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Value Modeling for Space Launch System Missions

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Figure 1: Artist's rendering of the SLS block 1b

Overview

Large scale projects, including the Space Launch System (SLS) are often defined in terms of mass, energy, and cost, rather than value or utility. The attributes describing a particular system are related to a specific value for each set of attributes (Figure 2). By comparing resultant values with specific attribute sets (Figure 3), the usefulness of a launch system for a variety of missions can be determined.

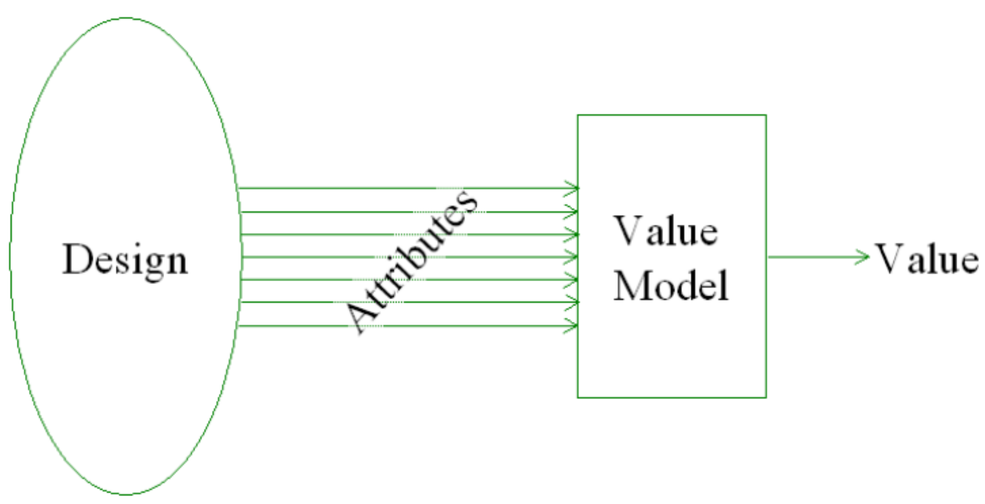

Figure 2: System of developing a value model

Name	Value	Units
Launch Payload	105.00	tonnes
Dev Cost	8.50	$B
Prod/Mfg Cost	1.00	$B
Learning Curve	0.90	none
Ops Cost	0.50	$B
Reliability	0.90	none
Dev Time	5.00	years
Time Between Launches	2.50	months

Figure 3: Attribute set for a lunar mining mission

Explanation

Using a method that is not confined to one dimension of units (such as cost or mass) provides a broader scope to the potential of that a vehicle has. Using Net Present Value (NPV) as the determiner of value allows relatability in a real world setting, as well as ease of comparing impacts of events at different dates.

$$\frac{\Delta NPV}{\Delta Payload} = \begin{cases} \dfrac{NPV_{hi} - NPV_0}{payload_{hi} - payload_0} \\ \dfrac{NPV_0 - NPV_{low}}{payload_0 - payload_{low}} \end{cases} \frac{\partial NPV}{\partial payload}$$

Figure 4: sensitivity analyses example for payload coefficient

Impact

A sensitivity analyses is a means of transforming the attribute sets into a linear equation for the model (Figure 4). Resultant equations are a simple and effective way to gauge what the return on a set of missions could be (Figure 5). By including stakeholders' desires to the equation which defines the value of a particular system[1], an alternative is given to design by requirements.

Key Findings

The SLS can be tailored to perform a variety of missions, though as a heavy lift launch vehicle it is more valuable to partake in missions requiring the delivery of large payloads across vast distances smaller launch systems are incapable of spanning in a timely fashion.

-0.01(Payload) - 1.61(Dev Cost) - 6.42(Mfg Cost) - 8.74(Learning Curve) - 0.49(Ref Unit) - 7.32(Ops Cost) + 396.09(Reliability) - 1.30(Dev Time) + 35.22(TBL)

Figure 5: Resultant value equation for lunar mining mission

References

1. .. Collopy, Paul, Dr. "Aerospace System Value Models: A Survey and Observations." (n.d.): 9

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