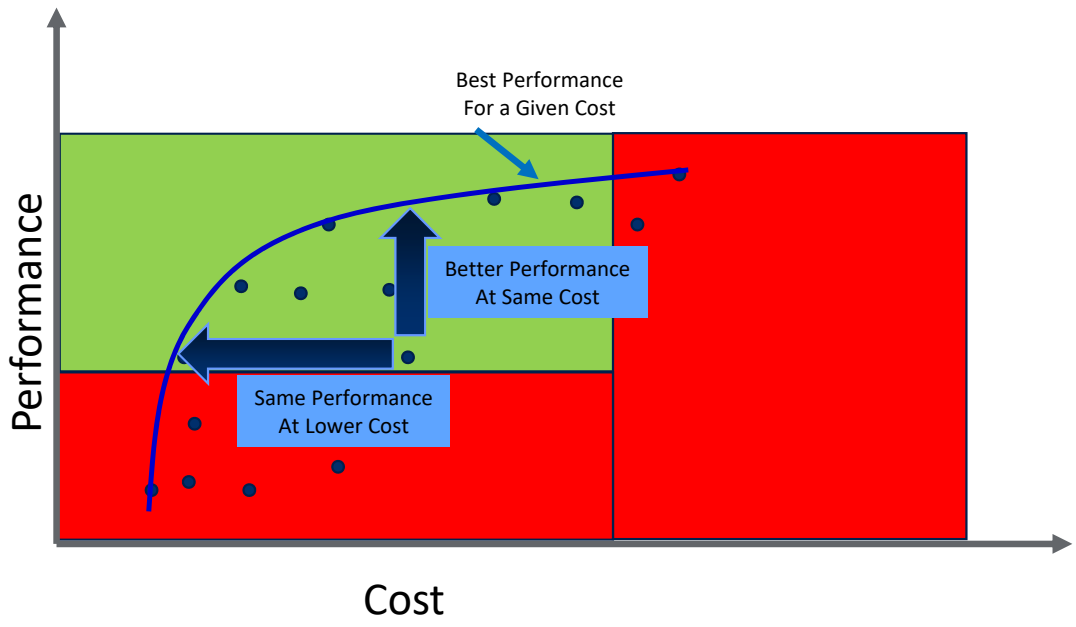
BEST PERFORMANCE FOR A GIVEN COST



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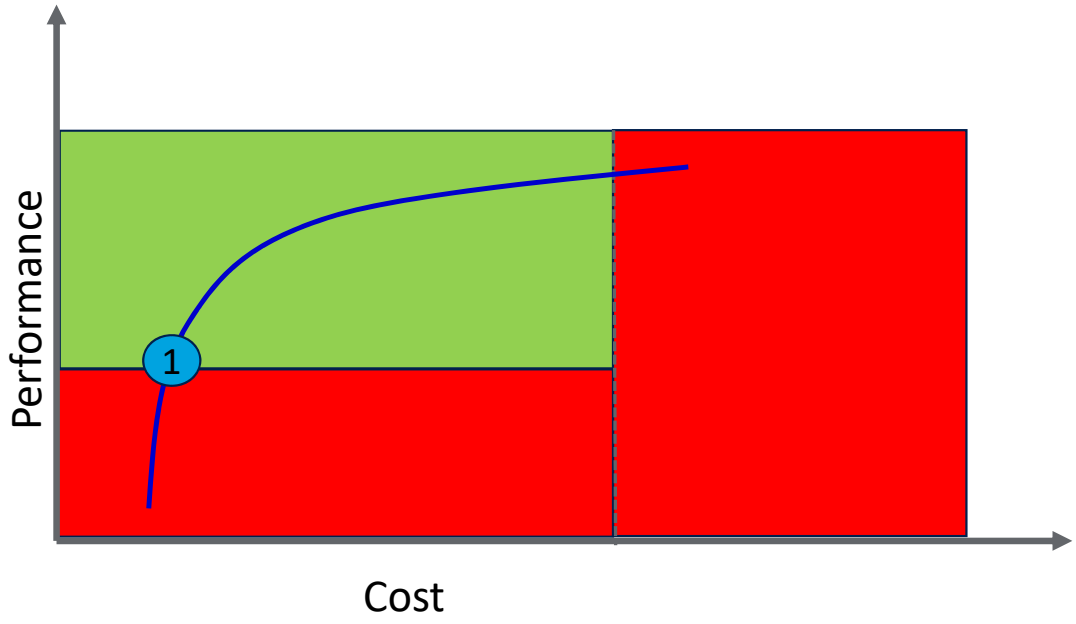
WHAT'S THE LEAST I CAN PAY TO GET WHAT I NEED?



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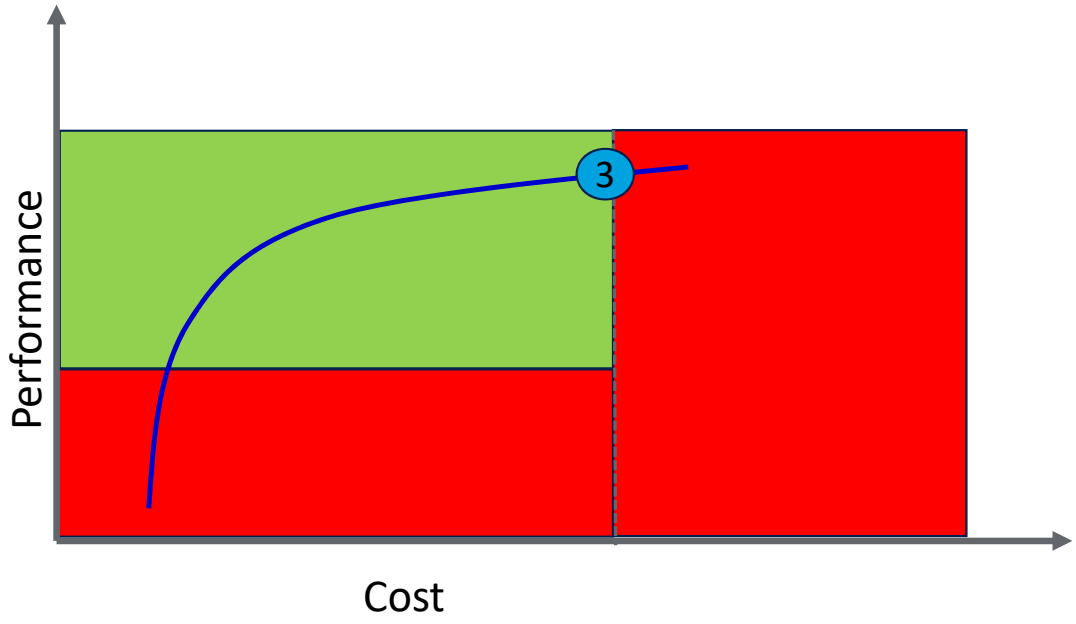
WHAT'S THE MOST I CAN GET FOR MY BUDGET?



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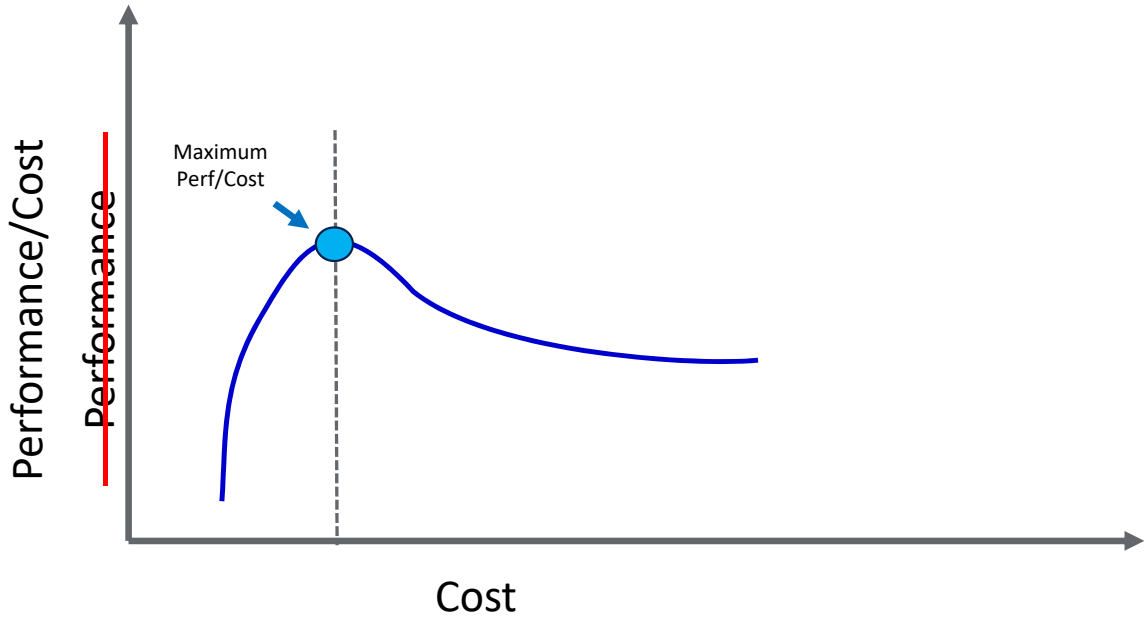
WHAT'S THE BEST PERFORMANCE FOR MY MONEY?



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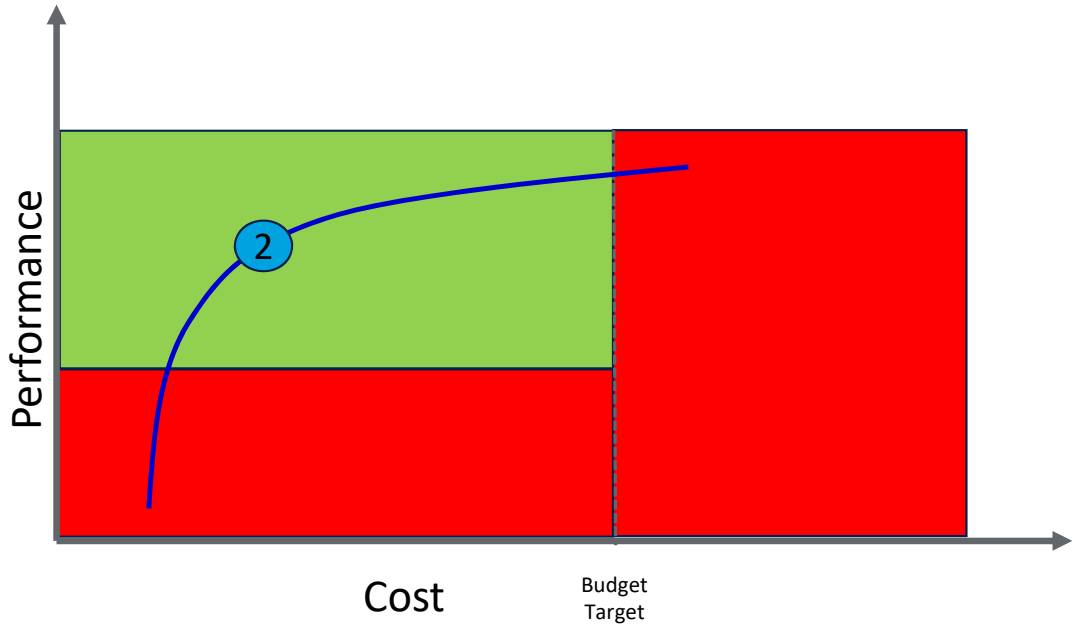
WHAT'S THE BEST PERFORMANCE FOR MY MONEY?



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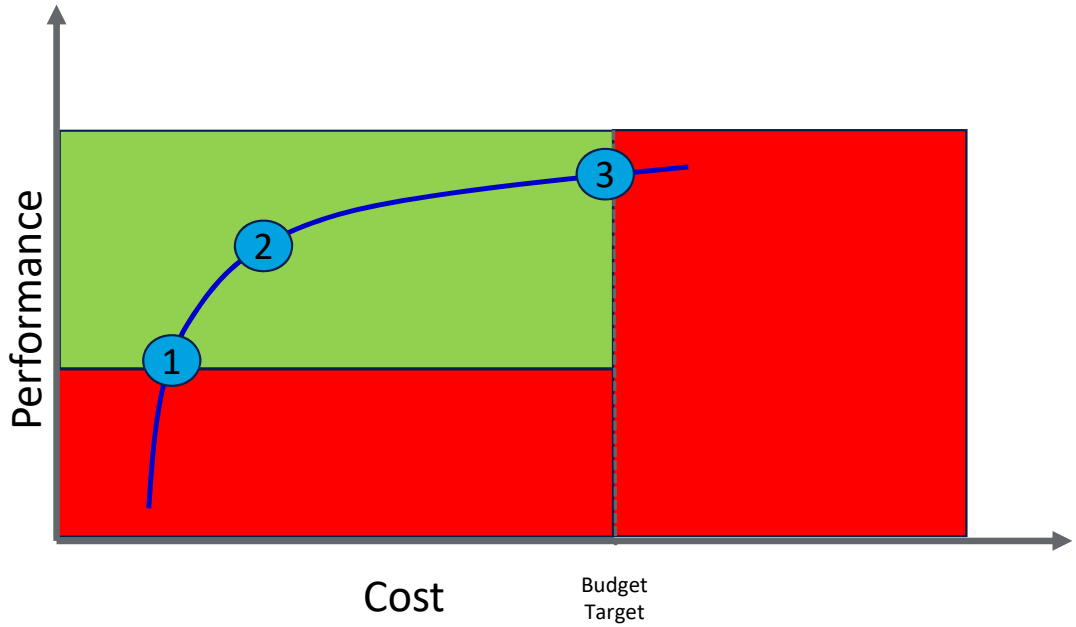
DRIVING VALUE



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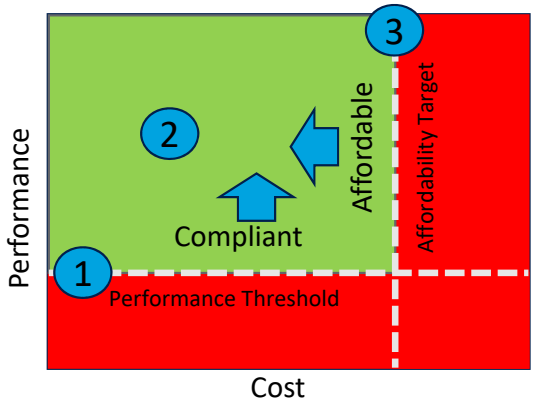
DRIVING VALUE WHERE COST IS PRIORITY



Value Driven Solutions:
- Focused on best value solution for customer
- Balances Cost, Performance, Risk and Schedule
- Requires understanding the mission/problem, acquisition strategy, and solution/trade space

Affordable: Cost ≤ Target
Performance Compliant: Performance ≥ Threshold
Value: Performance / Cost

Optimal Solution Strategy Depends on What Customer Values

1

Customer Values:
- Threshold Performance
- Minimum Cost

Customer Does NOT Value:
- Perf above Threshold
- Cost above min

Drive Value:
- Design to Perf
- Drive out Cost

$$\frac{\text{Meet Perf}}{\text{Minimize Cost}}$$

2

Customer Values:
- Max Performance/Cost
- Willing to pay for more perf, but only to a point

Customer Does NOT Value:
- Perf/Cost above point of diminishing returns

Drive Value:
- Maximize (P/C)
- Note: Not max P / min C

$$\text{Maximize}\left(\frac{\text{Perf}}{\text{Cost}}\right)$$

3

Customer Values:
- Maximum Performance
- Threshold Cost

Customer Does NOT Value:
- Lower Performance
- Lower Cost

Drive Value:
- Drive up Perf
- Design to Cost

$$\frac{\text{Maximize Perf}}{\text{Meet Cost}}$$

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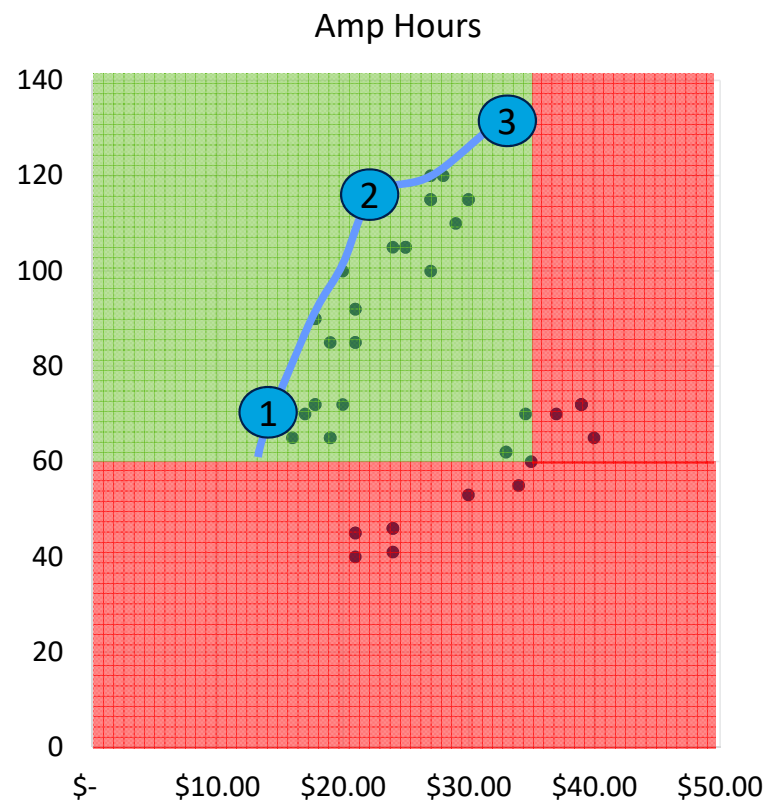
VALUE DRIVEN SOLUTIONS

- If customer needs at least 60 AH, and has an affordability target of $35
  - What are the options?
  - How do we drive value?
- Help the customer:
  - overlay the constraints on our trade space plot
  - add the efficient frontier
  - identify our 3 candidate value points
- Need some dialogue:
  - We have many options that meet those constraints
  - Does the customer value the lowest cost?
  - Or do the customer want to maximize the performance within your affordability target?
  - Or, would something in between be of interest?



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SUMMARY

- Affordability
  - Able to bear the price of something
  - Without adverse effects
  - In the context of all other things needed
  - But… tells me nothing about what I get for my money
- Value
  - Relative worth, merit, or importance
  - Value quantifies the exchange (ratio)
  - Tells me what I get for my money
  - Performance / Cost
- <u>Best</u> Value
  - Defined by Customer, varies
- Driving Value
  - Alignment with customer is critical
  - Best approach varies (1, 2, or 3?)
  - Use the trade space

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ROCKS CAN BE AFFORDABLE PETS

- In April 1975… Gary Dahl listened to his friends complain about their pets; this gave him the idea for the perfect "pet": a rock. A rock would not need to be fed, walked, bathed, or groomed, and it would not die, become sick, or be disobedient.
- Pet Rocks are smooth stones from Mexico's Rosarito Beach. They were marketed like live pets, in custom cardboard boxes, complete with straw and breathing holes. Dahl's biggest expense was the die-cutting and manufacture of the boxes. The rocks only cost a penny each, and the straw was nearly free.
- The fad lasted about six months… Dahl sold
  - 1.5 million Pet Rocks for $4 each
- https://en.wikipedia.org/wiki/Pet_Rock

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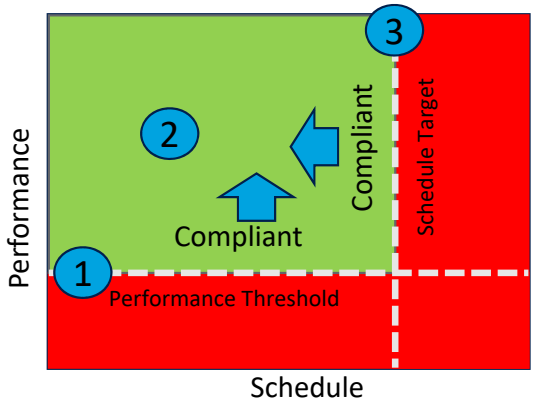
DRIVING VALUE WHERE SCHEDULE IS PRIORITY



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Schedule Compliant: Schedule ≤ Target
Performance Compliant: Performance ≥ Threshold
Value: Performance / Schedule

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1

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- Fastest Schedule

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- Schedule faster than min

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- Drive out Schedule

$$\frac{\text{Meet Perf}}{\text{Minimize Schedule}}$$

2

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Customer Does NOT Value:
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Drive Value:
- Maximize (P/S)
- Note: Not max P / min S

$$\text{Maximize } \left(\frac{\text{Perf}}{\text{Schedule}}\right)$$

3

Customer Values:
- Maximum Performance
- Threshold Schedule

Customer Does NOT Value:
- Lower Performance
- Faster Schedule

Drive Value:
- Drive up Perf
- Design to Schedule

$$\frac{\text{Maximize Perf}}{\text{Meet Schedule}}$$

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