Optimizing Systems Architecture and Whole of Life Costs through Design Profit®

NDIA Systems Engineering Conference
ERS Track

Engineered Resilient Systems

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Munro & Associates Inc.

DESIGNPROFIT® BUSINESS CASE BUILDER

MUNRO & ASSOCIATES, INC.

Ref: Abstract #16993

- Introduction
- Design Profit® / ERS Correlation
- Design Profit® Live Demonstration
- Design Profit® Future Enhancements
- Q&A

Since 1988, Munro has been a leader in delivering solutions to hundreds of customers around the world, helping them to achieve higher product quality with lower cost, resulting in better product value and higher company profits.

Munro understands the effects that design and other variables have on total life costs and has developed a unique suite of tools for managing cost and product complexity.

- **DFM / DFX, VE, VSM**
- **Lean Design® (reduce complexity)**
- **DP Cost of Quality™ (ensure robustness by design)**
- **Workshops**
    - **Bringing people together – rapid results**
- **Benchmarking and Teardown (technology infusion)**
- **The Wall Process® (stakeholder collaboration)**
- **Design for Manufacturing®**
- **Cost Estimating**
- **MRL Software, Training, and Assessments (risk & readiness)**

Design Profit® integrates these methodologies in a single integrated platform that provides a powerful collaborative AoA tradespace.

DESIGNPROFIT MUNRO & ASSOCIATES, INC.

Customers of Munro & Associates and *Design Profit®*

Aerospace
Aerojet
Astronix Corp
BAE Systems
Bell and Howard
BF Goodrich Aerospace
Boeing Commercial Aviation
Boeing Helicopter Systems
Boeing Satellite Systems
Cirrus
deHavilland
Drager Aerospace
Embraer
Indian Government
JAMCO
Lucas Aerospace
Martin Marietta
Martin-Baker Aircraft Co
McDonnell Douglas
MISATS
Monogram Systems
NASA - Langley Research Center
NASA - Johnson Space Center
NCAM
Piper
Primex
Rolls Royce Aero Eng
Schukra
Sikorsky
SPAR
Teague

Agriculture
DICKEY-john

Automotive
Air International
Ancra
Auto Latina
Automotive International
Bentley Motors Limited
Bosch
Brose
Chrysler
Davco
Delphi
Denso
Donnex/Donnelly
Ford
GM
Humphrey Products
Intier
ITT Automotive
Johnson Electric
Land Rover
Lectron Products
MG Rover
MTM Pty. Ltd. Australia
Navistar
PBR
Rover
Rover Group / BMW
Schefenacker
Sumitomo
Textron Systems
Thyssen Krupp - Budd
Toyota
TRW
Volkswagen

Boats
Mercury Marine
US Marine

Consumer Goods
Bose Corp
Brazeway
Fountain Head
Fuji Film
Hamilton Beach
Hunter Douglas
Mattel
Whirlpool

Defense
Alliant Techsystems
AlliedSignal
Boeing Integrated Defense Systems
Bofors
Brashear
Coleman Research
ComDev
Computing Devices
DARPA
Diehl
GEC Marconi
General Dynamics
Hamilton Sunstrand
Honeywell
Kaman
KDI
L3 Communications
Litton Guidence Control
Litton Laser
Lockheed Martin
Northrop Grumman
Picatinny Arsenal
Raytheon
Sandia Labs
Texas Instruments
Textron Defense Systems
Vickers
Westinghouse

Electronics
AB Dick
Compaq Computers
EMC
Hewlett Packard
IBM
Intel
Motorola
Nikon
Novellus
Pitney Bose
Siecor
Spartanics
Tektronics
Xerox

Furniture
Herman Miller

Homeland Security
AS&E

Industrial
ADIC
Advance Transformer
A.O. Smith
Ballard
Beacon Power Corp
Carrier Air Conditioners
Cymer
Dresser
Dupont
ElectroCom
Fluid Management
Graco
Ingersoll-Rand
International Fuel Cell
Muncie Power Products
National Cranes
Nordyne
NTC Products
Oldenberg
Otis Elevators
Samsung
Spectra Precision
Stihl
Syspal
ThermoKing
Trane
TSI
Von Duprin
Wagner Spray Tech
Wallace & Tiernan
Xomox

Medical
Abbott Labs
Alaris Medical Systems
Breg
Becton Dickinsen
Cardinal Health
CareFusion
Cobe Cardiovascular
Despatch
Dynacom
Ethicon Endosurgery
Guidant
Hill-Rom
Medtronic
Rela
Respironics
SciCam
SenDx
Stryker Medical
UMM - United Medical Manufacturing Co.

Off Highway
Case
Caterpillar
FMC
Grove Crane

Oil
Baker Oil Tools
General Electric
Ingersoll-Rand

Recreational Vehicle
Club Car
Harley Davidson
Polaris

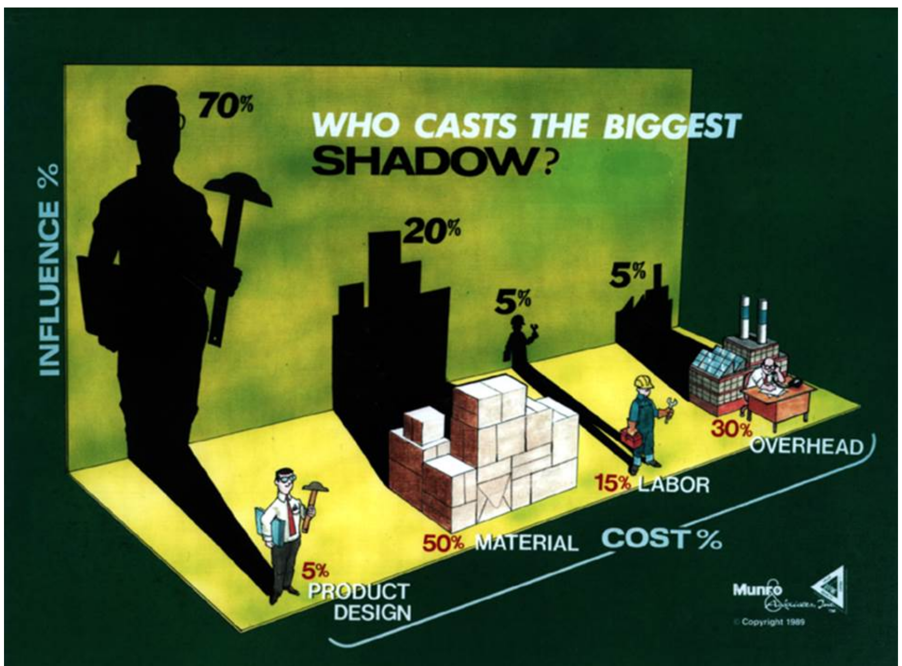
Robotics
RPT

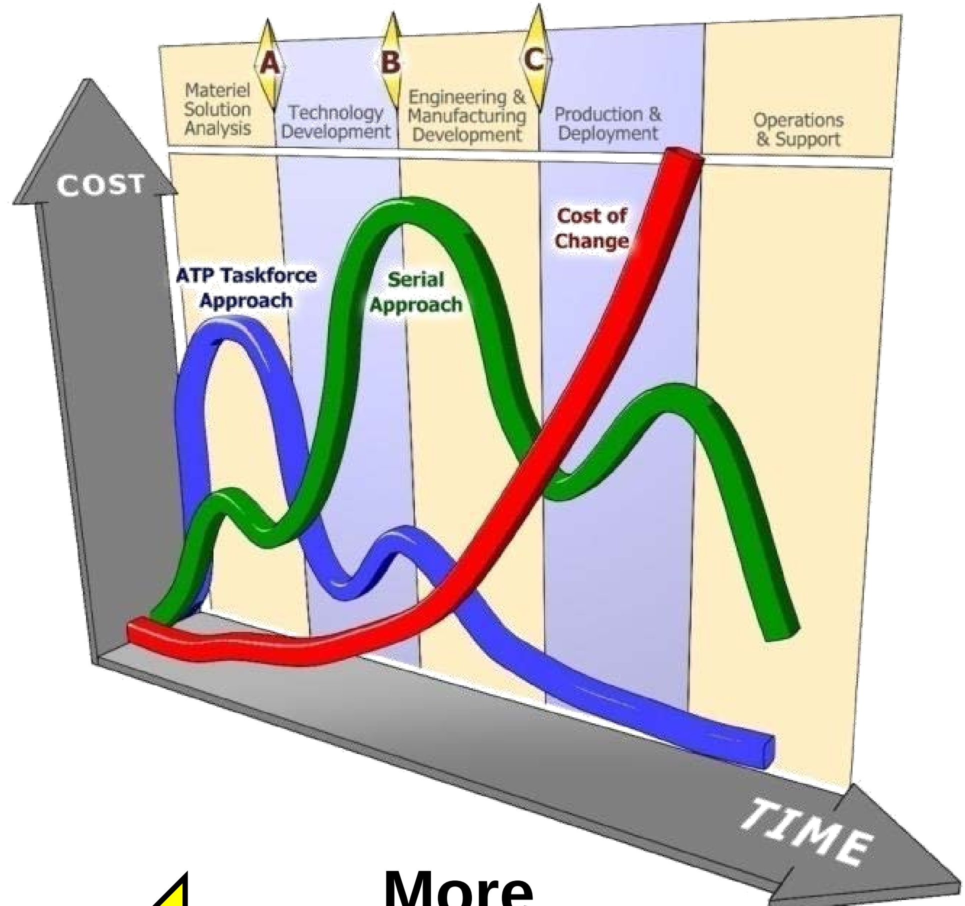
Ships
Atlantic Marine
Bath Iron Works
Electric Boat
NASSCO
Tenix

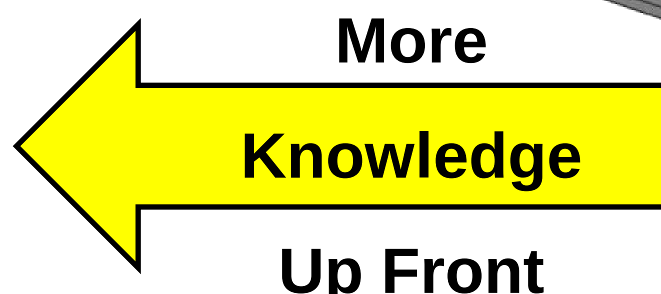
Transportation
Alexander Dennis
BlueBird
Cummins Engine
Daimler
Kentworth
Luminator
Onan
Ricon

5000.02 Approach

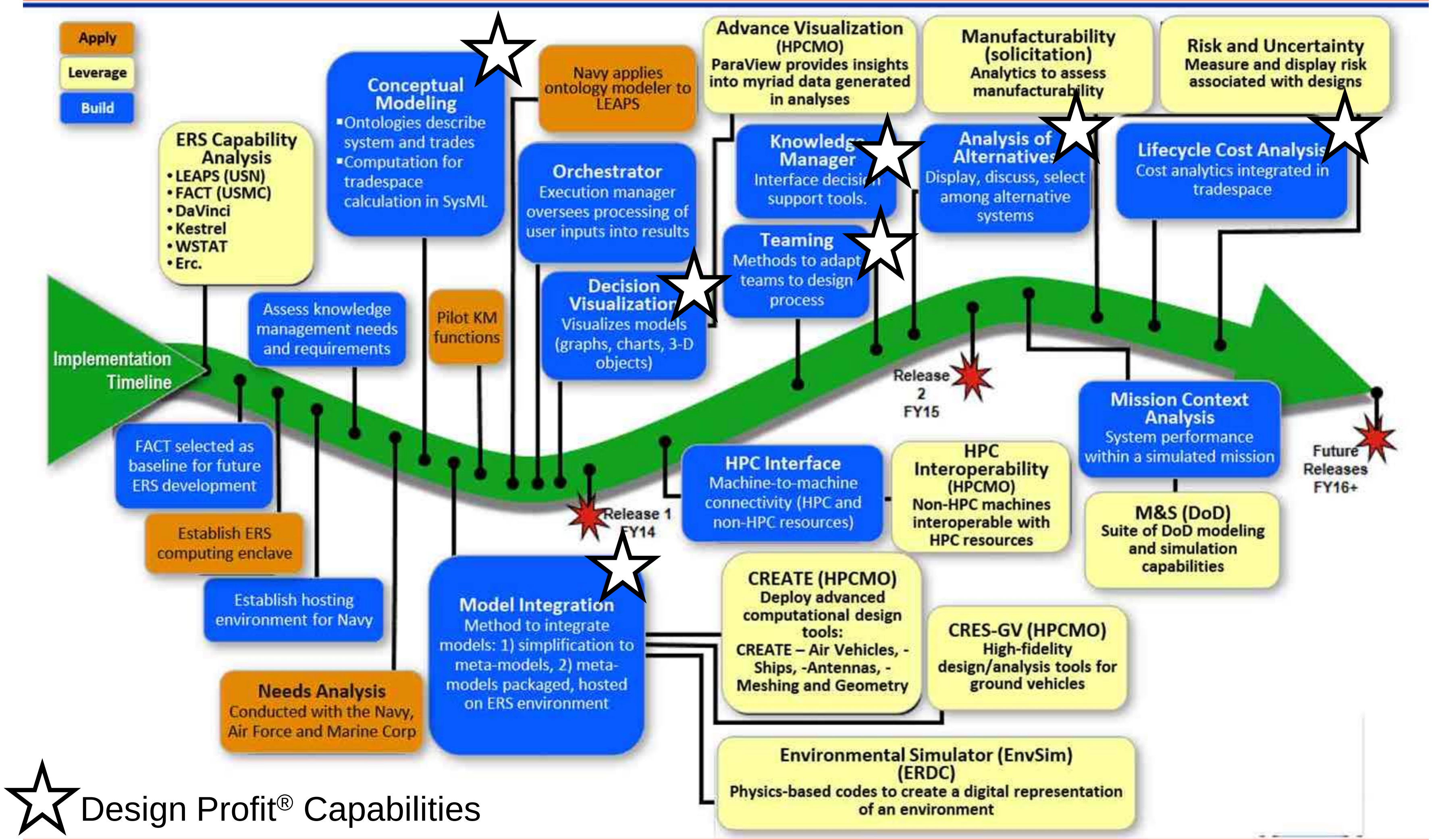
The majority of life cycle costs are fixed early in the concept stage.



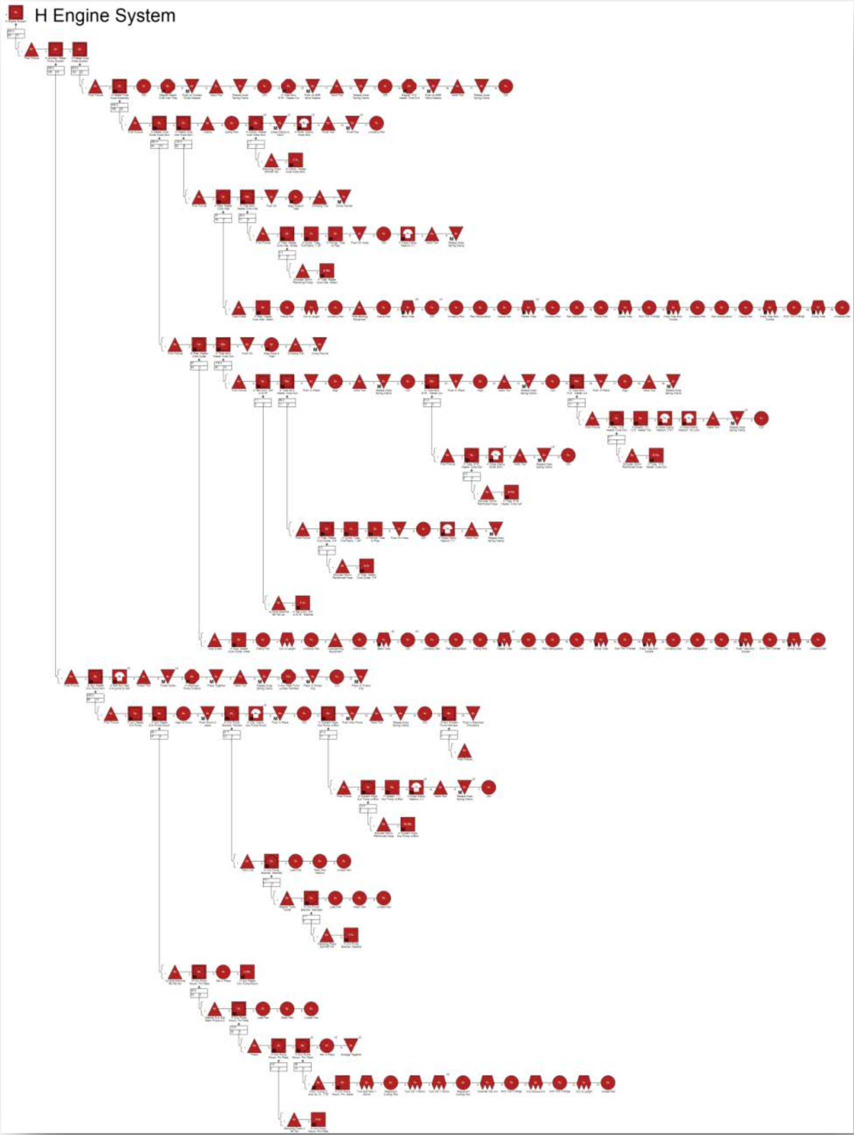




Architecture Roadmap



Source: ERS Overview, December 2013, Jeffery P. Holland, PhD, PE



Design Profit® provides a systematic approach to translate requirements into total life cycle costs through conceptual modeling.

This provides the platform for effective decision-making considering all relevant metrics.

The baseline model consolidates and allocates data at the symbol level.

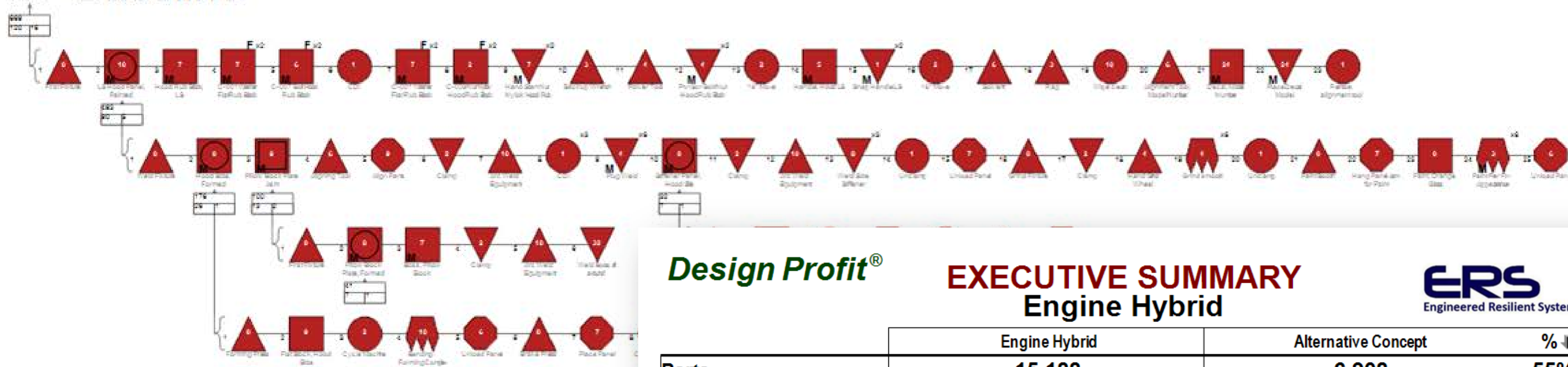
- Unit $
- Program $
- Quality $
- Labor $
- Machine $
- Overhead $
- Investment $

- MRL
- Maintainability
- Producibility
- Sustainability
- Supplier
- Lead Time
- etc.

Model Integration and Knowledge Manager

Design Profit® provides rapid generation and quantification of alternatives.

Baseline



Redesign

Design Profit®

EXECUTIVE SUMMARY
Engine Hybrid

ERS Engineered Resilient Systems

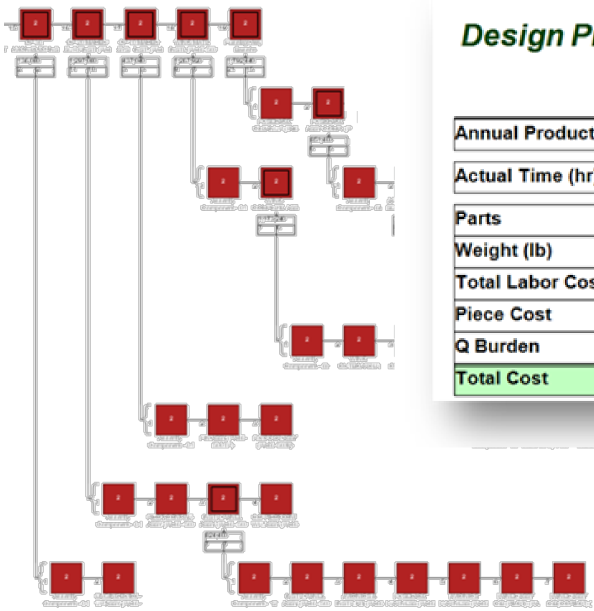
	Engine Hybrid	Alternative Concept	% ↓
Parts	15,188	6,908	55%
Good Parts	41	41	0%
Steps	59,224	25,660	57%
Actual Time (hr)	25.75	13.85	46%
Fasteners	1,162	647	44%
Ergo Dangers	0	0	0%
Poka Yoke Issues	14	14	0%
Total Weight	623.31 lb	428.56 lb	31%
Piece Cost	$3,199.36	$1,523.91	52%
Total Labor Cost	$1,083.00	$644.29	41%
Q Burden	$0.00	$0.00	0%
Total Cost	$4,282.36	$2,168.20	49%
Investment Cost	$23,295,640	$27,957,326	-20%
Simple Payback	N/A	1 month(s)	0%
Annual Savings	N/A	$951,373,733	0%

AoA and Decision Visualization

Optimal Data Fidelity: The right data at the right time to make the right decision.

"Perfection is the enemy of time."

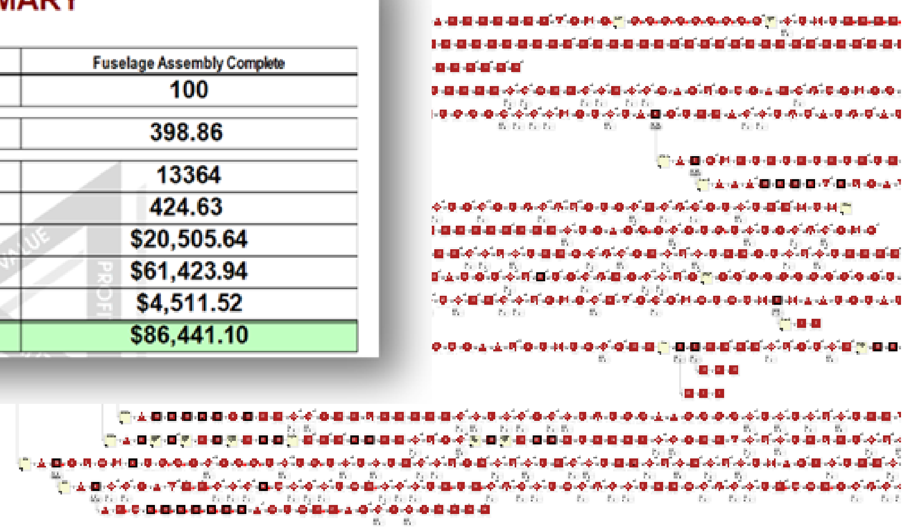
Concept



Design Profit® **EXECUTIVE SUMMARY**

	Fuselage Assy Baseline	Fuselage Assembly Complete
Annual Production	100	100
Actual Time (hr)	497.90	398.86
Parts	15	13364
Weight (lb)	0.00	424.63
Total Labor Cost	$25,597.04	$20,505.64
Piece Cost	$77,639.00	$61,423.94
Q Burden	$0.00	$4,511.52
Total Cost	$103,236.04	$86,441.10

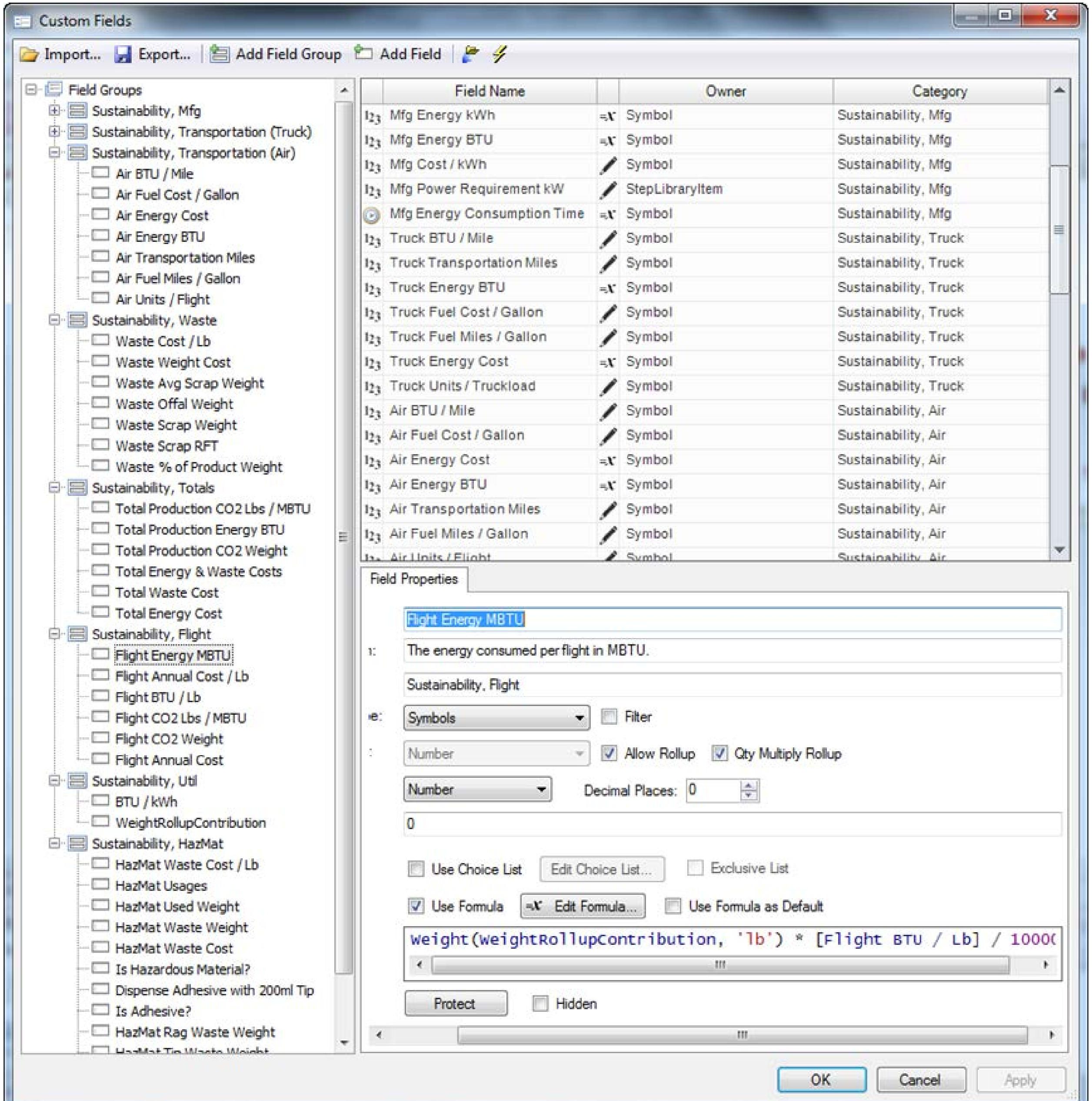
Full Granularity



TIME →

Low Fidelity Low Granularity Quick Turns	Increase granularity of unknowns to gain knowledge	High Fidelity High Granularity Detailed Refinements

Conceptual Modeling



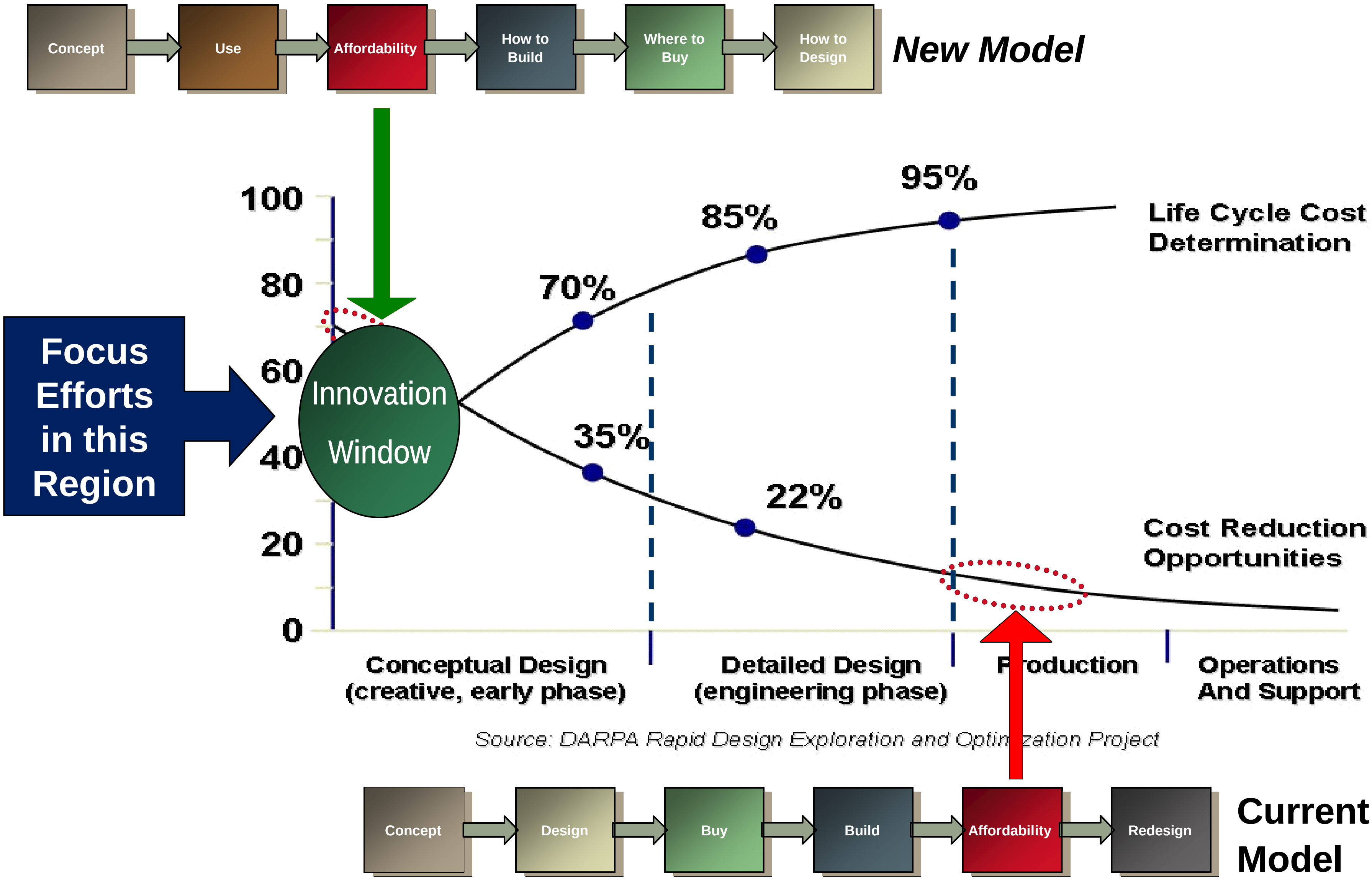
Integrated math modeling allows for nearly unlimited analytical capability.

The example shown allows the model to analyze and roll up sustainability costs.

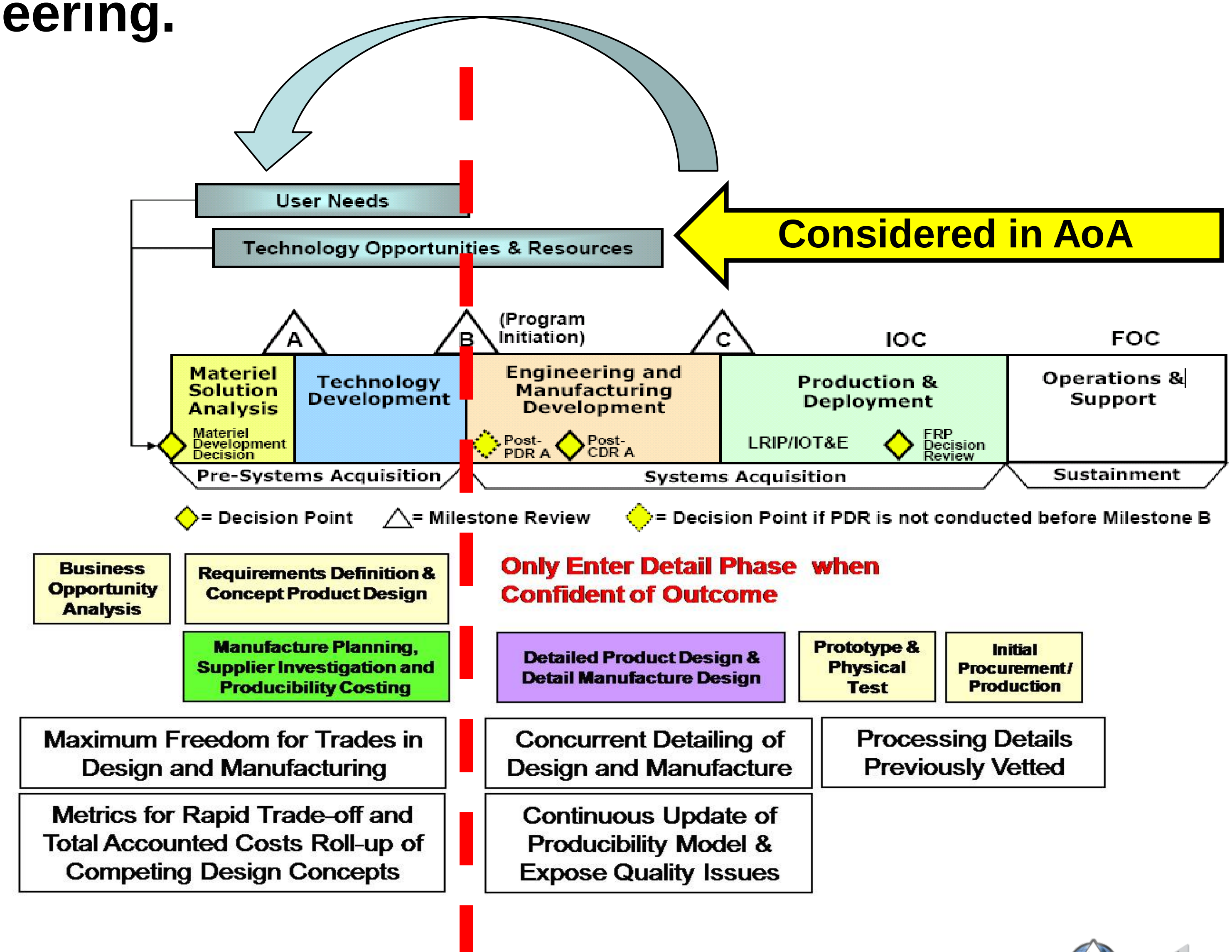
Life Cycle Cost Analysis

Shift Product Realization for Maximum Flexibility

Raytheon



Design Profit® provides data and history needed to perform total life cycle trade studies to minimize risk before engineering.



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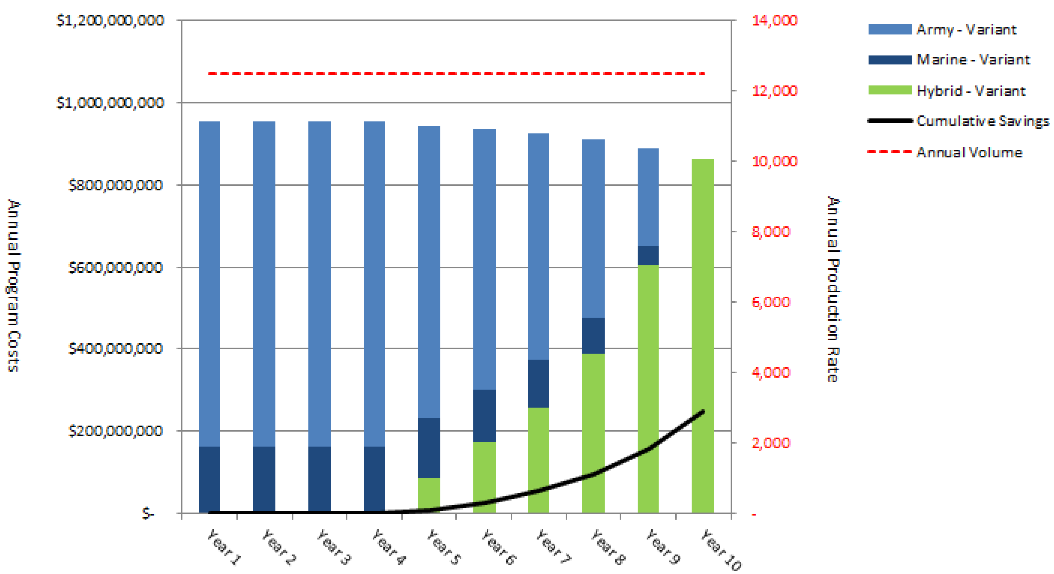
“I have been asking questions about this assembly for over a year and have never been satisfied with the answers. In just two hours, by mapping the build process all of my questions were answered without even having to ask any.”

- **Army Representative**

Live Demo

www.designprofit.com

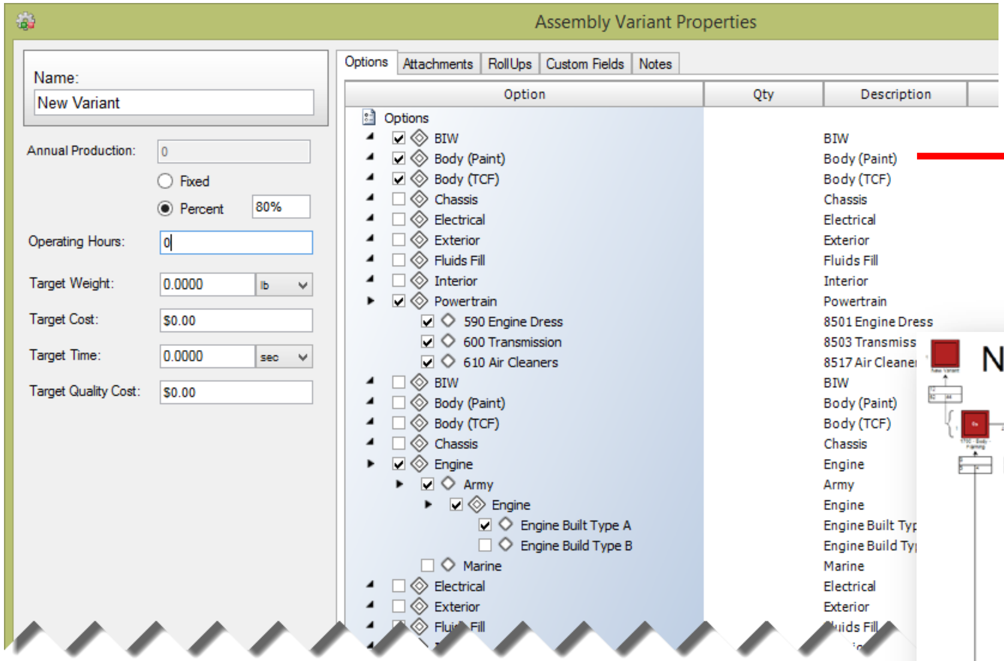
	Program	Army - Variant	Marine - Variant	Hybrid - Variant	Cumulative Savings	Annual Volume
Total Program Volume	125,000	100,000	25,000	125,000		
Cost Per Unit		$ 79,000	$ 65,000	$ 69,000		
Year 1	$ 952,500,000.00	$ 790,000,000	$ 162,500,000	$ -	$ -	12,500
Year 2	$ 952,500,000.00	$ 790,000,000	$ 162,500,000	$ -	$ -	12,500
Year 3	$ 952,500,000.00	$ 790,000,000	$ 162,500,000	$ -	$ -	12,500
Year 4	$ 952,500,000.00	$ 790,000,000	$ 162,500,000	$ -	$ -	12,500
Year 5	$ 943,500,000.00	$ 711,000,000	$ 146,250,000	$ 86,250,000	$ 9,000,000	12,500
Year 6	$ 934,500,000.00	$ 632,000,000	$ 130,000,000	$ 172,500,000	$ 27,000,000	12,500
Year 7	$ 925,500,000.00	$ 553,000,000	$ 113,750,000	$ 258,750,000	$ 54,000,000	12,500
Year 8	$ 912,000,000.00	$ 434,500,000	$ 89,375,000	$ 388,125,000	$ 94,500,000	12,500
Year 9	$ 889,500,000.00	$ 237,000,000	$ 48,750,000	$ 603,750,000	$ 157,500,000	12,500
Year 10	$ 862,500,000.00	$ -	$ -	$ 862,500,000	$ 247,500,000	12,500
Total Program Cost	$ 9,277,500,000.00	$ 5,727,500,000.00	$ 1,178,125,000.00	$ 2,371,875,000	$ 247,500,000	125,000



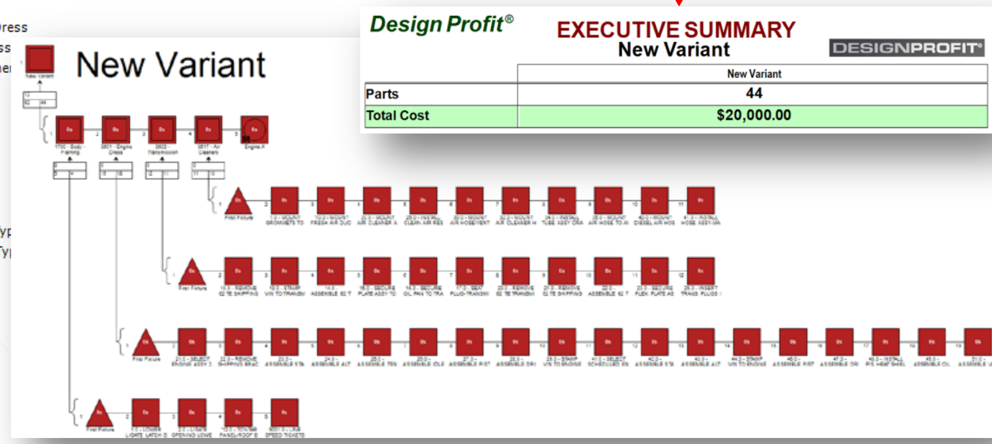
Using Design Profit®, model variations can be easily created to perform 'what if' scenarios.

Cost and weight targets can also be generated (Actual vs. Target).

Enhancements will need to be made for yearly volumes and visualization.



A life cycle cost model is generated based on your requirements.



Currently, the definition of a product requires a person to build the variant (Model X).

We propose to identify requirements and construct a model based on the requirements. The model will identify associated costs to the requirement. Putting costs against requirements can improve program definition.

Modeling is capturing knowledge, and this knowledge can be used to easily generate designs. Multiple options can be proposed based on factors such as cost, weight, and timing requirements.

Early intensive data mining is needed.

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Future Enhancements

LRU Packaging Optimization Analysis Tool

Electrical/Electronic LRUs and their connecting harnesses are a tremendous driver of design and manufacturing complexity and in service reliability and serviceability.

The proposed tool would reduce system complexity by optimizing LRU configuration and location to:

- Prioritize packaging of low-reliability LRUs to minimize service impacts.

- Prioritize configuration and location of LRUs to minimize harness circuits and length.


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Questions