

Controlling for Framing Effects in Multi-Stakeholder Tradespace Exploration

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- Motivation
 - Multiple-Stakeholder Decisions
 - Tradespace Exploration
 - Framing
 - Reframing Tradespace Exploration

- ‘Stakeholder incompatibility’ drives project cancellations
 - Can occur despite large feasible domain meeting requirements

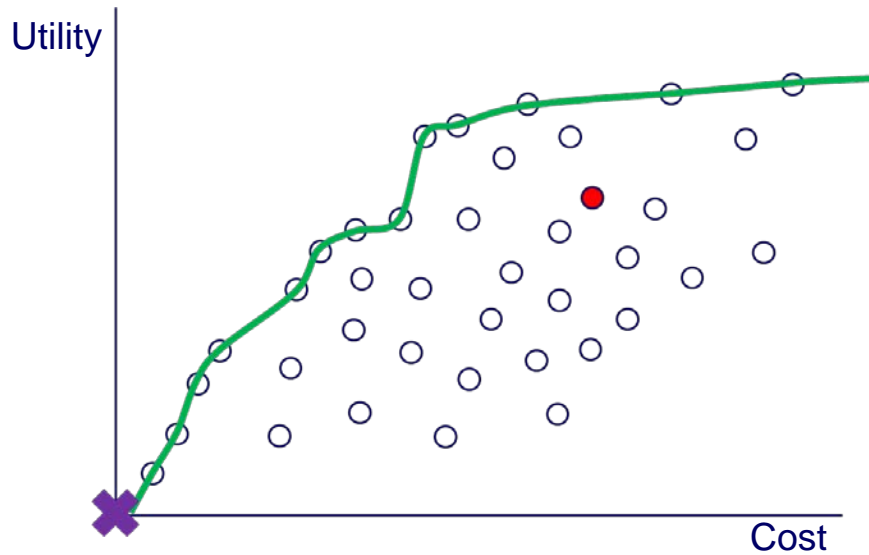


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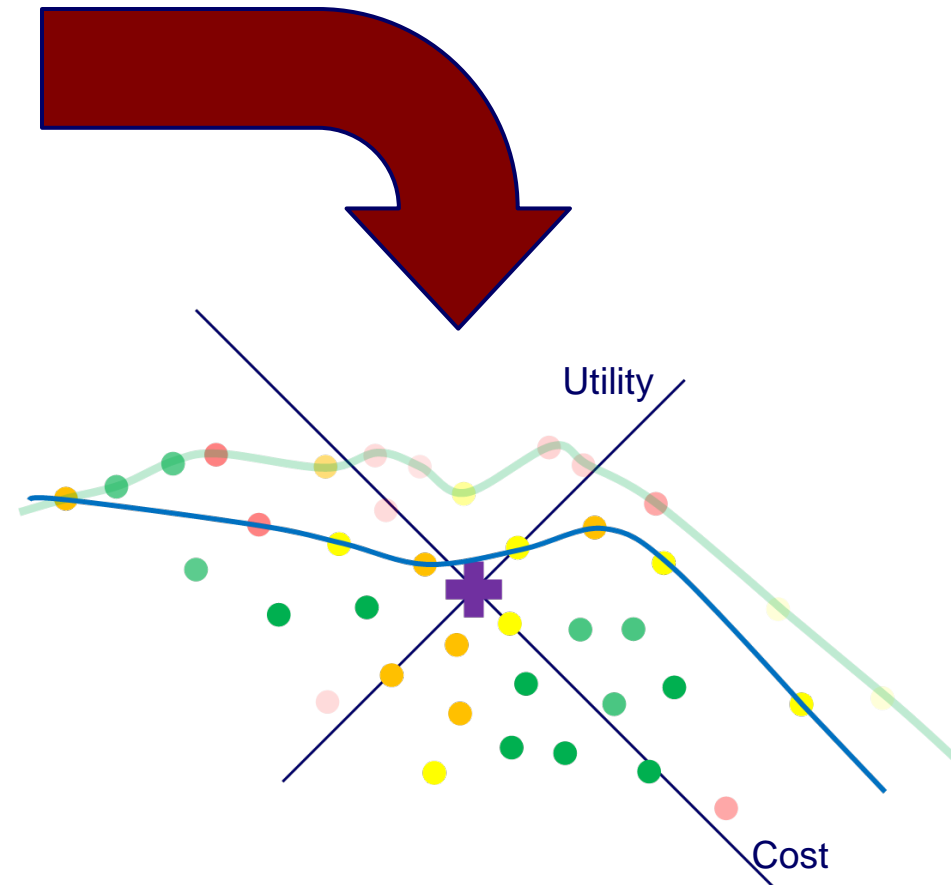
- Emergent need to improve negotiation between differing interests



A quick teaser...



- What would a tradespace *designed* for multiple stakeholders look like?
- Can we make better decisions this way?



Connected Stakeholders

Characteristics

High communication
Information exchange
Shared top-level goals
Eventually must agree

Techniques / Analysis

Collaborative engineering
Aggregate utility
maximization
Game-theoretic / automated
negotiation models

Key Example

Subsystem teams

- Significant existing literature
- Utility-focused, emphasizing normativity
 - Can numerically define “good outcome”
 - Possible due to considerable structure

Empowered Decision Makers

Characteristics

Independent
Have control over final decision (e.g., vote, veto)
Can withdraw from negotiation

Techniques / Analysis

Conflict resolution
Joint Fact Finding
Value Based Theory of Systems Engineering

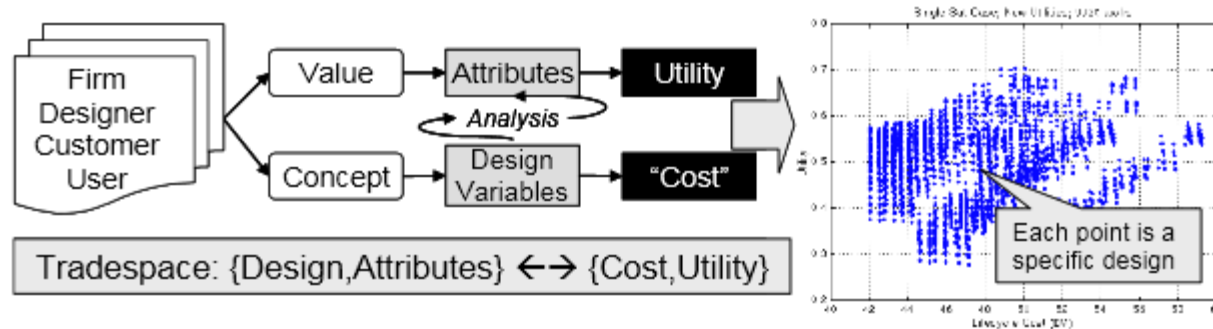
Key Examples

Governments
Companies
Military branches

- Blend of both utility theory and cost-benefit analysis techniques
 - Monetization and cost-benefit applicable in only some domains
- Reduced structure emphasizes prescription over normativity

Tradespace Exploration (TSE)

- System design paradigm with associated methods
- **Multi-attribute Tradespace Exploration (MATE)** maps system concepts into design variables and stated stakeholder preferences into performance attributes/utility functions

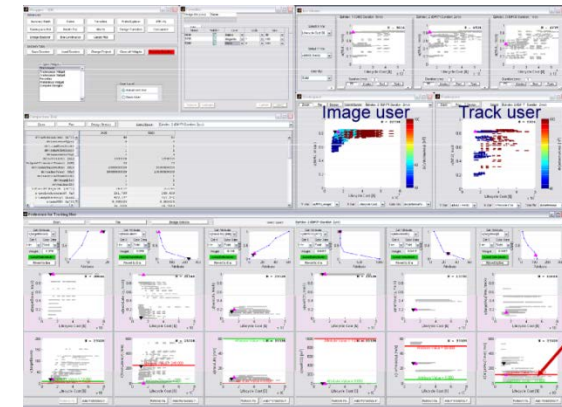


- Emphasis is placed on looking at a large set of alternatives and their outcomes
- Key goal: move away from point design analysis to **better understand the problem** via trends in outcomes (perceived value space)

Multi-Stakeholder TSE (MSTSE)

- Tradespace approaches (e.g. MATE) are a **natural extension** of many of the ideas central to “good” negotiation
- Early application of MSTSE was **developed heuristically** by applying the practices of standard TSE

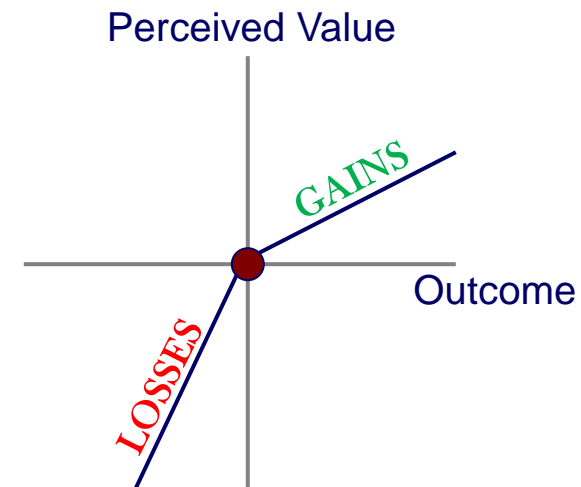
- Depersonalizes differing goals
- Focuses on interests (preferences)
- Uses objective metrics to evaluate choices
- Creates and explores many options



We should revisit MSTSE and evaluate the appropriateness of TSE techniques!

- **Framing effects**: differences in behavior driven by differences in the presentation of information
- Prospect theory → considerable empirical evidence that people frame decisions using **reference points** to define ‘gains’ and ‘losses’
- Asymmetrical **perceived value** around the reference point makes losses more impactful than gains

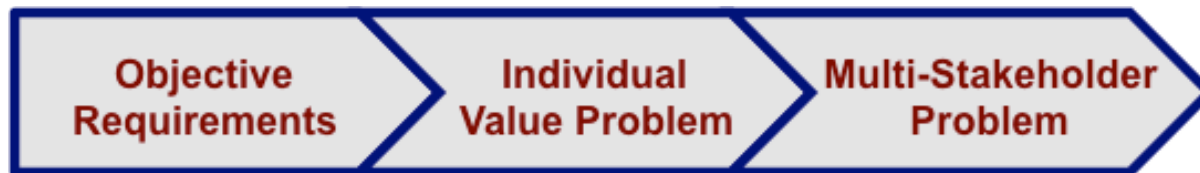
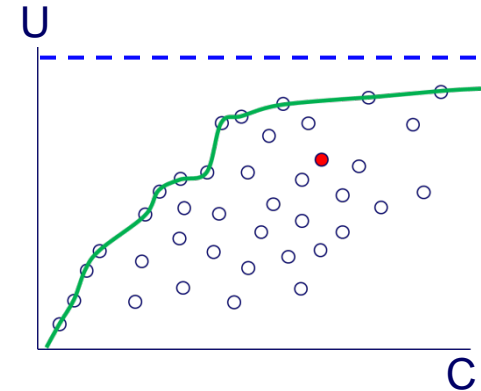
Proper selection of a reference point is critical to good decision making



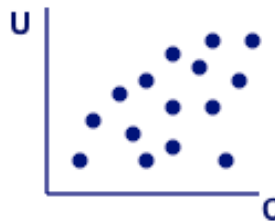
- What reference points exist in TSE?
 - Utility = 1, complete satisfaction of needs

Already countered → analysis withheld until tradespace shows constraints

- Pareto front: cost benefit efficiency
- Pareto front **too optimistic** for MSTSE?
 - Increasing problem sophistication



What do I want?



What can I get?



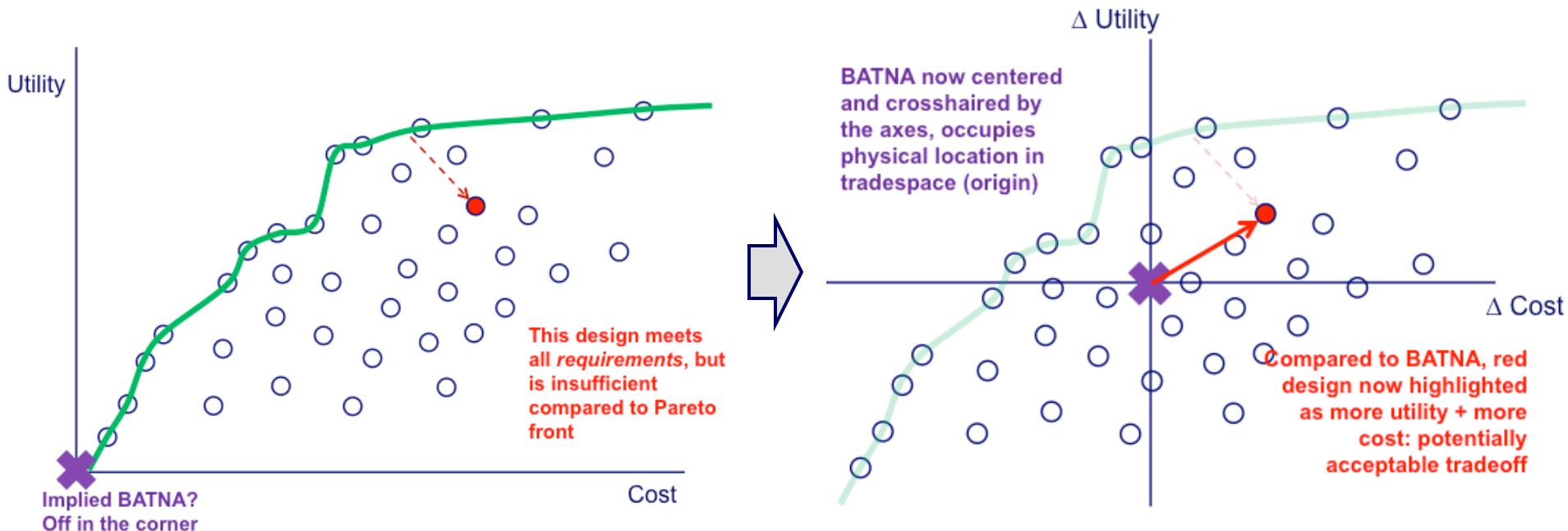
What can we agree on?

- Best Alternative to a Negotiated Agreement (**BATNA**) as reference point
 - Accepted boundary between true gains and losses in a negotiation
 - Must explicitly draw BATNAs into the problem formulation
- Increase information availability of **group** problem
 - Higher awareness of the ‘extra dimension’ of the tradespace
 - Reduce **positional bargaining** / attachment to one-sided solutions

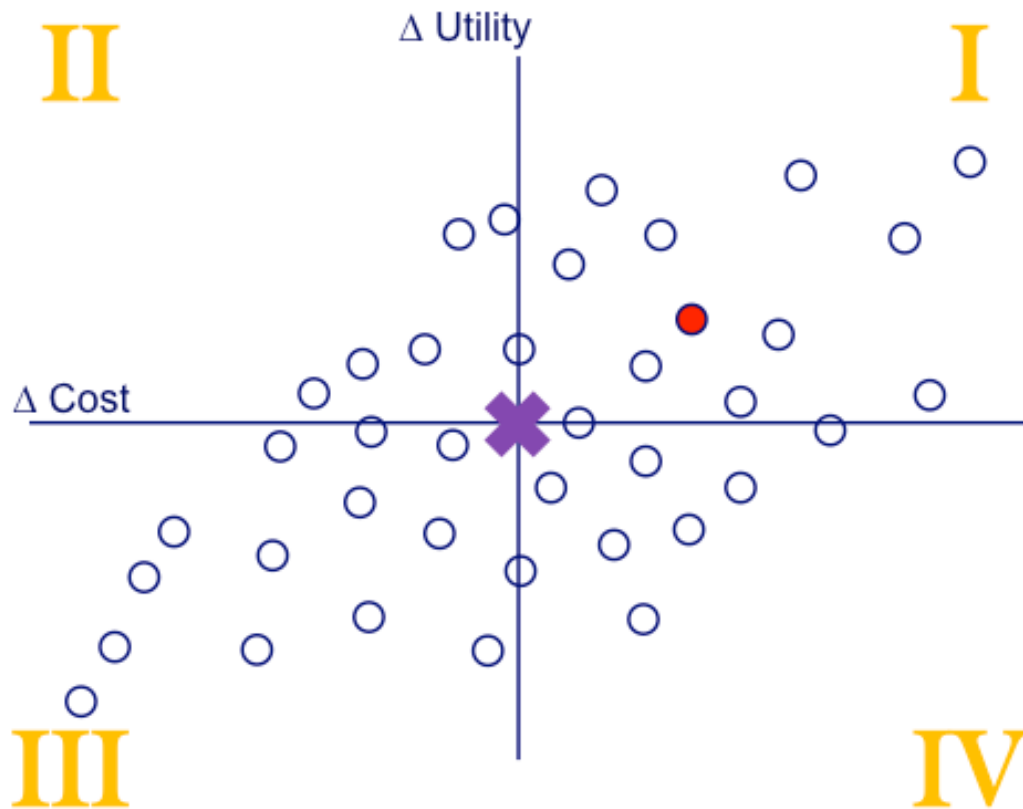
BATNA types

- ‘No solution’
- Backup plan
- Existing system

- Draw attention to BATNA
 - Central location, clearly marked by axes
- Provide reference alternative to Pareto front



- Quadrants have distinct 'categories' appeal

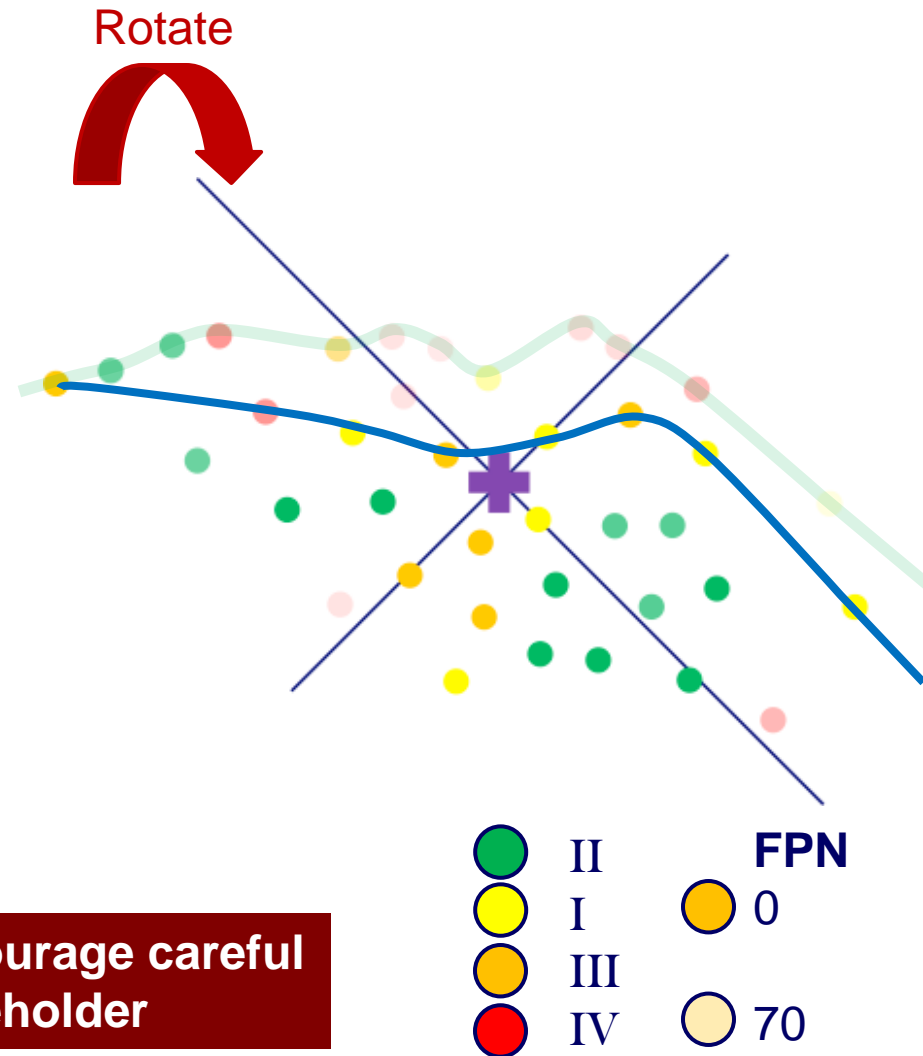


II
Less cost, more utility. Almost certain agreement (pending fairness/equality)

I + III
Cost/utility tradeoffs. Potentially viable/attractive.

IV
More cost, less utility. Almost certain refusal (unless side benefits to partnership are not captured)

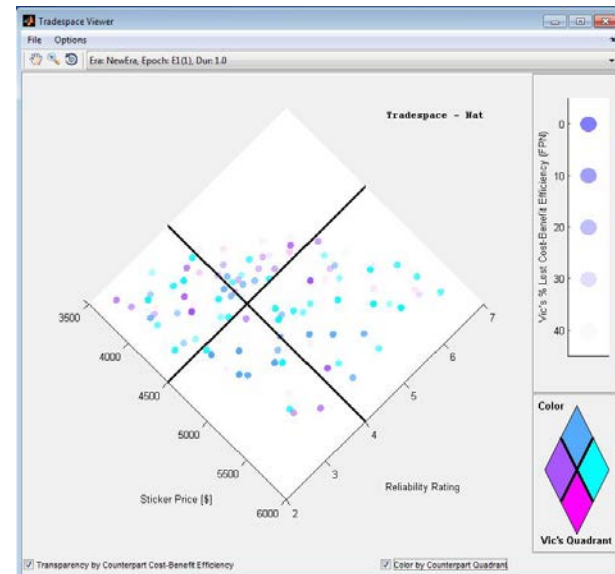
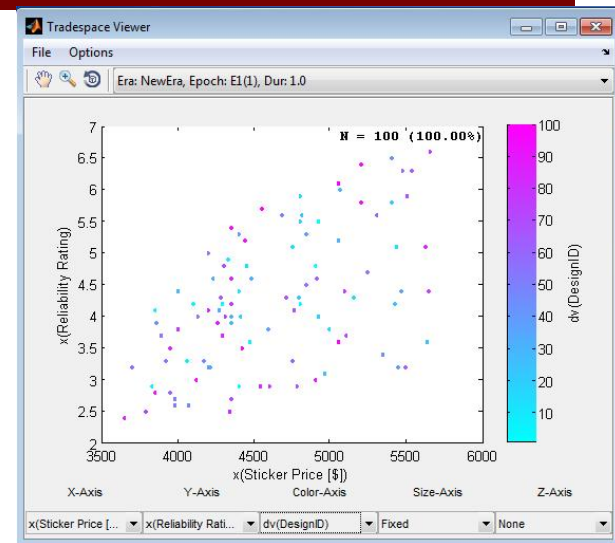
- Rotation
 - Reduce ‘bad habits’, increase systematic thinking
- Color
 - Exploit quadrant categorization to describe counterpart’s BATNA relationship
- Transparency
 - Fade out designs unlikely to be accepted by other party
 - Deemphasize individual anchors (original vs bold Pareto front)



Increase available information and encourage careful consideration of the MULTI-stakeholder

- Two-subject negotiation task: **in recruitment**
 - Using SEArI VisLab software
- Compare indicators between traditional vs. modified tradespace views
 - Comprehension
 - Positive teamwork
 - Speed / Quality of solution

vs.



- Complex, sociotechnical systems must reconcile needs of **multiple decision makers**
- TSE closely follows the foundations of **good negotiation**
- Framing impacts decision making, potentially **hampering the direct application** of TSE techniques to MSTSE
- The standard TSE tradespace can be modified for MSTSE to **theoretically reduce the impact** of individualistic framing and support negotiation goals

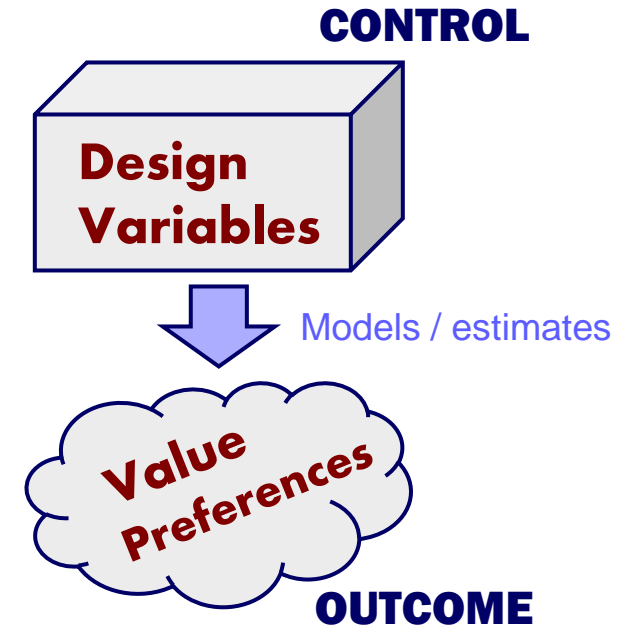
This paper focuses on TSE visualization, but other aspects of the TSE paradigm may detract from MSTSE... until future research finds them!

Thank You!

Questions?

Backup Slides

- Disconnect between design variables and value-creating objectives (control vs. outcome)
 - Traditional negotiation techniques rely on control OF outcome space
 - Complexity can result in loss of situational awareness → risk-aversion prevents agreement

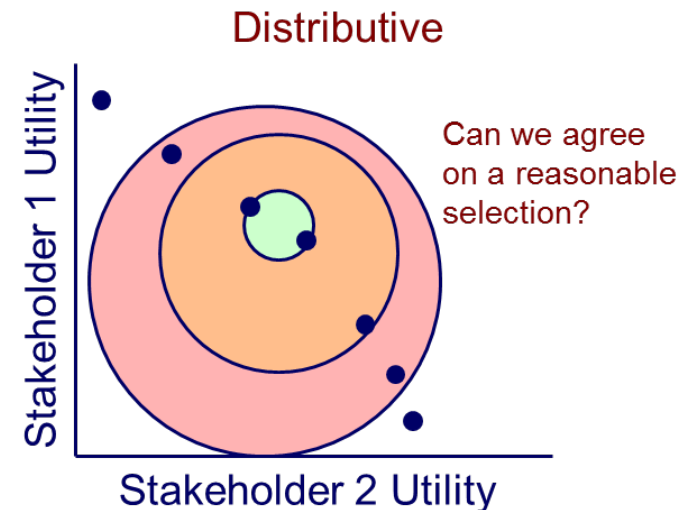


- **Uncertainty** in preference/utility statements
 - Changing of preferences when exposed to new data has been observed in complex problems
 - Utility elicitation is an “art”

- **Design Compromising**

- Selection of a design agreeable to all stakeholders, when no choices are optimal for all
- One or more stakeholders must accept suboptimal value in the name of fostering agreement
- Corollary to *distributive negotiation*, in which participants try to claim value

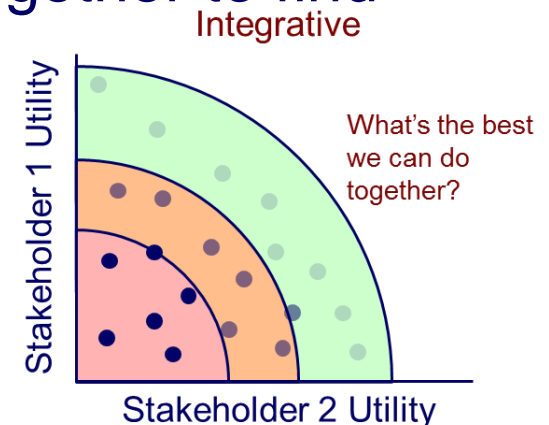
Preemptive claiming typically leads to positional bargaining and losses in total value: can we postpone this action?



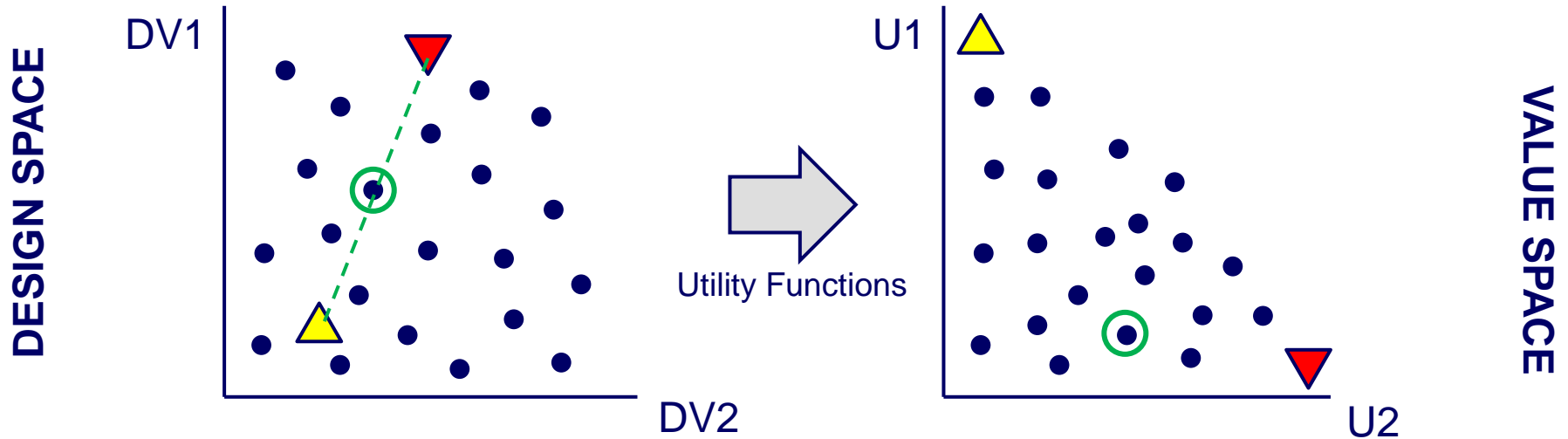
- Preference Compromising

- Modification of expressed utility function in order to promote agreement with other stakeholders
- Not a stretch: stated preferences are observed to change when stakeholders are exposed to additional information
- Corollary of *integrative negotiation*, in which the participants actively seek to work together to find mutual benefit

Mutual value is what makes compromises attractive: can we support this process in order to increase stakeholder satisfaction?



Common Bad Compromises Midpoint



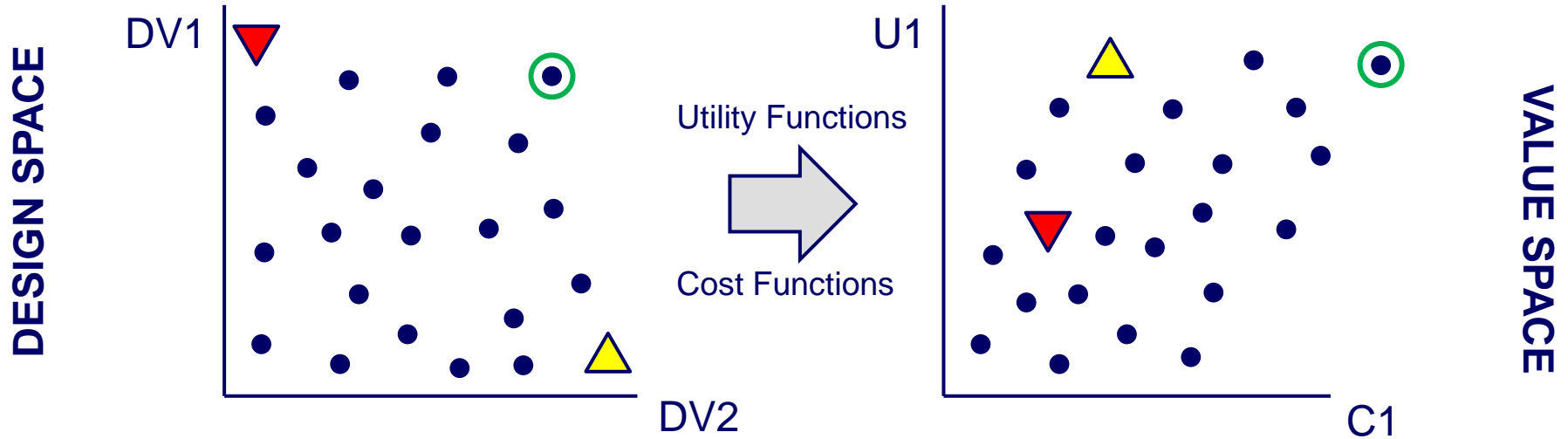
▲ Stakeholder 1's position

▼ Stakeholder 2's position

○ Midpoint solution = in-between selections in design space

**“MIDDLENESS” DOESN'T MAP TO VALUE SPACE
SIGNIFICANT MUTUAL BENEFIT NOT CAPTURED**

Common Bad Compromises Gold Plated



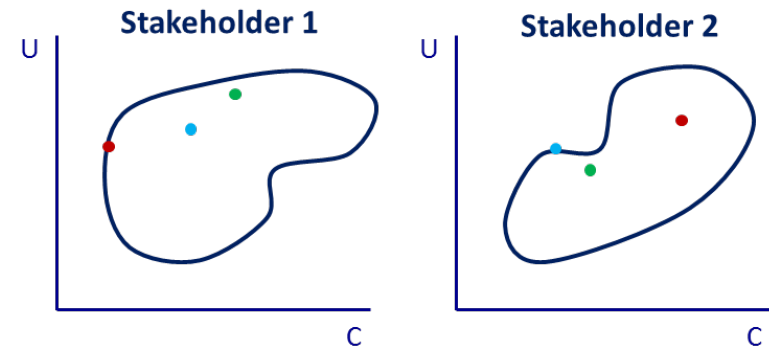
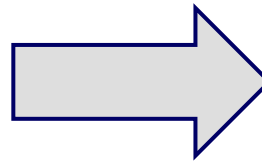
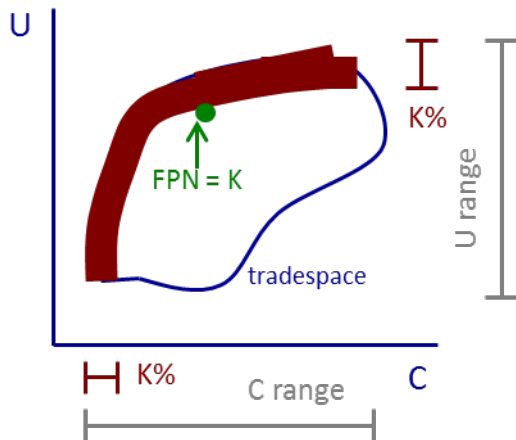
- ▲ Stakeholder 1's position (wants lots of DV2, utility unaffected by DV1)
- ▼ Stakeholder 2's position (wants lots of DV1, utility unaffected by DV2)
- Gold Plated solution = take lots of both DV1 and DV2

**SIGNIFICANT COST ADDED WITH NO GAIN FOR
EITHER STAKEHOLDER**

Tentative Value Metric for Compromise

- Potentially replace utility with Fuzzy Pareto Number (FPN) when bargaining “fairness” to capture cost effects on value
 - Especially useful if costs differ substantially between stakeholder for any given design
 - Set of designs “Pareto efficient in FPN” represent the smallest compromises from cost-efficiency necessary for agreement between stakeholders

FPN = minimum K for a design to be considered fuzzy Pareto optimal in a given epoch



Design	Stakeholder 1 FPN	Stakeholder 2 FPN
RED	0	18
GREEN	3	4
CYAN	10	0