

The Ultimate Balancing Act – Delivering Improved Customer Value in the Programmatic and Technical Performance of Smaller Satellites and Space Systems

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As the current economic crisis envelops all industries, the aerospace industry, and more specifically, the satellite manufacturing industry, is not immune to the effects of declining profits and highly competitive markets. Now more than ever, civil, defense, and commercial space customers purchasing satellites (buses and subsystems) are more acutely aware of how the value proposition of higher quality, reliability, and performance directly affects the success of their programs. To address this issue, this paper investigates the importance to program managers and technical staff, of the need for a more dynamic value engineering approach to smaller satellite and space systems development programs. A description of this new approach highlights how and why the delivery of more value in small satellite programs is important to a growing number of space customers and end-users. This paper illustrates this new approach by utilizing examples of simpler and more realistic methods for determining value models. This discussion addresses both the growing demands and expectations of customers for substantially higher returns on their investments, and identifies and measures the higher value technical and business management processes that lead to the successful delivery of increased product value to the customer. Finally, this paper concludes by summarizing the key findings as they relate to how organizations can successfully improve the value proposition of their smaller satellite and space systems development programs for the benefit of their key stakeholders, customers, and end-users.

Nomenclature

<i>V</i>	=	value performance
<i>VIM</i>	=	value improvement methodology
<i>VP</i>	=	value proposition
<i>Q1</i>	=	quality – technical parameters
<i>Q2</i>	=	quality – program performance
<i>P1</i>	=	performance – technical parameters
<i>P2</i>	=	performance (overall) – program performance
<i>R1</i>	=	reliability – technical parameters
<i>R2</i>	=	reliability – program performance
<i>T1</i>	=	capability – technical parameters
<i>T2</i>	=	compatibility – technical parameters
<i>T3</i>	=	capacity – technical parameters
<i>C2</i>	=	cost – program performance
<i>S2</i>	=	schedule – program performance
<i>R</i>	=	risk – program performance
<i>IV</i>	=	improved value
<i>IV1</i>	=	improved value – technical parameters
<i>IV2</i>	=	improved value – program performance
<i>VE</i>	=	value element
<i>VG</i>	=	value group
<i>VE1</i>	=	value element (placeholder) – technical parameters
<i>VE2</i>	=	value element (placeholder) – program performance
<i>E1</i>	=	value group element (placeholder)
<i>E2</i>	=	value group element (placeholder)

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<i>E3</i>	= value group element (placeholder)
<i>TP</i>	= technical performance
<i>PP</i>	= program performance
<i>VG1</i>	= value group one – technical parameters
<i>VG2</i>	= value group two – program performance
<i>VPpp</i>	= value proposition – program performance
<i>VPtp</i>	= value proposition – technical parameters
<i>EV</i>	= element value
TRL	= technology readiness level

I. Introduction

As smaller satellites and space systems become more suitable acquisition program choices, program managers and technical staff developing new programs are faced with the ultimate balancing act of delivering improved customer value by optimizing both the technical parameters (capability, capacity, compatibility) and programmatic performance (cost, schedule, risk) that delivers the optimal value to the customers (program managers, operators and end-users). Generally, as the project proceeds, program managers should initially assess and constantly measure their customers’ reasonable expectations for return on investment (value (cost)), which includes how they perceive quality, what level of reliability is expected, and given a predefined set of mission objectives, what level of value performance (*V*) defines mission success. These important measurement elements define successful value improvements and are integral measurements of a balanced (weighing technical capabilities versus programmatic performance) value analysis process that identifies areas of improved value. SAVE International, a national value engineering society, states that the applicability of value processes are important when [1]: “Value methodologies can be applied during any stage of a project’s development cycle, although the greatest benefit and resource savings are typically achieved early in development during the conceptual stages.” Therefore, the application of more dynamic value engineering, utilizing a balanced value-centric approach, by programmatic and technical managers is essential to program success. A more dynamic value engineering approach embraces a value proposition that changes the ways in which an organization actively pursues the efficient utilization of its resources to deliver improvements in value to its customers. The value-centric decision process that addresses how an organization will balance its approach to delivering improved customer value must incorporate the development of a set of dynamic value elements within the value proposition that ultimately creates the baseline measurement milestones used to identify improved value areas as the program develops and matures. There are three key value elements in the value proposition proposed here; they are quality, reliability, and performance. These key value elements are integral to balancing a robust value analysis process, identifying critical areas of value improvement, in both technical capabilities and programmatic performance of smaller satellites and space systems.

II. Value Improvement Methodology

From a program management perspective, a value driven (or value-centric) program equates to greater programmatic and technical performance returns for the resources invested in the acquisition, development, launch, and mission operations activities. In order to justify a programs’ overall effectiveness, in today’s budgetary and economically constrained environment, to both program management and more importantly to the customer, a more dramatic improvement in value must be demonstrated (identified and applied) in order to win approvals. Program management can apply this value decision process (value improvement model) to more clearly identify and assess potential areas of value improvement in specific areas of the program thus allowing for the more efficient channeling of the appropriate resources to areas that can deliver the desired improved value to the program and customer. Therefore, this proposed value improvement methodology may be useful as a decision-making tool in preliminary trade studies for feasibility and design approvals before the acquisition (development) process begins.

The value improvement methodology (*VIM*) proposed here (Fig. 1) is a value decision process comprised of a baseline value proposition (*VP*) and its value elements (*Q1, Q2, P1, P2, R1, and R2*) aligned to the two value groups (technical parameters and program performance). These VP elements are in-turn aligned with the technical parameters value elements (*T1, T2, T3*) and program performance (*C2, S2, R*) value elements, resulting in an average of both value areas (*IV1, IV2*), expressed as a percentage, which

then can be measured, in contrast, with a value improvement scale (Low, Medium, High). The resulting improved value (*IV*) for both value groups identifies how the two are in or out of balance. The improved value (*IV*) correlates directly to the degree of improved value represented by the “IV Score”. It is important to note here that the VE inputs are scalable which permits dynamically modeled results in which program managers have a wide latitude in which to model their resources to specific programmatic or technical areas of value improvement.

For reference, the methodology chart hierarchy (value performance, resource allocation, and improved value are denoted by broken lines) should be noted here, as a reference for program managers and technical managers to understand, the logical flow of the various factors that comprise the value improvement methodology.

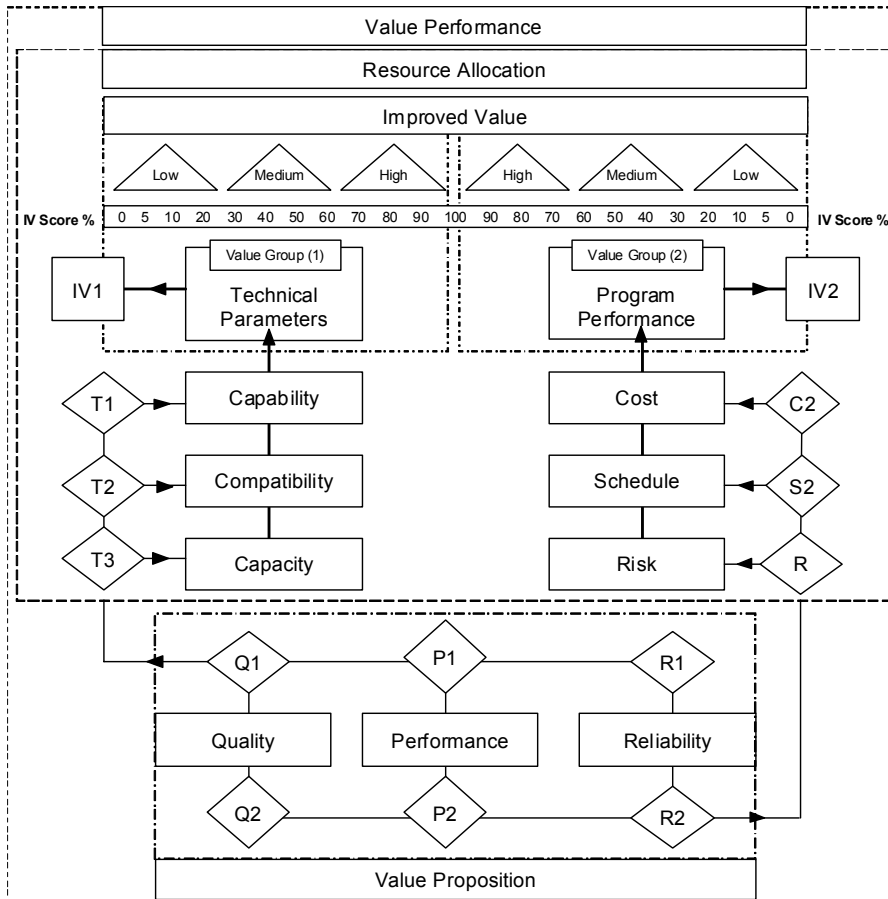


Figure 1. Value Improvement Model

III. Value Element Considerations

In order to set baseline considerations of the key value inputs described in the value improvement model (*VIM*) Fig. (1), a brief list of value components for each of the value elements which serves as a guide to identify key value characteristics that are important to program management and customers, as necessary in the formulation of value element inputs. Influencing factors, that may change some of the value components list, might include resource constraints, program technical and management limitations, and customer expectations. Key value input considerations are:

- A. **Technical Parameters** (hardware)
 - 1) Capability (*T1*) – TRL, longevity, resilience, and integrity
 - 2) Compatibility (*T2*) – launch, sub systems, and interfaces

- 3) Capacity ($T3$) – lifetime, data throughput, and redundancy
- B. Program Performance** (administrative and financial)
- 1) Cost ($C2$) – estimates, controls, and efficiencies
 - 2) Schedule ($S2$) – delays, milestones, and integrity (modifications/changes)
 - 3) Risk (R) – tolerance, avoidance, and monitoring
- C. Value Proposition** (technical and programmatic)
- 1) Quality ($Q1, Q2$) – monitoring, controls, and assurance (general)
 - 2) Performance ($P1, P2$) – benchmarks, results, and rewards
 - 3) Reliability ($R1, R2$) – acceptance, measurement, and analysis

It is important to note here that great care should be taken when considering value inputs (all value inputs), most importantly for capability (technical parameters) and cost (program performance) as they relate to technology maturity and schedule risk. Dubos [1] states that “The lack of technology maturity (or low TRL, sometimes described in the literature as technology uncertainty) is often associated with schedule risk, albeit qualitatively.” Resource allocation decisions and approvals are important considerations within a project that is under development.

IV. Modeling Value Improvement

In order to apply the value improvement methodology to the problem of measuring the balance between technical parameters and program performance, program managers can use the following value model to identify where to apply the necessary resources to achieve a balanced resource allocation for value improvement. Thus, this approach to modeling value improvement best illustrates where the delivery of resources are necessary to improve value for the key stakeholders (program and customers) as it relates to the value proposition (VP).

The value improvement model represented in this paper, Eq. (1) and Eq. (2), introduces two equations that generically express the calculations required to find improved value (IV). The definition of the value element (VE) equation Eq. (1) is a simple average where the element inputs ($E1, E2, \text{ and } E3$) from each of the two value groups (VG), technical parameters (TP) and programmatic performance (PP), and the resultant calculation is a percentage. The definition of the improved value (IV) equation is Eq. (2) as a simple average of the inputs where the value group element results ($VE1, VE2$) and the resultant calculation is a percentage. The calculation results of improved value (IV) are then compared to the value performance chart (IV Score %). This then results in a readily identifiable method of pinpointing where the balance between the two value groups (VG), technical parameters (TP) and program performance (PP) resides:

Where the *value element* equation

$$VE = \frac{(E1 + E2 + E3)}{3} * 100 \tag{1}$$

Where the *improved value* equation

$$IV = \frac{(VE1 + VE2)}{2} \tag{2}$$

To better illustrate the application of the generic equations previously discussed, the following set of equations are presented which best represents the process by which the value improvement model is expressed in quantitative form as each of the equations illustrated here are executed in correlation with Fig. 1. (Bottom to top) the improved value methodology. Several assumptions are important to note here; input value input ranges are .0 to .9, value element inputs should not be > .9 or < .0, and negative results are not valid in the VIM . The higher the value input the greater the weight to balance improved value.

Determine the value proposition (*VP*) inputs and calculate the element value (*EV*) Eq. (3) and (4) for value group one and value group two (*VG1*, *VG2*) technical parameters (*TP*) and program performance (*PP*), I define as:

$$VP_{tp} = \frac{(Q1 + P1 + R1)}{3} * 100 \quad (3)$$

$$VP_{pp} = \frac{(Q2 + P2 + R2)}{3} * 100 \quad (4)$$

where in Eq. (3) *VP_{tp}* is value proposition technical parameters, *Q1* is quality, *P1* is performance, and *R1* is reliability, and where in Eq. (4) *VP_{pp}* is value proposition program performance, *Q2* is quality, *P2* is performance, and *R2* is reliability.

Determine the value group (*VG*) element inputs and calculate element value (*EV*) Eq. (5) and (6) for value group one and value group two (*VG1*, *VG2*) technical parameters and program performance, I define as:

$$VE1 = \frac{(T1 + T2 + T3)}{3} * 100 \quad (5)$$

$$VE2 = \frac{(C2 + S2 + R)}{3} * 100 \quad (6)$$

Where in Eq. (5) *VE1* is value element technical parameters, *T1* is capability, *T2* is compatibility, and *T3* is capacity and where in Eq. (6) *VE2* is value element program performance, *C2* is cost, *S2* is schedule, and *R* is risk.

Determine improved value (*IV*) value element inputs and calculate element value (*EV*) Eq. (7), (8) for value group one and value group two (*VG1*, *VG2*) technical parameters and program performance, I define as:

$$IV1 = \frac{(VP_{tp} + VE1)}{2} \quad (7)$$

$$IV2 = \frac{(VP_{pp} + VE2)}{2} \quad (8)$$

where in Eq. (7) *IV1* is improved value technical parameters, *VP_{tp}* is value proposition technical parameters, *VE1* is value element technical capabilities, and where in Eq. (8) *IV2* is improved value program performance, *VP_{pp}* is value proposition program performance, and *VE2* is improved value program performance.

The resultant calculations of improved value for element value *IV1* and *IV2* are in correlation with the resource allocation chart Fig.2. A visual representation of improved value is a useful illustration as to where best to apply program resources, add to or subtract from a value group, and to improve the delivery of more value for the customer.

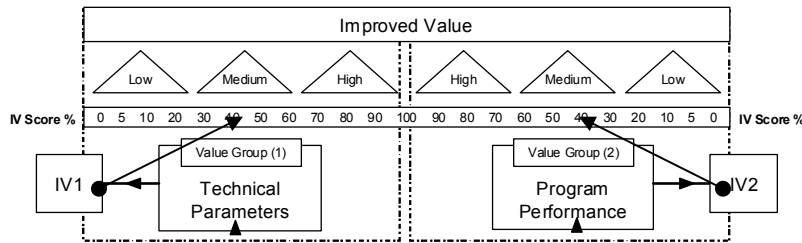


Figure 2. The improved value correlating to value groups (VG1 and VG2) and the improved value measure (IV Score %).

It is important for smaller satellite and space systems program management (civil, commercial and military) to recognize early in the program development stages where to optimize resource allocation and how the application of those resources affects the value improvement balance between technical parameters and program performance. Every program brings with it a different set of requirements and customer expectations. Therefore, the value improvement model presented here is one of many potentially useful decision-making tools that program management should consider as a way forward to establishing where to maximize the delivery of improved value based upon program requirements and customer expectations.

VI. Conclusion

This value improvement model does not represent all the permutations possible because there are too many to cover in this paper alone and will require additional work to mature the model. However, it does establish a starting point as to how to identify improved value and where best to apply the resources needed. Results of defining a value improvement methodology and model are given. This value improvement model is a starting point in preliminary trades and ongoing design phases as a value monitor that can aid in the refinement of the balance between program and technical requirements in order to achieve the desired results. The benefit of using this process as it applies to smaller satellite and space systems programs is that as is often the case, less resource allocation does not necessarily equate to improved cost or technical performance (value). The ability to quickly model and identify critical resource requirements as focus points and how they affect overall program value, will in turn affect how to maximize improved value and where the delivery of those resources are best for the customer in terms of program execution and mission success.

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References

- [1] Dubos, Saleh, and Braun, "Technology Readiness Level, Schedule Risk, and Slippage in Spacecraft Design" AIAA Space 2007 Journal of Spacecraft and Rockets Vol 45, No 4, July-August 2008 p 837
- [2] "Value Standards and Body of Knowledge", June 2007 SAVE International, 2007, p 11; also available online at http://www.value-eng.org/about_vmstandard.php (retrieved August 15, 2009)