

# 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.

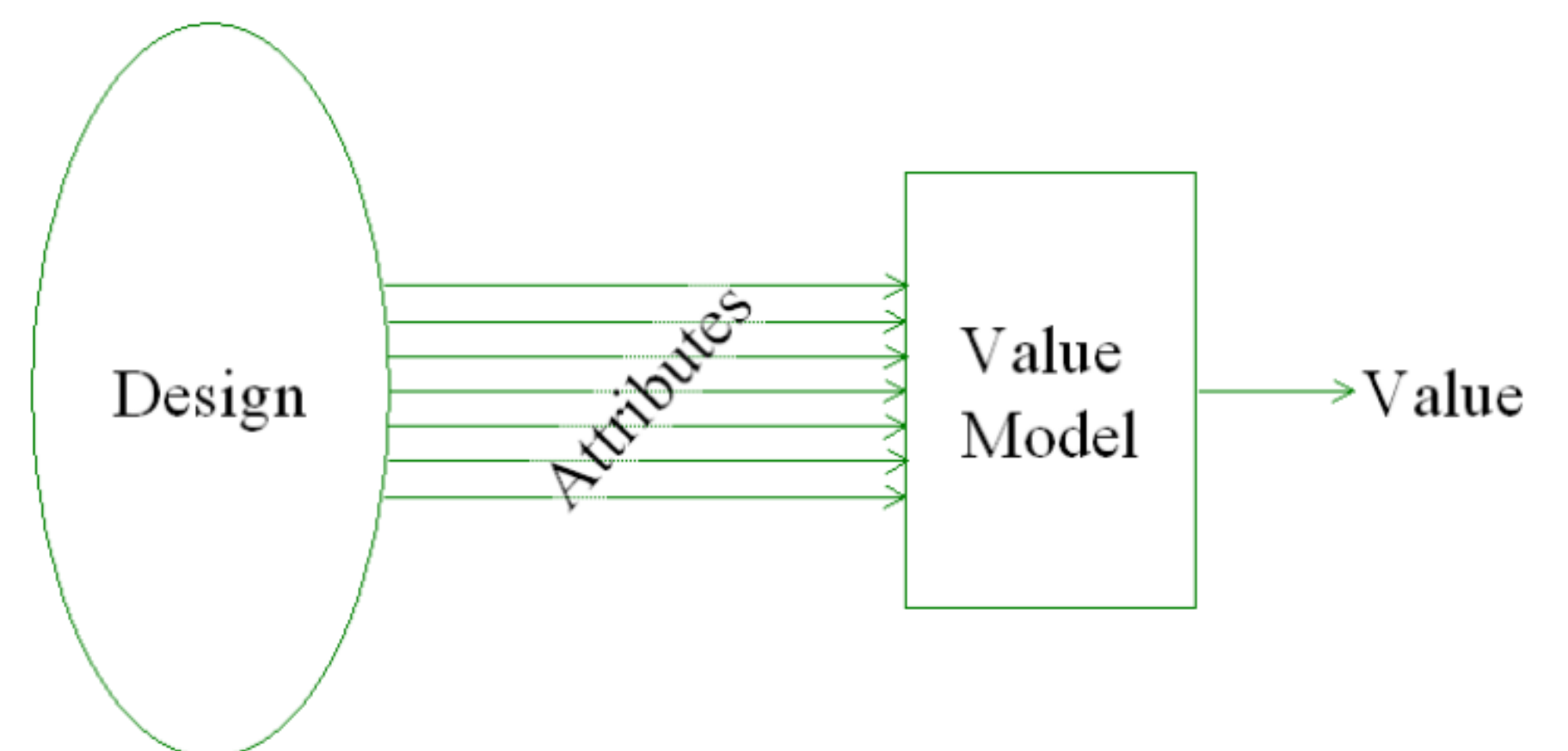


Figure 2: System of developing a value model

## 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.

$$\frac{\Delta NPV}{\Delta \text{Payload}} = \left\{ \begin{array}{l} \frac{NPV_{hi} - NPV_0}{\text{payload}_{hi} - \text{payload}_0} \\ \frac{NPV_0 - NPV_{low}}{\text{payload}_0 - \text{payload}_{low}} \end{array} \right\} \frac{\partial NPV}{\partial \text{payload}}$$

Figure 4: sensitivity analyses example for payload coefficient

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

## 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<sup>[1]</sup>, 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.

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

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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