

SDM tools serve US Air Force integration project

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Editor's note: This is the second in a series of articles by SDM alumnus Luke Cropsey, who is integrating knowledge from various MIT resources and transferring it to his employer, the US Air Force. This article expands on the use of several tools introduced in Cropsey's first article, which appeared in the fall 2008 edition of the SDM Pulse, available online at sdm.mit.edu.

Albert Einstein said, "The problems that exist in the world today cannot be solved by the level of thinking that created them"—and this is especially true in the design and implementation of complex socio-technical systems. The problems that emerge in bringing order out of complexity result from interactions that are already so entwined that simply understanding the problems' nature can be exceedingly difficult.

Addressing issues at a level deep enough to find solutions is even more challenging.

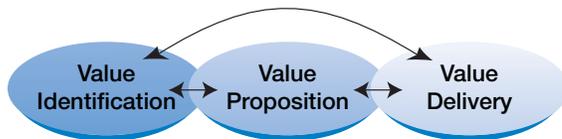


Figure 1. Value-creation framework.

Several tools taught in the SDM program have proved useful in controlling complexity and bringing analytical rigor to analyses, making it possible to work toward the solution of complex challenges with a high degree of confidence. In this article, I will examine two tools useful for aligning an enterprise to tackle complex problems: the enterprise purpose statement and the X matrix.

In Part 1 of this series, I explained that I am working on the integration of unmanned aircraft systems (UAS) into the National Airspace System. The overarching methodology I used to examine this problem was the value-creation framework developed by E. Murman et al. in *Lean Enterprise Value*, depicted in Figure 1. A key element in this approach is aligning value among enterprise stakeholders, which is especially challenging in situations where critical stakeholders appear to have value definitions that are at odds with each other.

In such situations, a structured approach to aligning value definitions is essential to creating lasting value. Figure 2 graphically illustrates that any solution must take into account both the stakeholders that are hierarchically above and below the activity under discussion (this is the vertical value alignment), as well as the needs of the multiple stakeholders that are involved across the scope of the enterprise (the horizontal value alignment).

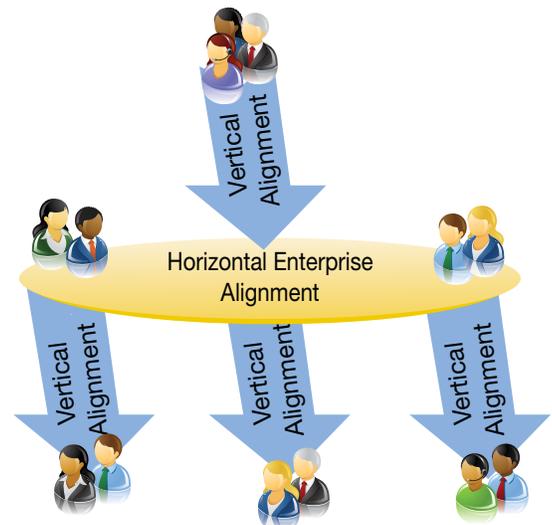


Figure 2. Vertical and horizontal value alignment.

Vertical alignment ensures that the project produces the required results, enabling those further down in the chain of command to work effectively and efficiently toward the organization's top objectives. Vertical value alignment is achieved using the enterprise context structure adapted from Professor Edward F. Crawley's system architecting playbook.

Horizontal value alignment keeps the project itself on track, integrating the needs of the numerous elements within the organization that have a stake in the project. The objective is to align the needs of all the stakeholders so that value flows through the entire extended enterprise.

Graphically depicting the UAS airspace integration effort as initially conceived (Figure 3), illustrates the problems of misalignment. First, the enterprise purpose (labeled "origin goal") does not fundamentally address the needs of the Federal Aviation Administration (FAA). (Note that "restore principle of maneuver,"¹ a higher level consideration in military doctrine, is outside the boundary of the enterprise because initially the UAS Airspace Integration Enterprise did not consider this to be part of their purpose.) Second, while training and operating UAS in the desired fashion certainly contributes to the broader upstream objective of "global strike," the overall intent is

¹ The "principle of maneuver" is a higher level objective of the military—one of nine "principles of war," outlined in U.S. military doctrine. The principle of maneuver calls for placing the enemy in a position of disadvantage through the flexible application of combat power.

not adequately captured. “Training and operating” better describe the activities required for global strike capability. Significantly, what is missing is the fundamental capability that will fully satisfy both the FAA and the Department of Defense (DoD) value needs.

Creating a more useful enterprise purpose statement, by expanding the objective to “restore maneuver” as depicted in Figure 4, allows both the FAA (safety needs) and the DoD (war fighting capability needs) upstream values to be explicitly addressed and linked to a common purpose.

Figure 4 shows the same project with all the stakeholders’ objectives aligned. Expanding the enterprise objective beyond “train and operate” to “restore principle of maneuver” and moving that objective to the center of the enterprise meets both DoD and FAA upstream value needs, while providing clear connectivity to the downstream tasks that will further these goals. In addition, while “train and operate” weighted the enterprise toward DoD needs, moving to the higher-level goal of “restore principle of maneuver” adjusts the focus of the enterprise to balance the needs of both primary stakeholders.

The applicability of “restore principle of maneuver” is clear enough in the DoD context, but the value to the FAA may not be as readily apparent. Recall, the undergirding value basis for the FAA is that of flight safety. Creating an enterprise purpose focused on increasing the maneuverability of a UAS contributes directly to meeting the primary value of the FAA—safety. It is perhaps worthwhile to expand on the idea of maneuver in this context, because the concept goes beyond the simple ability to fly, turn, ascend, or descend more quickly, although this is a significant component. More fundamental to the idea of maneuver is the knowledge required to know where you need to be in relation to the things around you (and consequently, avoid flying into them). This relational aspect of maneuver holds the lion’s share of value for the FAA.

Fundamentally, the need to create simultaneous value for key stakeholders in the enterprise is what motivates changes to the enterprise purpose and/or scope. Often, significant analysis may be required to correctly identify enterprise purposes that do not provide a positive value exchange for each key stakeholder. Resolving this misalignment in the enterprise purpose to create the appropriate conditions for positive value delivery to each key stakeholder is the defining criteria for re-scoping the

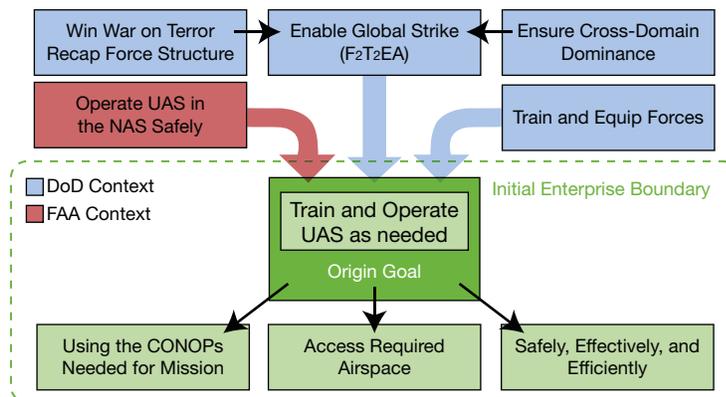


Figure 3. Enterprise context for UAS integration.

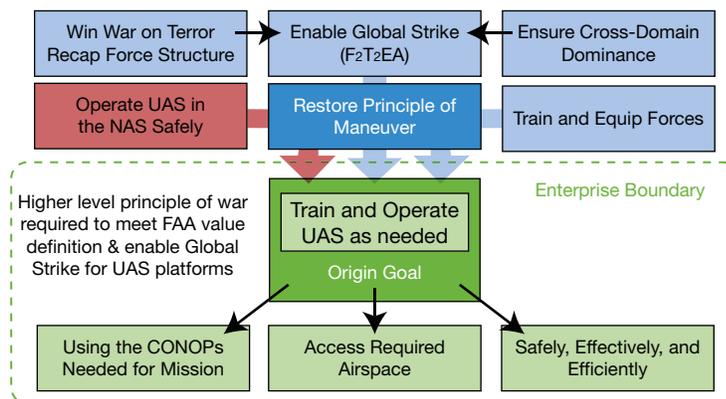


Figure 4. Expanded enterprise objective.

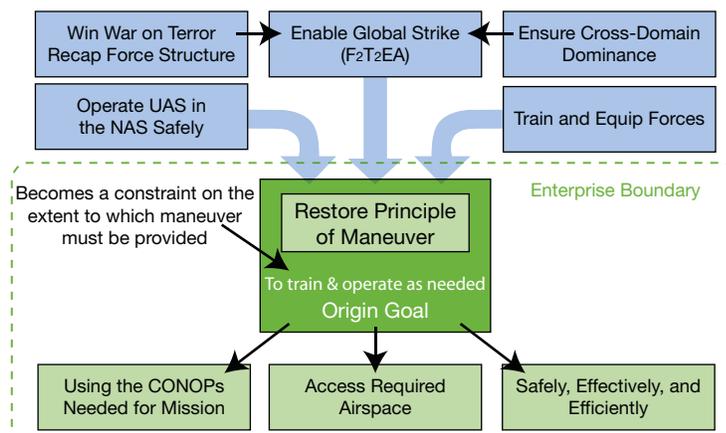


Figure 5. Final UAS airspace integration enterprise context.

SDM tools serve US Air Force project

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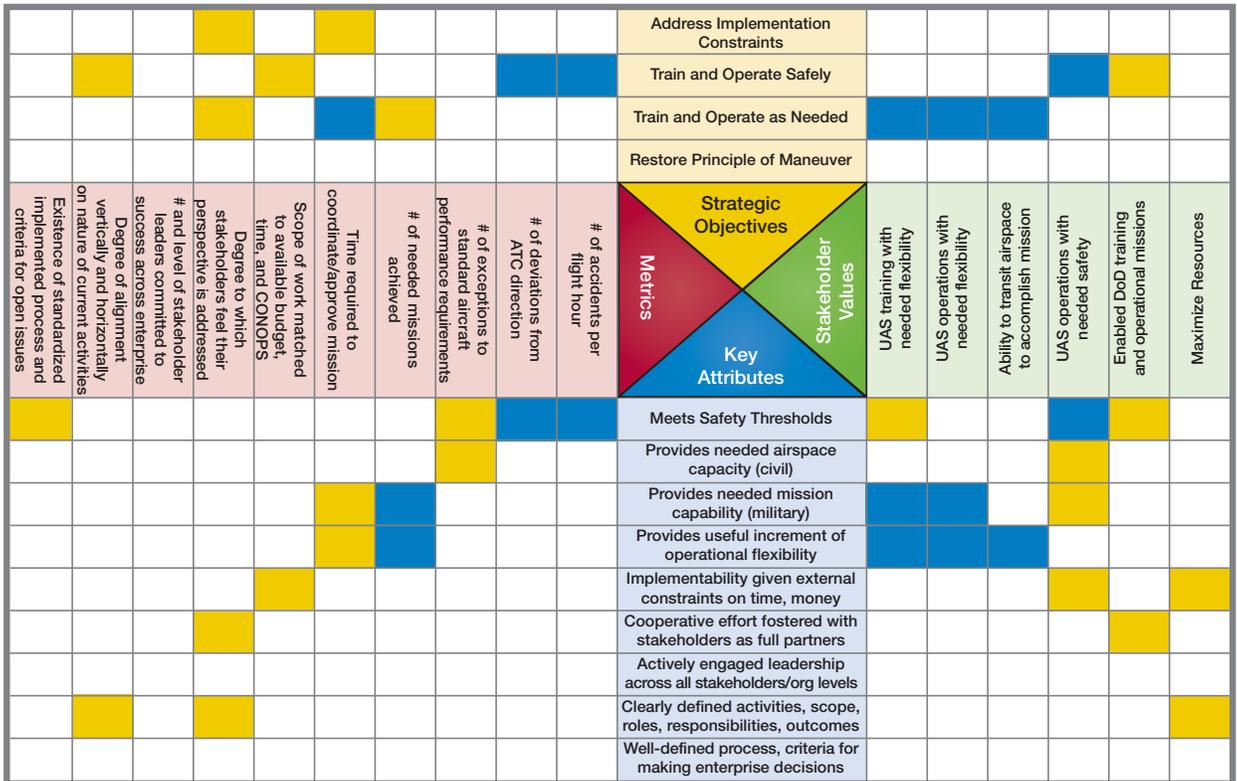


Figure 6. "As-is" X matrix for the UAS airspace integration enterprise.

enterprise purpose and must be doggedly pursued until each key stakeholder is convinced their value proposition has been met. In the case of the UAS airspace integration enterprise, it took a change in purpose from "train and operate" to "restore principle of maneuver" before both the DoD and FAA value propositions could be satisfied. Arriving at an enterprise purpose readily identifiable by all stakeholders as providing intrinsic value to their organization is perhaps the most difficult creative aspect of the enterprise architect's tasks. It requires an in-depth understanding of the enterprise stakeholders and their needs as well as the ability to view the problem each of them desires to have "fixed" from a fundamentally different perspective. Scoping the activity so the objective is broad enough to address all needs of primary stakeholders while keeping the problem solvable at the enterprise level creates a tension that must be maintained using experience and insights gained during the data collection effort.

With the vertical alignment of the enterprise value structure resolved, the focus shifts to the horizontal alignment of activities within the enterprise to ensure effective and efficient execution of the enterprise purpose. The X matrix, developed by Deborah Nightingale and Alexis Stanke of MIT's Lean Advancement Initiative, provides a

quick way to assess alignment of enterprise activities and metrics with enterprise purpose and value states.

Figure 6 depicts the "as-is" UAS airspace integration effort using an adaptation of the X matrix. There are four principal axes:

- *Strategic objectives.* Entries show the enterprise's overarching objectives and describe successful value delivery.
- *Stakeholder values.* Entries in the second axis, moving clockwise from the top, capture the primary value definitions across the enterprise's key stakeholders. The point of intersection between a "strategic objective" and a "stakeholder value" defines the degree of correlation between the two entries. Blue is used to denote a strong degree of correlation; yellow denotes a weak correlation; and a white box indicates no correlation. The colors make the degree of alignment easy to see.
- *Key attributes.* This axis captures what success looks like by describing how the stakeholder recognizes delivery of stakeholder values.
- *Metrics.* These provide a measure of progress

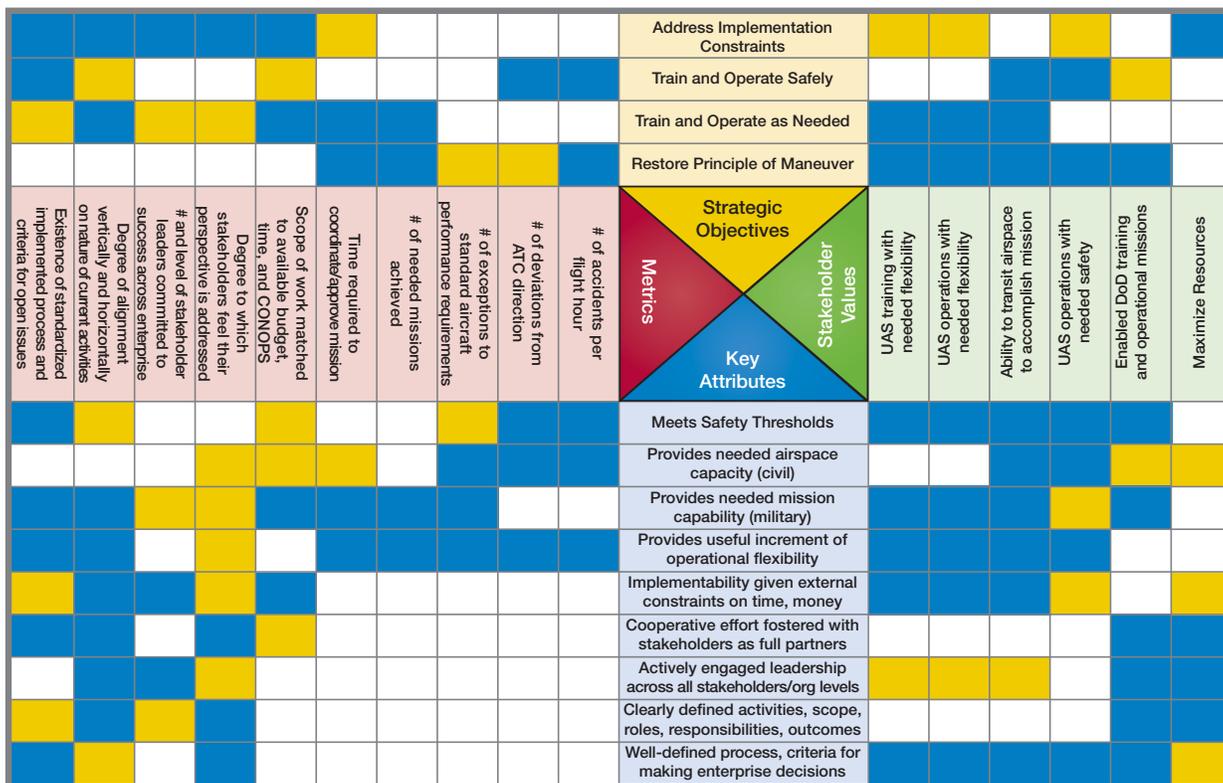


Figure 7. "To-be" X matrix for the UAS airspace integration enterprise.

toward attaining the key attributes and, ultimately, the objectives.

The value of the X matrix lies in the process of laying out each of these four axes consistently and logically, then assessing the degree of correlation between each successive axis. Too often, an analysis of this type reveals significant shortfalls. As Figure 6 shows, the "as-is" state frequently lacks any significant degree of correlation moving clockwise around the X matrix. Here there is only one case where a strong degree of correlation is preserved across all four axes—in the "Train and Operate Safely" strategic objective, which is strongly linked to "UAS operations with needed safety," "Meets Safety Thresholds," and "# of Accidents per Flight Hour." Everywhere else, strong correlation across the enterprise is lacking.

Solid data collection and analysis is the key to constructing a useful X matrix. In Figure 7, the four axes are laid out according to what the data indicates the values should be for the UAS matrix. This "to be" X matrix represents the vision the architect has for the enterprise and the roadmap for the enterprise architecting activity that will follow. In contrast to the "as-is" matrix, every entry on each axis of the "to-be" matrix is strongly correlated to at least one or more entries on the adjacent axes. Even a

cursory comparison between these two X matrices shows where improvements are needed.

A well-built X matrix provides the foundation for future value delivery. The structure of the X matrix forces a deliberate consideration of how the enterprise objectives and values are aligned with attributes and metrics. As obvious as this may seem, the number of organizations that actually employ a rigorous analysis of this type are few and far between. The method presents information in a simple enough format so that even complex enterprises can be taken in at glance. Armed with the insights provided by the X matrix analysis, the enterprise architect's task of synthesizing potential methods for delivering the desired results can be undertaken with a relatively high degree of confidence.

In my next article, I will discuss the use of Object Process Methodology (OPM) for architecting solutions using the information gleaned from the vertical and horizontal value alignment exercises just described.