Evaluating the Cost-Effectiveness of Alternatives

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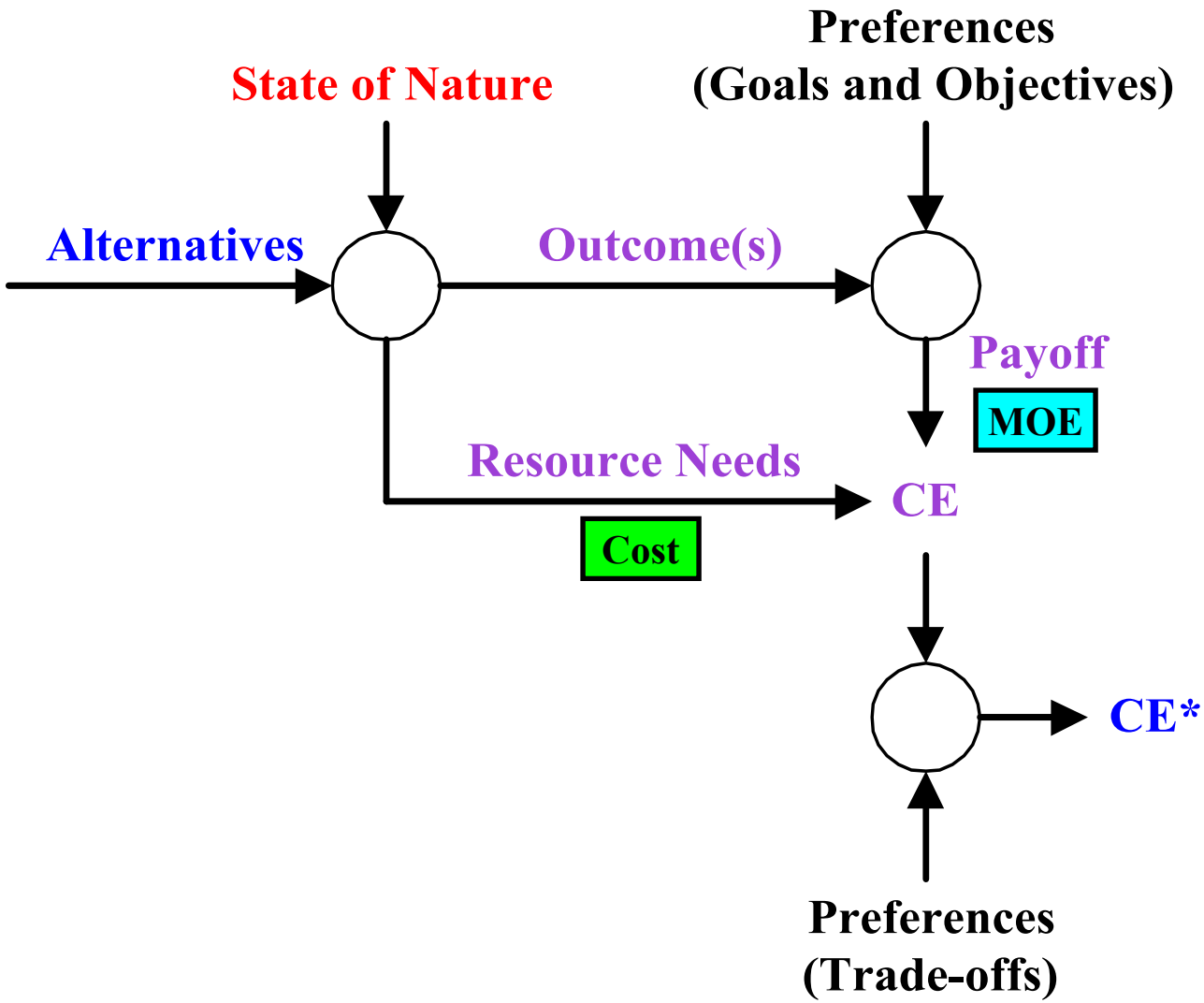
A mental model



Cost-Effectiveness

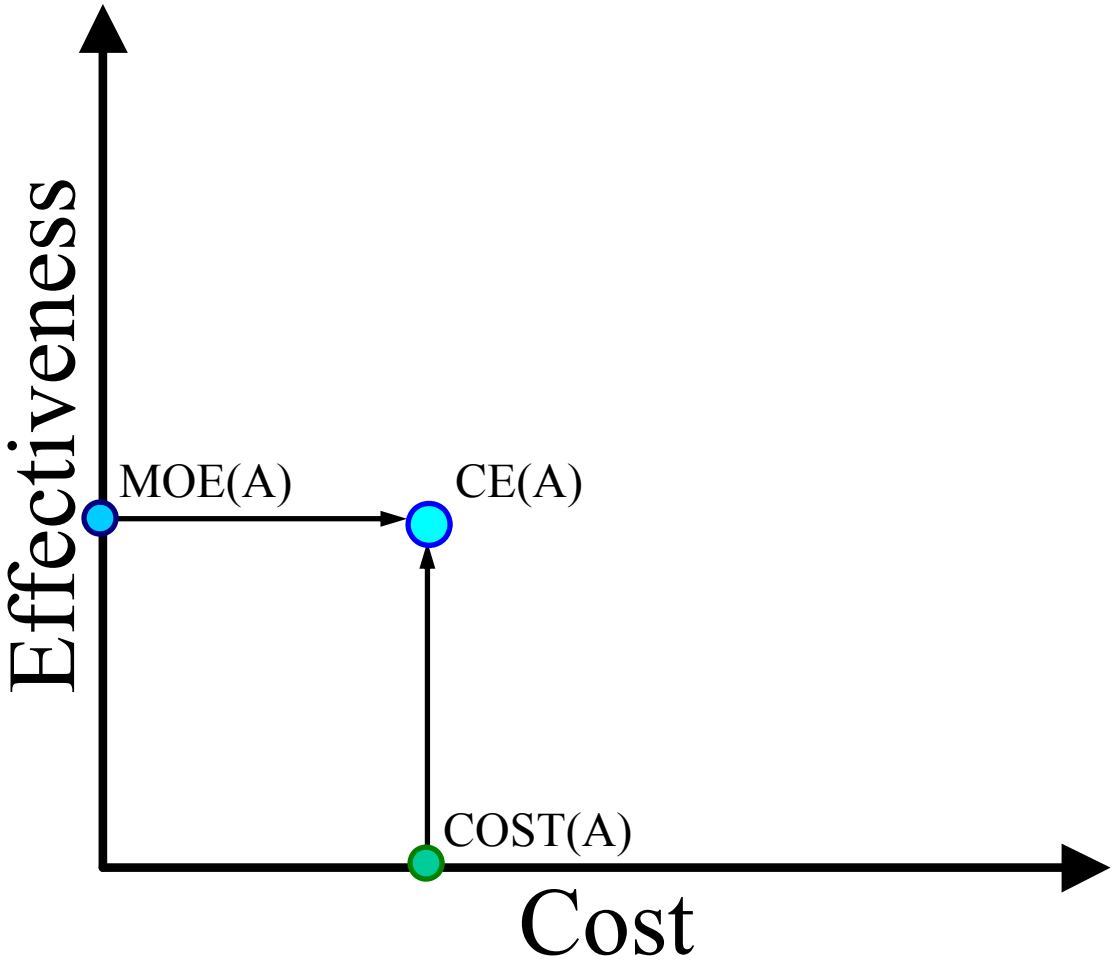
An indicator of the degree to which an alternative meets two objectives:

Maximize Effectiveness

Minimize Cost

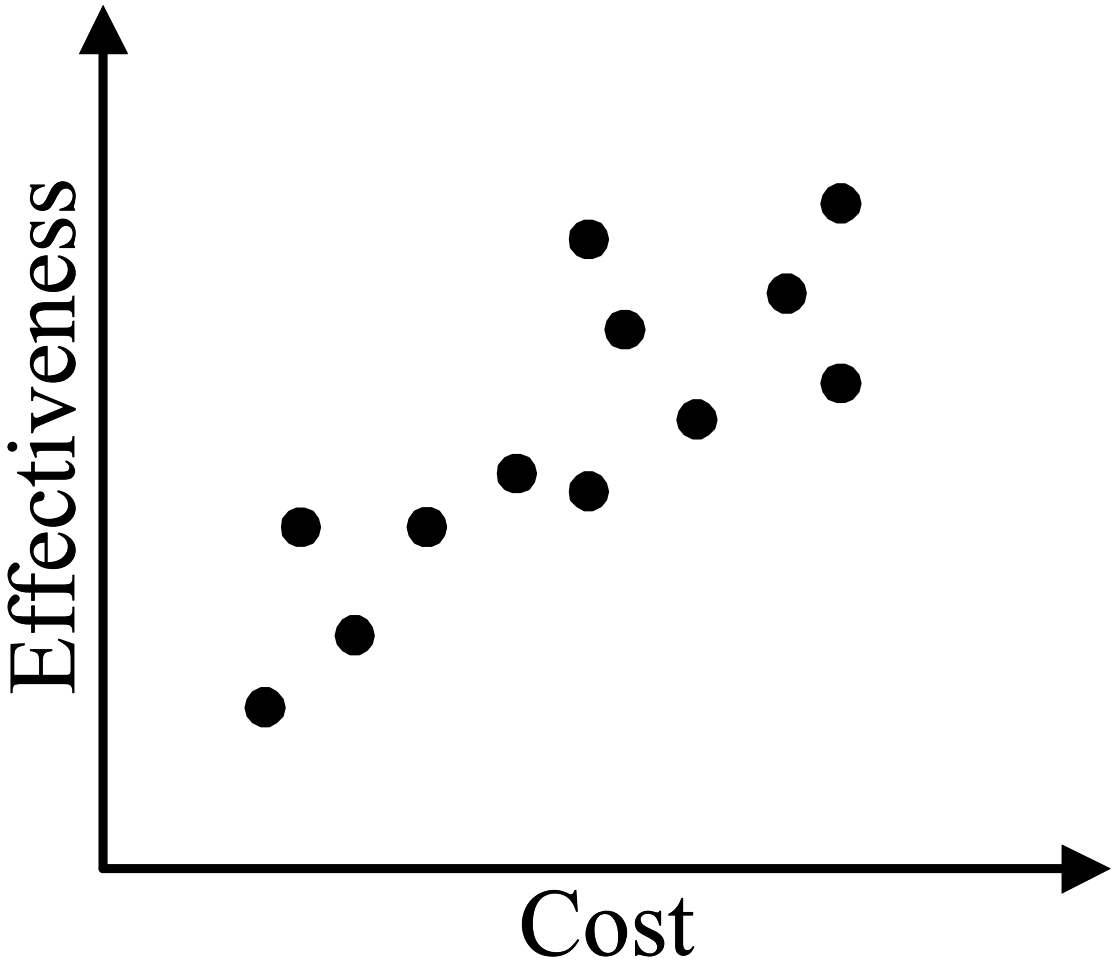
Cost-Effectiveness

We use a two dimensional framework



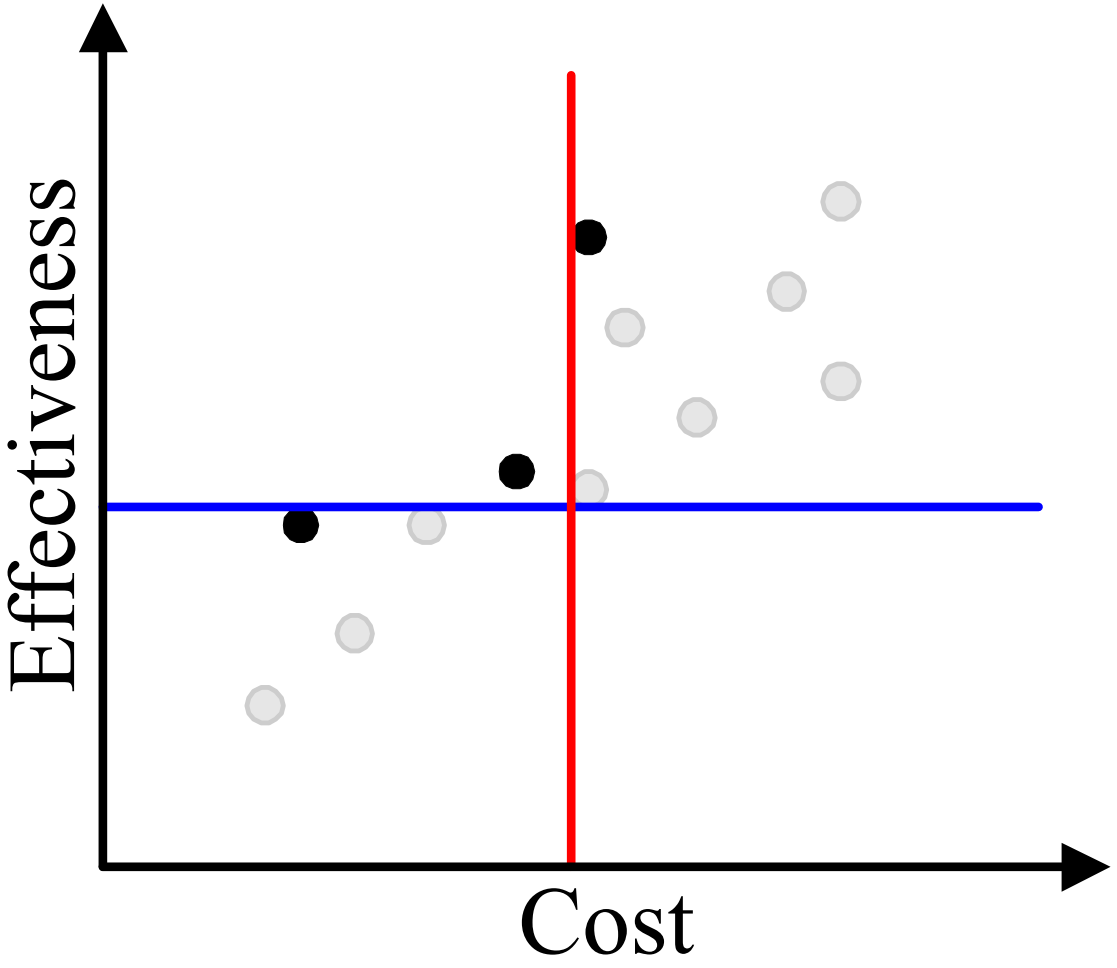
Cost-Effectiveness

The CE of an alternative is a point



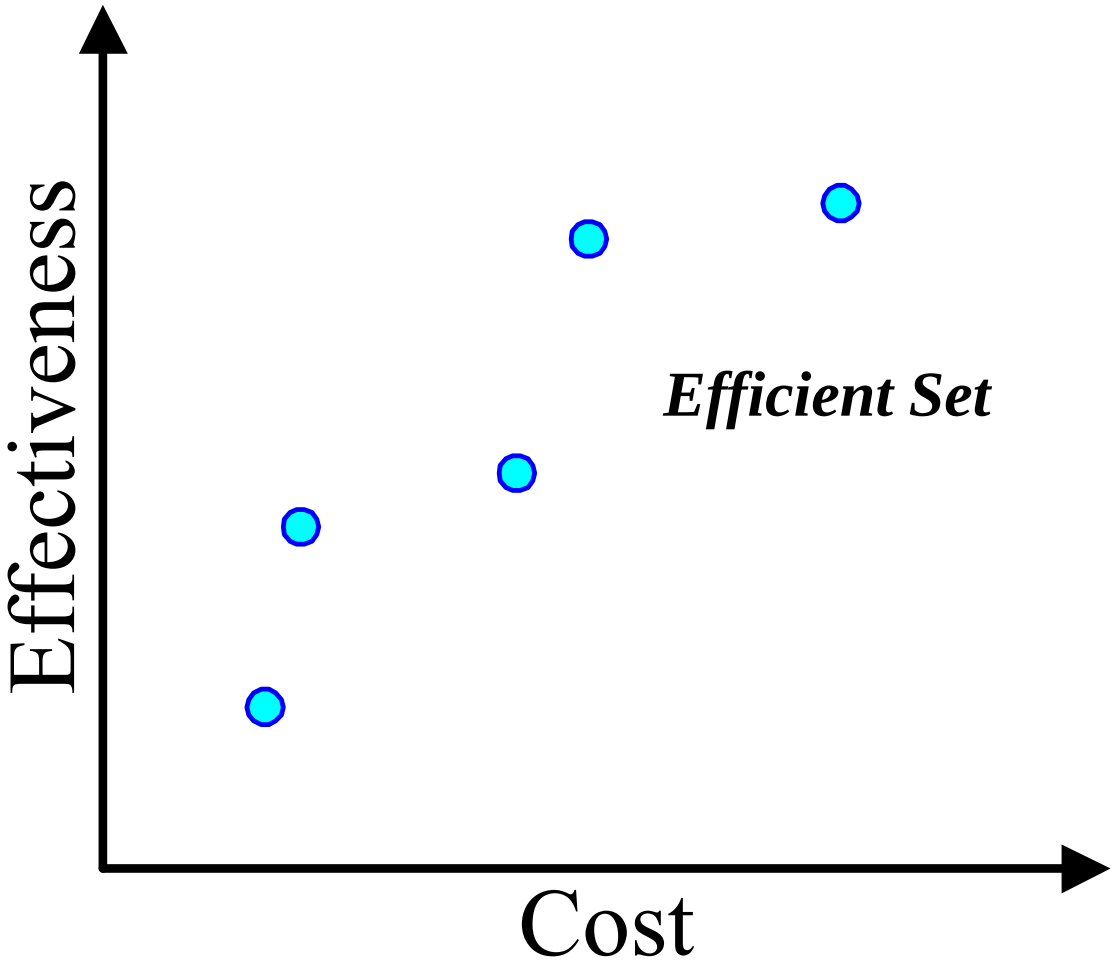
Cost-Effectiveness

The tyranny of fixed requirements



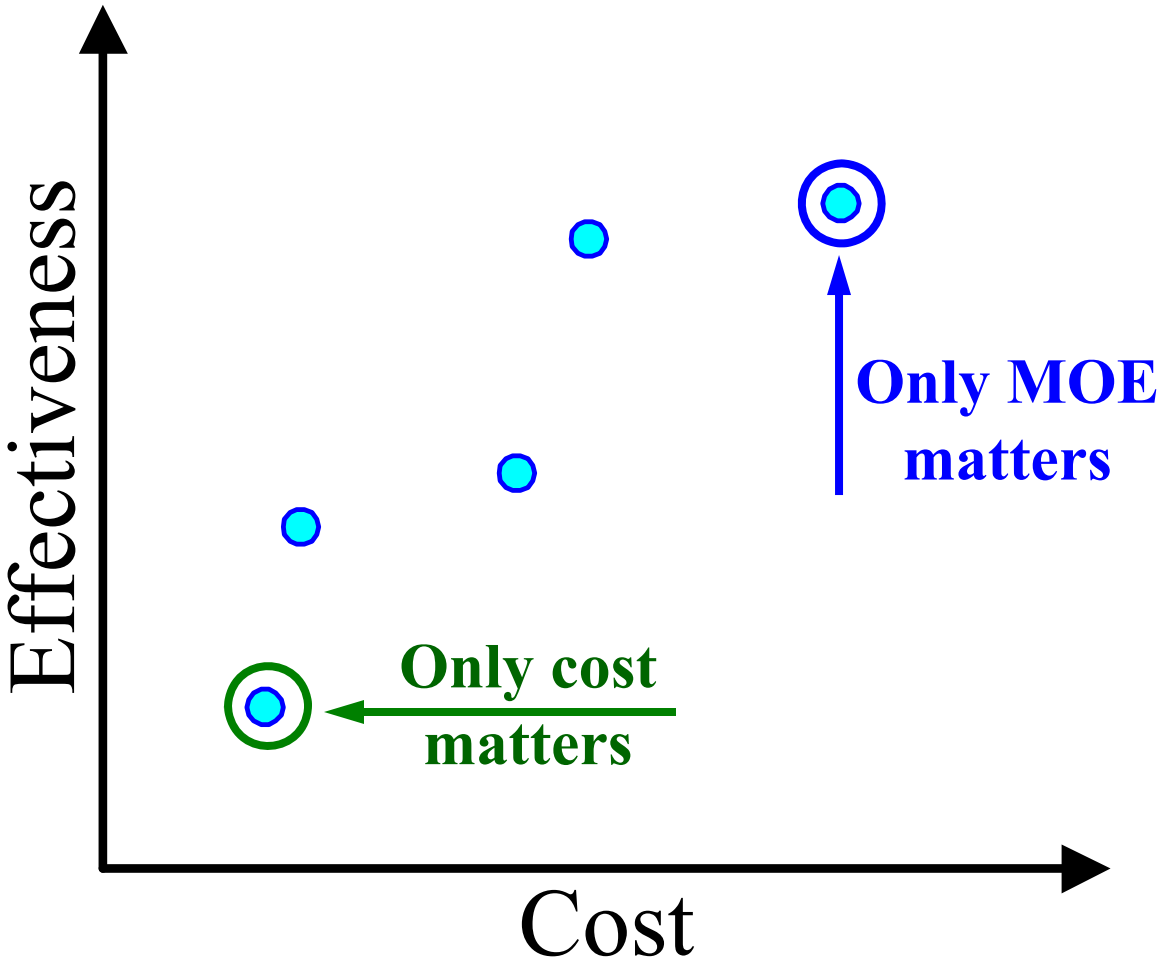
Cost-Effectiveness

The optimal alternative will be an efficient one



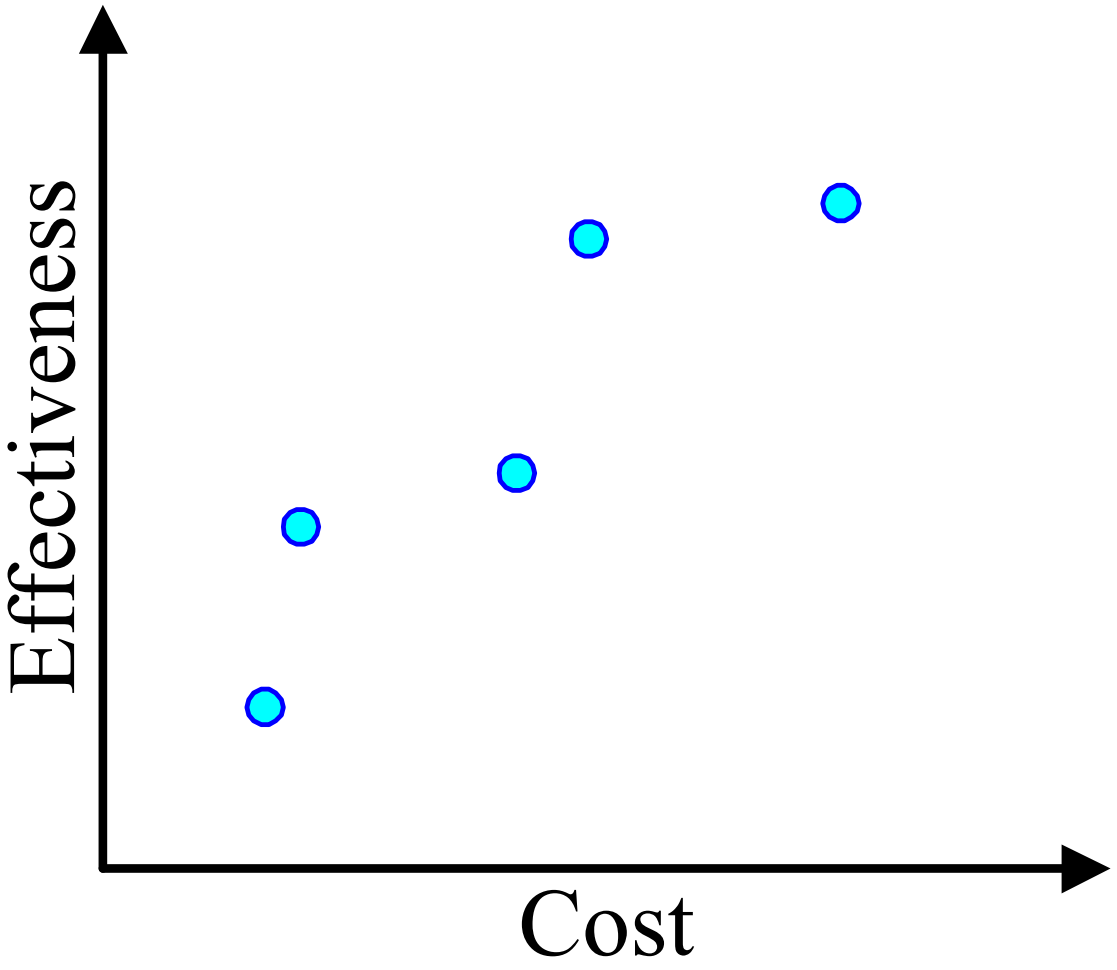
Which effective alternative is best?

That depends on what matters most to you



Which effective alternative is best?

What if both cost and effectiveness matter?

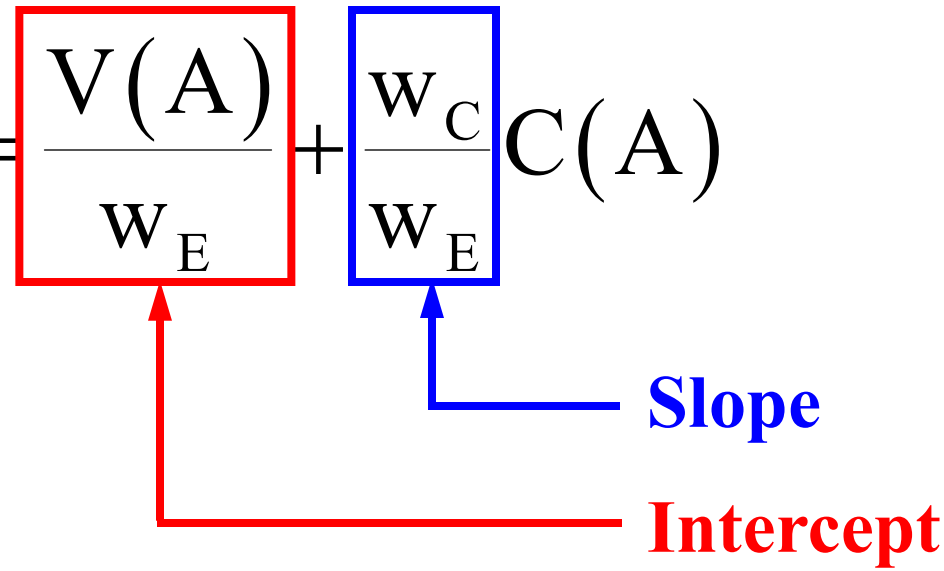


Cost-Effectiveness Tradeoff

What if we assume linear indifference curves?

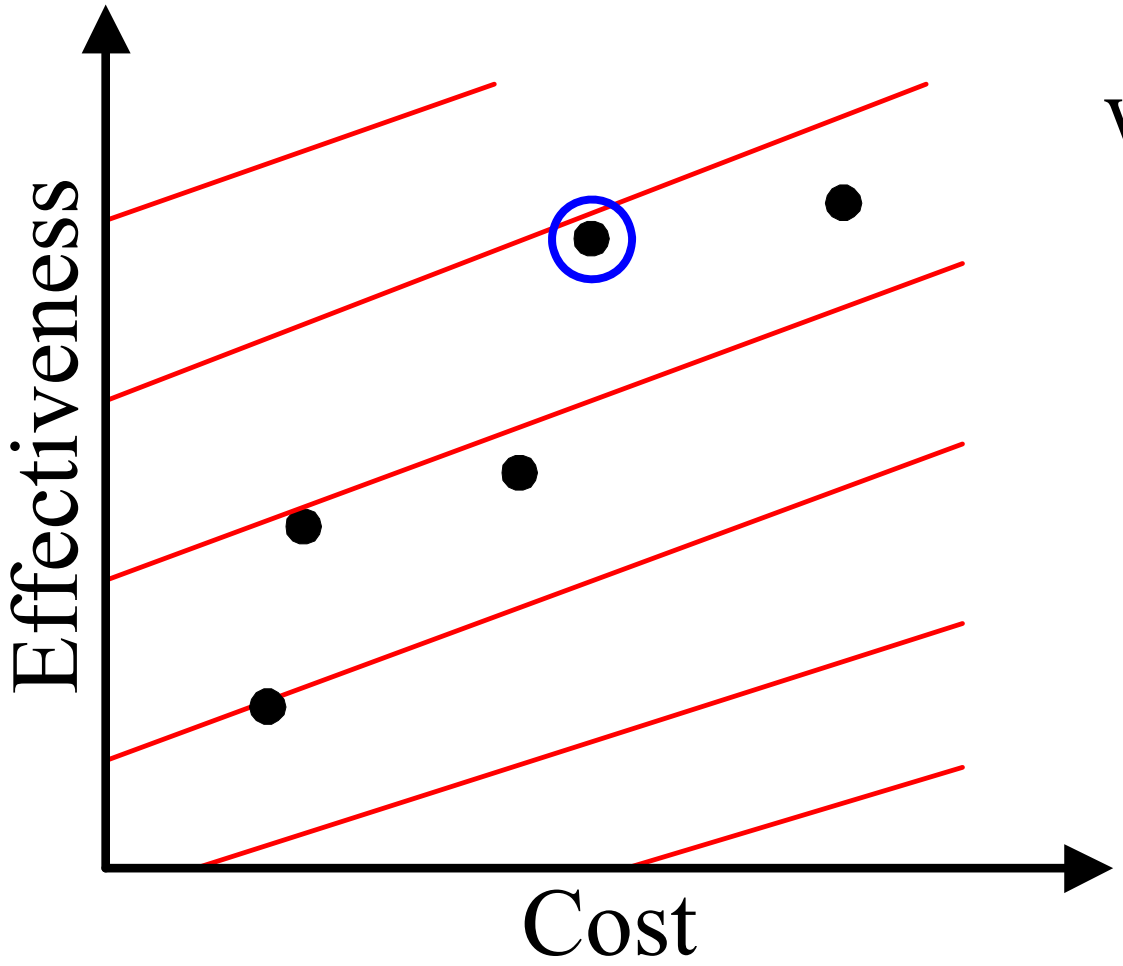
$$V(A) = w_E E(A) - w_C C(A)$$

$$E(A) = \frac{V(A)}{w_E} + \frac{w_C}{w_E} C(A)$$



Cost-Effectiveness Tradeoff

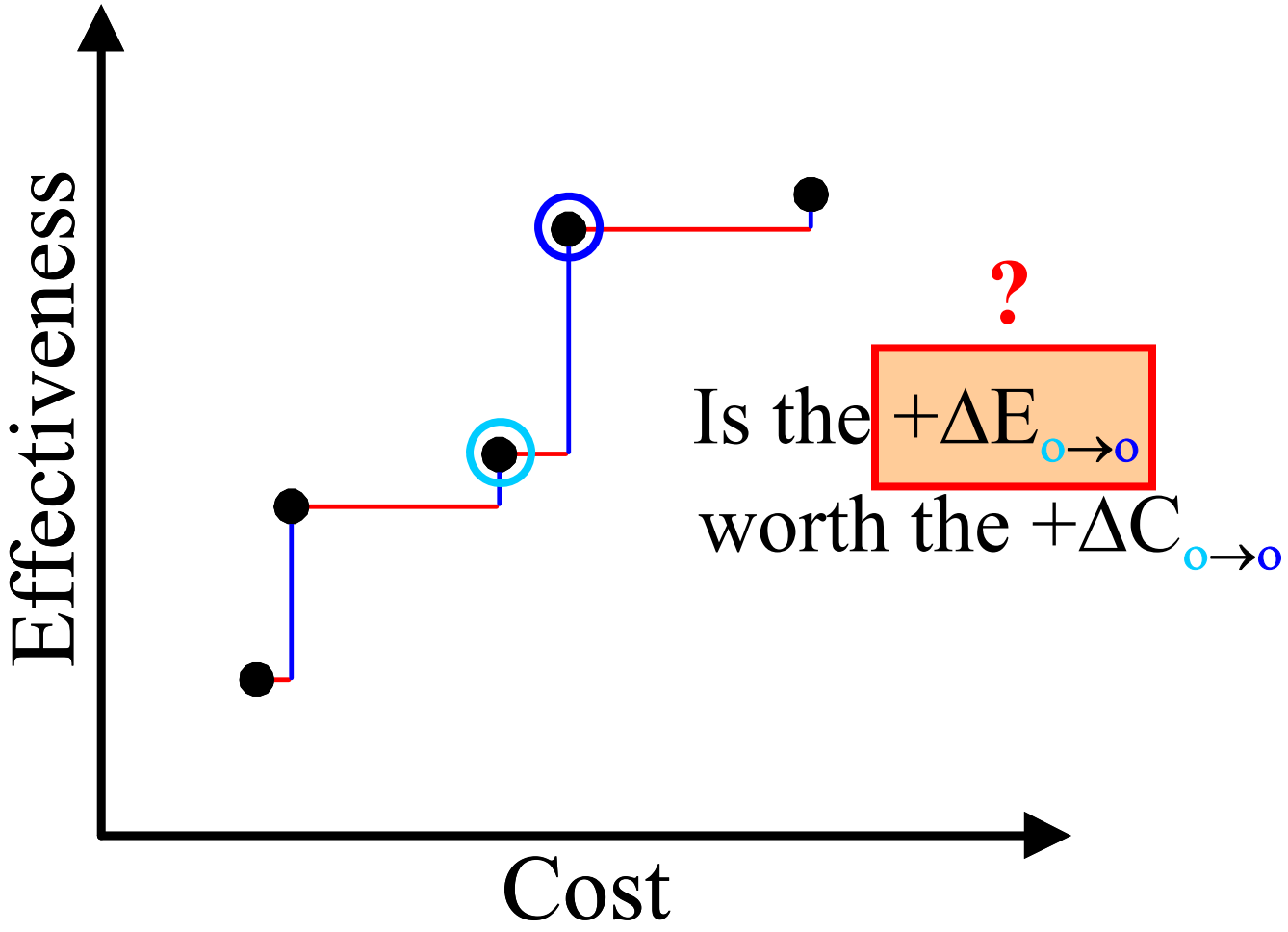
Constant trade-offs and the “best” alternative



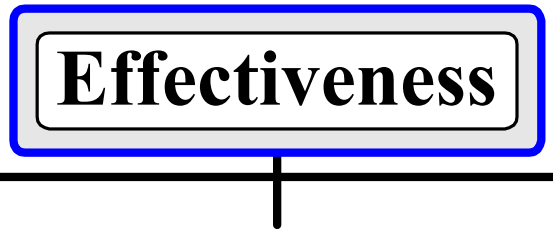
$w_E > w_C$

Marginal C-E Tradeoffs

Or we can look at marginals…

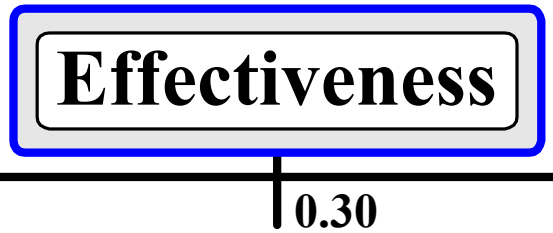


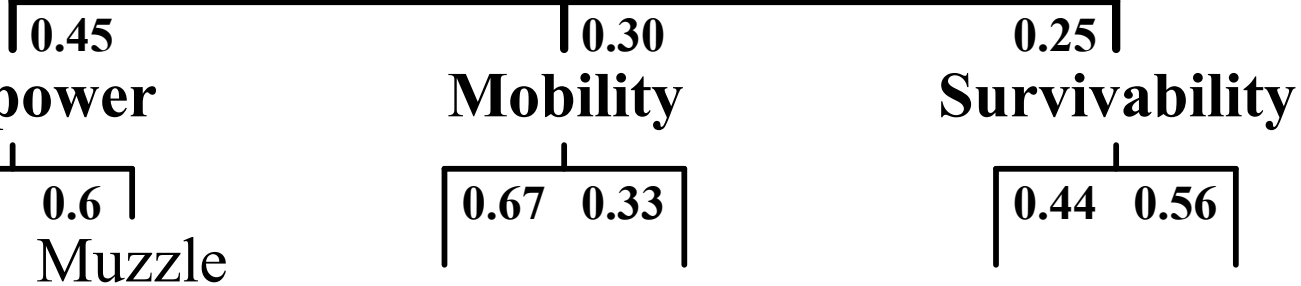
Example: Main Battle Tank



	Firepower		Mobility		Survivability	
	Caliber *mm*	Muzzle Velocity *mps*	Speed *kph*	Range *km*	Height *m*	Armor *mm*
A	120	1650	46	440	2.38	1724
B	120	1370	40	442	2.5	1930
C	120	1650	72	550	2.42	1620
D	125	1615	50	450	2.2	1397
E	120	1700	50	550	2.3	1450

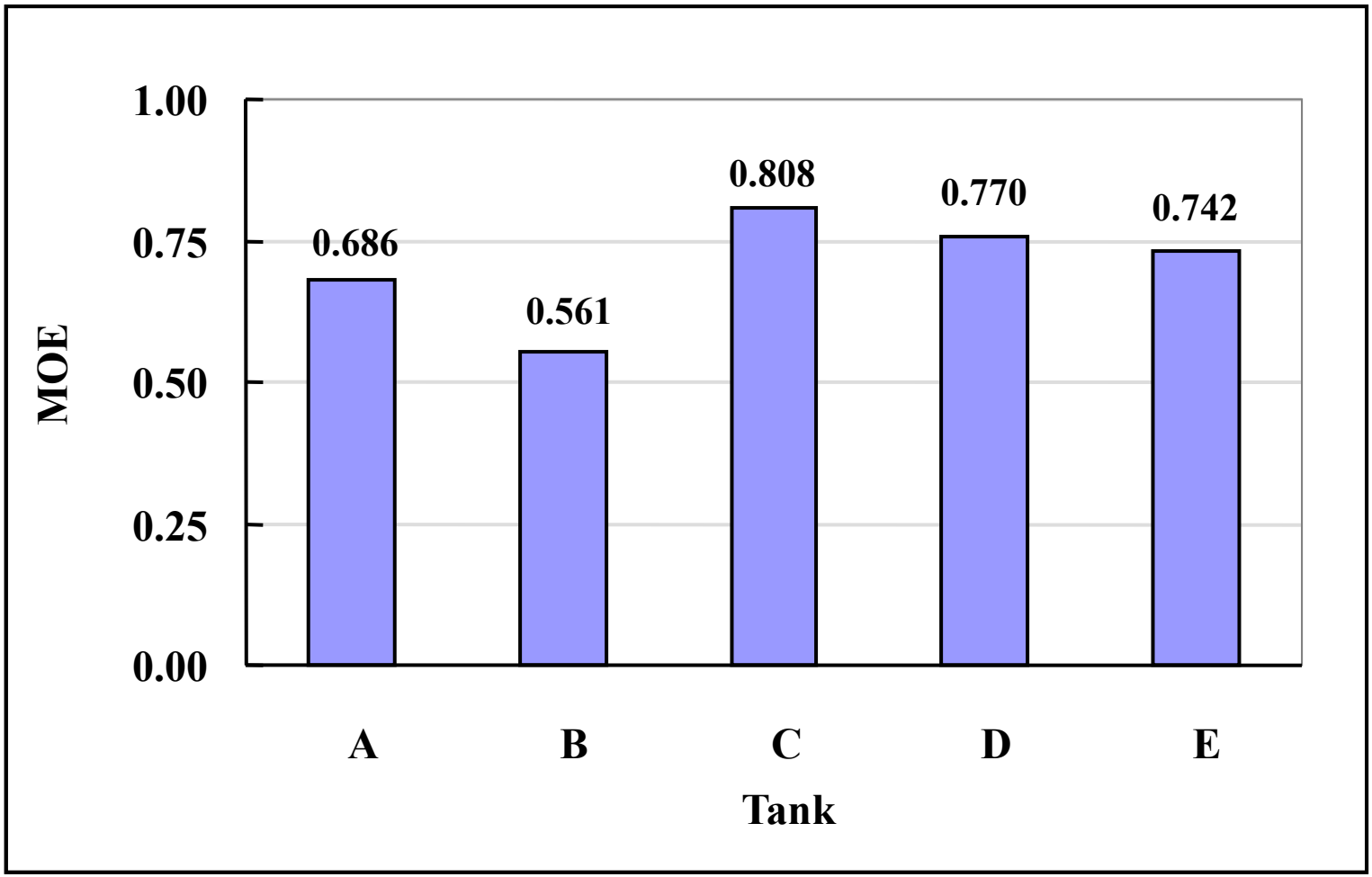
Example: Main Battle Tank



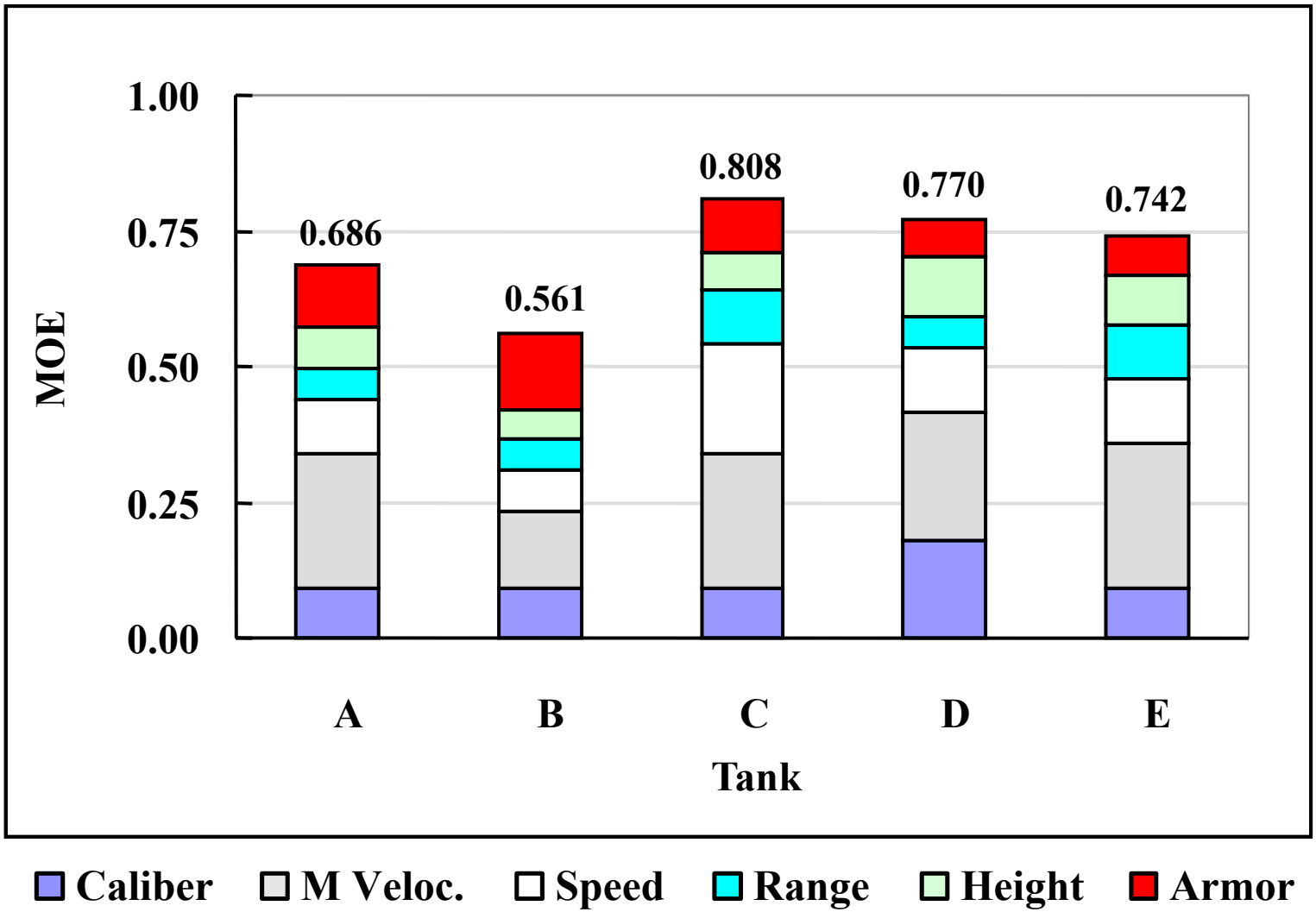


	Caliber *mm*	Muzzle Velocity *mps*	Speed *kph*	Range *km*	Height *m*	Armor *mm*
A	0.5	0.929	0.5	0.56	0.7	0.8
B	0.5	0.529	0.385	0.568	0.5	1.0
C	0.5	0.929	1.0	1.0	0.633	0.699
D	1.0	0.879	0.577	0.6	1.0	0.483
E	0.5	1.0	0.577	1.0	0.833	0.534

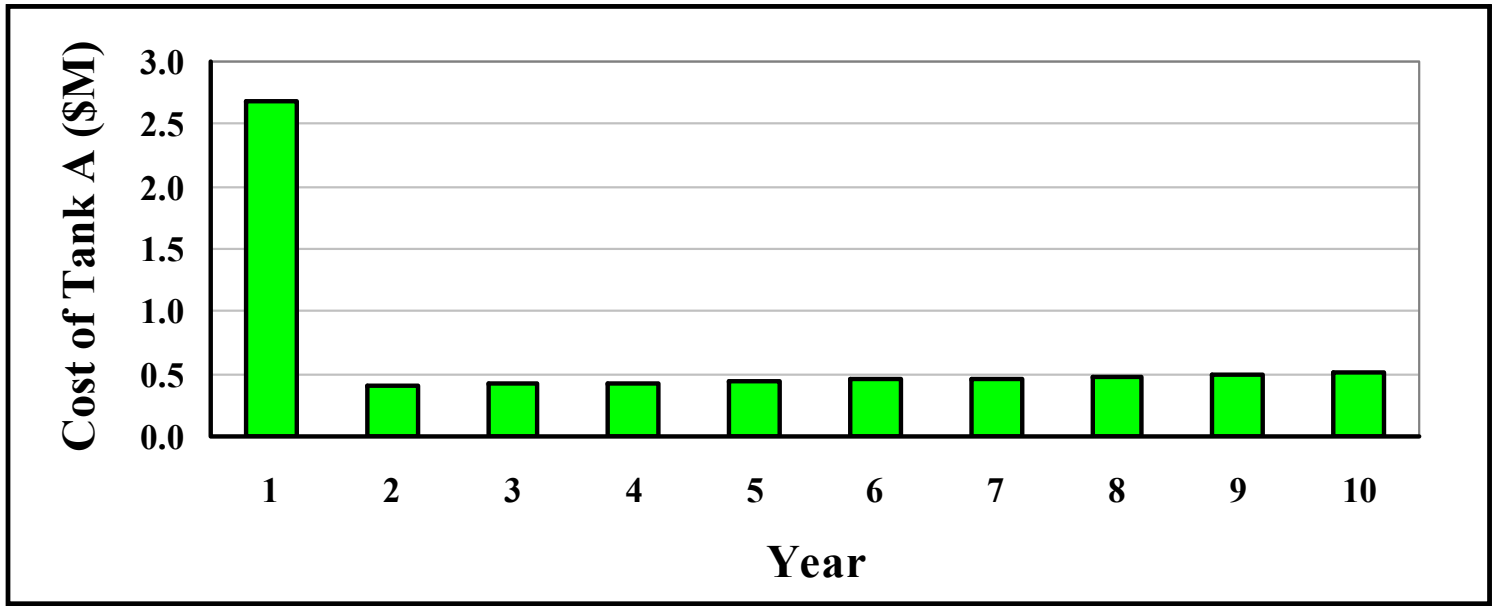
Example: Main Battle Tank



Example: Main Battle Tank

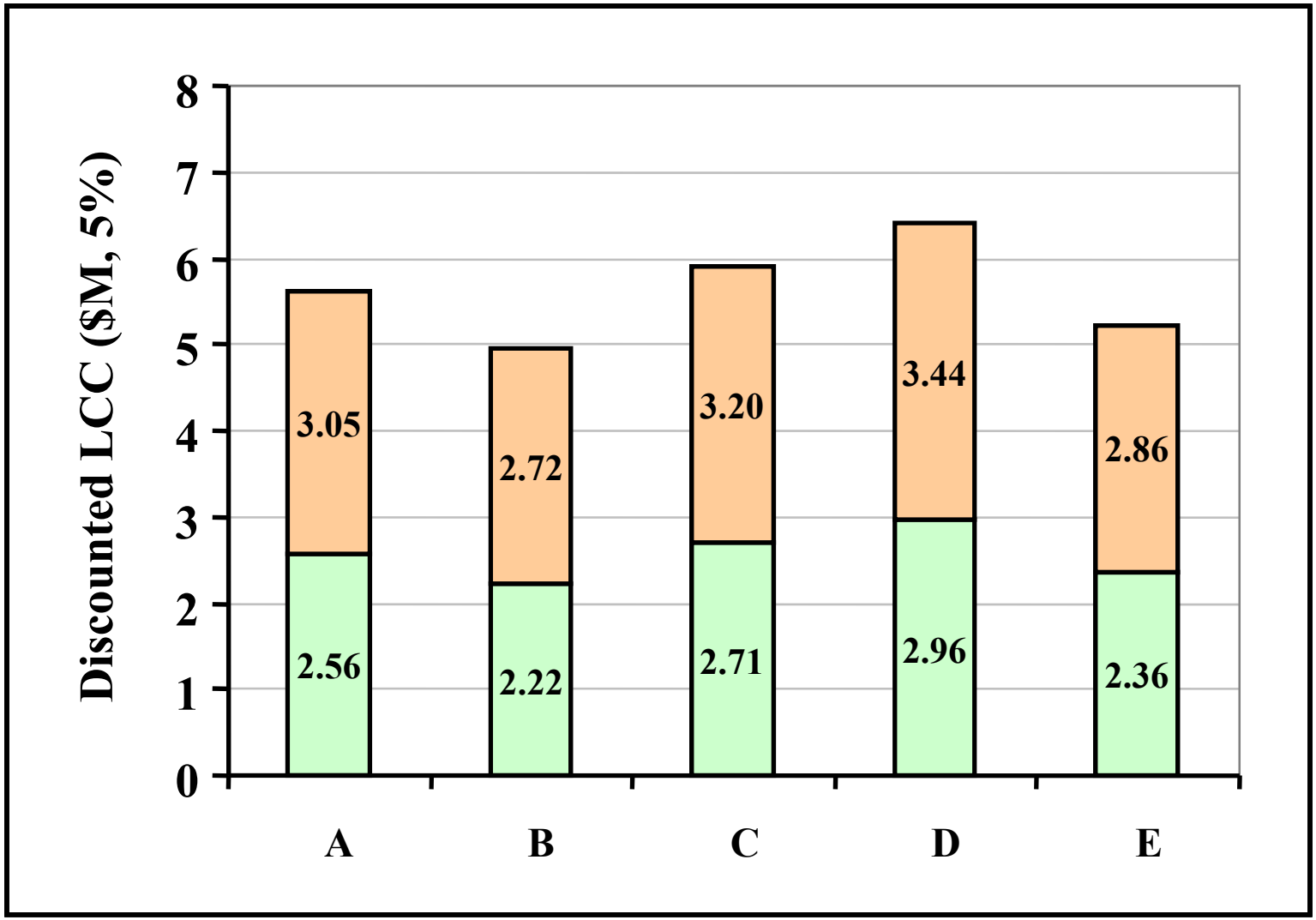


Example: Main Battle Tank

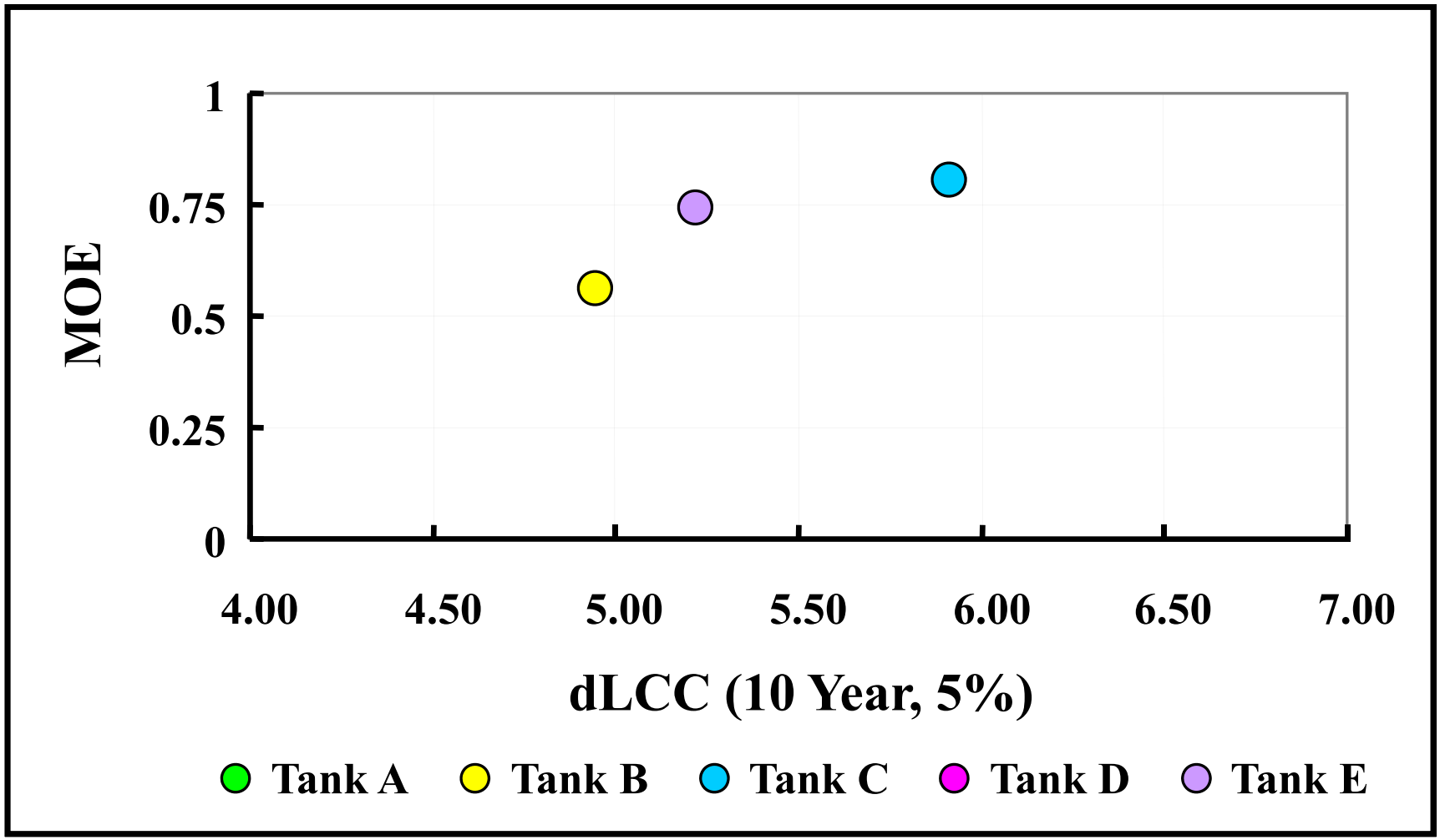


	Cost per Year ($M)									
Tank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	2.69	0.41	0.42	0.43	0.44	0.45	0.47	0.48	0.49	0.50
B	2.33	0.36	0.37	0.38	0.39	0.40	0.41	0.43	0.44	0.45
C	2.84	0.43	0.44	0.45	0.46	0.48	0.49	0.50	0.52	0.53
D	3.10	0.46	0.47	0.48	0.50	0.51	0.53	0.54	0.56	0.57
E	2.48	0.38	0.39	0.40	0.41	0.42	0.44	0.45	0.46	0.47

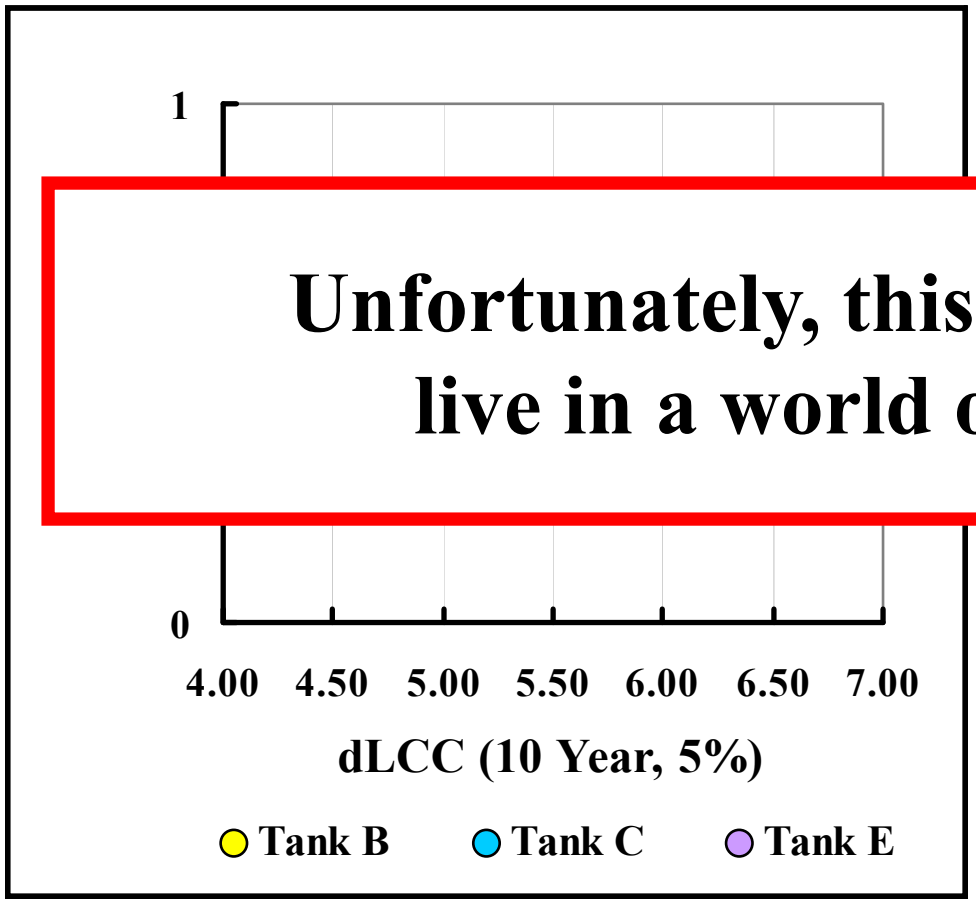
Example: Main Battle Tank



Example: Main Battle Tank



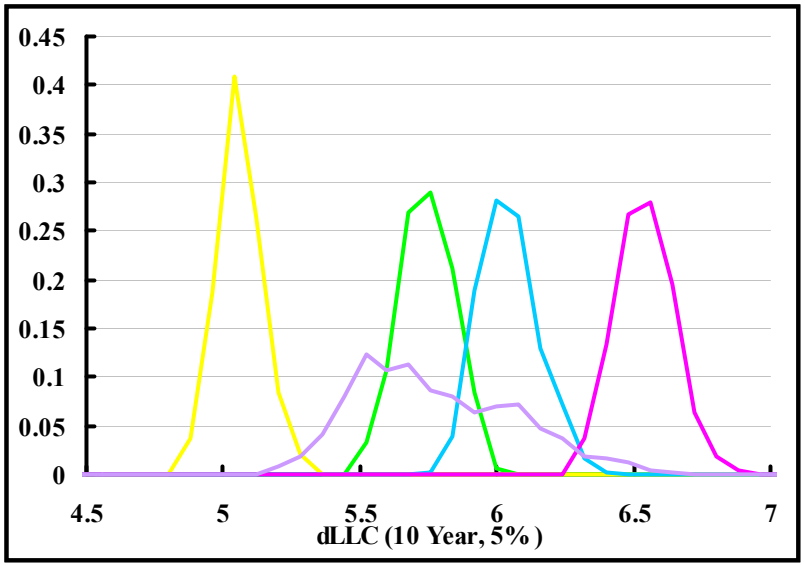
Example: Main Battle Tank

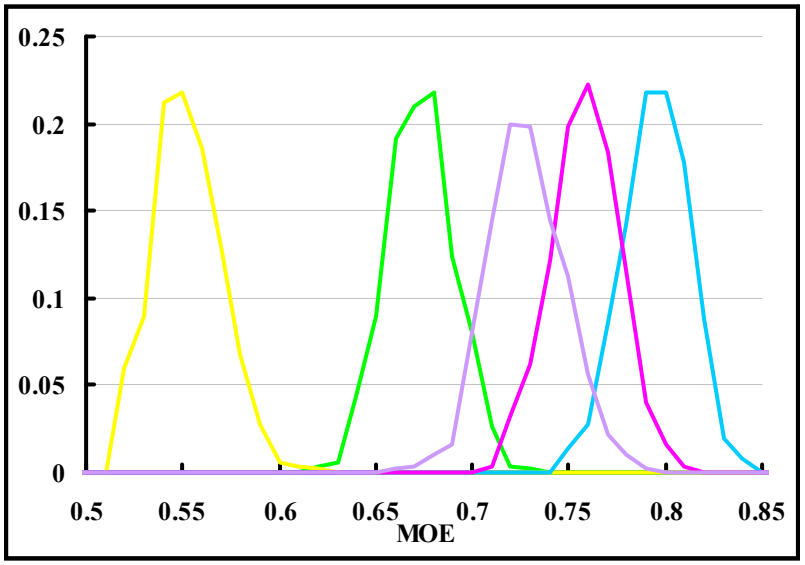


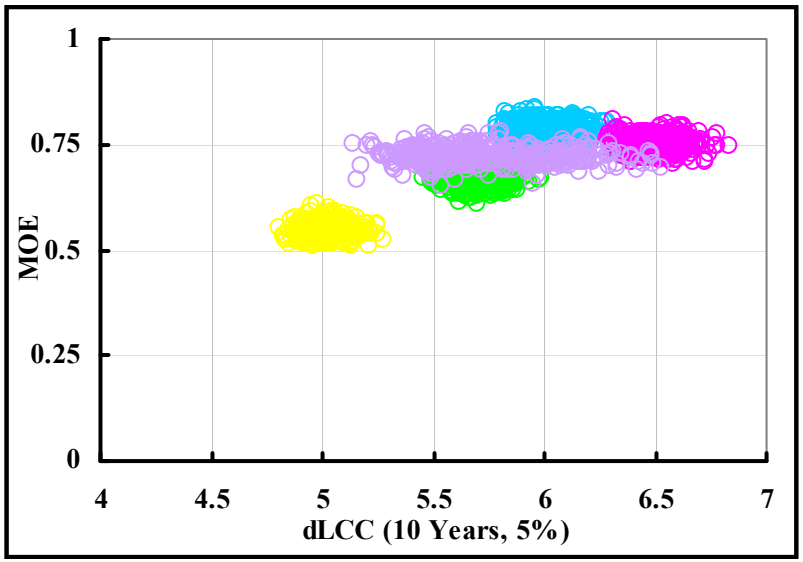
Attribute	B	E	Δ
Caliber	120	120	0
M. Velocity	1370	1700	330
Caliber	120	120	0
M. Velocity	1700	1650	-50
Speed	50	72	22
Range	550	550	0
Height	2.3	2.42	0.12
Armor	1450	1620	170
Cost	5.22	5.91	0.69

Unfortunately, this assumes that we live in a world of certainty…

Example: MBT with uncertainty

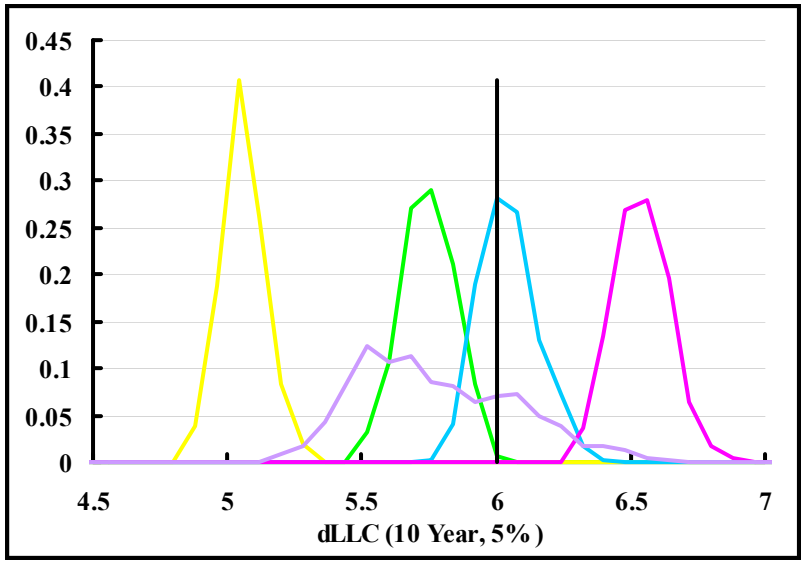


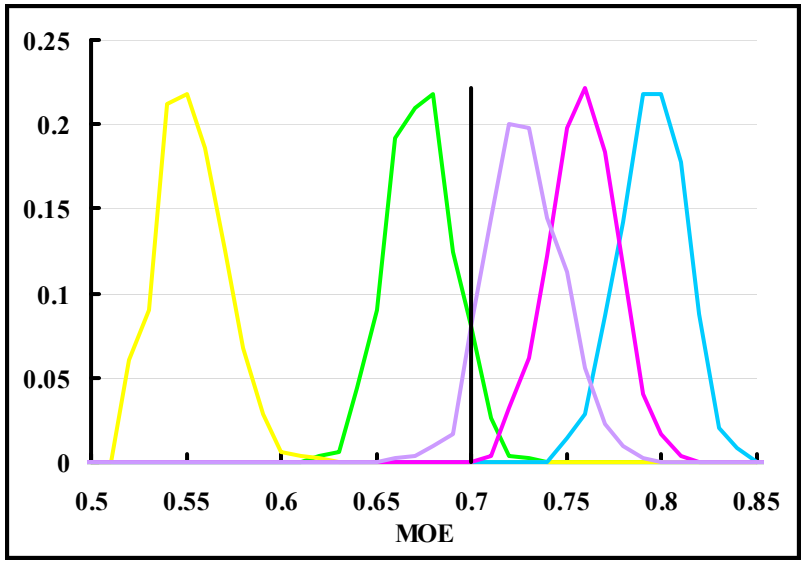


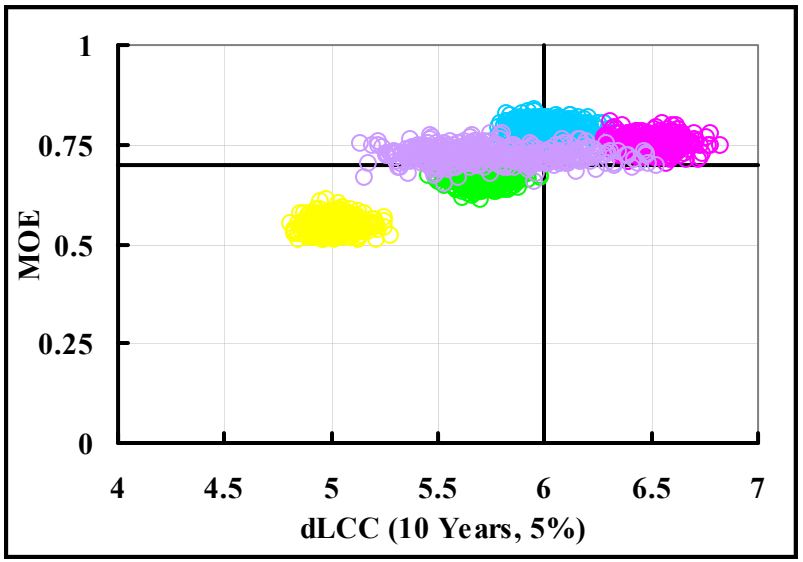


So, which tank should we procure?

Example: MBT with uncertainty







	P(dLCC≤6)	P(MOE≥0.7)	P(CE∈R)
Tank A	1.000	0.032	0.033
Tank B	1.000	0.000	0.000
Tank C	0.514	1.000	0.505
Tank D	0.000	1.000	0.000
Tank E	0.790	0.888	0.698

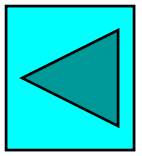
So, which do you want?

So What?

- CE is a composite measure.
  - Cost: Input
  - Effectiveness: Output
- It's useful to think about CE in 2-space.
  - Dominance
  - Efficiency
- Finding optimality requires making trade-offs.
  - Trade-off weights
  - Marginal trade-offs

Um… that's all, folks…

Effectiveness

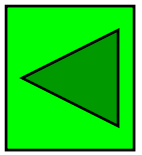


Effectiveness is a measure of ***output*** or ***capability delivered*** by an alternative.

A few examples:
- Winter Coat
- Personal Automobile
- New Aquarium Program
- Main Battle Tank

Alternatives could be systems of objects, broadly defined courses of action, policies, portfolios, etc.

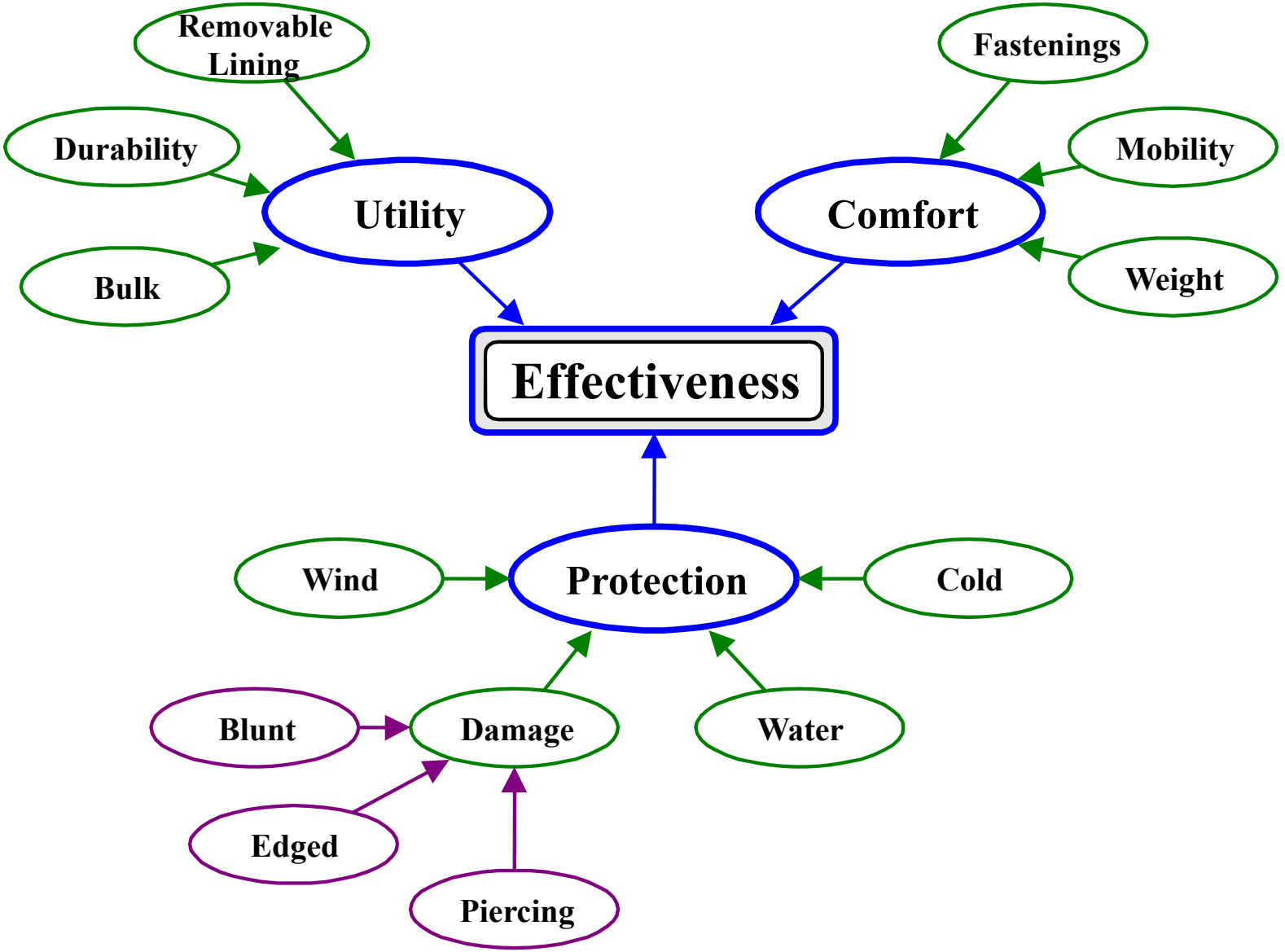
Cost



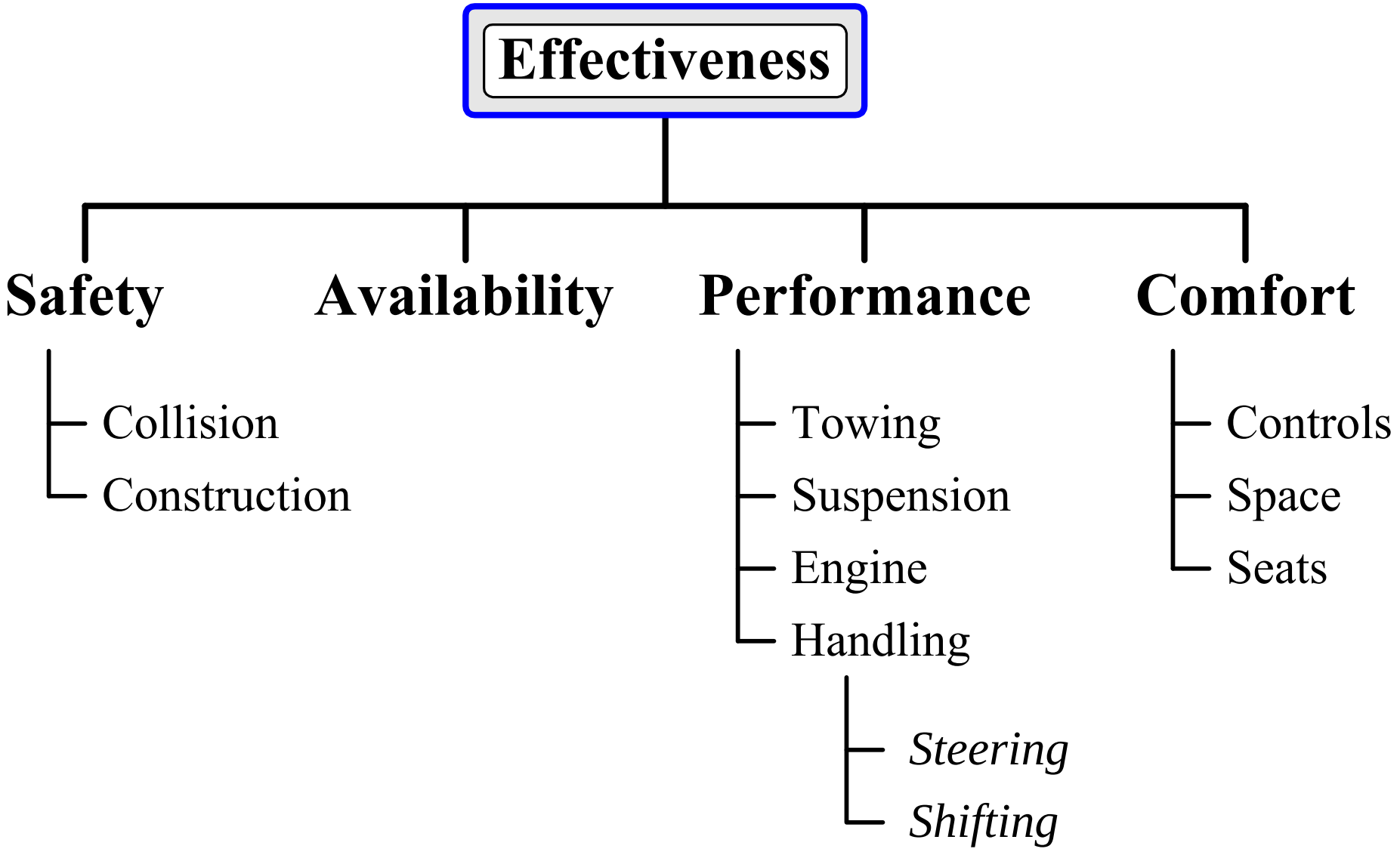
Cost is a measure of ***resources consumed*** as a consequence of an alternative.

A few examples:
- Present/Future
- Once-Time/Recurring
- Fixed/Variable
- Certain/Uncertain
- Relevant/Irrelevant
- ⋮
- Opportunity

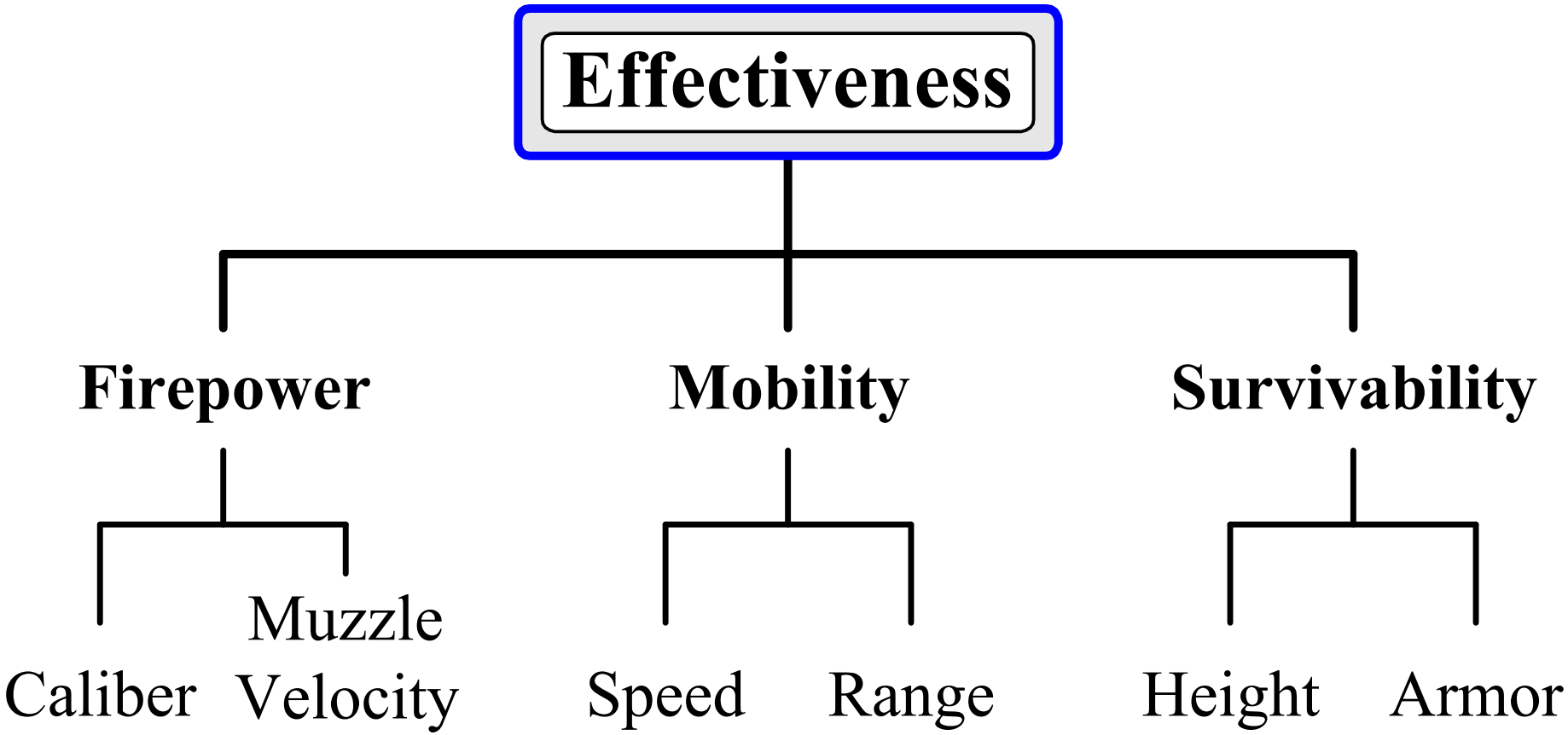
Winter Coat


Removable Lining
Durability
Utility
Bulk
Fastenings
Mobility
Comfort
Weight
Effectiveness
Wind
Protection
Cold
Blunt
Damage
Water
Edged
Piercing

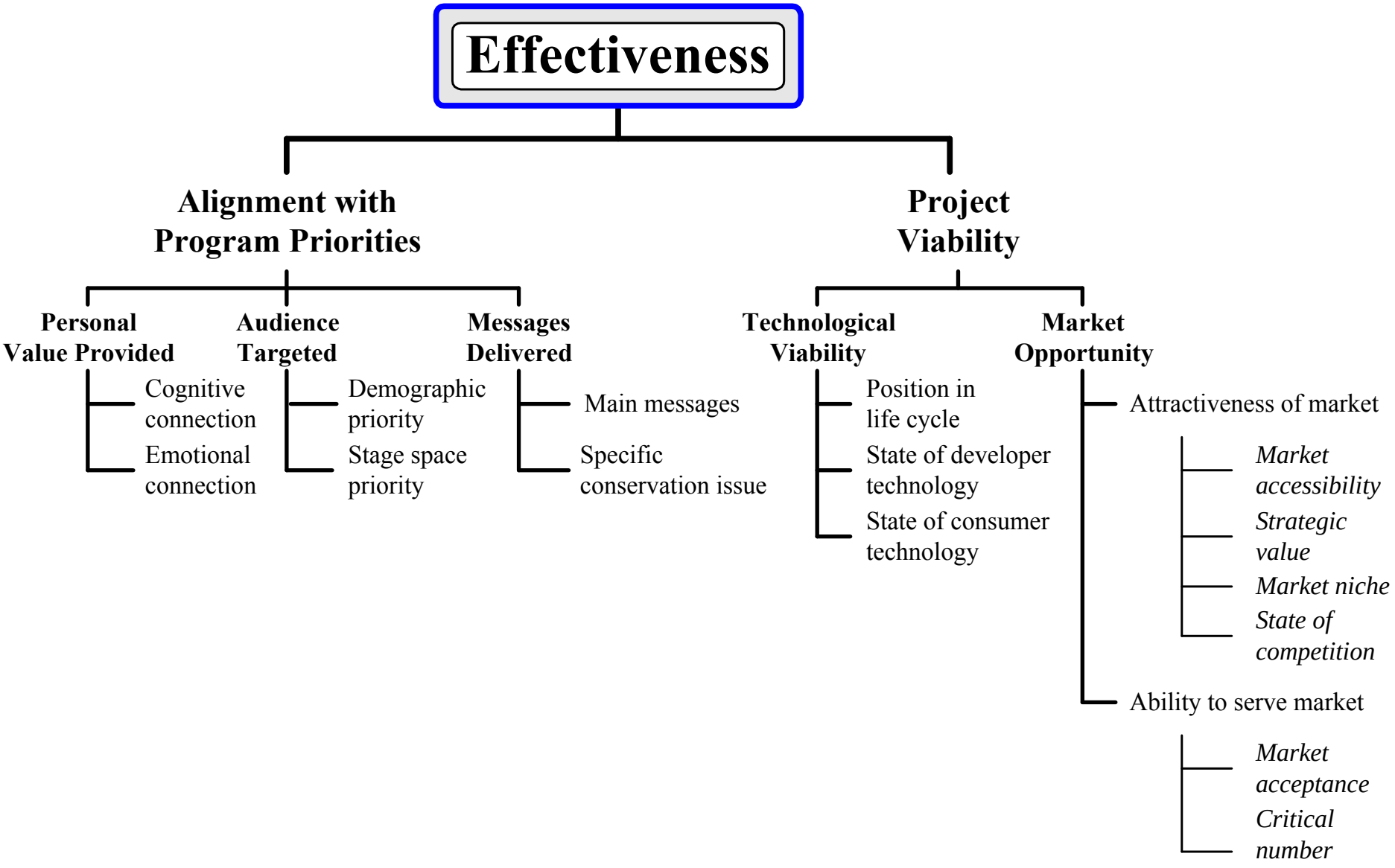
Personal Automobile



Main Battle Tank



New Aquarium Program



Life Cycle Cost