Leadership and the Dynamics of Inter-organizational Communication and Development

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Abstract

The development of large software-intensive space systems requires working across functions, disciplines, organizations, and even societal sectors. Space program stakeholders may include civilian and military governmental agencies as well as commercial and nonprofit organizations, and the program office must consider these in scoping, funding, development, and deployment decisions. The social and political challenges of inter-organizational work are further complicated by technical challenges. By their nature, research-to-order and very-large-scale engineer-to-order systems necessitate doing what has not been done before. Development managers of these programs must make decisions in the face of both uncertainty and novelty; in other words, not only is much unknown at the outset, but also much is *unknowable* at program initiation.

Little in management and leadership theory or practice prepares us to work across such socially and technically challenging boundaries. Traditional themes in management and leadership, such as the following, fall short in these situations:

- leading by expertise (very large space programs require more kinds of expertise than one person or group can master or comprehend);
- leading by tenure (technology innovations obsolete many kinds of technical experience);
- leading by authoritative position (no one person has authority over all constituents);
- leading by vision (no one person or group can see enough, in sufficient dimensions, and over an adequately long time horizon);

In itself, each organization participating in large space system development is hierarchical, and the policies, cultures, and forms of each organization teach us very little about how to manage, without authority, across organizational lines.

The question central to this research, therefore, is: How can we manage multiple organizations to produce collectively a coherent (yet multi-use) deliverable on time and on budget, when much is unknowable at the outset? Building on a case study of "disconnects" among baselines in a large system-of-systems software-intensive space program, we look at the dynamics—the "physics"—of inter-organizational communications over a multi-year time horizon. Disconnects, latent differences in understanding that can negatively affect the program should they remain undetected or unresolved, can jeopardize program targets for cost, schedule, performance, and quality. Using a grounded theory-building approach with the case data, we

constructed and analyzed a formal dynamic model of communication effectiveness across four organizations that sequentially and iteratively rely on each other for requirements and deliverables. Simulation analyses have disconfirmed some common beliefs about the sources of disconnects (e.g., from external requirements changes, or from slow decision-making by government entities). Analyses to date suggest that the highest points of leverage in reducing disconnects—and therefore mitigating program risks—lie in increasing expertise levels, improving communication clarity, and accelerating the pace of assessing the impacts of changes in partner organizations' understandings and actions, but *not* accelerating the pace of *acting* on those assessments.

Identifying points of leverage in the model-world is helpful, but identifying specific ways to act on these points of leverage requires additional insight, particularly in the face of 1) policies and market dynamics that prevent organizations from developing or retaining high-expertise personnel, 2) challenges in communicating technical trade-offs that also affect funding, schedule, and personnel requirements, and 3) difficulties in assessing quickly the implications of program changes. We therefore turn to program management practices and sociological and psychological research on distributed cognition and "boundary objects" (concrete objects used to communicate and transform understanding across differences in expertise, organizational norms, and time frames). We integrate elements from these fields to develop recommendations on how to raise expertise, increase clarity of cross-organizational communication, and accelerate the pace of organizational sense-making. Our goal is to articulate actionable ways that managers can facilitate the development of intellectual capital focused on a specific output, without having control of the entire scope of the program, and without knowing what is unknowable at the program outset.

Toward this end, we also offer a nascent theory of how, and why, to build better boundary objects. Managers of multi-use space system development programs must facilitate ongoing research that produces intellectual capital and also yields tangible outcomes on a schedule. This kind of program management differs significantly from managing the development of tangible or semi-tangible (such as software) products because the goal(s) of the program may not remain constant, the means to achieve the goal(s) are more ambiguous due to cross-organizational dependencies, and the quality of work-in-process is more difficult to assess. Helping others articulate, and then assess, the consequences of decisions affecting multiple program dimensions (e.g., cost, schedule, performance, quality, and constituency), while accounting for and addressing consequences distant in space and time, becomes central to managing and leading. Building better boundary objects is a critical first step in constructing the capability to collaboratively generate, across organizations, solutions to emergent problems. Viewing leaders in this context as facilitators of conversations on complex trade-offs in face of ambiguity, this research articulates a preliminary method for generating solutions amid socially and technically complex processes of multiple organizations.