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# Controlling for Framing Effects in Multi-Stakeholder Tradespace Exploration

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**Abstract**

Framing effects have been shown to have dramatic impact on human decision making in many domains, in certain circumstances even driving self-detrimental behavior. Multi-stakeholder tradespace exploration (MSTSE), an emerging technique for advanced multiparty decision making for engineering systems, has displayed many benefits with regards to insight-generation and identification of mutually beneficial solutions. However, for complex problems with no solutions that are individually optimal for each stakeholder, stakeholders may still resist "compromising" from their individual preferred solutions. This occasionally drives a failure to reach agreement, despite a design space with a considerable number of feasible designs with value for all parties. This paper hypothesizes that this result may be caused in part by an unintentional framing of the initial stages of MSTSE as an individual problem, establishing an unrealistically high reference point. Theoretically, this locks stakeholders into a mindset that forces them to "compromise" down, rather than more appropriately building up mutual value from the "no agreement" alternative. This paper addresses the current literature of multi-stakeholder system design, the ramifications of framing on MSTSE, considerations for establishing a more appropriate reference point, and example techniques and visual representations for doing so. A preliminary set of experiments is described to confirm the hypothesized framing effect and to validate visual representations for mitigating its impact.



*Keywords: tradespace exploration, multi-stakeholder, multiple stakeholders, framing effects, negotiation*

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**Nomenclature**

| | |
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| TSE | tradespace exploration |
| MSTSE | multi-stakeholder tradespace exploration |
| Stakeholder | a person/group with a defined interest in a given system |
| Decision maker | a stakeholder with non-negligible control over the system design process and outcome |

## 1. Introduction

As a paradigm for solving complex design problems, the majority of research in tradespace exploration (TSE) has focused on the analysis of the space of alternatives with the goal of uncovering design choices that are optimal or near-optimal[1,2]. These designs feature desirable combinations of attributes for a given system stakeholder, including technical attributes, cost, and, more recently, -ilities[3]. Less tradespace research has been devoted to the multi-stakeholder problem, in which there are multiple parties with different desired attributes of performance, who must agree on a single design selection in order to proceed with development. Many standard value-measuring techniques, such as utility theory, operate on individuals only and have been shown to break down when used to combine the preferences of groups[4]. Often, practitioners have taken to ignoring these results, optimizing some function of each stakeholder's utility, or simply selecting a baseline and allowing iterative design improvements only if they benefit every stakeholder individually[5,6]. These techniques, though fast and sometimes effective, run counter to the goal of *exploration* by looking at only a subset of possible designs, limiting the potential for improving stakeholders' understanding of the problem, and increasing the possibility that a superior mutually desirable design is overlooked or not evaluated. Because of these limitations, multi-stakeholder tradespace exploration (MSTSE) has largely relied on the best practices for *individual* tradespace exploration, with all stakeholders using those methods in parallel[7]. This parallel exploration has the goal of uncovering as many alternatives as possible, empowering stakeholders to make an educated decision on how best to negotiate with their counterparts. The group decision problem, however, is not just a series of individual decisions and must incorporate interpersonal dynamics and psychological considerations of what makes a "good" decision and what constitutes a "fair" solution. In order to further improve the likelihood of discovering superior compromise solutions, MSTSE should move beyond parallel individual exploration and incorporate lessons from the behavioral economics and negotiation literature.

Framing effects have been shown to have dramatic impact on human decision making, with even subtle differences in framing resulting in surprising variation of outcome[8]. The current practice of MSTSE as a combination of individual exercises frames the problem for each participant *first* as an individual and *second* as a group. According to Prospect Theory, humans make decisions with regard to a reference point (often influenced by framing) and are strongly negative about decisions that result in outcomes below that reference ("losses"), more so than they are positive about results above the reference ("gains")[8]. By encouraging stakeholders to spend time on the problem individually, their reference point is reinforced at a high level, essentially centering the mind of each stakeholder on the question: "how much value could I get if everyone else had to agree with me?" For most complex problems, realistic compromises will be significantly below this reference point and thus appear as unappealing "losses," possibly blocking the acceptance of a mutually beneficial solution that could otherwise be agreed upon. Framing the multi-stakeholder problem as a *group* exercise from the start has the potential to establish a more appropriate reference point at the beginning of the exploration, and make a larger set of potential designs within the tradespace visible as "gains" that all parties might agree to develop.

This paper conducts a review of common practices for system design with multiple stakeholders and discusses their relevance and appropriateness for use with tradespace exploration. Then the ramifications of standard, individual-focused tradespace exploration techniques on the framing of the group decision problem are described. Discussion focuses on the creation of a more productive framing for MSTSE. Additionally, example techniques and visual representations designed to reinforce a group-focused reference point over the individual are presented.