

Getting Contractors to Cooperate

A Game-Theoretic Approach to Optimizing Acquisition Behaviors

Misaligned incentives between contractors and the PMO produce ineffective cooperation, causing wasted effort, lost time, and poor results. Using game theory to frame these situations, and agent-based modelling to quantify them, we can design incentive mechanisms to promote cooperation and improve results.

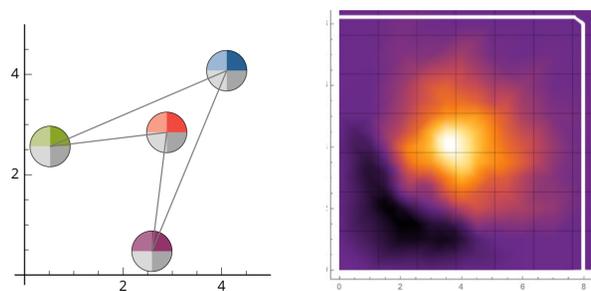


Figure 1: Animating effects of varying moral hazard incentives shows how to drive behaviors toward goals.

Theory: Principals, Agents, & Moral Hazard

Acquisition is a “Principal-Agent” problem where an expert “agent” (i.e., contractor) works for the “principal” (i.e., government PMO). Since the agent has better information than the principal, and their interests conflict, the exchange often goes awry. The government can’t always verify contractor claims, so contractors may be deceptive, and quality vendors may not get the price they deserve. A contractor may even take on excessive risk because the government bears the costs—that’s called “moral hazard” (see Figure 1).

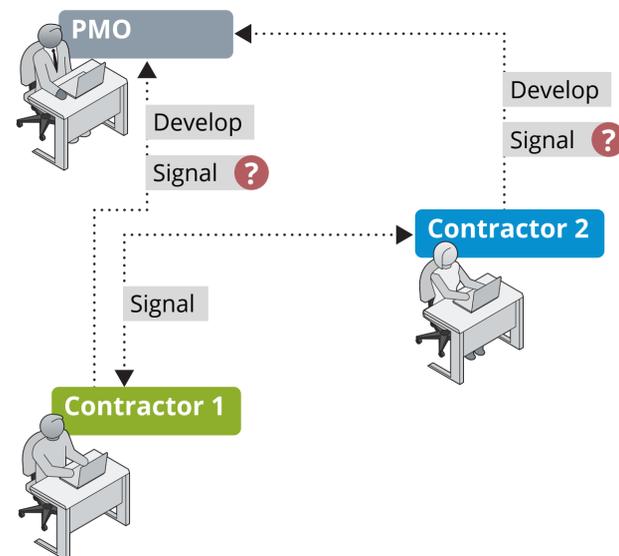


Figure 2: Contractors’ incentives may make them uncooperative, while claiming to help the program.

Poor Contractor Cooperation with GATI

Despite “Government As The Integrator” (GATI) becoming more widespread, PMOs are still learning how to do GATI. Without a Lead Systems Integrator (LSI) leading a consortium, independent contractors have little incentive to share data and support other contractors, causing delays, overruns, and poor performance—all while denying such actions to the PMO to avoid penalty (see Figure 2).



Figure 3: Three types of incentive mechanisms can appeal to three levels of the contractor organization.

Incentive Mechanism Solutions

Custom incentive mechanisms can align contractor incentives, so contractors serving their interests also serve program interests. Multiple incentives used together maximizes results, reaching multiple organizational levels (see Figure 3).

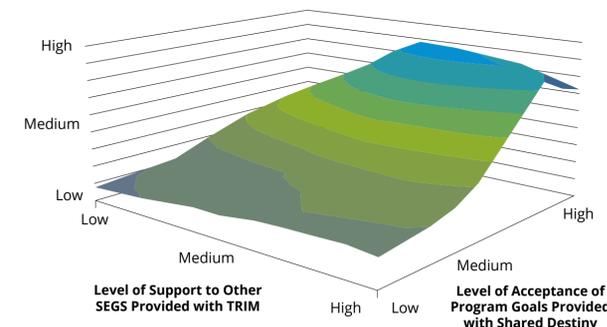


Figure 4: The effect of pair-wise combinations of incentive types on program performance

Modelling & Simulating Program Behavior

By analyzing GATI contractor incentives using game theory, we can characterize the likely contractor and PMO moves and counter-moves. Modelling can then quantify the outcomes of the game, to see which incentives best promote cooperation (see Figure 4).

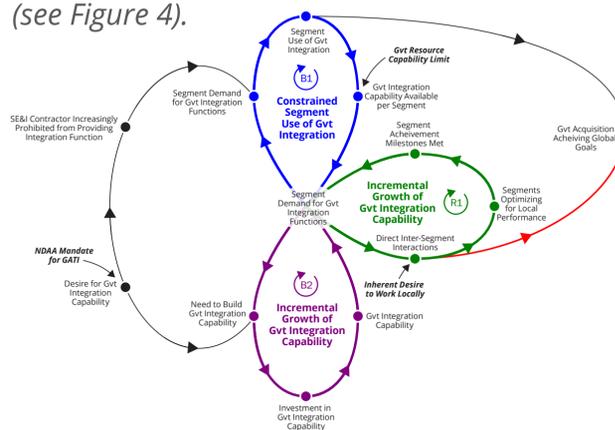


Figure 5: Growing demand for government integration is frustrated by limited resources, driving segment-level integration to meet local goals, undermining program success.

A Real-World Program with GATI Issues

As one program moved from LSI to GATI, the PMO wasn’t ready to do system integration (SI). The SI contractor lost its duties, but the government was slow to grow its own SI. The segments became impatient with the poor PMO SI support and turned to their fellow segments to do the SI work. Without central SI the segments made tactical decisions that didn’t consider the global good of the program (see Figure 5).

Empirical Validation & Piloting Incentives

Remaining FY17 Work: Interview USAF program staff to gather empirical data.

Future Work: Pilot the most promising mechanisms in a real-world acquisition program and measure the results.

Preliminary High-Level Research Results

Incentive fees (e.g., TRIM) focus contractors program work, but a mix of types of incentives is needed to be effective across different kinds of contractor organizations.

Incentivizing contractors to meet cost/schedule goals can subvert other incentives promoting cooperation, thus sacrificing program goals.

Incentives are “weapons” in an ongoing “war” that must evolve and be replaced. Evolutionary Game Theory models competition in a population of acquisition programs to evolve and adapt incentives over time to keep them effective.

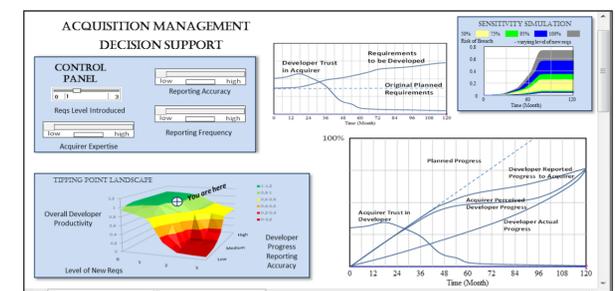


Figure 6: A notional concept of what a modeling/simulation workbench could look like

Future Engagement Model for Programs

This approach can solve many incentive problems that plague acquisition performance. We envision a virtual Acquisition Modelling Laboratory (vAML) service, based on game-theory and modeling/simulation, that helps DoD acquisition programs mitigate such problems and improve program outcomes (see Figure 6).

Copyright 2017 Carnegie Mellon University. All Rights Reserved.

This material is based upon work funded and supported by the Department of Defense under Contract No. FA8702-15-D-0002 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center.

The view, opinions, and/or findings contained in this material are those of the author(s) and should not be construed as an official Government position, policy, or decision, unless designated by other documentation.

NO WARRANTY. THIS CARNEGIE MELLON UNIVERSITY AND SOFTWARE ENGINEERING INSTITUTE MATERIAL IS FURNISHED ON AN "AS-IS" BASIS. CARNEGIE MELLON UNIVERSITY MAKES NO WARRANTIES OF ANY KIND, EITHER EXPRESSED OR IMPLIED, AS TO ANY MATTER INCLUDING, BUT NOT LIMITED TO, WARRANTY OF FITNESS FOR PURPOSE OR MERCHANTABILITY, EXCLUSIVITY, OR RESULTS OBTAINED FROM USE OF THE MATERIAL. CARNEGIE MELLON UNIVERSITY DOES NOT MAKE ANY WARRANTY OF ANY KIND WITH RESPECT TO FREEDOM FROM PATENT, TRADEMARK, OR COPYRIGHT INFRINGEMENT.

[DISTRIBUTION STATEMENT A] This material has been approved for public release and unlimited distribution. Please see Copyright notice for non-US Government use and distribution.

Internal use:* Permission to reproduce this material and to prepare derivative works from this material for internal use is granted, provided the copyright and "No Warranty" statements are included with all reproductions and derivative works.

External use:* This material may be reproduced in its entirety, without modification, and freely distributed in written or electronic form without requesting formal permission. Permission is required for any other external and/or commercial use. Requests for permission should be directed to the Software Engineering Institute at permission@sei.cmu.edu.

* These restrictions do not apply to U.S. government entities.

Carnegie Mellon® is registered in the U.S. Patent and Trademark Office by Carnegie Mellon University.

DM17-0734

Getting Contractors to Cooperate: A Game-Theoretic Approach to Optimizing Acquisition Behaviors